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Cost and Schedule Overruns in Construction Projects

An internal study on how to manage the key factors causing project overruns

Master's Thesis in the Master's Programme Design and Construction Project Management

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ABSTRACT

For several years, proper cost and time estimations of construction projects have been a prevailing issue in construction industry. Despite the efforts made to prevent overruns within construction projects through the proposition of new estimating models and methods, project cost overruns and delays continue to occur with the same frequency. To manage project overruns, coupled with the fact that having the right cost and time estimation is crucial in order to achieve success in different kind of construction projects. This report aims to identify the internal key factors causing cost and schedule overruns and to investigate how these internal key factors affect and lead to overruns in a Swedish construction company. By addressing these factors, the study aims to find practical controlling mechanisms for managing and preventing project overruns from occurring.

A review of literature including eleven internal key factors considered to be the most common internal contributing factors have been identified. A qualitative research based on interviews with different managers at the company has been conducted. Besides, A quantitative research based on survey has also been adopted in order to collect more relevant data for obtaining a more realistic result. The empirical findings indicated that the most influential key factors was poor planning, lack of experience and ineffective communication. Therefore, in order to avoid the identified internal key factors causing project overruns, using the RCF method, having experience feedback sessions, bridging production with tender and improvements of site management should be embraced.

Key words: construction industry, construction projects, cost overruns, time delays, Reference Class Forecasting

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PREFACE

We would like to start by thanking our academic supervisor at Chalmers University of Technology, Viktoria Sundquist, for guiding and supporting us throughout the entire process of our master thesis. Viktoria supported us with great constructive and objective feedback.

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Maria Daoud Rajha

Honnia Hama

1 Introduction

The chapter aims to introduce the study. To begin with, a problem background to the focus of the study, cost and schedule overruns in construction projects is given. Thereafter, the aim and research questions are declared.

1.1 Background

Construction projects are described by Vrijhoef&Koskela (2005, p. 14) as ”*coalitions of firms; a number of independent firms coming together for the purpose of undertaking a single construction project and that coalition of firms having to work as if it were a single firm*”. The construction industry is also dominated and characterized by a project-based production and organizations consisting of several independent and temporary project teams (Vrijhoef& Koskela, 2005). Other characteristics of the construction industry are interdisciplinary, process discontinuities and unique projects (Gustavsson et al., 2012). These characteristics described, makes the construction projects highly dependent on efficient communication and effective project management. Despite this, the construction industry is still having lower efficiency and relatively high structural complexity compared with other industries (Vrijhoef& Koskela, 2005).

Since the industry constantly growing in complexity, the success of projects are not always straightforward (Bresnen et al., 2004). The concept of success could always differ among the organizations in terms of what they regard as important to project success. The determinants of project success are not always clear-cut (Vrijhoef& Koskela, 2005). On the other hand, finishing construction projects within the calculated cost and according to the schedule is a key aspect in the evaluation of project success (Adam et al., 2015). Accordingly, determining the accuracy of cost and time for projects is a challenging issue in the construction industry (Akinci& Fischer, 1998). Construction delay refer to the delay that occurs when a project goes beyond the contract date or the date agreed by the parties for delivering the project (O'Brien, 1976). Delays usually lead to a costly situation and could therefore affect the project performance to achieve its objectives. What causes delays in construction projects are often unpredictable but can, for example, depend on poor site management and risk management, unforeseen site conditions, slow decision makings and design changes (Adam et al., 2015). Thus, there are various factors that could lead to delays and cost overruns in construction projects (Majid& McCaffer, 1998).

Delays in construction projects are one of the most recurring problems in the industry affecting project stakeholders, owners, involved actors and users (Faridi& El-Sayegh, 2006). The key objectives, such as time, cost, safety and quality, are jeopardized by delays and result in extension on project time which in turn leads to extra cost on the budget. It is therefore important to identify the key factors causing delays and cost overruns in construction projects in order to avoid them, or at least mitigate them. Cost overruns often occur in large and complex projects and Flyvbjerg et al. (2003) report that it is not unusual that large projects in areas such as road, rail and other areas of construction tend to exceed their estimated budget with more

than 50-100 %. Flyvbjerg et al. (2003) further report that more than 90% of construction projects has exceeded their planned time and budget. The authors also found that the overruns have been constant for the past 70 years which means there is no improvement in planning or in managing the problems for budget and time overruns (Flyvbjerg et al., 2003).

The iconic Opera House in Sydney, Australia, is a common example of construction project failure. The project construction started in 1963 and was scheduled to be finished in 4 years with a budget of AUS $7 million but became ten years delayed with a cost about 1357% over the original budget (Garcia& Martin, 2012). Thus, the Opera House Sydney project is one of the worst projects that ended up as a disaster for both the architecture and the client. The key factors that caused this extensive delay of the Opera House was the disputes between different actors of the project, poor planning and management, change orders in late stages and the forced redesigning. In Australia, Chan&Kumaraswamy (1997) also found that only one-eighth of building contracts were completed within the scheduled completion dates and that the average time overrun exceeded 40% (Chan& Kumaraswamy, 1997).

Majid and McCaffer (1998) furthermore, classify the causes of delays using three different classifications: i) the one caused by the client (compensable delays), ii) the one caused by the contractors (non-excusable delays), and iii) the ones caused by unforeseen actions (excusable delays). The contractor is expected to have control over the non-excusable delays since these delays are mainly caused by contractors and subcontractors actions. Therefore, understanding the underlying factors that contribute to causes of non-excusable delays would be a good base in order to identify the problems faced by contractors during the construction process.

The study in this thesis is conducted in collaboration with a Swedish construction and turnkey contract company which is one of Sweden's largest construction organization. The company has been one of the fastest-growing companies domestically over the last decade by developing modern, creative and complex projects all around Sweden. Three different departments are implemented in the company: building, construction and project development. The study investigates the internal key factors in the company included in non-excusable delays, in depth to see how the contractor including estimators, project management team and site managers should avoid overruns by using the controlling mechanisms suggested later in the thesis.

1.2 Aim of the study

The aim of the study is to investigate internal key factors at the company that cause cost and schedule overruns in construction projects. By addressing these factors, the study contributes to approaches for managing and preventing overruns from occurring. The study thus provides methods and recommendations for avoiding problems in project controlling by identifying and analyzing the so-called non-excusable delays caused by the contractor itself.

1.3 Research questions

In order to fulfill the aim of the study, two research questions are identified:

> Research question 1: What are the internal key factors causing cost and schedule overruns?
> Research question 2: Which project controlling mechanisms can be utilized to manage the internal key factors causing overruns?

2 Theoretical Framework

This chapter provides the theoretical framework. The aim of this chapter is to present theories, definitions and models within the area of research study. The main purpose of this chapter is to identify the internal key factors that cause construction delays and cost overruns, as comprehensively as possible through an intensive and broad review of past research carried out by various researchers in different construction environments.

2.1 Estimation of cost and time in the various phases of a project

There are several stages of a construction project, see figure 1, and in the early stages of the design phase, an estimation of time and cost is needed in order to complete the project preparation (Singh, 2009). The tender documents, furthermore, are prepared based on the estimation documents and other preliminary information provided by client. Contractors provide their estimation documents including time and price for each activity and equipment. After the appraisal process, the best and lowest price contract is awarded (Katre& Ghaitidak, 2016). The contract document is the binding agreement between a contractor or several contractors and the client. It, further, stipulates the project timeline for completing the scope of work within the estimated cost.

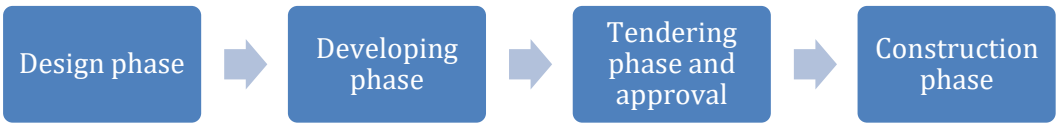

Figure 1. The difference project phases of a construction projecta construction project

2.2 Time delays

Delays could be described as incidents that affect the project progress and delay project activities (Katre& Ghaitidak, 2016). Factors causing schedule overruns in construction projects often occur through internal and external causes such as delays or inaccuracy in design, unavailability of material and resources. Furthermore, completing a project within time could be seen as an indicator of efficiency, even though the construction industry is subject to unpredictability (Aibinu& Jagboro, 2002). Delay and cost overruns could occur in both the design phase and the construction phase according to (Singh, 2009). However, Assaf&Al-Hejji (2006) report that project delays and cost overruns occur mostly during the construction phase due to most of the project budget is consumed under this phase and many unforeseen factors are always involved, such as resource consumption, involvement of several different actors and contractual relations. On the other hand, Aibinu&Jagboro (2002) define construction delays as a circumstance project owner as well as contractor separately or together contribute in delays of the construction project within the original or agreed contract period. Furthermore, Stumpf (2000) presents delay as the extension of time required to complete all the activities that are

stated on the contract. In fact, delays are caused by the lack of performance or a postponement of time from the stipulated estimated finishing time that can be caused by contractor, consultant or client as well as by some other unforeseen actions.

2.2.1 Type of delays

Delays in construction projects could happens by contractors or clients either under their control or out of control (Kaming et al., 1997). However, there are several discussions in the literatures about delays' classifications. In this respect, Ibbs Jr (1984) and Kraiem&Diekmann (1987) classifies delays into three main categories. Excusable delays, non-excusable delays and concurrent delays, and furthermore excusable delays in compensable and non-compensable delays, see figure 2.

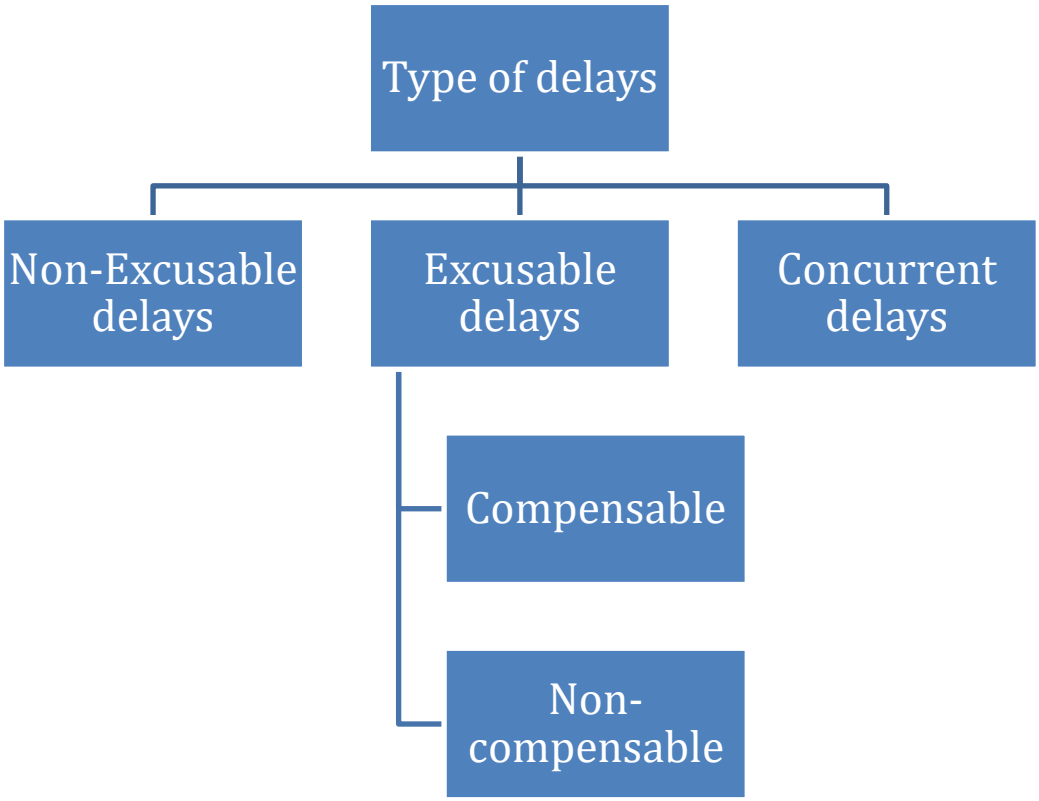

Figure 2. Type of delays

2.2.1.1 Non-excusable delays

This type of delays is caused by contractors, suppliers or sub-contractor's actions that the client cannot excuse (Kraiem& Diekmann, 1987). In these situations, the contractor has no right to get neither liquidated damage for delays nor time extensions from the client even though if the delays affect the whole project negatively. Liquidated damages are an amount of money agreed by both parties stated in the contract to compensate the aggrieved party for inexcusable stop of the project. The aim of having liquidated damages in the contract is to evaluate the damages that would be incurred by the party if the contract has been interrupted by an unexcused delay (Kaming et al., 1997).

Furthermore, the contractor has the sole responsible to pay for these delays which mean that the owner could be able to retrieve delay damages from the contractor (Kaming et al., 1997). The amount of the recovery is determined in the contract between the client and the contractor.

However, in some cases, the client could be entitled to liquidate damages. This happens when the contractor has no ability to provide enough labors to complete the work on planned time. Non-excusable delays could accept the risk of delayed performances.

2.2.1.2 Excusable delays

This type of delays are mainly caused by unforeseen events or actions that could appear during the construction phase and are furthermore, not related to the actions done by the contractors (Kaming et al., 1997). Therefore, these actions are out of the contractor's control and are not caused by any fault of them. However, it could sometimes lead to further delays if the contractors do not deal with it in an appropriate way. Such actions could, for example, be bad weather conditions, changes orders by the client, errors in specifications, different site conditions than planned, or even, concealed soil conditions and intervention of outside agencies (Sweet, 1977). This type of delays is divided into Compensable and Non-compensable delays.

- **Compensable delays**
  Compensable delay could be described as a delay the client has control over (Kaming et al., 1997). In this type of delay, the contractor can be provided with additional time and money if the client causes the delays. This could for instance be, change in specifications in the work, late supply of client's materials or information, differing site conditions. If the specifications in the contract does not include a provision acquitting to the client from liability for delays, the contractor have the right to time extension and compensatory damages.
- **Non-compensable delays**
  Non-compensable delays are caused by unexpected actions out of the contractor's or the client's control. As a result of this, both contractor and clients must carry out the consequences of the action and both are liable to pay the extra cost (Kaming et al., 1997). These delays, among others, could be caused by weather conditions, fires, actions done by the governments. In such cases, the contractor has the right to time extension but not to get paid for any financial compensation by the client.

2.2.1.3 Concurrent delays

Concurrent delays are when two types of delays has been presented above or more synchronize and happen at the same period of time (Kraiem& Diekmann, 1987). In the construction industry, concurrent delay occurs when non-excusable and excusable delays occur during an overlapping period or at the same time. Concurrent delays can be classified by combining the different types above as:

- Excusable delay and non-excusable delay.
- Excusable delay and compensable delay.
- Excusable delay, non-excusable delay, and compensable delay.
- Non-excusable delay and compensable delay.

2.3 Cost overruns

Cost overruns occurs when the final cost is higher than what was planned in the initial phases of a project and what was stated in the contract (Bordat et al., 2004). Cost overruns have the same magnitude in recent periods as in earlier periods which means that this problem has no clear solution yet Lundman (2011).

Cost overruns in construction project contracts include change in claims of many actors as well as change orders. Claims mean when changes occur from the requirements (agreements) stipulated in contracts between the client and the contractor (Jahren & Ashe, 1990). The authors identified *"the cost overrun rate"* which is a percentage that refers to the difference between actual and planned cost. Change orders refer to that the implementation of the project did not take place as agreed in the contract. Additionally, removals or even modification in contracts may occur. There are many forms of consequences of change orders such as cost increasing which can be expressed as the cost plus a fee, lump sum or a unit price. This price needs to be documented and approved by project parties (Jahren & Ashe, 1990).

Avotos (1983) states that there are different logics of how to measure the volume of the cost increase within the same project. One logic is based on the comparison between final costs and preliminary estimates, whereas another logic depends on the comparison between final costs and estimates from the tendering phase. The later the estimate, the less possibility of cost increase in order to minimize uncertainty. However, the amount of the cost increase depends sometimes on cost underestimation in initial phases because the estimates can be based on different assumption. The opposite situation overestimated cost, will show up when the project has succeeded from the cost perspective, although the truth is that the reported cost was higher than the actual cost. Therefore, having good information and more details could lead to minimizing cost overruns in later phases of projects. Usually, the vast majority of project delays occur during the construction phase, where many unforeseen factors are always involved.

2.4 The relation between cost overruns and time delays

According to Abdullah et al. (2009) cost overruns is the next most frequent effect of construction delays after time overruns. Kaming et al. (1997) further explain that all kind of delays cost automatically which in turn lead to various consequences and losses for all project participants such as contractor, client, suppliers and consultants. Delays do not lead only to cost overruns, but it also causes disputes and claims between different actors of project (Yogeswaran et al., 1998). If the time of the project completion is stretched due to many reasons that the employer or contractor is responsible for, the contractor will pay the additional cost which is called liquidated damages which can be for example overhead and profit. Additionally, this lead to minimize the profit due to that interest will keep accumulating and end up with what Flyvbjerg calls "*Interest trap"* (Flyvbjerg et al., 2003). Interest trap is where the increasing of payments of interest, profit and escalating construction cost lead to cost overruns. On top of that, additional cost will be added for the reason of rework if any construction mistakes occur. As stated by (Sun& Meng, 2009) the additional cost of rework can reach 10-15% from the estimated cost which means that rework delays are the most frequent cause of cost overrun.

2.5 Common factors causing cost overruns and time delays in construction projects

This section provides a background about eleven identified factors causing overruns in construction projects. These eleven factors, shown in table 1, are considered to be among the most common factors causing project overruns. Each factor will later be studied throughout a survey and interviews.

The eleven identified factors
Poor planning
Lack of experience
Ineffective communication
Project complexity
Poor site management
Miscalculation
Poor material planning
Optimism planning
Low moral
Poor financial planning
Poor monitoring and control

Table 1. The eleven identified factors

2.5.1 Poor planning

The process of planning for construction projects involves determining, analyzing, devising and organizing resources necessary for the project (Griffith& Watson, 2004). In the construction industry, planning is the total process of determining a method, order, manpower and equipment required to undertake a building project (Mohamed& Anumba, 2006). Harris&McCaffer (2013) argues that there are two different levels of planning in the construction industry. The first level is strategic planning which manages the scope, procurement, timescales and the financial. The strategic planning for a project is considered to be crucial for the outcome and with the rising numbers of large projects the deployment necessitates even more strategic planning in depth. The second level explained by Harris&McCaffer (2013) is operational planning and comprehends a more detailed look over the project's resource requirements. This part comprises an establishment of method statements for each activity, such as, a tender or feasibility plan. Both strategic and operational planning is essential for the construction industry and are usually made by the employees with help from tools and techniques.

A study done by Lundman (2011), include a case study of the Bothnia Railway Line and eight other large projects, the study illustrates that project overruns occurred during the planning and design stages. Only minor overruns occurred during the procurement and the construction stages. Another presented result by Lundman (2011) was that 85% of the overruns was from indirect costs such as detailed design, administration and preparatory work. Also, Al-Momani (2000) conducts a quantitative analysis in order to investigate the main causes of construction overruns. He results in that the major causes of delay in construction of public projects were directly related to designers in term of slow decision making and improper planning. He further adds that the clients, for these projects, blame contractor's improper planning. Al-Momani (2000) argues that the contractors poor planning can be attributed to lack of experience.

2.5.2 Lack of experience

According to Lind&Brunes (2015) one explanation for incorrect estimations is lack of experience and competence. Lack of experience could, according to Majid and McCaffer (1998), lead to ineffective communication, poor planning, lack in project controlling and improper construction solutions, and furthermore to project overruns. Lack of experience and competence could also be another explanation for inaccuracy in geotechnical investigations (Lind& Brunes, 2015). Geotechnical conditions might, for example, be founded more complex than expected and require more experienced engineers. Therefore, having the right competence in the right place in order to ensure that all tasks done professionally is vital according Lind&Brunes (2015).

2.5.3 Ineffective communication

The construction industry is reliant on effective communication between participants, teams and organizations (Dainty et al., 2007). The construction industry is project-based and the team members work together for a short period of time and this temporal associations, in which technical language are exchanged, complicates an already struggling communicating environment. For several years, ineffective communication has been known as a delimiting factor. Baguley (1994) explains five different types of factors causing difficulties in communication: lack of clear objectives, faulty transmission, perception and attitude problems, environment problems and the phenomenon "*Chinese Whispers*". Dainty et al. (2007) states all these barriers to be more prevalent in the construction industry than others. For example, lack of clear objectives will differ between stakeholders and information could easily be misunderstood and perceived (Dainty et al., 2007). Transmission barriers also exists in the construction industry whereas incompatible information technologies could lead to misunderstandings of each other. Team members from different professionals and background interpret situations differently and difficulties in perceptional and attitudinal could occur. Working on site and in construction environments could affect communication with noisy surroundings and physical distance. The phenomenon of "*Chinese Whispers*" is truly relevant in the construction industry. The phenomenon describes a message being gradually perverted and distorted along the message chain. In the construction industry message chains are longer than usual and the longer the message chain becomes, the more distorted it becomes (Baguley, 1994).

According to Emmitt&Gorse (2006), a substantial factor for successfully completing construction projects is effective communication. The one aspect of project management, that pervades all others, is communication. With ineffective communication between the team members, the project team cannot succeed in realizing their objectives. Good communication skills are additionally one of the key management competences of leadership and decision-making. Regardless of the project size and complexity, construction projects are undertaken, and nothing is particularly stable for long, and uncertainties and interdependence are constant factors.

2.5.4 Project complexity

Cost overruns has been more observed in large projects in both private and public sectors (Lind & Brunes, 2015). According to Jahren&Ashe (1990) there is a proportional relationship between project size and cost overruns and the larger the construction project is, the greater cost overruns. The large construction projects are called mega projects and are defined in terms of the projects complex nature, hugeness and impact on the society (Altshuler& Luberoff, 2004).

Project complexity is driven by four features: infrastructure size, project uncertainty, infrastructure newness and infrastructure interconnectivity (Lebcir& Choudrie, 2011). The four features could have significant influence on the project time plan. Project uncertainty is the most influential feature for time overruns. Project uncertainty is, furthermore, described as the gap between the knowledge needed to plan for a project and the available knowledge of the project team to start planning. A lot of information and data are not available at the beginning of the projects, which could contribute to high level of errors and rework during the construction stage. Interconnectivity of infrastructure is the linkage between different elements in a project. If the level of interconnectivity is high in a project, then task after task is affected when there are changes. This means that a low level of coordination and information exchange among project members could lead to time overruns and delays. Furthermore, infrastructure size refers to the size of the project delivered at the end. Infrastructure size is related to the number of components, tasks, activities and actors included in the project. The more elements included in a project, the more need of coordination. Infrastructure newness represents the level of constructing similar past infrastructure. A high level of infrastructure newness refers to higher level of work requirement. This could then increase the complexity. Lebcir&Choudrie (2011) further explain that projects involving high innovations can take longer time to complete compared to projects involving low innovations. Therefore, in innovative projects the decision-makings should be based on a trade-off between the effects on the time plan, the benefits, financial rewards and returned advantages. A recommendation from Lebcir and Choudrie (2011) is that the project managers should choose a low infrastructure interconnectivity structure as this reduces the time overruns.

2.5.5 Poor site management

There are several site management challenges that occur on construction sites (Mohamed& Anumba, 2006), and these challenges and difficulties affect project time and budget (Trauner, 1993). A study made by Mohamed&Anumba (2006) presents the site challenges within three different categories; management and administration challenges, technical and engineering challenges and on site communication challenges. The study show that common problems that occurred under the category “management and administration challenges” were poor information, inaccurate and inadequate planning, training and educational problems, motivational issues and lack of skilled and experienced workers. The main reason for the problems on site are characterized by high work overload and pressure (Griffith& Watson, 2004). With the rapid pace of developments in technology in the construction industry, the site managers must enhance their knowledge of new techniques, new materials and innovative ways of managing construction site in an effective way. This would enable them to keep in touch with other professionals engaged in the construction process and overcome unexpected problems that appear during construction phase.

(Dube et al., 2015) suggested three points that lead to effective site management:

- Having the right people is very important for contractors to handle building projects.
- Effective communication: formal lines of communication have to be clearly established from the beginning of a project and among all parties involved in the project in order to avoid misleading and losing of information.
- Progressing system: this is the act of controlling, measuring and recording of progress in comparison with planned requirements in order to meet up the planned.

General administration and paperwork activities should not be the only responsibility of site managers (Griffith& Watson, 2004). The authors describe, in a case study, that site managers have insufficient time to undertake what is sometimes time-consuming tasks as administration work. The case study conducted with experienced site managers, with full entire site control, found that time spent in the office performing non-productive and value tasks would not add any value to the project. There are several special characteristics site managers must have to succeed in their role and daily managing of the construction sites. Among these are, sound knowledge of construction and the competencies to overcome daily obstacles. However, in order to become a proficient manager, there is a requirement to have some key managerial skills such as planning, organising, controlling, forecasting, co-ordinating and good communication skills. Through these skills, there are many key activities that the site managers should take into consideration. The key activities are shown in the figure 3 below:

Activity	Site managers• comments
Managing people	Treat all site personnel as you would like to be treated, with respect and courtesy
Managerial approach to rules	Managers must enforce the rules fairly and without any favour; they must be consistent
Innovation	Create an environment where ideas for improvement are accepted and the penalties for failure do not outweigh the rewards of success
Lead by example	The site manager must have the ability to work well with other people as part of a productive team
Plan all work activities	Plan all work activities with sufficient time to obtain the best solutions. All activities must be co-ordinated, with safe working practices being employed at all times
Communication	Make sure all site staff know what is required of them and that they have all the required information and resources to complete set tasks
Information Technology	Become familiar with the latest computer technology and make the best use of IT
Training	It is essential that a manager's performance and role are reviewed by their organisation: the effectiveness and efficiency of the manager can be improved by ensuring adequate training is provided to address any shortfalls
Delegation	Site managers should not be overwhelmed with tasks which, as a consequence, would lead to some vital aspects of their role suffering. They should be prepared to delegate but this must be linked to the training issue

Figure 3. The key activities recommended by experienced site managers (Griffith& Watson, 2004).

2.5.6 Miscalculation

Siemiatycki (2009) states that the technical difficulties with predicting future events is considered as one of the common factors causing overruns. The author adds that inadequate forecasting techniques and procedural errors could cause incomplete and inaccurate calculations. Siemiatycki (2009) also refers in his article about the prevalence of incomplete studies at the time that projects were approved, this resulted in future cost escalations when more detailed design and cost are given. Majid and McCaffer (1998) illustrates that improper planning such as inappropriate procedures and lack of experience could lead to many miscalculations which in turn cause overruns and delays in projects. Inadequate studies prior to project approval were identified for different sizes of projects small, large and complex projects costing hundreds of millions of dollars. Furthermore, Flyvbjerg et al. (2003) explain that

inadequate studies prior to project can be caused by strong need of methods and incentives for the planners that would produce more reliable and accurate information.

Lind & Brunes (2015) presents two parts of a framework, the descriptive part and the explanatory part. The explanatory part is based on Flyvbjerg's studies and focuses on why calculation can be incorrect. The explanation of incorrect calculation could be either forced to be incorrect or unpurposely incorrect due to incompetence (Lind & Brunes, 2015). While Lind & Brunes (2015) situate political, economic, and psychological arguments for escalating costs as unconscious mistakes and technical errors, there is a small group of scholars such as "Machiavellian Megaprojects" and "The Lying Game" who have been far more explicit in identifying miscalculations. They argue in these articles that the procedural errors and miscalculations occurs due to high and significant deception.

2.5.7 Poor material planning

The process of delivery and material handling in construction project, according to Fellows et al. (2009), is to order and manage the appropriate material to the project at the right time, quantity and price. The four types of information necessary for managing material and delivery is specifications, instruction, contract drawings and bill of quantities. There are usually a site manager or sub-ordinate that manage the materials on site and the crucial task includes monitoring the materials, and quality and quantity checks. The site manager needs to implement site control measures that, among others, include: controlling the materials received and the materials to be delivered, ensuring that the materials are store safe and weatherproof, ensuring that materials and tools are fully used to realizing the objectives.

Chan and Kumaraswamy (1997) present in their article 83 factors that cause overruns which in turn are grouped into eight categories. Material related delays are one of them and described as factors that are difficult to manage. The factors can be shortage in providing material, changes of materials, shortage of equipment and poor material procurement programming (Chan & Kumaraswamy, 1997). Majid and McCaffer (1998) also categorize the material related delays, see figure 4, shows all the possible material related factors that can contribute in project delaying.

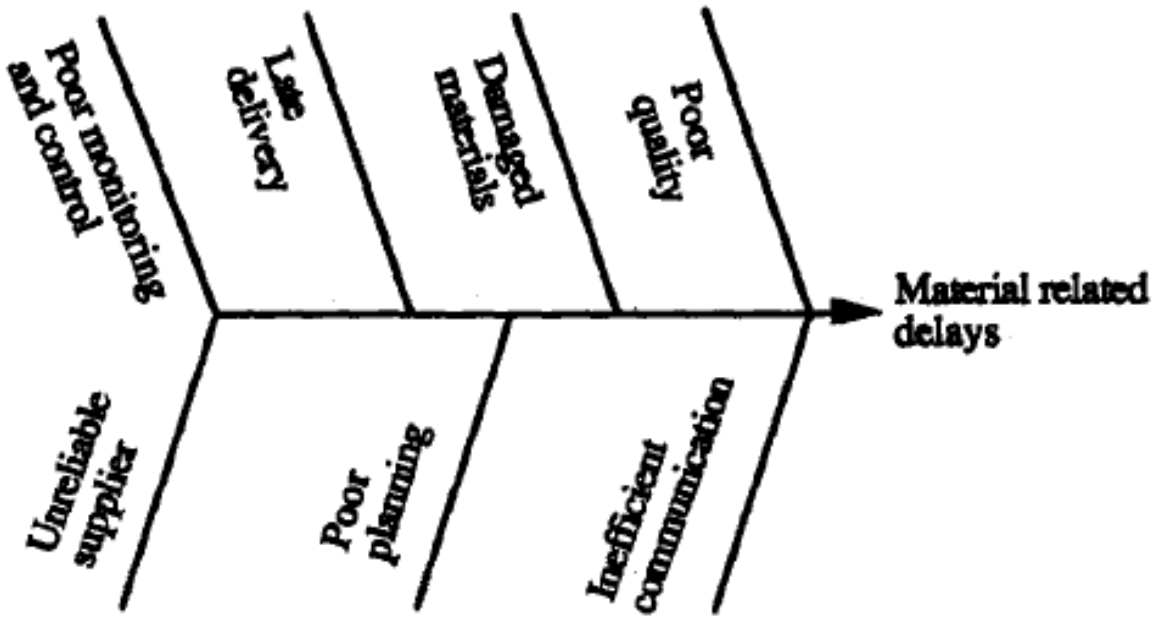

Figure 4. Simple cause- and effect diagram which present possible material related factors (Majid & McCaffer, 1998)

2.5.8 Optimism planning

The estimated cost, time forecast and benefits from projects particularly in complex construction projects are usually over-optimistic in the planning phase (Cantarelli et al., 2013). Psychological explanations are based on the terms called optimism bias and cognitive bias or planning fallacy. Planning fallacy is to underestimate the time, cost and risks of any action and overestimated benefits for those actions (Kahneman& Lovallo, 1993). While cognitive bias is the systematic tendency to be overly optimistic, there is a strong relation between the two terms optimism bias and planning fallacy. However, since the link with cost overruns is stronger for optimism bias, the preference is given to this notion to support psychological explanations. Rational choice theory presented by Kahneman&Lovallo (1993) is considered useful basis for understanding cost overruns because it addresses economic, political and psychological elements of the phenomenon.

Love (2011) criticizes Flyvbjerg's (2009) who focuses only on political/strategic factors and optimism bias. Love (2011) therefore presents that the theory of optimism bias with project overruns does not adequately explain why social projects consistently are underperformed in terms of time and cost. Additionally, Love (2011) points on the relationship between optimism bias and lack of experience specially in design and procurement stages where the time given to this tasks are not enough to calculate and therefore wrong procurement and estimations could occur and later leads to overruns.

Flyvbjerg et al. (2009) explain that managers fall victims of a psychological analysis and planning fallacy. In other words, they overestimate benefits and, at the same time, underestimate cost and time. They also overlook the potential for mistakes and miscalculations. Managers make decisions based on delusional optimism rather than on a rational weighting of

gains, losses or even detailed estimated calculations. When managers make decisions, they tend to proportionally avoid risks and isolate the current problem from other choices that may be pending, as well as from future opportunities to make similar decisions (Kahneman & Lovallo, 1993). The cognitive bias leads to be more optimistic in project forecasting which could lead to cost overruns. This bias is a result of inside view in forecasting. Therefore, Flyvbjerg et al. (2009) show that an adoption of an outside view from the problem is useful to mitigate delusion, meaning to ignore the details of the current project and use similar done projects as references to forecast outcomes for the current project.

2.5.9 Low moral in term of low motivation

Chitkara (1998) describe that low moral could arise from several issues, such as, insecurity of employment, repeated transfers and changes in work scope and methodology, and additionally, also from conflicts between supervisors and workers. Lack of moral could be seen in lack of attendance and engagement, frequent sick days and lack of inspiration and dwindling productivity. Furthermore, Shahzadi et al. (2014, p. 159) describe employee motivation as, "*Employee motivation is a reflection of the level of energy, commitment, and creativity that a company's workers bring to their jobs".* Motivation could be seen as the driving of the employees for achieving the organization's goal and objectives. The managers, therefore, have a crucial role of motivating their employees. However, low moral and low motivation could lead to low productivity and low employee performance (Shaban et al., 2017).

2.5.10 Poor financial planning

Delayed payment to contractors and consultant, poor financial planning and the lack of incentives and resources are considered as strong causes of cost overruns (Cantarelli et al., 2013). Due to lack of incentives, project forecasters do not provide an accurate estimation of the project budget and schedule. Similarly, due to a lack of resources, decision-makers tend to choose between projects which in turn lead to competition. Project promoters consciously undervalue costs in order to make projects look more attractive and thereby increase the chance of being selected. To use project resources in an inappropriate way leads to unsustainable project and therefore to overruns. Underestimating costs increase the chance of getting the project started.

Majid & McCaffer (1998) summarize economic and financial related delays in four points. The first point is poor financial planning in the design phase. The second point is about poor monitoring and controlling of how resources and processes are financed, meaning that managers do not take any corrective budgetary actions when it is needed. The third point is inadequate fund allocation which is also related to poor planning and the fourth point is delayed payments to contractors or suppliers. Cantarelli et al. (2013) illustrate that the economic explanation for cost overruns were primarily established on neoclassical economics and rational choice theory. Neoclassical economics is a framework which emphasize the importance of incentives which is a key factor in shaping decision-makings related to costs. In other words, "*the dedicated funding causes little incentive to produce accurate figures because accurate figures decrease the chance of receiving part of the funding"* (Pickrell, 1992, p. 158). Neoclassical economics helps to find a good explanation for the action of consciously misrepresented data which has its roots from shortage of incentives for those who plans.

Rational choice theory has another explanation for cost overrun. The theory aims to comprehend the social and commercial behavior of planners. It shows the tendency of

individuals to calculate the costs and benefits of an action, recognize their preference functions and constraints facing them before taking a decision (Arrow, 1990). Individuals tends to underestimate costs in order to maximize benefits and profits. The theory is considered potential in explaining cost overruns for both economic explanations and psychological explanations.

2.5.11 Poor monitoring and control

Monitor and Control Project Work is the process of tracking, following and reporting all the progress to ensure that the implementation of each activity is carried out according to the objective planning (Phillips, 2013). Monitoring and control processes mainly depends on gathering data about the actual implementation, analyzing these data and turning them into indicators that represent information about the current situation of time, cost and quality of all the carried activities. If any problems or gaps are diagnosed, a corrective action should be taken.

Doloi (2013) reveals that poor project management in term of project controlling during the construction phase produces lacks in the project plan and cost control. This could also lead to missing the actual targeted outcomes expected by different actors of the project as clients, contractors and consultants in the overall development processes. Therefore, the technical ability and well-experienced project managers is considered crucial in order to achieve project success. The contribution of contractors and consultants in the process of cost monitoring and control is equally important in achieving success in projects according to (Iyer& Jha, 2005).

Project managers should have several competences and among them is to involve themselves in the project through regular budget update. This is further crucial for keeping control over the project progress and taking active part in construction control meetings. Control meetings should be conducted regularly depending on project complexity and situation. Doloi (2013) furthermore emphasizes that the contracting parties, such as tender managers, should have well technical planning and controlling skills for gaining an effective cost performance. Having a clear process of the project control is a vital requirement for retaining proper control progress.

2.6 Reference Class Forecasting (RCF) method

The Reference Class Forecasting, RCF, method is used for future project planning through looking and learning from similar projects from the past (Flyvbjerg et al., 2016). The method predicts the objectives of planned actions and processes depending on actual objectives in a reference class of similar actions that have previously been forecasted. Kahneman&Tversky (1977) found that the human's way of thinking is generally optimistic due to a overconfidence and insufficient consideration of distributional data about outcomes and benefits. Therefore, the project managers could strategically undervalue the cost, time, and the risks of planned actions whereas they overvalue the benefits of the same actions (Batselier& Vanhoucke, 2016). Errors occur as a result when estimators take, what is called an "inside view", where the focus is only on the elements of the specific planned action instead of on the actual outcomes of similar projects that already been completed. The RCF method takes an "outside view" on planned actions rather than an inside view by looking to the direct outcomes of projects. So, forecasts should not be confined to the most likely estimation, but rather present the full range of estimation and information from other similar projects to the one being forecasted. Reference Class Forecasting for a specific project are divided into three steps according to (Flyvbjerg, 2006):

1. **Determine past or similar projects to be references to the current project**
   Numerous of points have to be taken into consideration while choosing reference projects. Firstly, it is required to identify the variables of both current and the reference project by comparing the current situation with the reference specifications. After that, the similar specifications are being chosen as a reference. The project should be broad enough to be expressive but also similar enough to be useful when comparing it with the reference project.

2. **Establish a probability distribution of outcomes for the selected reference projects and the parameter that is being forecasted**
   After the reference class projects are chosen, the similar recent projects are identified and their outcomes are arranged from the least similar to the most favorable. The outcomes and objectives are based on different environmental conditions in each of the cases. Choosing the most similar projects are not that easy process. It is sometimes required to use the mean values and standard deviation to select the similar projects.

3. **Compare between reference and current projects in order to establish the most likely objectives**
   This stage is about finding the most likely objectives between the current and the reference project. To gain more accurate forecast, it is needed to assess the reliability of predictions by finding the correlation between the predictions and actual outcomes.

The RCF method was firstly used by the UK Department for Transport in 2004 for implementing the UK Treasury's Green Book Guidance on Optimism Bias Uplifts. As noticed, the three-step of using the RCF method above does not include any specification of using it in specific projects or in project management (Batselier& Vanhoucke, 2016). The first implementation of the RCF method in project management was presented by Flyvbjerg (2006). Flyvbjerg, furthermore, implemented the method in a project in the transportation sector

without quantitative evaluation of the accuracy of the RCF technique. RCF was then developed by Flyvbjerg and COWI in 2004. The RCF method is described by Flyvbjerg, Cowi and Kahneman as "*the single most important piece of advice regarding how to increase accuracy in forecasting through improved methods*" (Kahneman, 2011). In 2016, the concept started officially to be used in Europe's largest civil engineering projects. After that, major UK transport infrastructure projects and programs started to use the model. The Project Management Institute also used the concept RCF in its standard for project time plan and cost estimation. The UK and Denmark has made the RCF method mandatory for larger rail and road projects. Furthermore, the RCF has been used on individual projects by the governments of Sweden and many other European countries. The method was obligatory used in the US Government Accountability Office's assessment of the business case of California High Speed Rail. The method is suitably used when having non-routine locally, routine nationally or internationally projects, such as, building concerts halls, sports stadiums, major bridges and urban regeneration projects in order to be able to establish a reference class (Flyvbjerg et al., 2016).

The main benefits of using the RCF method is to be having similar detailed data instead of only having assumptions such as assumed actions, assumed uncertainties or even assumed calculations (Flyvbjerg et al., 2016). The RCF helps to reduce optimism bias of forecasts by having a past projects to base on. Using the method then leads to much greater accuracy, since it provides a statistical study of past actions. While there are many advantages, there are also disadvantages that should be taken into account. Finding the appropriate reference project to be used in comparison is a difficult task. The variables that describe the states of the projects need to be determined in order to compare the states, which could take time to be done. Moreover, implementing the RCF could be inaccurate if a company plan for a unique project that has never been done before.

3 Research methodology

This chapter of the thesis aim to explain the research methodology. Firstly, the research process chosen to follow will be presented and used to collect data, both theoretically and empirically. Figure 5 presents the research process followed to facilitate the understanding of the research process. Followed by a presentation of the interviews methods, survey methods, data analysis and a critical evaluation of the chosen method. Lastly, the ethical aspects of the study will be presented.

3.1 Research process

There are two basic research approaches, quantitative and qualitative (Leedy& Ormrod, 2005). In the quantitative research approach, samples of a population are taken to be observed or questioned in order to investigate a problem for finding real answers and solutions. While the qualitative research approach is concerned with subjective evaluation of opinions and attitudes. Qualitative methods could be lacking in giving direct answers, but are however, relevant at developing more questions. In this research, both qualitative and quantitative approaches will be followed and carried out.

A mixed approach of both descriptive and exploratory (Sreejesh et al., 2014), was combined in order to answer the research questions. The descriptive approach has been done in form of literature and online research, and the exploratory approach in form of interviews and survey. Survey is considered as the primary research method for exploratory research types and as one of the most important quantitative methods (Bhat, 2016). Various types of survey could be used to explore opinions, trends, etc., and with the advancement in technology, survey could now be sent online and easily accessed. While getting a lot of information from public sources, it could be important to conduct an in-person interviews to get in-depth information on the subject being studied. The research questions were designed to explore and determine the causes of time and cost overruns in construction projects. Furthermore, the study has adopted both qualitative and quantitative forms. The qualitative approach was accomplished in form of interviews and the quantitative approach in form of a survey. The main database for this study was provided through the interviews. Furthermore, the information gathered from the survey provided the study with an overall understanding of the contributing factors.

The stages in figure 5 has been followed in the order of problem identification, theoretical frameworks, research methodology, empirical inquiry, analysis and discussion, recommendations, and lastly conclusion. This approach has been chosen in order to identify and assess the common causes of cost and time overruns in order to find relevant project controlling mechanism for managing and minimizing overruns in construction projects in the company. The literature review was gathered from past similar research both in inside and outside Sweden. The literature review, further, supports the identification of the internal key factors causing cost and schedule overruns by categorizing and analyzing them. Due to the significance of obtaining objective and critical perspective by various actors working in the company, the interviewee's opinions and answers are considered critical and crucial for this study. After data collecting, the results are interpreted and discussed based on comparison

between literature review and collected data. Recommendation on further studies is given as well. Lastly, conclusions are drawn to provide a short summary.

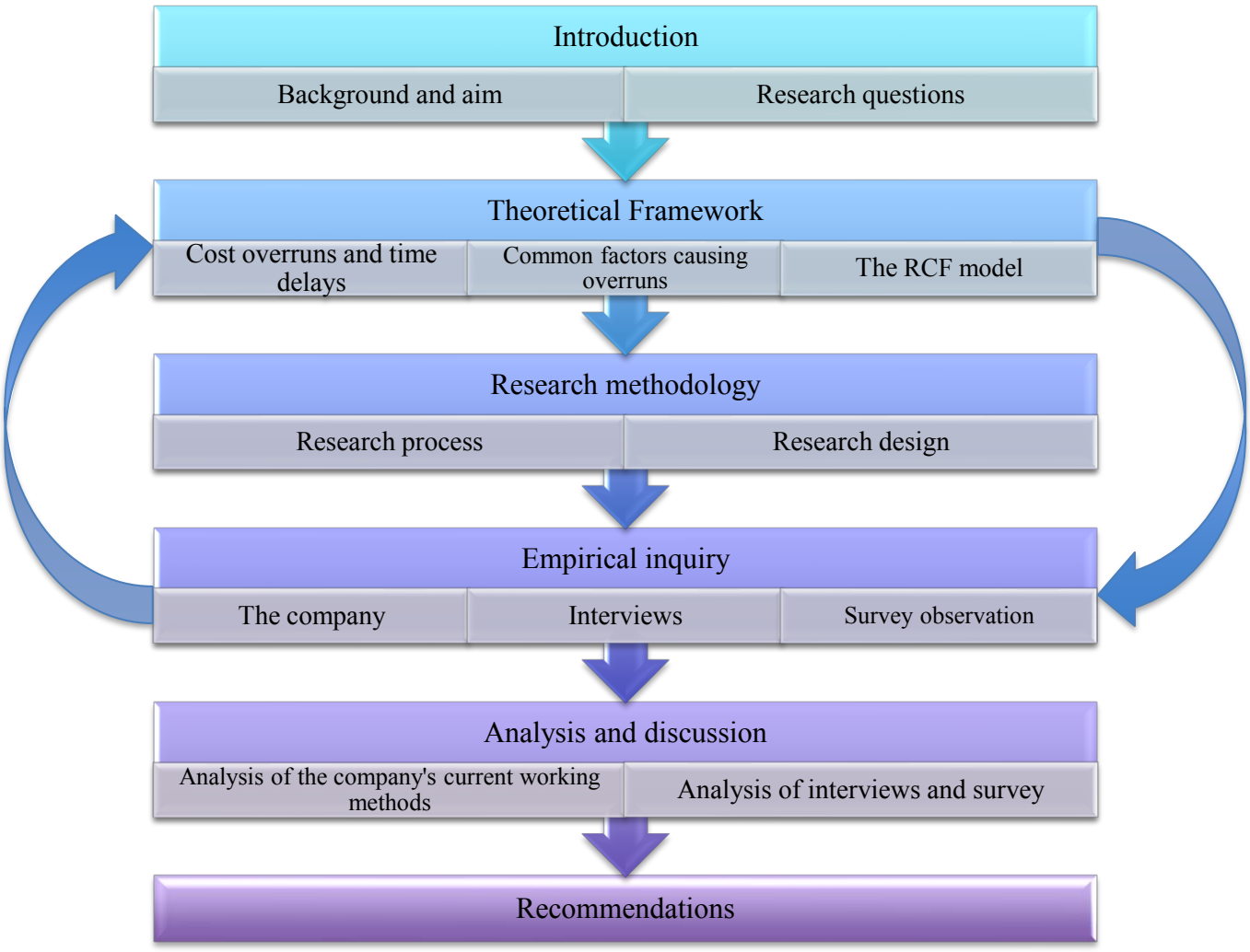

Figure 5. Presents the followed approach in this thesis illustrated by the authors

3.1.1 Literature research

Parallel to the interviews and the survey dispatching, the literature research was constructed in order to create a theoretical framework for the thesis. The literature research also provided the authors with inspiration for the survey and the interviews, and furthermore with knowledge for constructing the topic. The literature research was mainly gathered from the databases Chalmers Library and Google Scholar. Conference papers, books, scientific articles and master theses has been gathered through the databases. In order collect relevant information about the chosen company, their website has been used as an inspiration source. Both Swedish and English literature has been used throughout the process.

Some of the key words used in the researches included “Cost overruns in construction industry”, “Time delays in construction industry”, “Factors causing overruns in the construction industry” and “The Reference Class Forecasting method”. There has been great focus on collecting

knowledge about the RCF method since the authors wanted to provide the company with a method based on the RCF method. The knowledge has been gathered through videos presenting the method at other universities and scientific articles about implementing the method.

3.1.2 Interviews

According to Sreejesh et al. (2014), there are three types of interviews, unstructured, semi-structured and structured interviews. Furthermore, semi-structure interviews are preferred in order to let the discussion open when new questions appear (Sreejesh et al., 2014). Therefore, in this thesis, semi-structured interviews have been implemented to be able to establish a structure covering all identified key factors. The semi-structured interviews have also been adopted to keep all the interviews open for follow-up questions that could arise.

The interviews were conducted with four different roles that has been nominated by the company due to the interviewees crucial role in project planning and construction. The interviewees were chosen from both the design phase and the construction phase for covering all the phases of a project. Ten different interviews were conducted in total, where three of them were interviews with construction managers, four others were project managers, two other interviews were site managers and lastly one operation manager. The interviews have been structured into different categories: introduction, project management and communication related. The interviewees were firstly asked to present themselves and their roles in the projects in order to gather information regarding their experiences. Later on, they were asked relevant questions about this study, see Appendix A. However, in order to understand the operation in the company, the authors have asked the operation manager some extra questions, see Appendix B. Due to the pandemic, the interviews were conducted online through Microsoft Teams. The aim of interviewing several managers from the same role was to compare various sights of employees with the same professions at the company. The interview questions have been carefully chosen in order to collect relevant data and the interviews were transcript through both recordings and handwriting notes during the interviews. Due to using semi-structured questions, several new questions appeared during the interviews.

3.1.3 Surveys

A questionnaire has been sent to a good amount of employees working at the company in order to rank the already identified key factors, see appendix C. According to (Leedy& Ormrod, 2005), questionnaires can be used for the qualitative data collection using quantitative scales to quantify the data obtained in order to produce descriptive results. There are two types of survey questions, closed-ended and open-ended. The survey adopted in this research utilizes closed-ended questionnaires which means that no additional comments could be added by respondents. Survey questions were sent out digitally to relevant employees for this topic at the company all around Sweden. 50 people answered the survey, which is a decent number of answers to analyze. Limited professions has been chosen to participate in the survey in order to gather a qualitative data.

A good questionnaire design is crucial to obtain a good survey result (Zikmund, 2000). The questionnaire design in this study was based on the information taken from the extensive theoretical frameworks and literature review. Identified eleven factors for delays and cost overruns have been categorized based on the sources of overruns. While selecting the factors, the ability and relevance to investigate them at the company was considered. The factors were designed carefully and comprise the major causes of cost and schedule overruns such as poor/financial planning, lack of experience, optimism planning, poor site planning, lack of

communication, project complexity, miscalculation, low moral and poor controlling. Each factor has a ranking scale from 1 which expresses ”Not so much” to 5 which expresses “Much”. Table 1 show the degree of impact of each number from the ranking scale. The used ranking scale is shown in figure 6.

Figure 6. The ranking scale

From the total of 139 surveys distributed, 50 responses has been received, Table 2. Of the 50 answers, 4 was from site managers, 25 from project directors/managers, 11 from construction directors/managers, 7 from operation managers and 3 from tender directors/managers. Out of 19 site managers, 21% answered which could most likely be explained by their busy schedules. 43% of the project directors/managers and 100% of the operation managers responded which is considered to be adequate for analysing data. The construction directors/managers and the tender directors/managers response rate were 26% respective 25%. According to Moser&Kalton (1993), the data analysis is acceptable when the responding rate exceeds 30%. However, if the rate is lower than 30%, the data fails and the results will not be reliable.

Description	Number distributed	Number of respondents	% of responses received
Site Managers	19	4	21%
Project Directors/Managers	58	25	43%
Construction Directors/Managers	43	11	26%
Operation Managers	7	7	100%
Tender Directors/Managers	12	3	25%
Total	139	50	36%

Table 2. Survey participants

3.2 Data analysis

As presented in the research type part, both qualitative and quantitative approaches will be carried out. Based on that, two ways were adopted to analyze data. According to (Sandelowski& Barroso, 2003) collected data will be converted to become information in two ways, description analysis and interpretation analysis. It is suitable for the researchers who want a low level of interpretation to use the qualitative descriptive approach such as content analysis and thematic analysis. Thematic analysis uses minimal description to collected data, and interprets various aspects of the research topic. While the grounded theory or hermeneutic phenomenology, in which a higher level of interpretive complexity is more suitable to use when interpretation is required. There are various views with respect to the implication of description

and interpretation in qualitative research. On the other hand, several researchers believe that both descriptive and interpretative approaches require to be interpreted even if the interpretive component is hided in discussions. Both survey and interviews will be analyzed based on interpretation analysis. Javadi&Zarea (2016) illustrate on the importance of having a diversity of data sources that can be used, including interviews, surveys, documents and notes. The collected data both from interviews, survey and the assessment of the new organization structure of the company were analyzed according to thematic analysis and was then compared to the theoretical frameworks presented in chapter 2.

3.3 Critical evaluation of the method

The method was relatively strong due to that both qualitative and quantitative data has been included, which could be of interest to the company. However, a limitation of time, limited chosen professions to respond the survey and the number of respondents was relatively small. Furthermore, a limited number of survey respondents with the same professions was also a problem faced, as an example, only three tender managers answered the survey, which is considered to be low number. All the theories founded, revolved around cost and schedule overruns in infrastructure projects in the public sector. The authors did not find any sources of cost and schedule overruns in the private sector. Therefore, there was a challenge to collect data about cost overruns and time delays in private sector. However, the internal factors causing project overruns are similar in both private and public sector.

3.4 Ethical aspects

Ethical standards and following an ethical process are critical to the success of any research both when conducting interviews and sending surveys (Kvale& Brinkmann, 2009). Several ethical aspects were considered when conducting the interviews and when sending the survey. As mentioned in the article by Kvale&Brinkmann (2009), ethical aspects should be taken into consideration in all research stages. In this thesis, the interviewees have been informed about their anonymity in the research and only the authors of the thesis knew their identity. As long as the interviews has been recorded, the interviewees has also been informed about the purpose of recording, which is to facilitate the transcription of the interviews. One considered challenge was to find relevant interviewees that could give honest and meaningful answers for the critical questions. The interview question were designed to be ethical and positive oriented in order to provide the interviewees with a comfortable environment. Another ethical aspect of this study, is the authors moral responsibility toward the company. Kvale&Brinkmann (2009) suggest that the researchers should integrate and feel responsible towards their research. Therefore, a confidential disclosure agreement were signed between the authors and the company.

4 Empirical inquiry

This chapter aims to present the empirical data that is used in analyzing the factors that cause overruns with focus on the company hierarchy, conducting interviews with different actors working on the company and survey that was done inside the company. The starting part will be presenting the company, its working method and its organization structure. Thereafter, interviews with site managers, project directors, construction managers and operation managers will be presented and considered a mainly empirical data for the analyzing. Lastly, the result of the survey that is done inside the company will be presented in the end of this chapter. The main purpose of the survey is to rank the already identified key factors causing cost and schedule overruns and then to determine the most critical factors that are required to be given due attention in order to minimize overrun problems in the studied company.

4.1 Interviews

All interviews will be presented in this chapter.

4.1.1 Interviews with site managers

In this thesis, two site managers, site manager A and B, have been interviewed regarding the issue of contributing factors causing overruns in construction projects. The site manager is responsible for planning, personnel, quality and finances during the construction phase. The interviewees was first presented with the issue and later on asked to answer the interview questions with own experience.

Site Manager A considers his schedule to be strain and potential which prevent from predicting errors earlier. The project size might be decisive in some cases was the answer when a question about project complexity was asked. However, a small project can be a problem when miscalculation occurs. The critical factor for overruns are miscalculation in the design phase of projects due to that many projects are rapidly calculated. A bad designing when building a cycle bath was given as an example of miscalculation by the site manager A, which lead to both time and cost overruns. There were many activities that weren't even taken in to consideration in the design and appeared then during construction. Therefore, they were connected with problems all the time for instance contaminated soil and problems with landowners.

Both site managers A and B illustrate that the quality of project planning is poor in the last few years due to lack of experience in some stages and not having the right competence in the right place. Site manager A added that in some projects, lack of resources is noticeable. The right resource composition makes it easier for the site manager to work, according to site manager A. Site manager B clarified that some knowledge about managing mega projects is missing in the company.

Another example given by site manager A was a big project that had a poor site management, poor planning, poor material planning and under qualification in resources in both design and construction phase. Poor material planning was due to that they weren't watchful and accurate with the name of materials and product specifications which lead to order wrong materials and therefore cost and schedule overruns. However, he mentioned that they have a quiet good controlling on the material delivery through good communication with suppliers and good planning for the time delivery. A recommendation from site manager A is to always have experienced procurement managers.

Communication between different actors for a project is good where they have planning meeting in the beginning of every week. Labors, co-workers, different managers attend the meetings. But a problem that site manager A see is that during meetings, there is no notes taken and the information are not documented which lead to that many information get lost. There is always too many information at the same time and if they were not documented then they are missed. A problem with communication site manager experiences is that all information have to reach everyone which take longer time in any process to be done.

In the company, they have follow-up meetings each quarter according to the interviewees. They have also meetings every month where they double check that everything is under control. Site managers have regularly meetings with their project directors where they calculate the time had been taken for all activities and how much time the future activities will take, to ensure that they have control over the time and the problems in projects. Site manager A mention that the more problems they have in a project, the more the motivation is affected and the more construction phase is affected. Therefore a good motivation to the employees by their managers is crucial.

4.1.2 Interviews with project directors

Four project directors have been interviewed. The project directors were involved in different projects and are considered as central figures in this study. The project director is responsible for completing specific projects and looking for new projects in the area. They are also a collaborative partner for site managers and construction managers, mainly in design phase of projects. The project director works independently with project management and manage procurement, purchasing, calculations, forecasts and planning. The project director is furthermore responsible for getting everyone in the project to pull in the same direction. Due to anonymity the project directors has been named project director A, B, C and D.

The four interviewees agreed that project complexity is not a key factor for project overruns. Project director A thinks that both small and mega projects have the same amount of administration work. Project director A, further, considers mega projects to be safer if they are under calculated since there is more space for the company to earn back the cost. though managing budget in small projects are considered an easier task. Project director B believes that the effect on decisions are bigger in mega projects. However, no matter the size, all projects requires the same amount of detailed planning. Project director D, on the other hand, believes that project complexity could affect the project negatively if there is lack of experience. Furthermore, project director B has previously used reference projects in the planning phase in order to compare the planned project with similar past projects.

The directors does not always have the same responsibilities in the projects and in the organization. The role of a project director at the company is to have an overall control of the projects, contact with clients and furthermore, a bolstering actor for the site managers. Depending on the size and complexity of the projects, the project director participation varies. In small projects the project directors participation is above 20-25%, while their focus in larger projects are 100%. This also depends on the experiences of site managers.

Project Director C explains that the company needs more various experiences among their employees. The project teams chose their team members depending on competencies relevant for the upcoming project. Project director C and D emphasizes the importance of having the right competence in the right place. However, Project director B thinks that experience is more important than drive, but a driven employee could quickly gain experience. Project director A

believes that a perfect organization includes employees with different ages, gender and ethnicities. Furthermore, Project director A thinks that it is important with employees that are apt to changes.

The project directors believes that involving resources from the production stage could minimize the risk of project overruns. Project director A and B believes that miscalculation could be avoided by involving resources from the production phase. However, Project director D emphasizes that there is not always resources available for this. Project director C implies that Building Information Modeling, BIM, is an important tool for preventing project overruns since BIM detects problems before construction. Project director B and C considers foundation work as risky and a key factor for cost overruns. They imply that good foundation work could prevent cost overruns later on in the production.

Project director A prefers to work on site in order to monitor and control information about the project. However, Project director C believes that the hierarchy on site could get confuse when the project directors are on site, and both Project directors C and D prefers to leave responsibilities on site to the site manager. Projects director C adds that management by walking is a good way to communicate. According to Project director B, approximately 30 of 40 emails a day are emails with "unnecessary information". The director states that information easily could get lost. However, all four directors prefers emailing since it is a way to store information.

4.1.3 Interviews with construction directors/managers

Three construction managers have been interviewed in this thesis. The roles of the construction managers are to manage the employees in the prevailing projects and furthermore, responsible for the project results and the financials. At some level, the construction managers also have a responsibility in the contracts. The managers have an overall role in several projects. However, the role varies depending on the project size and complexity. The construction managers is also the representative of the projects regarding the organization and the clients. Two key roles are to drive and lead the projects forward. The manager is involved in both day-to-day work and long-term planning. They lead, plan and follow up schedule and execution corresponds to the client's wishes. The three construction managers interviewed are, in this thesis, named construction manager A, construction manager B and construction manager C.

Construction manager A implies that inexperience in combination with project complexity is a key factor for failure. Construction manager C disagrees with this statement and believes that there are no differences in both size and complexity when it comes to projects. Construction manager B, on the other hand, indicates that the more complex a project becomes, the more pre-conditions needs to be realized. The interviewee C also implies that there are more to jeopardize in larger projects and that "complexity" could mean different things in different projects. All three construction managers have previously been in projects that exceeded both in time and in budget. However, the managers explain that overruns can be saved through working in teams, delegating resources, and using the competences necessary.

According to interviewee C, it is highly important to be clear when communicating in the construction industry. The interviewee further explains that there are several nationalities in the industry that do not communicate in the same way, and that it is therefore highly important to always speak with clear language in order to not miss on information and misinterpret. Construction manager B, believes that the challenge with communication is who to inform and how to communicate. The interviewee further explains that the daily dialogues are important to

control what happens in the projects and between the team members, but also how to manage the obstacles that could occur in the project. Construction manager A believes that there are both positive and negative sides of emailing. The interviewee receives a lot emails per day and prefers emails that are clear and personally received.

Construction manager B thinks that optimism depends on project and the type of contracts. The interviewee states that the tender calculation usually is a dream scenario and that the calculation is made with the cheapest possible in order to win the contract. Interviewee A agrees with interviewee B about that it depends on the project and the situation. However, construction manager C states that they have to be optimistic when calculating since problems always could occur. The interviewee believes that realistically calculating for a project with the best possible competence is the way to go. Besides, to also point out where the risks may occur.

Furthermore, construction manager A trusts that resources from production could reduce the chances of project overruns. However, the interviewee also believes that too much opinions from the production could provide an increase of costs for the projects. Construction manager B states that it is important to have the right competence when calculating for a project, and further explaining that, the importance is in the details of production and purchase orders. The interviewee also clarifies that it is significant to predict risks and difficulties in early stages. Construction manager C implies that planning for tendering could always improve and that it is important with experienced tender managers. The interviewee also believes that it is highly important for the tender managers to have self-perception, and furthermore, to realize when to ask for a helping hand.

All three construction managers agree that motivation could affect the projects. Construction manager B additionally believes that motivation affect the project outcome and that the motivations are low when the project is facing problems.

4.1.4 Interview with operation manager

The operation manager has a strategic role in the company. The construction managers send reports about projects performance to their operation manager in order to follow up and checkup that all processes are under control. In the same way, the operation manager also reports to the regional manager. During meetings with other managers at the company, the operation manager discusses the economics of all projects, personnel questions, contract related issues and market situation. Operation managers have also meetings with clients and consultants.

In this study, one operation manager has been interviewed. The reason of interviewing an operation manager was to gather information about the strategy of the company current working methods to manage overruns and further, to know more about the company's organization. An important task of the operation manager is to build a strategic relationship with clients. The company has a goal of meeting one to two clients per month, even if this is not always the case. Furthermore, the most challenging task, according to the interviewee, is to get the right person in the right place. However, he interviewee declared that the company lacks experiences in some directions.

When asking about communication in the company, the answer was that there is a challenge in communication and that it is important to understand how to communicate. Personnel meetings are always better than phone or emails. According to the interviewee, digital communication is for great help, especially when physical meetings are not possible. The interviewee mentioned that the quarter meetings, which are conducted four times a year, are crucial for following up

project progress. Furthermore, the managers also send a short monthly forecast to their managers.

The operation manager referred to that the economic and time plan changes can sometimes depend project size, type and complexity but that it mainly depends on miscalculations. Miscalculation according to the interviewee could, for example, be that planners and estimators have miscalculated or forgotten to count some elements and items presented in drawings. A relevant action to take is to include the resources from the production phase in the design phase. This is something the company already are working on.

4.2 Survey observations

This chapter will introduce observations from the survey. Firstly, observations from the site managers, project directors/managers, construction directors/managers and operation managers. Later on, a presentation of all factors. The diagrams will show all rankings in each factor from all participants.

4.2.1 Site managers

Out of 50 responses, 4 identified themselves as site managers. The two most contributing factors according to these site managers are "poor planning" and "ineffective communication". These two factors have an average ranking of 4.25 out of 5. One reason for ineffective communication could be that the site managers are located on site, and that communication with the rest of the managers and organization could take more time than direct contact. The factors that the site managers considers least contributing, ranked as an average of 3.25, are "low moral", "project complexity" and "poor material planning". "Low moral" and "project complexity" are ranked low as an average of all the survey participant. Furthermore "poor material planning", also ranked as low by all participants, could be for the reason of remarkably good material planning at the company. All factors are on average on the same level and the difference is not much noticeable. The direct related factors for site management, "lack of experience" and "poor site management", has an average of 4 out of 5 which is quite high and noteworthy.

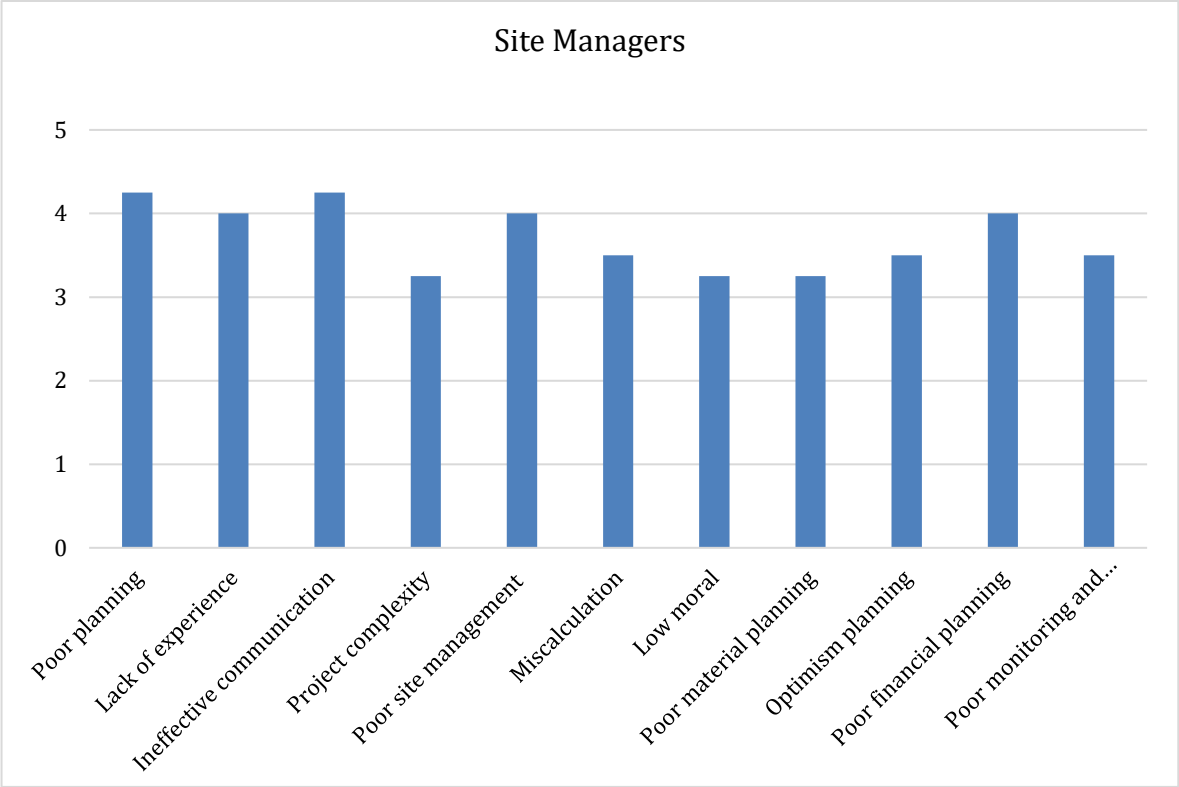

Figure 7. Average ranking of site managers

4.2.2 Project directors/managers

Out of 50 answers, 25 identified themselves as project directors/managers which is 50% of all participants. The responds from the survey shows that most of the project directors/managers ranks each of the categories above average as contributing factors for causing overruns. Highest ranked factor among the 25 participants was “poor planning” with an average of 4.36 out of 5. Even “poor site management” was ranked high among the factors by the site managers, with an average of 4.08 which is noteworthy. The least contributing factor according to the 25 project directors/managers were “optimism planning” and “project complexity” ranked as an average of 2.96 out of 5.

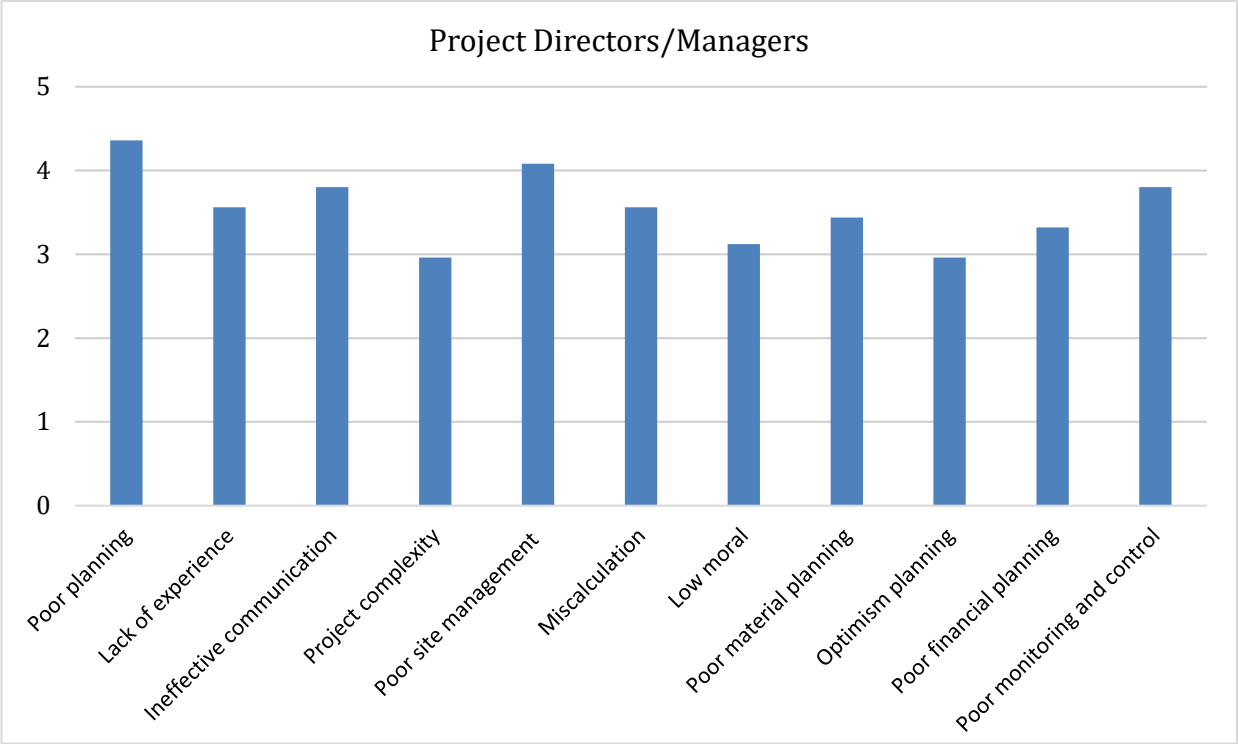

Figure 8. Average ranking of project directors/managers

4.2.3 Construction directors/manages

Out of 50 answers, 11 identified themselves as construction directors/managers. The highest contributing factors according to the construction directors/managers were "poor planning" and "poor site management" with an average of 4 out of 5. The least contributing factors ranked as 2.81 out of 5 were "project complexity" and "low moral", similar to all other participants responds. "poor monitoring and controlling" has a pretty high ranking as 3.8 of 5 which is remarkable

Figure 9. Average ranking of construction directors/managers

4.2.4 Operation managers

Out of 50 responds, 7 identified themselves as operation managers. The highest contributing factors according to these participants were "poor planning" with an average of 4.57 out of 5 which is quite high and noticeable. The least contributing factors according to the operation managers are "low moral" and "project complexity" with an average of 2.43 respective 2.57. Even "poor site management" and "lack of experience" are ranked as high contributing factors.

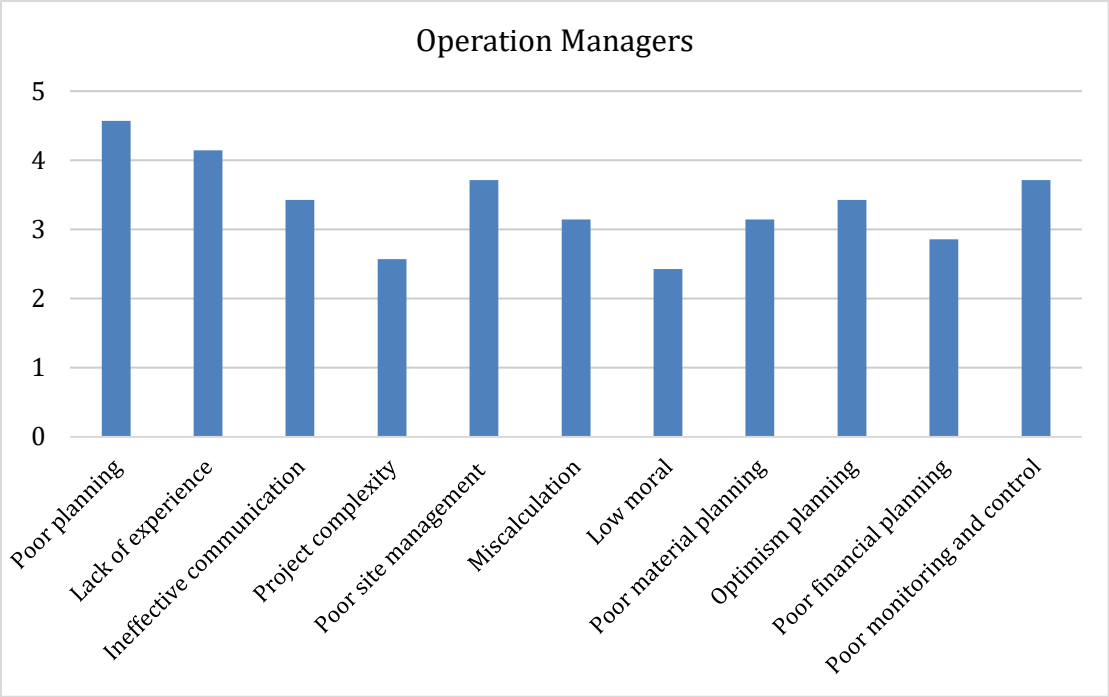

Figure 10. Average ranking of operation managers

4.2.5 Average ranking of all participants

The diagram below presents the average ranking of all participant. The two highest ranked factors according to all were "poor planning" and "poor site management". These two factors seems to be common factors causing project overruns according to all participants.

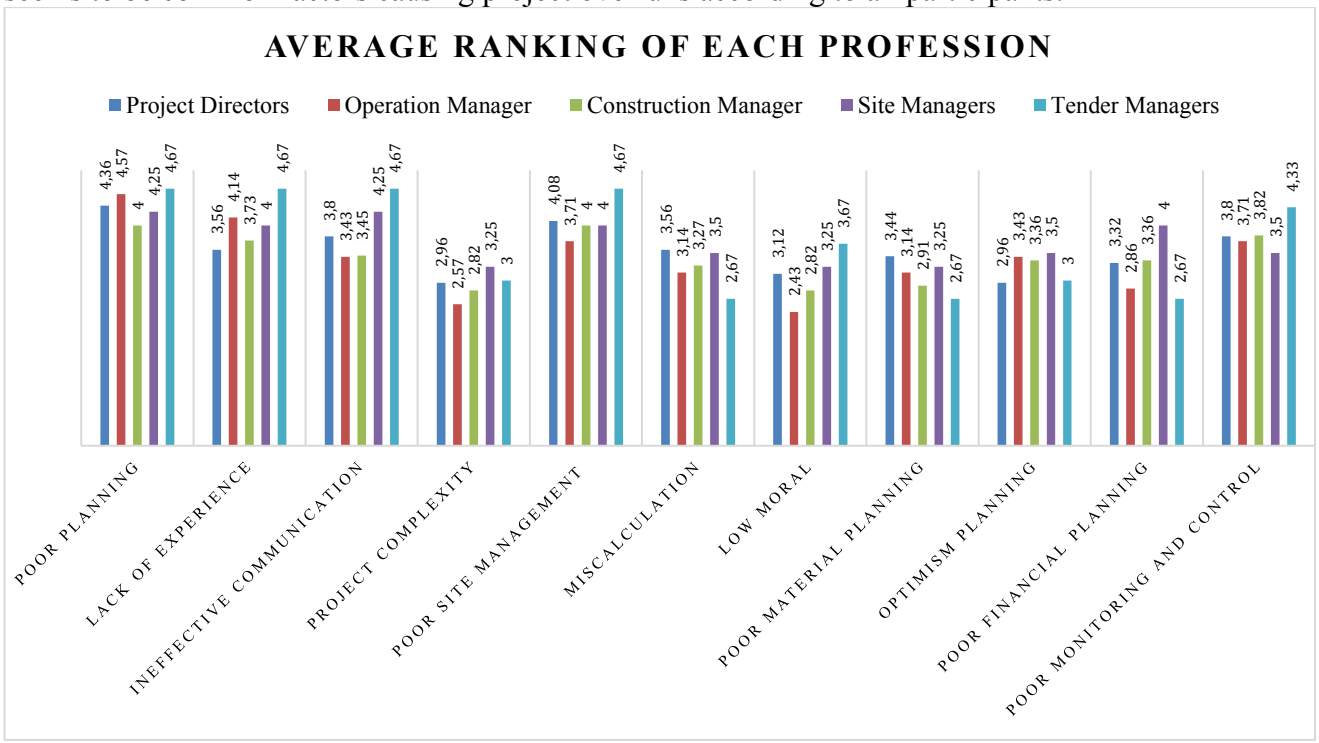

Figure 11. Average ranking of each profession

Factor	Average ranking of all participants (high to low)
Poor planning	4.32
Poor site management	4.04
Poor monitoring and control	3.80
Lack of experience	3.78
Ineffective communication	3.76
Miscalculation	3.38
Poor financial planning	3.28
Poor material planning	3.22
Optimism planning	3.16
Low moral	3.00
Project complexity	2.90

Table 3. Average ranking of all participants (high to low) for each factor

4.2.6 Average ranking of all participants for each factor

58% of all survey contributors ranked poor planning as the highest contributing ranking. Only one participant thought that poor planning has low affection on project overruns. 94% ranked the factor as above average which can indicate that poor planning is the most common factor causing overruns.

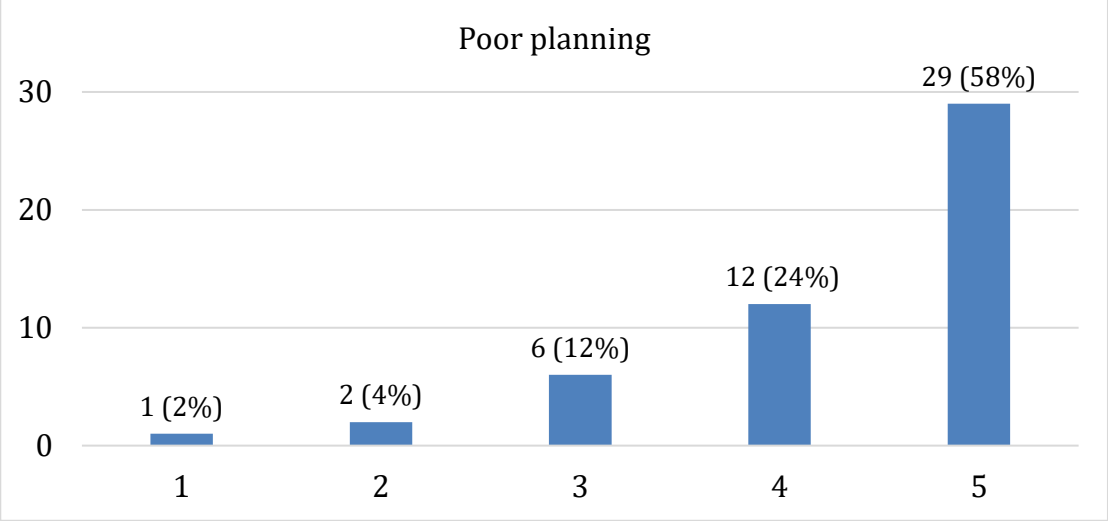

Figure 12. Rankings of poor planning

Lack of experience is also a high contributing factor according to 90% of the participants. Most of the participants ranked this factor as 4, which is not the highest contributing ranking but higher than average. Only 10% believes that lack of experience has low affection on project overruns.

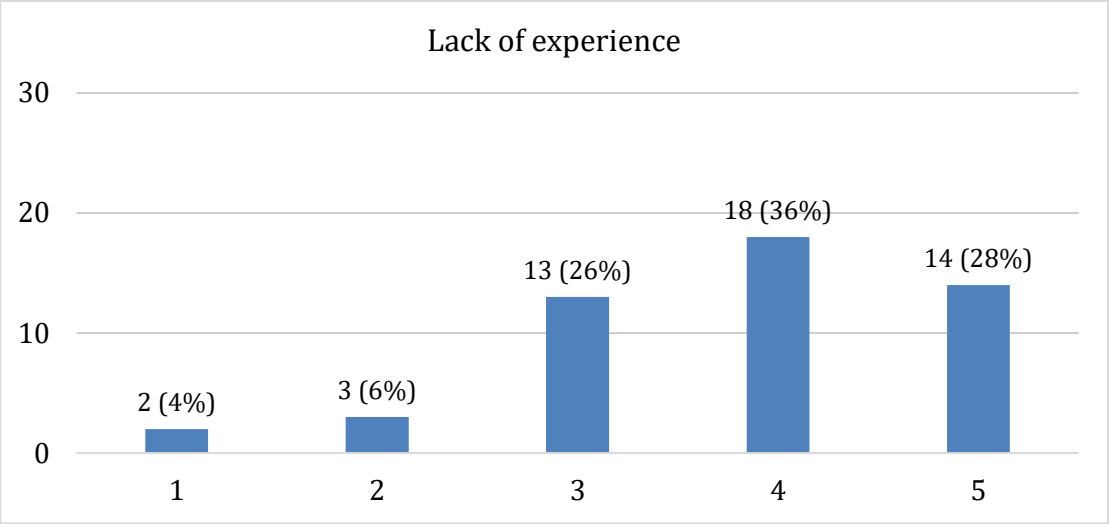

Figure 13. Rankings of lack of experience

Ineffective communication is also a high contributing factor according to 92% of the participants. However, most of the participants ranked this factor as 4, which is not the highest contributing ranking but higher than average. Only 8% believes that ineffective communication has low affection on project overruns.

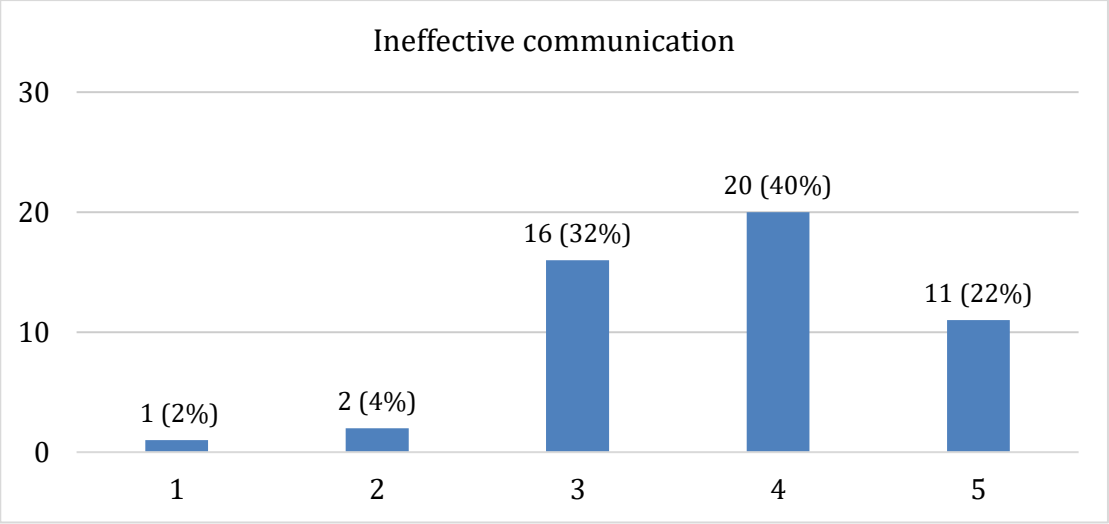

Figure 14. Rankings of ineffective communication

Project complexity is one of the two least contributing factors causing project overruns according to all participants. 42% ranked this factor as above average and only 6% believes that project complexity is a high contributing factor. The three participants that have given the highest ranking, 5, for project complexity are three project directors/managers.

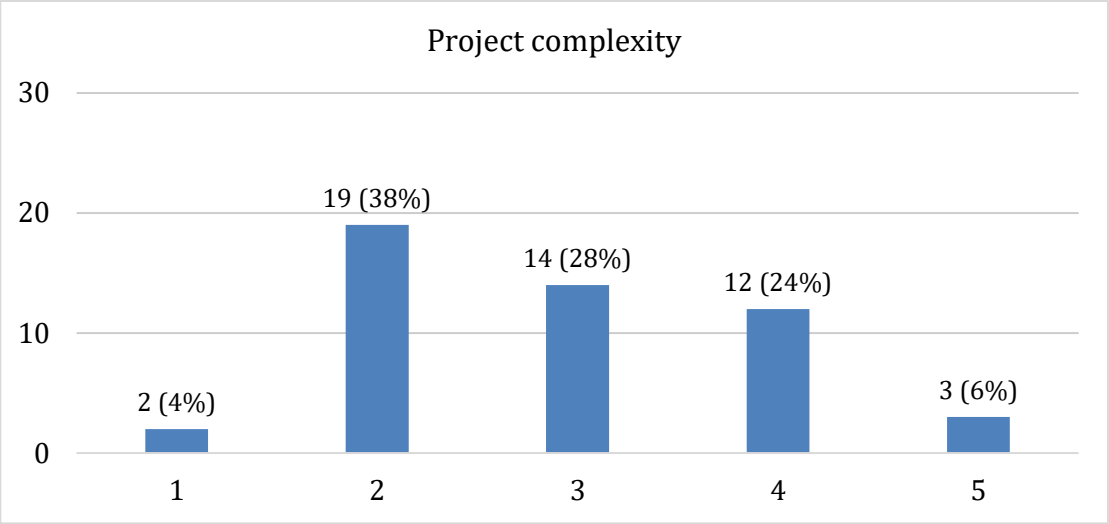

Figure 15. Rankings of project complexity

38% of all survey contributors ranked poor site management as the highest contributing ranking. No participants thought that poor site management has low affection on project overruns. 92% ranked the factor as above average which can indicate that poor site management is one of the most common factor causing overruns.

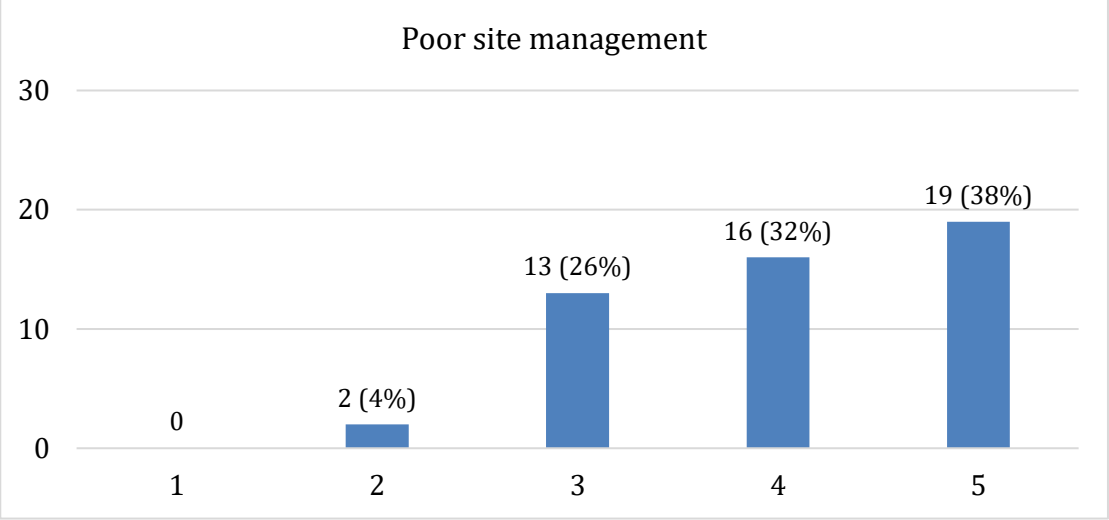

Figure 16. Rankings of poor site management

Miscalculation is a factor ranked as both high and low contributing factor. 34% of all participants gives the factor a ranking of 3 out of 5. However, 78% of the survey contributors rank the factor above average while none of the participants ranked the factor as the least contributing ranking.

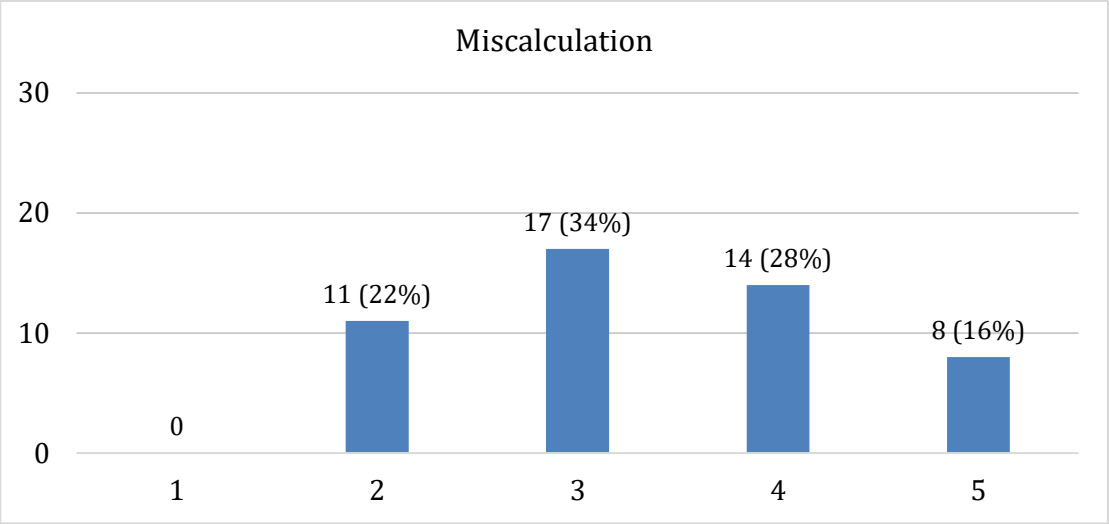

Figure 17. Rankings of miscalculation

Low moral is the factor that are quite similar in the rankings. 56% ranked the factor above average, while 44% ranked the factor as low contributing factor for project overruns.

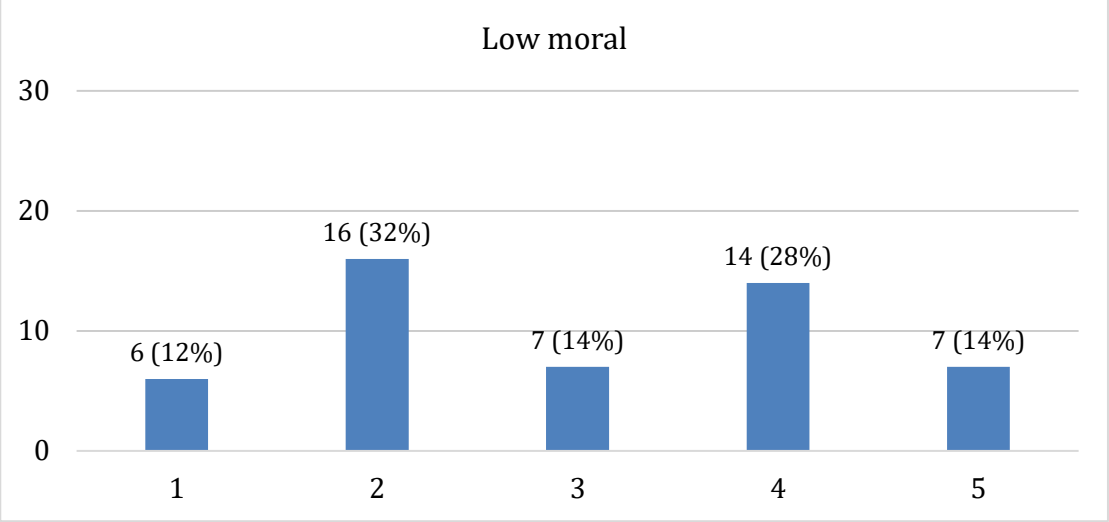

Figure 18. Rankings of low moral

Poor material planning is a factor ranked as both high and low contributing factor. 32% of all participants gives the factor a ranking of 3 out of 5. However, 72% of the survey contributors rank the factor above average, while 8% of the participants have ranked the factor as the least contributing ranking.

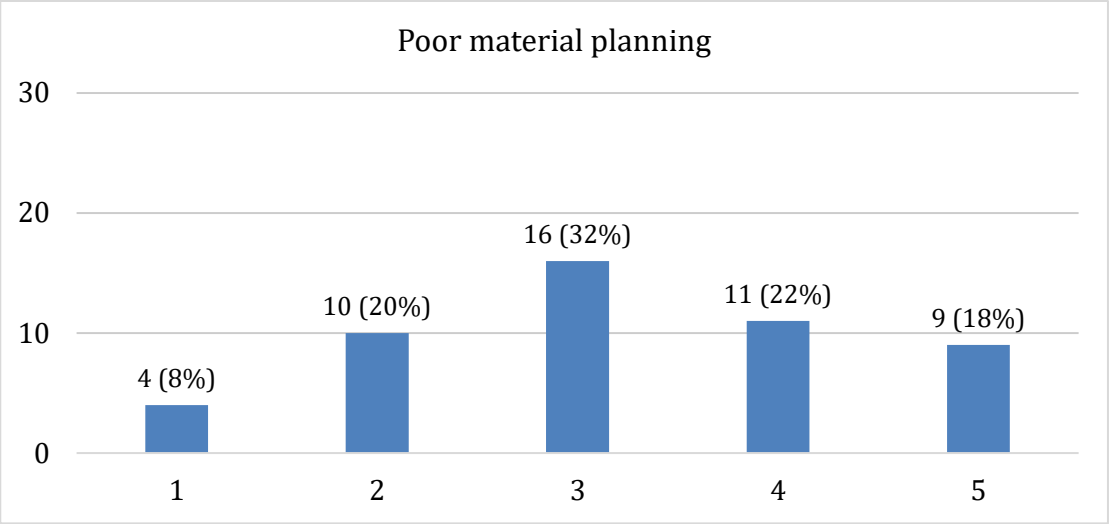

Figure 19. Rankings of poor material planning

92% ranked optimism planning between 2 and 4 and only 6% ranked the factor as highly contributing. Ranking 2 and 3 got even rankings of 28% each. Only 2% ranked optimism planning as least contributing factor for project overruns.

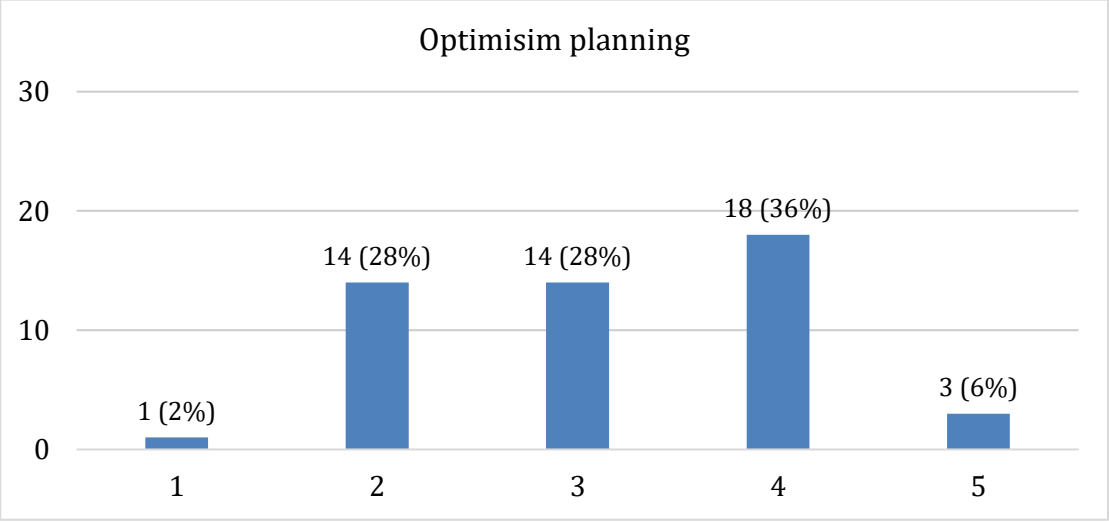

Figure 20. Rankings of optimism planning

Poor financial planning is a factor ranked as both high and low contributing factor. 30% of all participants gives the factor a ranking of 2 out of 5 which considered a bit low. However, 68% of the survey contributors rank the factor above average, while only 2% of the participants have ranked the factor as the least factor affect the project schedule and cost.

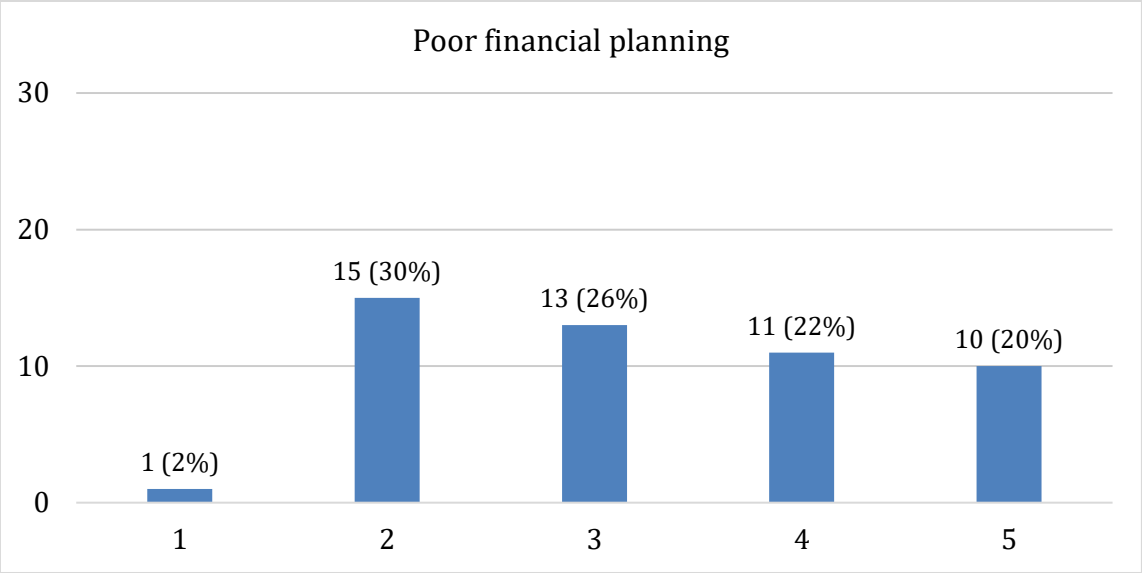

Figure 21. Rankings of financial planning

Poor monitoring and control has also high ranking as 86% of the participants ranked this factor above average. However, most of the participants ranked this factor as 4, which is not the highest contributing ranking but higher than average. None of the participants believes that poor monitoring and control has an affection on project overruns.

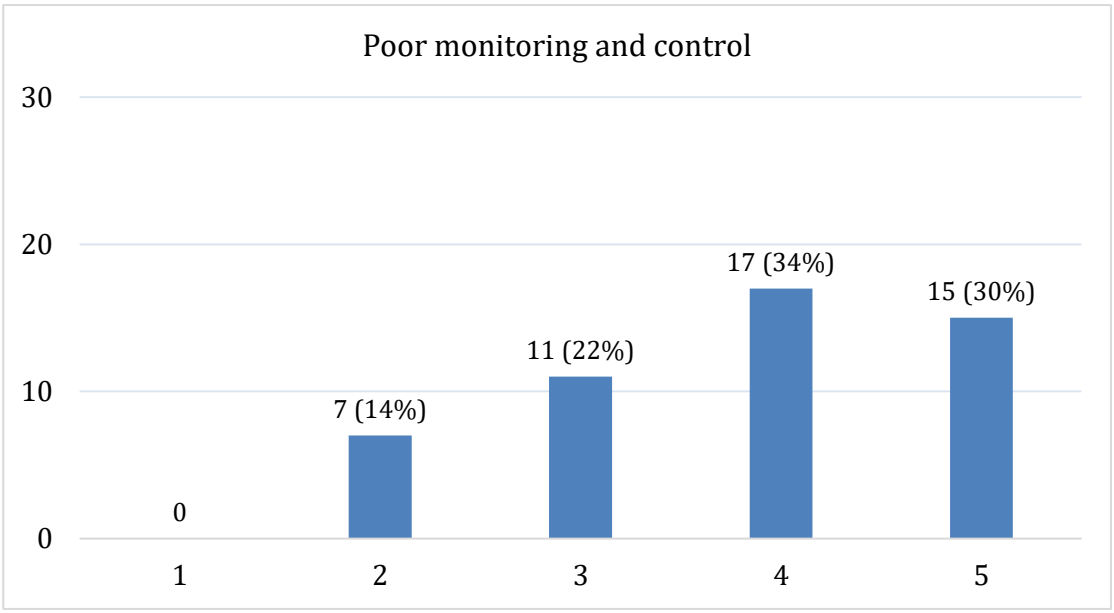

Figure 22. Rankings of poor monitoring and control

5 Analysis and discussion

This chapter firstly, introduces an analysis of the company's current working methods. Further on, the chapter focuses on analysing and discussing the results of the empirical inquiry based on the theoretical frameworks presented.

5.1 Analysis of the company's current working methods

In this section, the current working methods at the company will be analyzed in order to further discuss methods and strategies for improvement. The interviewees have continuously been asked about their current working methods. The working methods at the company, with focus on the factors, are strategic and overall deliberate. The company have both monthly and quarterly forecasting where the company reconciliate their on-going projects. This system provides the company with information that could be necessary to adjust when the project run the risk of overruns. Even with monthly and quarterly forecasting, one of the interviewees preferred weekly forecasting in order to earlier detect problems that could occur. The interviewee further argued that with weekly forecasting, or weekly reports, the company could more rapidly manage changes in the projects. The company are currently working in a project management program called "*Byggsamordnaren*". The system is, among other things, used for managing time plans, documents, change orders, calculation and budget, and furthermore forecasts and reconciliations.

The company recently changed their organization structure and according to one interviewee the past six months have not routinely been the same and this has affected the meetings since a lot of roles have disappeared. However, there is always an agenda for the meetings and the meetings are overall cautiously planned for. The company has regular meetings where the managers reconcile with each other and meetings where the managers reconcile with the employees. As an example, the company have tendering meetings, where the first meeting is called "start meeting for tendering". In these meetings, the agenda is already settled and everyone knows what the meetings are supposed to be about. These meetings are generally about the tender and whether the company should make the bidding procedure or not. Furthermore, the agenda includes whom should attend the meetings, the subjects and the decisions that needs to be taken in this particular meetings. After the start meeting, the company has several more meetings regarding the subjects.
The company also have management meetings where the managers overlook the organization about what is going on, economically and financially, QEHS (quality, environment, health and safety) questions, recruitments and project statuses. These meetings does usually also have agendas. The interviewee furthermore, indicated the importance of documenting meetings. Documenting meetings are some sort of evidence, of what the team have talked about and what is supposed to be done. Project related information from meetings lands in *Byggsamordnaren*.

Furthermore, the company measures the motivation among their employees with a system called "*Winning Temp*". The system weekly sends out email with surveys regarding the well-being of the employees. This allows the managers to overlook the well-being of their employees and to oversee the motivation in general. All answers on the survey are anonymous, which offers a safety for the employees to open up if there would be any problems. The system then report this, also anonymous, to human resources and to the managers. This, furthermore, allows the leadership in the company to constantly improve.

5.2 Analysis of interviews and surveys

Poor planning

Since the project overruns mainly occur during project planning, it was expected that the factor poor planning would get a high ranking among other factors in the survey. Poor planning is the most common affecting factor among the eleven identified factors causing overruns in the company. 29 of 50 respondents gave the highest ranking, 5 out of 5. The factor also got 4.32 as an average ranking, which is considered the highest average ranking among all factors. Furthermore, the site managers, operation managers, tender managers, project directors and construction managers, ranked poor planning independently as the highest contributing factor.

Poor planning is a common problem in the company and could be explained by lack of competence, experience and deliberated planning. Deliberated planning is highly important in the earlier stages of construction projects. Harris&McCaffer (2013) argue that both strategic and operational planning are crucial for obtaining the project outcome in order to complete the project on budget and time, as well as, providing all resource requirements for the project. According to the operation manager, resources from production should be supporting and coaching the tender department in order to avoid miscalculations. The project directors interviewed explained that their role, among others, is to support the site managers. Depending on the site manager's experiences, the project director's role varies. In projects with experienced site managers, the project director could be managing several projects parallelly. However, in projects with unexperienced site manager, the project director spends more time supporting the site manager. Furthermore, there is not always available resources in the company. Personnel shortage in the production according to site manager A could be an explanation of inadequate level of planning in projects. As further mentioned by the construction managers and the project directors, it is proficient to involve resources with site management experience in the design phase in order to obtain more realistic planning. Involving resources from the production phase could minimize the risks of project overruns and affect the motivation among the employees. According Lundman (2011) and the interviewees, project overruns are mainly occurred during the planning stages. Using the right competences and resources in the right place is highly crucial and recommended by the theories, construction managers and the operation manager. Another subject discussed with project director C regarding project planning, was the implementation of BIM in the projects for preventing non-excusable factors causing overruns. Implementing BIM in a project could cost the client a lot and could therefore be a reason for not implementing it. However, in projects with uncertainties, the usage of BIM could prevent cost overruns and be profitable at the end.

Poor financial planning

According to the survey and the respondents, poor financial planning is overall considered as a factor contributing of overruns. Among all the participants, the factor was ranked 3.28 of 5 and in a deeper analysis, 32% of the participant ranked the factor relatively low while 68% ranked the factor over average to high. Among all respondents, the site managers ranked poor financial planning as a high contributing factor, while the operation managers ranked poor financial planning as relatively low. Both site managers interviewed, considered problems in the design phase. Furthermore, one of the construction managers explained that the design phase could always improve. The interviewee pressured that the importance lies in the experiences and experience feedback.

Lack of experience

45 of 50 respondents ranked the factor "lack of experience" above average. Among the five highest ranked factors, lack of experience is considered the fourth most affecting factor. However, lack of experience is highly ranked by the site managers and the operation managers, rankings 4 respectively 4.14 out of 5. The operation manager interviewed, stated that the

company was missing the substance of experienced workforce. Furthermore, according to the site manager A, the quality of design phase has abated over the past few years. Site manager B stated that there is lack of experience in the design phase of complex projects. Poor planning, lack of experience, ineffective communication, poor site management and poor financial planning were ranked as the five highest contributing factors according to all survey respondents. Lack of experience and ineffective communication could be seen as the root causes of poor planning, poor site management and poor financial planning. Lack of experiences does not mean that the company lack in competent employees, but rather that the employees does not have long and varying experiences. Since the company is relatively new on the market, most of the employees are comparatively young and the company has not the advantages of several senior employees. Another difficulty is recruiting experienced site managers and the explanation for this, according to one interviewee, could be that the site managers move up the hierarchy after a few years on site management. The interviewee further explains that this could depend on the pressured and strain schedule. Furthermore, the main explanation for incorrect estimation and miscalculation is lack of experience and competences according to Lind&Brunes (2015). As also noticed from the interviews, lack of experience, poor planning and miscalculation are all somehow connected to one another. Lind & Brunes (2015) furher explains that lack of experience and competence could be a possible explanation for inaccuracy in geotechnical investigations. Site manager A and project director C highlighted geotechnical issues in the interviews. Site manager A mentioned that poor planning due to lack of experience was problematic in the geotechnincal investigations. However, project director C explained that not allocating enough budget on geotechnical investigations are the most affecting cause of overruns. Furthermore, lack of experience is not the only explaination for inaccuarcy in geothecnical investigations.

Ineffective communication

Lack of experience furthermore could cause ineffective communication. As Dainty et al. (2007) state that the construction industry is reliant on effective communication between participants, teams and organizations. Communication could be challenging among the different professions and the extended communication chain in the construction industry and would therefore require clear and head-on communication skills. Construction manager C implied the highly importance of clear language in order to not misunderstand or misinterpret information. Dainty et al. (2007) describe that transmission barriers exists in the construction industry whereas incompatible information technologies could lead to misunderstanding. Although communicating by emails is preferred by the employees since it is a good way for information storage, the information could easily get lost due to a high number of emails received daily. Furthermore, project director B explain that the employees receives several unnecessary emails per day which in turn could lead to missing significant information. Therefore, the authors believes that communication that necessities urgent solutions should be solved by a quicker method, such as phone calls or face to face. However, this could affect the workday of the internal management team if they got interrupted by several questions during the day. 40% of survey respondents believes that ineffective communication has a relatively high effect on cost and time overruns in projects. In project-based industries, the communication is a common challenge due to that interactions are mostly characterized by unfamiliar groups working together under a short period before disbanding to work on other endeavors as stated by Dainty et al. (2007). One challenge in communication is to know who and how to inform. This challenge is noticed at the company since several interviewees referred to the existing problem that information have to reach everyone, and this in turn affect the frequent of operations. Moreover, Baguley (1994) explain that perception and attitude problems lead to difficulty in communication among workers. This reflects the difficulties in communicating due to diverse

nationalities in the industry. However, this is not considered a problem but rather a sign of intelligibility and the substance of clear communication. Dainty et al. (2007) mentioned that communication barriers are more prevalent in the construction industry than other industries. Thus, management by walking is a preferable way to obtain more effective communication according to project director C.

Project complexity

Project complexity was ranked as the lowest contributing factor where only 6% believe that the factor is directly related to overruns. Besides, most of the interviewees agree that project complexity is not a common contributing factor, however, the risks and the effect on decision-making is higher. Jahren and Ashe (1990) states that the larger the construction project is, the greater cost overruns. This statement was in contrast with what was observed in the interviews about no difference in both size and complexity when it comes to overruns in construction projects. Furthermore, no matter the size, all projects require the same amount of administration and planning. There could be a lot of non-available information and data in the beginning of complex projects, which in turn could lead to high level of errors and rework in the construction phase. "Complexity", however, could mean different things such as technical complexity, geotechnical complexity or unique project complexity. Complexity could contribute to uncertainties, especially in unique projects. According to Lebcir and Choudrie (2011), projects involving high innovations could take longer time to complete compared with projects with low innovations. This highlight the importance of using the RCF method. The RCF method could be really useful in projects with different kind of complexity. The method provides an outside view on past completed similar projects and could therefore, facilitate the complexity of the planning of current projects. Instead of having assumptions on assumed actions, the method offers detailed data on comparable projects. However, implementing the RCF method could be inaccurate if the company plan for a unique project that has never been done before.

Poor site management

The survey shows that the factor "poor site management" is ranked as the next highest factor after "poor planning". The participants ranked the factors as 4.04 out of 5, which evince that poor site management is a high contributing factor for overruns. Furthermore, 19 of 50 participants ranked the factor as 5 out of 5, and 12 out of the 19 were the project directors/managers. This could be explained by that the project directors/managers work closely with the site management. The three main categories of poor site management according to Mohamed and Anumba (2006) are management and administration, technical and engineering and site communication. Difficulties with on-site communication has been mentioned by site managers in the interviews. Project director A and B were located on site permanently in order to monitor and control the ongoing project and to have direct contact with the site management. However, project director C preferred to temporarily be located on site in order to not affect the hierarchy on site. Depending on the experiences of the site managers, the project directors chose to be located on site or not. However, another reason for the project directors to be on site, the matter of budget. As mentioned by Dube, Aigbavboa, and Thwala (2015), project controlling progress in comparison with planned requirements is crucial in order to have effective site management. Poor site supervision and management is an effect of lack of experienced site managers according to the interviews with the project directors. The company struggles with finding experienced site managers and are therefore using the project directors as monitoring and control. This, furthermore, could affect the effectiveness of the project director's role. The site managers in mega projects are supported by a construction engineer to relieve the strain schedule of the site managers. The company could therefore, in every project, use this as a strategy in order to relieve the project director from monitoring and controlling the site

management. The project director could focus more on customer relations, tenders and supporting the construction manager.

Miscalculation
Miscalculation is a factor ranked as both high and low contributing factor. Only 16% of the participants ranked the factors as 5 out of 5, while 34% ranked it on average. 78% of all survey contributors ranked the factor above average, though none of the participants ranked the factor as the least contributing. Improper planning such as inappropriate procedures, inadequate planning and lack of experience could lead to several miscalculations. The explanatory part of Lind & Brunes (2015) framework focuses on why calculation can be incorrect and the explanation of incorrect calculation could either be forced to be incorrect or unpurposely incorrect due to incompetence. The more experienced tender estimators the company has, the greater the subjective decision will be based on objective experiences. Furthermore, the more detailed estimation of duration in each activity could lead to accurate completion time.

Well-detailed planning is significantly crucial to avoid miscalculation. Flyvbjerg et al. (2003) explain that inadequate studies prior calculation is caused by strong need of methods. The RCF method could minimize miscalculations if there is a similar refence project. The gap between uncertainties and the knowledge existing about the current project could diminish by using the RCF method. However, if there is no reference project, the chances of miscalculations could increase due to uncertainties.

Moreover, involving resources from the production could minimize miscalculation and this is further suggested by the employees at the company through an internal study about why miscalculations occur. Involving resources from the production could contribute to on-site competences and experiences that is lacking in the tender department. Furthermore, the motivation among the production resources could be affected positively if they contribute in planning stages.

Low moral
Low moral was the factor ranked by the participants as both high and low contributing. Among all respondents, 56% ranked the factor over average for a factor causing overruns in construction projects. 44% ranked the factor low, as no influence or slightly influencing overruns. The responds show that the factor is not considered as an extreme factor for causing overruns. However, 42% ranked the factor as 4 or 5 out of 5, which somehow demonstrates that the factor is contributing for overruns according to some respondents. In a deeper analysis, most of the professions ranking the factor as high influencing are site managers and project directors. One reason for this could be that site managers and project directors work closely together with direct contact with external actors.

The more problems a project face, the more the motivation is affected. The motivation could decrease if there are frequent obstacles occurring in the projects. As mentioned above, the motivation could increase by involving resources from the production in early stages. This provides a partnership between the design and the construction phases which in turn contribute to the production resources being a part of the whole process.

Chitkara (1998) describe that low moral could arise from several issues, such as, insecurity of employment, repeated transfers and changes in work scope and methodology, and additionally, also from conflicts between supervisors and workers. Lack of moral could be seen in lack of attendance and engagement, frequent sick days and lack of inspiration and dwindling

productivity. However, the system "*Winning Temp*" adapted at the company could measure the well-being of the employees which indeed could decrease the low employee moral.

Poor material planning

The factor "poor material planning" was ranked both high and low as a contributing factor causing overruns. Most of the participants ranked the factor 3 out of 5 which refer to that the factor is not a strong contributing factor. Looking more into the factor, 72% ranked the factor over average which somehow predicts that poor material planning could be a reason for overruns. This could happen if the planning for material is not deliberated or if the material is delayed. Delayed material could pause the project unexpectedly. However, according to the interviewees, this is not a common problem faced in the company.

Site manager A mentioned that there is no remarkable poor material planning in the company, although, the main reason for why it could happen is that they were not observant and accurate with materials specifications. This, furthermore, could lead to wrong ordered material which in turn could lead to delays. Fellows et al. (2009), ensure that ordering and managing the appropriate material to the project at the right time, quantity and price is important. Therefore, having well-experienced procurement managers who strategically find cost-effective deals and has a good material ordering control is crucial. The site managers need to implement site control measures that include controlling materials received and the materials to be delivered. In addition, the site managers need to ensure that materials and tools are fully used in order to realize the objectives.

Optimism planning

According to Cantarelli et al. (2013), projects in the construction industry tend to be over-optimistic in the planning stage and this could also be seen in the survey rankings. The factor "optimism planning" was ranked 3.16 of 5 by all participants. Most of the participants ranked optimism planning with 4 out of 5. Additionally, 46 of 50 participants ranked the factor over average for contributing factor causing overruns in construction projects. According to the interviewees, optimism planning is more or less necessary for construction projects and tenders. In order to participate in the tendering, the managers and estimators necessities to plan more optimistically than involving all risks they could foresee. However, the important part of this is to be realistically optimistic when tendering. Furthermore, the RCF method helps to reduce optimism bias of forecasts by having a past project to base on. Using the method then leads to much greater accuracy since it provides a statistical study of past actions and projects.

One reason for optimism planning, according to Flyvbjerg (2009) is that managers tend to plan based on delusional optimism rather on rational weighting of gains, losses or even detailed estimated calculation. However, according to the interviewees this is not the case at the company. One interviewee explained that anyone could plan for a project and a tender. The important part of calculating is the experiences among the estimators and to inspect the estimation for opportunities and risks. The interviewee further explained that top managers could have an opinion in these matters and argue that the estimated cost does not match the budget and further order the estimator to make a drawback in the estimated cost. If situations like these emerges, optimism planning could affect the project negatively and overruns in both budget and schedule could arises. The estimation of project cost requires accuracy and carefulness, and it is therefore really important to leave the cost estimation to the estimators only. However, another reason for optimism planning could be prematurely planning. Meaning that there could be lack of time in the planning for a project.

6 Recommendations

This chapter presents project controlling mechanisms on how to manage the internal key factors in order avoid project overruns. These recommendations are considered to help the company to prevent cost overruns and time delays.

6.1 Using the RCF method

Firstly introduced as an recommendation for managing and avoiding cost overruns are the RCF method. This method provides an overall structure on what to do in projects with challenges. The RCF method has never been implemented in a Swedish private construction company officially as a concept. However, the company in this study has previously used reference projects when planning for different projects according to one of the interviewees. The RCF method limit the tendencies to over-optimistically plan for projects when it comes to cost, time and risks. Furthermore, it provide the project team with an outside view on outcomes of past similar actions, instead of an inside view. RCF could present a new promising approach in the company to reduce risks based on the high uncertainties that construction projects could have. Moving towards more innovative construction projects in Sweden, the industry faces more challenges and uncertainties within the design phase. Implementing the RCF supports the project teams with references projects in order to avoid optimistically planning and miscalculation. This further leads to much greater accuracy since the method provides a statistical study of past actions.

A further recommendation from the authors for the company is to establish a system in order to gather all relevant information taken from past projects. By saving all projects accomplished, the company could produce their own reference projects data base. This should then be available for all offices and employees. The reference projects does not necessarily need to be carried out in Sweden only, the international benchmarking projects could furthermore be valuable reference projects. The RCF method could be utilized as a project controlling mechanism to manage the following internal factors: miscalculations, poor planning, optimism planning, projects complexity and poor monitoring and control.

6.2 Experience feedback

Another recommendation from the authors is having experience feedback sessions. These sessions could be in form of meetings, daily activities or conferences after each project. The experience feedback is highly important in order to avoid repeated missteps and inaccuracies. Usually, the project teams move on to new projects even before some projects are fully completed. This, furthermore, leaves no room for experience feedback sessions or knowledge transferring. One interviewee explain that the knowledge and lessons learned stays within the team or the employees individually. However, the authors have been giving this a lot of thoughts and suggests that the organization, with the project teams from each completed project, could arrange some sort of activity for an experience feedback session. This could even be arranged when new projects already have started. The important part of the experience feedback session is to document all lessons learned in order to save information and make it available for the organization in the future. It is, further, important to document what went wrong, but also what went right. This is additionally relevant to the previous recommendation, the RCF method, if the company decides to save reference projects then the lessons learned from each project get saved along the reference projects for future use.

6.3 Bridging production with tender and design

Another recommendation from the authors is to bridge resources from production with tender and design. Furthermore, most of the interviewees pointed out that miscalculations could be avoided if resources from production were more involved in the design phase and vice versa. This is especially important in construction companies with overlapping design and construction The company already focuses on this, by involving resources from production for supporting and coaching. However, the authors wants to further point out the importance of this and to mix employees with a variety of experiences.

6.4 Current forecasting

Current forecasting is highly recommended by the authors and could be explained by an on-going forecast that could be done weekly. The construction industry necessitates continuously checkups, especially in mega projects. The current forecasting becomes a foundation for better and faster adjustment of resource requirements and taking right initiative for the future based on changes in the projects. Furthermore, one of the construction managers interviewed, preferred weekly forecasting in order to more rapidly detect problems and manage changes in the project.

6.5 Site management

Due to the strain schedule of the site managers and lack of experience among them, the authors have recommended the company to establish a role of a construction engineer on site. This role could provide the site manager with support of administration, contracts and further documentation. The construction engineer could then be focusing on relieving the site manager from paper work and documentation that need compilation. By achieving this, the site manager could then focus on the construction and what is going on on-site, time plan and leadership and the team.

6.6 Future research

The thesis focused solely on identifying the internal key factors causing project overruns in the company. The internal factors can not only be considered as the main roots causing overruns. There are several other factors that need to be considered, such as, external factors that are both predictable and unpredictable. These factors has not been taking into account by the authors due to limited time. Suggested future research could then be to investigate the external factors in order to complement this study.

Further research could be to implement the suggested RCF method at the company. The RCF method could present a new promising approach supporting and limiting the tendencies to over-optimistically plan for projects. This might be of huge interest to implement the method at a Swedish private construction company since the method has previously been used in large public infrastructure projects.

7 Conclusion

This study has been focusing on identifying internal key factors causing cost and schedule overruns in construction projects. Eleven key factors have been identified and used as a basis for the study. The study has, furthermore, showed that the most common factors causing project overruns at the company were poor planning, poor site management, poor monitoring and control, and lack of experience. The least contributing factors according to the interviews and the survey were project complexity and low moral. The authors have suggested six possible project controlling mechanisms for managing and avoiding project overruns.

The empirical inquiry showed that lack of experience is the main root for poor planning, poor site management and miscalculation. The company struggles with finding experienced site managers and are therefore using the project directors as monitoring and control. This affect the effectiveness of the project director's role. The authors have then suggested to support the site manager with a construction engineer in order to relieve the project director from site management and the strain schedule of the site managers. This could be used as a strategy in every project with unexperienced site managers. Lack of experience in the company, furthermore, affect the design phase and thus contribute to poor planning and miscalculation. The suggested project controlling mechanism for this according to authors, is to bridge production resources to the design team. Other suggestions for preventing poor planning and miscalculations from occurring are the RCF model and experience feedback. The RCF method could, further, be used as a strategy in order to avoid poor planning, miscalculations and optimism planning. The method provides a statistical study of past actions in construction projects, which in turn lead to much greater accuracy in project planning.

The empirical inquiry further showed that poor monitoring and control is a high contributing factor causing overruns in construction project. In order to avoid poor monitoring and control, the authors have suggested to implement current forecasting. Current forecasting could more rapidly detect problems and manage changes in the project.

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9 Appendix

Appendix A - Interview questions for the site managers, project directors and construction directors/managers

Introduction:

- A brief introduction of us and our thesis
- Explain the anonymous interviews and ask if we can record the interview

Part 1: Background

- What is your earlier education and experience in the construction industry?
- What is your role in the company and in different projects?

Part 2: Project related

- Do you think that project complexity could lead to project overruns? If yes, which factors do you think could affect this?
- Have you ever participated in a project that went over budget and time frame? If yes, what caused this? Could you tell us more about it and your role in the project?
- How do you manage cost overruns and time delays in projects? Could you give us an example of how you have managed this before?
- Have you ever found that a reason for project overruns was a consequence of change orders? If yes, what was the reason?
- How do the project follow-up look like in the company? And how do you check that the project progress follows the plan?
- How carefully do you choose your project team?

Part 3: Calculation

- Are you usually realistically optimistic when plan for a project?
- How detailed do you plan for a project before bidding?
- How closely do you work with production resources? Could this reduce cost estimates?

Part 4: Communication management

- How do you communicate within your team and who are involved project team?
- Do you experience any communication problems within your team? What difficulties could arise and how do you manage the difficulties?
- How do you experience the motivation among the employees?
- Do you think that a company with a majority of young and driven employees can affect projects negatively?

Part 5: Material

- Do you get any shortage of material delivery? How often does this happen and how do you usually solve it?
- How do you ensure that you do not have a shortage of material?

Appendix B - Interview Questions for the operation manager

Introduction:

- A brief introduction of us and our thesis
- Explain the anonymous interviews and ask if we can record the interview

Part 1: Background

- What is your earlier education and experience in construction?
- What is your role in the company and in different projects?
- How does a workday look like for you?
- What is considered to be the biggest challenge in your professional role? Or in a project?

Part 2: Company related

- Can you tell us more about the company? And your department?
- What is the biggest challenge in your department?
- How are your meetings structured? And who are involved in the meetings?
- How do you communicate with external actors?
- How do you communicate internally?
- What do you consider to be the biggest challenge in communication? Is there a "better way" to communicate?
- Does the company use any system to compile information from meetings?
- Can you tell us about the decision-making process in the company?
- How does the work environment look like in the company?
- How do you experience motivation among other employees?

Part 3: Thesis related

- How do you manage changes orders, both early in the design stage and in late stages?
- How does the project forecast look like? Do you use any program or tool?
- How do you manage detected problems in the forecast?
- How do you manage cost overruns in projects?
- How do you manage time delays in projects?
- How do the project follow-up look like in the company? And how do you check that the project progress follows the plan?

Appendix C - Survey

Survey: Common factors causing cost overruns and time delays in construction projects

Denna undersökning görs i samband med ett examensarbete på Chalmers Tekniska Högskola och Serneke. Examensarbetet undersöker faktorer som bidrar till att byggprojekt går över budget och tidsram.
Du svarar på enkäten genom att ranka ett alternativ mellan 1-5 som du vet är en faktor till överskridandet. Ju högre siffra, desto högre bidragande faktor.
Enkäten förblir anonym.
Tusen tack för deltagandet!

English
This survey is in collaboration with a master thesis at Chalmers University of Technology and Serneke. The study is investigating common factors causing cost overruns and time delays in construction projects.

You will answer the survey by ranking an option between 1-5 that you know is a factor causing overruns. High number = high contributing factor.

The survey will remain anonymous.
Thank you for your participation!
*Obligatorisk

1. Profession (important!) *

2. Poor planning *

	1	2	3	4	5	
Not so much	◯	◯	◯	◯	◯	Much

3. Lack of experience *

	1	2	3	4	5	
Not so much	◯	◯	◯	◯	◯	Much

4. Ineffective communication *

	1	2	3	4	5	
Not so much	◯	◯	◯	◯	◯	Much

5. Project complexity *

	1	2	3	4	5	
Not so much	◯	◯	◯	◯	◯	Much

6. Poor site management *

	1	2	3	4	5	
Not so much	◯	◯	◯	◯	◯	Much

7. Miscalculation *

	1	2	3	4	5	
Not so much	◯	◯	◯	◯	◯	Much

8. Low moral *

	1	2	3	4	5	
Not so much	◯	◯	◯	◯	◯	Much

9. Poor material planning *

	1	2	3	4	5	
Not so much	◯	◯	◯	◯	◯	Much

10. Optimism planning *

	1	2	3	4	5	
Not so much	◯	◯	◯	◯	◯	Much

11. Poor financial planning *

	1	2	3	4	5	
Not so much	◯	◯	◯	◯	◯	Much

12. Poor monitoring and control *

	1	2	3	4	5	
Not so much	◯	◯	◯	◯	◯	Much