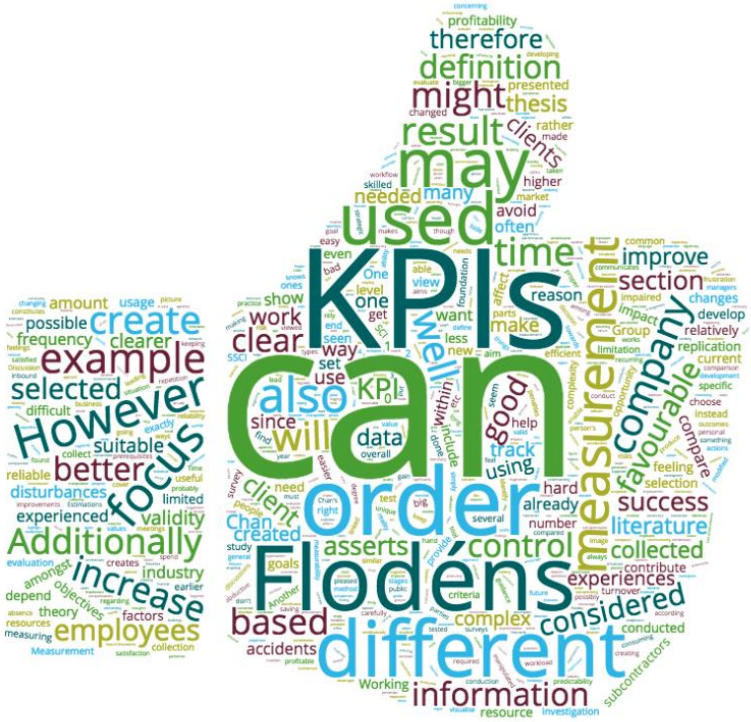
CHALMERS
UNIVERSITY OF TECHNOLOGY



Key Performance Indicators in Construction Projects

Identification, Development and Selection

Master's thesis in Design and Construction Project Management

FELICIA STOCKENBERG
AMANDA SULTÁN

Department of Construction Management
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2018

Master's Thesis ACEX30-18-38

Key Performance Indicators in Construction Projects

Identification, Development and Selection

Master's Thesis in the Master's Programme

FELICIA STOCKENBERG
AMANDA SULTÁN

Department of Architecture and Civil Engineering
Division of Construction Management
CHALMERS UNIVERSITY OF TECHNOLOGY

Göteborg, Sweden 2018

Key Performance Indicators in Construction Projects
Identification, Development and Selection

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

FELICIA STOCKENBERG
AMANDA SULTÁN

Examensarbete ACEX30-18-38/ Institutionen för Arkitektur och samhällsbyggnadsteknik,
Chalmers tekniska högskola 2018

Department of Architecture and Civil Engineering
Division of Construction Management
Chalmers University of Technology
SE-412 96 Göteborg
Sweden
Telephone: + 46 (0)31-772 1000

Cover:
The words from the discussion and conclusion of this thesis conducted into a figure. Conducted at wordclowds.com

Key Performance Indicators in Construction Projects

Identification, Development and Selection

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

FELICIA STOCKENBERG
AMANDA SULTÁN
Department of Architecture and Civil Engineering
Division of Construction Management
Chalmers University of Technology

ABSTRACT

Measurement tend to make things happen by showing the progress and thereby motivate people to take action. Performance measurement can be used as a tool within an organization to connect the daily activities to the strategic objectives. Key Performance Indicators, KPIs, are indicators that focuses on performance directly linked to the most critical success factors within an organization and can indicate if the performance is in compliance with the strategic goals and objectives. The environment of construction projects is constantly changing, and the complexity of the projects contributes to a high level of uncertainties. By using measures, it is possible to track the causal factor behind the result and KPIs can dissolve organizational performance into a manageable number of indicators.

The aim of this thesis is to identify, develop and select KPIs suitable for the production process of construction projects at Flodéns, which is a limited company in the construction sector. The selection of KPIs was delimited into a general, yet limited and focused KPI matrix which can be used to enable continuous monitoring of the production process to achieve project success and enable comparisons between projects. The selection of KPIs resulted in 13 KPIs intended to be measured during the production process, complemented by 9 KPIs intended to be measured in the final stage of the projects.

However, there are aspects that must be considered when, or if, KPIs should be implemented. For example, measurement can lead to sub-optimization which can result in impaired performance. Additionally, estimations used as inputs can be manipulated to create good results if the focus is set on the result of the KPIs rather than the performance it-self. Finally, the KPIs must be used wholehearted to generate useful information. If not, the data collection and measurement will be of less quality and the KPI-values will be close to useless.

Key words: Key Performance Indicators, Measurement, Measures in Construction, Project Success, Iron Triangle, Productivity, Identification, Development, Selection

Key Performance Indicators i Byggprojekt

Identifiering, Utveckling och Urval
Examensarbete inom masterprogrammet Design and Construction Project Management

FELICIA STOCKENBERG
AMANDA SULTÁN
Institutionen för arkitektur och samhällsbyggnadsteknik
Avdelningen för Construction management
Chalmers tekniska högskola

SAMMANFATTNING

Mätning har en tendens att få saker att hända genom att visa framsteg och därigenom motivera människor att agera. Prestationsmätning kan användas som ett verktyg inom en organisation för att koppla samman dagliga aktiviteter med strategiska mål. Key Performance Indicators, KPIer, är indikatorer som fokuserar på prestation som är direkt länkad till de mest kritiska framgångsfaktorerna inom en organisation och indikerar ifall prestationen går i linje med de strategiska målen. Förutsättningarna för byggprojekt ändras hela tiden och komplexiteten i byggprojekt bidrar till många osäkerheter. Genom att använda mätetal är det möjligt att spåra orsaksfaktorn till resultatet och KPIer kan fördela den organisatoriska prestationen till ett hanterbart antal indikatorer.

Syftet med denna avhandling är att identifiera, utveckla och välja ut KPIer som är lämpliga för produktionsprocessen av byggprojekt hos Flodéns, som är ett aktiebolag inom byggbranschen. Dessutom kommer ett urval av KPIer att genomföras och sammanställas i en generell KPI-matris som kan användas för att möjliggöra kontinuerlig bevakning av produktionsprocessen för att uppnå lyckade projekt och möjliggöra jämförelser mellan projekt. Urvalet resulterade i 13 KPIer som ska mätas under produktionsprocessen. De kompletteras med 9 KPIer som ska mätas i slutet av projekteten.

Det finns dock aspekter som måste beaktas när, eller om, KPIer ska implementeras. Mätning kan till exempel resultera i suboptimering vilket kan leda till försämrad prestanda. Dessutom kan uppskattningar som används som ingångsdata i KPIer manipuleras för att skapa bra resultat om fokus är inställt på resultatet av KPI snarare än prestationen. Slutligen måste KPIer användas helhjärtat för att generera användbar information. Om de inte används helhjärtat kommer kvalitén på informationsinsamling och mätning sänkas och KPI-värdena oanvändbara.

Nyckelord: Key Performance Indicators, Mätning, Mätning i byggindustrin, Projekt framgång, Projekt triangeln, Produktivitet, Identifiering, Utveckling, Urval

Contents

Preface

This master's thesis was carried out at the Department of Civil and Environmental Engineering at Chalmers University of Technology, Sweden. It was conducted between January and June 2018 as a final stage of the master's program Design and Construction Project Management.

We would like to thank our supervisor, professor Christian Koch at the Division of Construction Management at Chalmers for guiding and supporting us throughout the master's thesis. You made the supervision fun and motivating and have enriched us with interesting discussions.

Additionally, we would like to thank Flodéns for letting us be a part of the strategy work within the company. Special thanks to Flodéns' strategy consultant, Rolf Albriktsen, who have guided us through our identification, development and selection of KPIs. Your experience and knowledge have inspired us. Further, we would like to thank our supervisor at Flodéns, Ronnie Forsberg, for providing us with information and insights about Flodéns and the construction sector.

We would also like to thank CMB and Prolog for inspiring us in the development of the aim for this thesis.

Gothenburg May 2018

Felicia Stockenberg
Amanda Sult

1 Introduction

Measurement have a tendency to make things happen by showing the progress and thereby motivate people to take action (Parmenter, 2015). Performance measurement can be used as a tool within an organization to connect the daily activities to the strategic objectives (Parmenter, 2015). Furthermore, measurement can improve the decision-making skills in organizations, create a deeper understanding and a clear view of how the business is going, and also provide warnings if something is going in the wrong direction (Marr, 2015).

1.1 Background

A construction project includes many different activities and interactions, which can be both planned and unplanned (Chan & Chan, 2004). The environment in construction projects is constantly changing, and the complexity of the projects contributes to a high level of uncertainties. By using measures, it is possible to track the causal factor to the result and create a picture of the performance linked to the critical success factors within an organization (Parmenter 2015). Thus, management can use measures to control and improve performance. Additionally, it is important to measure performance in order to gain important competitive leverage against the competitors and to see if the organization is going in the right direction and perform in alignment with the goals (Bhatti et al., 2014).

Project success aims to guide project managers to achieve the best possible outcome (Chan & Chan, 2004). However, the definition of project success remains diffuse to a lot of people within the construction industry, even though most people are striving towards it. Project success has been investigated by several researchers but there is still no general definition (Chan & Chan, 2004). However, there are different proposals on how to measure success and what criteria that are important to consider when measuring success in construction projects. Additionally, there are many different measures from which an organization can choose some and these are often called Key Performance Indicators (KPIs) (Bhatti et al., 2014). KPIs are indicators that focuses on performance directly linked to the most critical success factors within an organization and should indicate if the performance is in alliance with the strategic goals and objectives (Parmenter, 2015) & (Marr, 2015). The definition of KPIs according to Oxford dictionary is;

> A quantifiable metric of performance, usually against a predetermined target for an individual, a team, [...]. These metrics can be both financial and non-financial and are used to track progress towards goals. (Doyle & Oxford Reference, 2011, p. 218)

KPIs dissolves organizational performance into a manageable number of indicators (Marr, 2015). However, there are some factors that should be considered when developing KPIs (Collin, 2002 in Chan & Chan 2004), for example, the KPIs must be measured in a systematic and consistent way in several projects to enable improvement in performance and comparison between different projects. It is also important to choose the right KPIs for the specific organization and only use a manageable amount of KPIs to avoid a time-consuming process when measuring.

Flodéns is a limited contractor company in the construction sector located in the Gothenburg Region. In 2014, the company had 33 employees, a turnover at 84 million SEK and a -2,03% profit (allabolag, 2018). 2015, a new CEO was hired at Flodéns with the mission to develop and expand the business (Flodéns, 2018f). In order to reach the new goals, the development of a new strategy commenced with the help of a strategy consultant. The strategy includes a new vision, value words and goals for the overall performance in the organization (Flodéns, 2018d). In 2017, the company had 50 employees, a turnover at 442 million SEK with a 4,03% profit (allabolag, 2018). Even though an improvement can be seen, there is no clear view of exactly how the specific projects have contributed to the improvements. The current measurements conducted at the company include both results on a company and a project level, however the projects themselves are not followed up on all the inbound parameters. This thesis will develop KPIs linked to the strategy and enable measurement of different aspects of the production process to gain a better understanding of the performance and create the ability to control the projects.

1.2 Purpose

The aim with this thesis is to identify, develop and select key performance indicators suitable for the production process of construction projects at Flodéns. The selection of KPIs was conducted into a general, yet limited and focused key performance indicator matrix which can be used to enable continuous monitoring of the production process to achieve project success and enable comparisons between projects.

To specify the aim, following problem definition has been formulated:

- Why should construction companies measure performance?
- What is project success according to Flodéns?
- What KPIs can be used to measure the production process at Flodéns?
- What effects can be expected from the measurement?

1.3 Delimitations

This thesis will not consider the implementation of KPIs in construction projects nor provide solutions on how unfavourable results of the KPI measurement can be managed. The KPIs will only be focusing on the management of the production process of construction projects and will not consider other phases, such as design or tender.

2 Theoretical Study of Performance Measures

In order to identify and make a selection of KPIs, a theoretical study was conducted. It consists of different views of project success, different aspects of performance measures and an investigation of what types of KPIs that can be used in the construction industry. Additionally, the theoretical study investigates how KPIs can be identified and selected, but also how performance measurement affects organizations.

2.1 Project Success

Project success is a well discussed concept and the meaning of project success vary between different people, project teams, industries etc. (Chan & Chan, 2004). Chan & Chan (2004) asserts that in order to improve performance while striving towards success, success must be defined and a general agreement on how it should be measured is needed. There is no general definition of project success, but Chan & Chan defines the project success criteria as "the set of principles or standards by which favourable outcomes can be completed within a set specification" (Chan & Chan 2004, p.2).

A construction project includes many different activities and interactions. The environment is constantly changing, and this contributes to uncertainties in construction projects (Chan & Chan, 2004). Project managers uses project management as a tool in construction projects to reach successful outcomes. Researchers have identified factors that usually contributes to project success (Jha & Tabish, 2012). There are three different criteria that since long have been defined as the fundamental criteria concerning success according to Chan & Chan (2004), Ramlee et al. (2016) and Jha & Tabish (2012). These are cost, time and quality and are often referred to as the "iron triangle", see figure 2.1. Even though these are considered to be the basic and most crucial performance indicators, there is an increased interest in other criteria as well, such as satisfaction and safety (Chan & Chan, 2004). According to Ramlee et al. (2016), success factors are attributes that have a direct impact on the construction project. If a project is completed on budget, on time and reach the performance goals it is often considered as a successful project (Ramlee et al., 2016) & (Bhatti et al., 2014).

Figure 2.1 Illustration of the iron triangle

The complexity of construction projects causes uncertainties and in order to keep the projects on track, there is a need for measurements during the process (Ramlee et al., 2016). According to Ramlee et al. (2016) there are other dimensions that can be used

to define project success as well. For example; meeting design's goals, benefit to the end user and benefit to the developing organization. According to Bhatti et al. (2014) the most important performance indicators concerns cost, financial aspects, quality, time, flexibility, delivery reliability, safety, customer satisfaction, employees' satisfaction and social performance. Bhatti et al. (2014) asserts that these performance measures seems to have a significant impact on the overall organization. Jha & Tabish (2012) suggests that success traits such as management action and human factors has impact on project success.

2.2 Measuring and Monitoring of Performance

Project success can be reached by creating managerial superiority which needs strategic performance management (Ercan & Koksal, 2016). Research of performance in construction companies often focuses on the productivity on the site or processes within project management and there is a limited amount of studies that focuses on competitiveness (Ercan & Koksal, 2016). In order to gain important competitive leverage against the competitors it is important to measure the performance (Bhatti et al., 2014). According to Bhatti et al. (2014), measurement is the only way to see if the organization are going in the right direction and perform in alignment with the goals. Performance measurements are used to compare, evaluate and control business operations and can be used on different levels, such as group, sub-group, individual processes and project level (Bhatti et al., 2014). There are many different measures from which an organization can choose some and these are often called KPIs (Bhatti et al., 2014). KPIs can create a focus on the most important aspects of performance, but it can also contribute to unintended and unfavourable consequences which will be described in section 2.2.5 (Parmenter, 2015).

2.2.1 Key Performance Indicators

KPIs are indicators that focuses on performance directly linked to the most critical success factors within an organization (Parmenter, 2015). According to Parmenter (2015), some of the main benefits of measuring performance is the possibility to connect an organization's critical success factors to daily actions and the possibility to improve performance. Parmenter (2015) asserts that KPIs makes it possible to track the causal factor to the result and by measure these factors, the management is able to control them and thereby improve the performance. According to Marr (2015) KPIs aims to provide information about the performance in an organization and tell if the performance is in alliance with the strategic goals and objectives. Furthermore, KPIs dissolves organizational performance into a manageable number of indicators which can support the decision making and thereby improve the performance (Marr, 2015).

To measure performance, an identification of performance indicators is necessary (Bhatti et al., 2014). These performance indicators should create a detailed view of the process performance in an organization. Performance indicators have been divided into different categories depending on the approach by many researchers, and financial and non-financial indicators are identified as the two main groups (Bhatti et al., 2014). Parmenter (2015) on the other hand asserts that financial indicators are focusing on results rather than performance. Meaning that financial indicators create a wide view of how the whole organization is doing while non-financial indicators are focusing on the performance of a group of people working close together towards the same goals.

Marr (2015) claims that the KPI concept often is misunderstood or overused and that KPIs often are considered financial. Marr asserts that KPIs do not have to be financial and asserts that anything can be measured simply by studying the difference between two things and if it answers a critical business question it can be considered a KPI.

The non-financial indicators can be divided into different categories (Bhatti et al., 2014). Quality, time, flexibility and delivery reliability are common performance indicators for example, but also safety, customer satisfaction and productivity. Similarly, Parmenter (2015) claims that KPIs can be divided into different groups of characteristics, for example timely, simple and team based. Marr (2015) claims that KPIs are relevant to all types of business when they are used correctly. However, it is common that organizations collect a lot of data and measure everything that is easy to measure, without knowing how to use the collected information (Marr, 2015).

The calculation of KPIs can be divided into two different groups where different methods are used (Chan & Chan, 2004) & (The KPI Working Group, 2000). One of these groups include mathematical formulas while the other focuses on a rating system where people involved in the project gets to rate their experiences of different aspects. Chan & Chan (2004) presents a rating system that is divided into seven different levels where stakeholders gets to rate different aspects according to their own judgement and opinions. The KPI Working Group (2000) presents a similar method but are using a scale from 1-10 instead. Furthermore, The KPI Working Group (2000) divide the KPIs into three subgroups, *headline*, *operational* and *diagnostic measures*. Where the headline focuses on the overall state and are measures on a company level. The operational KPIs are the ones linked to the activities at a company, for example the construction projects in a construction company. The diagnostic indicators are used to gather information of the possible changes in the headline and operational measures.

2.2.2 Identifying, Developing and Selecting KPIs

KPIs can be collected by identifying existing KPIs and by designing KPIs suitable for the organization or project (Marr, 2015). According to Marr (2015) KPIs aims to provide answers to questions related to key performance. The important thing is to define exactly what should be measured and key performance questions aim to capture important factors concerning strategic objectives. Marr (2015) asserts that only the information needed to achieve the objectives is relevant to collect. In order to guide the KPIs to deliver relevant information, a few short and clear performance related questions connected to each strategic objective should be identified. According to Parmenter (2015), the process must be structured when measures are designed. The people that will design the KPIs, must be well engaged in, and possess knowledge about, the subject (Parmenter, 2015). Additionally, Parmenter claims that measures must be linked to the critical success factors and that it is important to mix experience and knowledge with re-thinking and new visions when developing measures (Parmenter, 2015).

An important aspect when identifying and designing KPIs is to select the right number of KPIs, not too many and not too few (Marr, 2015). Similarly, Collin (2002, in Chan & Chan, 2004) asserts that it is important to only use a manageable amount of KPIs regularly to avoid a time-consuming process when measuring. Parmenter (2015) claims that ten KPIs usually is enough for an organization and that many organizations can do

well with less than 10 KPIs. To choose the right KPIs, Marr (2015) has presented a framework including ten steps that can be used, see figure 2.2. For example; linking the KPIs to the strategic objectives, checking for existing data and create a process for the data collection.

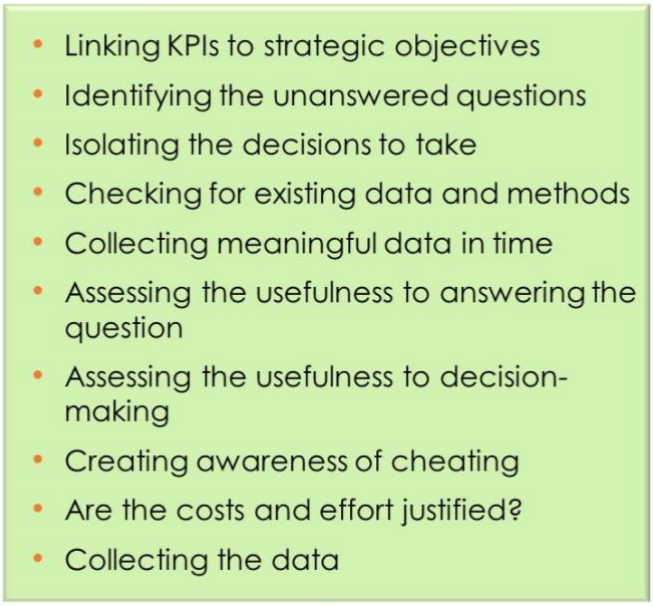


Figure 2.2 Ten steps that can be followed when choosing KPIs (Marr, 2015)

By following the steps in figure 2.2, a selection of an adequate number of suitable KPIs can be conducted (Marr, 2015). Likewise, Parmenter (2015) has presented a list of different techniques that can be used to select KPIs. Some of these techniques are listed below:

- Remove unnecessary and duplicated measures
- Formulate the measure in a way that is clear and easy to understand
- Consider strengths and feasibilities with each measure
- Identify unintended consequences for the measures
- Decide what actions to take in order to minimize the unintended consequences

Questions that can be considered when developing and selecting KPIs are for example What is good performance and how can it best be measured? and What is poor performance and what type of measure could provide warnings of this? (Parmenter, 2015). According to Parmenter (2015) it is important to have nonfinancial measures and measure frequently. It also has to be clear what the measures and the results should be used to and that the measures encourage appropriate behaviour (Parmenter, 2015). Additionally, Parmenter claims that testing the KPIs is an important step in the selection process.

There are some factors that should be considered when developing KPIs (Collin, 2002 in Chan & Chan 2004). For example, the KPIs must be measured in a systematic and consistent way in several projects to be able to use the measures to improve the performance and make comparison between different projects. In addition to this, the KPIs should not be too complex or difficult to measure since this may result in a resource-consuming process, instead the collection of data to the KPIs should be as simple as possible. All members in an organization must both understand and accept

the KPIs if the measurement of performance should be effective (Collin, 2002 in Chan & Chan 2004). To decrease the impact of variables that is specific for one construction project, many different projects is required in the measurement (Collin 2002 in Chan & Chan 2004). The results of the KPI measurement needs to be visualized in a simple and understandable way that is easy to update and access, and the KPIs used may also need to be developed and refined with time (Collin 2002 in Chan & Chan 2004).

A common mistake when developing KPIs is to focus on what everyone else are measuring instead of what is actually needed in the organization (Marr, 2015). Richmond et al. (2016) asserts that there are three main challenges when conducting comparable measures for the construction sector. One of them is the change in environment of where the production takes place. Another is the in- and outputs which are rarely well-defined and when the sources are not reliable, the measurement loses its value. Finally, measurement methods differ in details of how the data is collected but also the definition of the measures (Richmond et al., 2016). Therefore, a clear standard is needed. Josephson (2013) claims that to be able to compare measurements within the construction industry, concepts related to cost and area needs to be unified.

2.2.3 Compilation of KPIs and the Needed Data

When KPIs have been identified, a decision of how they should be compiled and how the data should be collected is needed (Parmenter, 2015) & (Marr, 2015). To be able to use KPIs they must be organized in a clear and constructive way (Marr, 2015). The data needed for measurements must be easy to collect and require low input. Construction projects often lasts several years which asserts that the process have to be measured several times to create a view of how well the project is doing which make the measurement expensive (Josephson, 2013).

To collect the selected KPIs and the data needed, Parmenter (2015) suggests that a matrix can be used. An important aspect when developing a matrix is that it should be accessible for the employees within the organization and be easy to use and understand. Parmenter (2015) presents an example of a layout where the KPIs identified can be collected, see figure 2.3. The matrix presented provides information needed about the measures. For example, the name of the measure, who is responsible for the measure, the frequency of the measurement, suggested targets, and the origin with the measure. Other aspects that can be included in the database are for example how well the indicator describes the performance and how measurable the indicator is (Parmenter, 2015).

Name of Performance measure	Type of measure (KRI,RI, PI, KPI)	Person responsible	BSC perspectives	Time Zone (Past, Current, Future)	Frequency of measurement (24 by 7, daily, weekly, monthly)	Suggested target	Origin of measure (Name of critical success factor / success factor)
Number of initiatives **implemented from** the quarterly rolling key customer survey	PI	John Doe	CF	Past	Weekly after survey (stop after 10 weeks)	All initiatives implemented within 3 months of survey	Retain key customers, Increase repeat business from key customers
Late planes, more than two hours late	KPI	Susan John	F, CF,E&C IP, SS, I&L	Current	24 by 7	<3 per week	Timely arrival and departure of planes
Number of initiatives **to be implemented** to get planes on time	RI	Basil John	CF,IP,F,E&C	Future	Weekly	>3 per month per team	Timely arrival and departure of planes
xxxxxxxxxxxxxxx xxxxxxxxx	PI	xxxxxxx	xxxx	xxxx	xx	xx	xxx

F = Financial Results CF = Customer Focus, E&C = Environment & Community, IP = Internal Process,
SS = Staff Satisfaction, I&L = Innovation & Learning

Figure 2.3 Example of a compilation for the selected KPIs and the needed data (Parmenter, 2015). The information presented in column 2, 4 and 5 will not be used in this thesis.

Marr (2015) present a template similar to Parmenter's database where data of the selected KPIs can be collected. Information included in this template are for example the strategic objective connected to the measure, the key performance questions the measure will answer, the name of the KPI, the formula, target, source of data, frequency of data collection and who is responsible for the measure, etc. Additionally, Marr (2015) suggests that aspects like possible unintended consequences with the measure and needed resources can be included in the template.

2.2.4 Unintended Measurement Consequences

Parmenter (2015) claims that all performance measures can include unintended consequences. Poorly designed measures can result in impaired, rather than improved performance (Parmenter, 2015). When a measure is used, the focus may shift from aspects that is not measured. Additionally, Parmenter (2015) asserts that when measures are resulting in rewards or different kinds of penalties for the staff, this may cause a behavior where the staff only focus on the result of the measure, and not what is best for the business.

Marr (2015) claims that a common mistake when developing and implementing KPIs is that too much information is collected without any plan on what the information will be used to. It is not only time and cost consuming to collect data that will not be used, it also creates frustration among the people that collect the information. According to Tahviladeh (2015), who has studied general information collection from citizens in politics, there are some risk that have to be considered in an information gathering process. When satisfaction of the participants is measured, information of opinions and experiences is collected (The KPI Working Group, 2000). There might be an underlying expectation that the information gatherer will act in accordance to the opinions but there might not always be an intention or a possibility to make any changes (Tahviladeh, 2015). This could lead to an inevitable disappointment among the people (Tahviladeh,

2015). Therefore, it is important to have a plan on what the information gathered will be used for and to know that there is a risk with collecting information from other participants.

2.3 Appropriate KPIs for Construction Projects

According to Josephson (2013) there is a need for further developed measurements in construction. Chan & Chan (2004) have investigated if there are KPIs that can be used to measure the success in construction projects by measuring performance. The basic criteria related to project success is time, cost, and quality, as mentioned in section 2.1, but there is an increased interest in other criteria as well. Health and safety, the satisfaction of participants and financial aspects are some examples of what should be considered when developing KPIs aswell (Bhatti et al., 2014) & (Chan & Chan, 2004) & (The KPI Working Group, 2000). Additionally, Chan & Chan (2004) claims that the environmental performance should be considered, and The KPI Working Group (2000) mentions change orders as one of the main groups of KPIs that should be considered. Finally, there is also a need for suitable productivity measures in construction projects (Josephson, 2013).

2.3.1 Time

The time criteria can concern the time it takes to complete a project (Chan & Chan, 2004), but also the lead time, delivery lead time, due date performance or frequency of delivery (Bhatti et al., 2014). In Chan & Chan's (2004) research, three different formulas concerning time is presented; construction time, time variation and speed of construction, see table 2.1. The construction time is calculated as the total time, in days or weeks, from the start on site until it is practical completed. The time variation is a measure of the increase or decrease in time compared to the estimated time and expressed in percentage. The impact of the extension of time (EOT) that the client has granted is discounted in this measure. The speed of construction is calculated by dividing the gross floor area by the time of construction measured in days or weeks. Additionally, The KPI Working Group (2000) states that there are more aspects to consider in regard to time. For example, time for different parts of the project process, not only the construction phase. The KPI Working Group asserts that one aspect that could be taken into account is how well the predicted time plan aline with the time consumed in reality for the different stages of a project. This can be done by dividing the actual time by the planned time as shown in table 2.1 and the information can be used to do better estimations in the future.

Changes in the scope of projects are often inevitable and they often add time to the time plan (The KPI Working Group, 2000). Similarly, the time it takes to fix problems or defects, either during the construction process or after the handover of a project, are aspects that are related to the timeframe and can be used as KPIs (The KPI Working Group, 2000). All projects have an estimated time frame, and as mentioned before, it is common that the estimated time is not consistent with the real time of a project. Therefore, time predictability is a measure The KPI Working Group (2000) recommend, see table 2.1. Time predictability can be measured on different aspects and for different phases of projects by studying how long it was planned to take to complete different tasks in relation to how much time that was actually consumed.

Table 2.1 Formulas of KPIs related to time

References	Measure (KPI)
Chan & Chan (2004)	$Construction\ time = Preactical\ completion\ date - Project\ commencement\ date$
Chan & Chan (2004)	$Time\ Variation = \frac{Final\ Construction\ time - Revised\ contract\ period}{Revised\ contract\ period} \times 100\%$ Where: Revised contract period = original contract period + EOT EOT = extension of time
Chan & Chan (2004)	$Speed\ of\ Construction = \frac{Gross\ floor\ area\ (sqm)}{Construction\ time\ (days\ or\ weeks)}$
The KPI Working Group (2000)	Time Change orders = Extra time needed from a change
The KPI Working Group (2000)	Time to fix defects

Note that the time included in each parameter should be defined since it might not be viewed the same by everyone involved (The KPI Working Group, 2000). Other aspects related to time that can be considered are for example; supply lead times, supplier delivery reliability, manufacturing lead time, standard run time, actual run time, wait time, setup time, move time and inventory turnover (Bhatti et al., 2014). However, these are more related to industries focusing on line production.

2.3.2 Cost

According to Bhatti et al. (2014), most stakeholders are focusing on the cost performance of projects. Therefore, cost is an important aspect that can be measured in the context of project success (Chan & Chan, 2004). It can be measured as the cost per unit or as the net variation of the final cost expressed in percentage as shown in table 2.2 (Chan & Chan, 2004). Cost related KPIs can include efficiency and effectiveness and be measured by using different cost accounting systems (Bhatti et al., 2014). Bhatti et al, (2014) claims that cost measurement should include manufacturing cost, value added cost, selling price and service costs. However, these are more linked to, and frequently used in, the line production rather than the construction industry.

Some cost measures include all the costs from the start of a project to the completion, such as costs of changes during the construction period or cost of litigations etc. and are not confined to the tender sum only, see table 2.2, (Chan & Chan, 2004) & (The KPI Working Group, 2000). Similar to the time aspect, the predictability for cost can be calculated (The KPI Working Group, 2000). For example, predicting the cost for different parts of the project phase, but also predicting the costs for defects occurring later in the production phase (The KPI Working Group, 2000). According to The KPI Working Group (2000), an aspect that often is overlooked is the annual operating and maintenance costs. This could be used to enlighten the end-user's perspective throughout the entire project process.

Table 2.2 Formulas of KPIs related to Cost

References	Measure (KPI)
Chan & Chan (2004)	$Unit\ cost = \frac{Final\ Contract\ sum}{Gross\ floor\ area\ (sqm)}$
Chan & Chan (2004)	$\text{Net variation} = \frac{\text{Net value of variation}}{\text{Final contract sum}} \times 100\%$ $\text{Net value of variation} = \text{Final contract sum} - \text{Base}$ $\text{Base} = \text{Original contract sum} + \text{Final rise and fall} - \text{Contingency allowance}$ EOT = extension of time
Chan & Chan (2004)	$Speed\ of\ Construction = \frac{Gross\ floor\ area\ (\text{sqm})}{Construction\ time\ (days\ or\ weeks)}$
The KPI Working Group (2000)	$Cost\ Change\ orders = Cost\ of\ changes$
The KPI Working Group (2000)	$Cost\ of\ construction$
The KPI Working Group (2000)	$Cost\ of\ litigations$
The KPI Working Group (2000)	$Cost\ to\ fix\ defects$
The KPI Working Group (2000)	$Cost\ in\ use = annual\ opperating\ and\ maintenance\ cost$

2.3.3 Quality and Participants' Satisfaction

A high customer satisfaction can increase the financial performance since it increases the loyalty of the existing customers and reduce the price elasticity (Bhatti et al., 2014). Therefore, Bhatti et al, (2014) claims that the highest focus should be on the ability to deliver on time and delivering the right quality of the product. When it comes to client satisfaction The KPI Working Group (2000) describes three main criteria. The satisfaction of the product, the process and the specified criteria. To measure the client satisfaction related to overall performance and specified criteria, The KPI Working Group (2000) have conducted a survey that can be handed out to the client (see appendix A). The client specified criteria consists of ten different criteria which the client can grade from most to least important, see table 2.3. The criteria of most importance get the weight of 10 and the least important criteria get the weight of 1. The client then gets to rate the criteria after the completion and the final score is calculated by multiplying the weight points with the scores, and divide the summarised value by 55, the total amount of weight points, in accordance with equation 2.1.

$$Final\ client\ score = \frac{\sum(weightpoint\ \times\ score)}{55} \qquad (2.1)$$

Table 2.3 The KPI Working Group's (2000) Client specified criteria

	Client specified Criteria	Weight point (by the client)	Score (1 to 10)
1	Low running costs	10	7
2	Bright and spacious working space	9	4
3	Low maintenance costs	8	8
4	Comfortable temperature all year round	7	5
5	Good sound insulation	6	2
6	Built on time	5	3
7	Built within budget	4	7
8	Large meeting rooms	3	5
9	Company-coloured decoration	2	10
10	Defect free at 'available for use' stage	1	6

Bhatti et al. (2014) claims that quality is the key success-factor for every organization, and that the organization that can produce the highest quality for the lowest prize will be the most successful. However, Bhatti et al, are not taking marketing or other aspects into account when making this statement. White (1996, in Bhatti et al., 2014) discussed that there are different dimensions of quality, for example; features, reliability, durability, aesthetics and perceived quality. Quality can be measured by looking at the number of quality issues (The KPI Working Group, 2000) or by weighing the defect on a scale from either 1-7 (Chan & Chan, 2004) or 1-10 (The KPI Working Group, 2000). This can be done by checking the quality of the input and output looking throughout the process (Bhatti et al., 2014). The KPI Working Group (2000) claims that quality KPIs can be conducted by measuring remaining defects at the handover date or the defects that are found during the warranty period. Those can be measured either by examine outstanding quality issues or all of them. The KPI Working Group define a quality issue as:

> An issue that affects the project so that work needs to be redone, modified or compromised to a lower standard than originally agreed. (The KPI Working Group, 2000, p. 17)

Additionally, The KPI Working Group describes three different types of qualities issues; Compromised, Reworked and Rejected. This asserts that different issues can be categorized by their level of seriousness and how to solve them. The Rejected work involves issues that need to be completely redone. Rework is when a task needs some changes in order to meet the agreed quality standard (The KPI Working Group, 2000) & (Bhatti et al., 2014). Compromised issues are the ones that the project group, or client, can accept to be of less quality than the agreed standard and therefore does not need to be redone or reworked.

2.3.4 Financial Aspects

According to Ashley & Alarcón (1996), value can be seen as a measure of the resulting business benefit from the project. Most construction projects are profit-oriented and all people involved are trying to maximize the profit. This makes value and profit an important aspect considering project success (Chan & Chan, 2004). Net Present Value (NPV) is the most common measure related to the financial achievement and the formula is presented in table 2.4, where the current cost is calculated in order to see what the investment is worth in the future. The KPI Working Group (2000) lists other measures that can be used as financial KPIs, see table 2.4. Most of these measures are well known, such as return on investment and the interest rate. The KPI Working Group provides measures to follow up the estimations that were made before the initiation of the project, such as interest rate and profit. The Profitability is a headline measure that can be used on the projects in order to see how well they are performing and since it is expressed in percentage it enables comparison between projects.

Table 2.4 Formulas of KPIs related to Financial aspects

References	Measure (KPI)
Chan & Chan (2004)	$NPV = \sum_{t=0}^{n} \frac{NCF_t}{(1+r)^t}$ Where: NCF = Net Cash Flow r = discount rate
The KPI Working Group (2000)	$interest\ rate$
The KPI Working Group (2000)	$\text{Profitability} = \frac{\text{Profit}}{Turnover}$
The KPI Working Group (2000)	$\text{Return of capital employed} = \frac{\text{Profit}}{Capital\ employed}$
The KPI Working Group (2000)	$Profit\ Predictability = \frac{Actuall\ profit - Planned\ profit}{Planned\ profit} \times 100\%$
The KPI Working Group (2000)	Time taken to reach final account

2.3.5 Health and Safety

Work environment is another criterion that can be included when measuring project success (Chan & Chan, 2004). Using safety as an indicator of success is reasonable because of the possible delays and financial losses resulting from accidents, but also be able to investigate the work environment (Chan & Chan, 2004). Safety can be calculated in different ways, for example by dividing the total number accidents by the total number of employees or hours worked, see table 2.5 (Chan & Chan, 2004). The KPI Working Group (2000) describes another way to measure health and safety by

looking at accidents, see table 2.5. Both the number of accidents with and without fatalities and the time that is lost due to the accidents can be measured. In order to make it easier to compare, these KPIs are measured per 100,000 hours worked, it can be measured either on a project or a headline level (The KPI Working Group, 2000). The accidents counted should not only include the parties at site but third parties as well. According to Bhatti et al. (2014) safety does not only depends on the work structure but also the technical arrangements. Meaning that the safety is dependent on how the work is carried out and how the safety information is spread at the workplace. The safety risks can be used as measures as well.

Table 2.5 Formulas of KPIs related to Health and Safety aspects

References	Measure (KPI)
Chan & Chan (2004)	$Accident\ rate = \frac{Total\ number\ of\ accidents}{Total\ numberof\ employees} \times 100\%$
The KPI Working Group (2000)	$Accidents = \frac{reported\ accidents}{100\,000\ hours\ worked}$
The KPI Working Group (2000)	$Lost\ Time = \frac{Lost\ time\ due\ to\ accidents}{100\,000\ hours\ worked}$

2.3.6 Environmental Performance

The construction industry has a large impact on the environment (Chan & Chan, 2004). Bhatti et al. (2014) claims that organizations owes responsibility to the society they operate in, and in extension the environment. The waste and scrap resulting from the production is of importance when creating sustainable projects and working towards a sustainable environment (Bhatti et al., 2014). This can be measured by counting how many projects that are environmental friendly. The ISO 14001 is a standard that gives environmental management guidance (Swedish Standards Institute, 2018). There are several other standards that can be used in order to ensure that a company is working with sustainability (Chan & Chan, 2004). The Pollution Control Ordinances can be more directly linked to the construction industry since it includes noise-, water-, air pollution, asbestos controls and the waste disposals (Chan & Chan, 2004). The different types of measures can be viewed together as an indicator of how well the company performs in an environmental aspect.

2.3.7 Change Orders

The number of changed orders can be measured in order to follow how many changes that have been made during the process (The KPI Working Group, 2000). The changes are made on the initiative of either the client or the project manager and measured in the number of changes made, see table 2.6 (The KPI Working Group, 2000). The cost and time difference resulting from the changes are linked to the number and the complexity of the projects and the measure can therefore be useful to follow the impacts of the changes.

Table 2.6 Formulas of KPIs related to Change orders

References	Measure (KPI)
The KPI Working Group (2000)	$Client\ change\ orders = number\ of\ changes\ ordered\ by\ the\ client$
The KPI Working Group (2000)	$Project\ manager\ change\ orders = number\ of\ changes\ ordered\ by\ the\ project\ manager$

2.3.8 Productivity

Compared to the production industry, the construction industry is often considered as an industry where the development of productivity is remarkable low (Josephson, 2013). The results and prerequisites of construction projects vary a lot from project to project and according to Josephson's study (2013), there is a need for suitable and useful measurement of productivity and disturbances linked to individual construction projects. Construction projects are often complex and includes unique prerequisites which causing difficulties when measuring productivity (Josephson, 2013). According to Josephson (2013) a large amount of data is required to get a true and correct view of the productivity when measuring. In addition to the large amount of data required, it is also difficult to define productivity and use it in a way that all the stakeholders involved find interesting and relevant in practice. Productivity does not necessarily mean the same thing to everyone involved, and it is therefore important to define if the productivity concept refers to the construction process, the use of the produced product, or the business that the product is produced for, when investigating productivity in construction projects (Josephson, 2013). According to Josephson (2013), a higher level of predictability is needed to increase the productivity in construction projects, but also the possibility to plan the whole process. Additionally, Josephson (2013) argues that a higher level of replication is needed to create an increase in productivity. To create a more predictable process which is possible to plan, disturbance must be minimized (Josephson, 2013).

Even though it is difficult to measure productivity and get a true and valid outcome from it, it is important to collect data that is related to productivity and use it to inspire improvement (Josephson, 2013). Productivity is usually defined as the ratio between output and input, see table 2.7 which according to Josephson (2013) is easier to use in the production industry where the replication is higher than in project-based organizations. Josephson (2013) asserts that other aspects, such as the cost of faults and the amount of disturbances, needs to be measured to complement the traditional way of measuring productivity. For example, Josephson (2013) uses the perceived free-of-disturbance as a complementary measurement and weather is an example of a possible disturbance. Faults can be related to planning, realization, coordination and communication. One problem with measuring the degree of free-of-disturbance by letting project managers rate how they experience the situation, is that the people that work in these projects may be so familiar with these disturbances that they do not consider them to be disturbances (Josephson, 2013). The KPI Working Group (2000) ranks productivity as business performances and measure productivity as company value added per employee as shown in table 2.7. Labour productivity can be calculated by dividing the profitability with the number of hours worked (Forsberg, 2008).

Forsberg emphasizes that it is important to know that the measurement in themselves does not enhance productivity, but they can imply that factors linked to the productivity needs to be changed in order to enhance productivity. Helmrich (2001 in Forsberg, 2008) describes three factors that can enhance productivity:

- Development of methods
- Improvement of performance
- Increase in utilization rate

Where the development of methods is the most common aspect in the productivity improvement. Performance or employee motivation is considered an important tool in productivity development work (Helmrich, 2001 in Forsberg, 2008). At the same time, it is important to remember that performance is not the only factor affecting productivity and working harder is not the only way to increase productivity. According to Helmrich (2001, in Forsberg, 2008), productivity can be measured by multiplying a value for method, performance and utilization rate, see table 2.7.

Table 2.7 Different definitions of productivity

References	**Measure (KPI)**
Josephson (2013)	$\frac{input}{output}$
The KPI Working Group (2000)	$\frac{Company\ value\ added}{employee}$
Forsberg (2008)	$\frac{Profitability}{hours\ worked}$
Helmrich (2001) in Forsberg, (2008)	$Method + Performance + Utilization\ rate$

3 Methodology

In this chapter, the methodology used to fulfil the aim with the master's thesis is presented and analysed. The methodology chapter aims to create a clear description of how the work has been carried out. The thesis is based on a literature study and an empirical study where different research methods has been used to collect data and obtain KPIs.

3.1 Research Approach and Design

In order to fulfil the aim, the thesis is based on a mixed theory research approach where qualitative and quantitative data has been integrated to create a more complete understanding of the problem formulation than by only using one of these research methods (Creswell, 2014). The Mixed Method is based on the explanatory sequential mixed methods, see figure 3.1. The first step included a broad collection of quantitative information and analysis of the information collected, and then a conduction of qualitative research was done to complement the quantitative information and create a deeper understanding of the problem (Creswell, 2014). The information has been collected thru a literature study, observations, discussions with company representatives and both internal and external documents provided by the company.

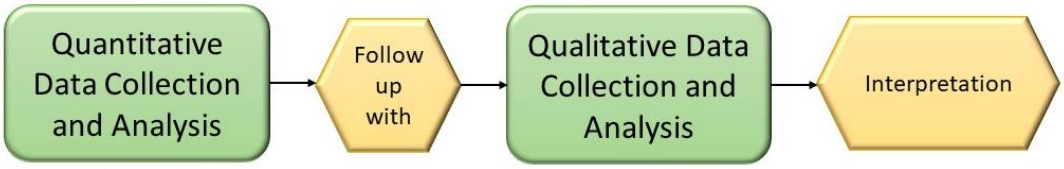


Figure 3.1 Collection and analysis of data in an Explanatory Sequential Mixed Method. (Creswell, 2014)

According to Creswell (2014) a quantitative approach is the most suitable when the aim is to identify factors which have impact on an outcome. Therefore, this was a suitable approach for this thesis. However, there is a limited amount of research of KPIs suitable for construction projects and according to Creswell (2014) it is meritorious to use a qualitative approach as well in such cases. It is not necessary to make the distinction between the two approaches since there are some aspects which are overlapping and others that are left out (Bryman & Bell, 2017). A mixed method, consisting of both a quantitative and a qualitative approach, was used in the conduction of this thesis.

To be able to add new material throughout the process, the abductive research strategy was used. This non-linear approach enables a continuous movement between the theory and the empirical study and the theoretical and empirical data can be seen as complementing rather than determining each other (Dubois and Gadde, 2014). The abductive method is favourable since the conducted KPIs can be developed tested and modified throughout the process in order to receive a valid and adaptable result.

3.2 Literature Review

A literature study was made in the beginning of the thesis to create a view of the topic and to put this thesis in a context. The literature study was implemented following the steps recommended by Creswell (2014). At first some key words were selected to locate useful material in the literature review. The key words used were:

Key Performance Indicators, Measurement, Measures in Construction, Project Success, Iron Triangle, Productivity

When the key words were identified, a search for relevant literature was initiated by using the databases Scopus, Summon, Google Scholar, physical libraries and suggested literature from the supervisor, Christian Koch. Approximately 40 different articles and books related to the topic were then chosen and skimmed. Of these initial articles and books the, for the topic, most interesting and relevant ones were chosen to collect useful literature. Thereafter, summaries of those where written, analysed and organised by important concepts to form the final literature chapter in this thesis.

All literature has been critically reviewed by examine if the authors provide critiques to their studies and discusses different views of their topic. Additionally, the relevance and reliability of the literature used has been discussed with the supervisor. Some of the investigated studies was conducted several years ago and can be considered old in the context. However, since they are not used for showing the present, but rather give examples of KPIs or how they can be used, the credibility is still considered valid.

3.3 Empirical Study

The data collected in this thesis was merely open-ended and, according to Creswell (2014), the qualitative approach is the most suitable for that. Therefore, the empirical study mainly has a qualitative approach. It was conducted at Flodéns and aims to identify complementary KPIs to the theoretical study. The information gathering was conducted by taking part of internal strategic documents, participation on strategy workshops and construction meetings, discussions with employees, and own observations from the encounters with the company. Initially, the strategic work and objectives in the company was investigated. Thereafter, KPIs complementary to the theory was identified and developed by studying the current workflow in different projects. Thereafter the suitability of the identified KPIs was investigated and tested based on the company's strategic objectives and the measurability of the KPIs. Finally, a selection of the most suitable KPIs for the company was conducted. Only KPIs that were considered general enough to be applied on different types of projects, and enable comparison between different projects within the company, was selected.

Bryman & Bell (2017) describes six steps in a qualitative research approach, see figure 3.2, which formed the basis for the empirical study. However, some alterations were done in order to fit the aim of this thesis.

Figure 3.2 Bryman & Bells six steps of a qualitative research approach (Bryman & Bell, 2017).

The first step, according to Bryman & Bell (2017), is to *create general research questions*. The research questions formulated in this thesis can be found in section 1.2. Suitable subject was *selected* to be recurring construction projects at Flodéns, in line with step number two in Bryman & Bell (2017). The *Gathering of data* was done through observations and information gathering from the company, discussions and both internal and external documents. The fourth step, *interpretation*, was done to see if the selected KPIs could be measured by using information gathered from the day to day operations without causing any big changes. In the fifth step, *Conceptual and theoretical work*, the data collected was compared with the findings from the literature study, in chapter 2. Additionally, some adjustments were done to the selected KPIs and the adaption to the organization was re-evaluated. The *Findings and Conclusions* was analysed in chapter 5 and compiled in a KPI matrix. Thereafter, the results were discussed in chapter 6.

3.3.1 Observation and Communication

To collect information of possible measures and what type of data that can be collected in the different projects, observations was performed. The focal point for the observations was to study the existing strategic work and to investigate if data for the KPIs could be gathered from the existing meetings or through a minor change. The observations in this thesis was done by joining meetings at different construction projects and attending strategy workshops during the spring of 2018. To investigate what information that can be collected without any major change in the meeting content, the observations were nonparticipant and followed the structure of the meetings and workshops in accordance with Bryman & Bells' (2017) descriptions of how nonparticipant and semi structured observations should be conducted. Additionally, some documents were gathered in connection with the observations in order to get additional information, such as meeting protocols and documents of protection- and environmental rounds etc.

Additional information was gathered from external sources, such as Flodéns web page and other public sources, and internal documents received from the company. Two internal strategy documents provided by Flodéns were used in order to gain knowledge

about the strategic work and the goals for the company. A strategy workshop with the management and white-collar workers at Flodéns was joined in order to gain a deeper understanding of the employees' interpretation in the strategy work. Furthermore, information and knowledge about Flodéns and the workflow was gathered from Ronnie Forsberg[1], a work manager at Flodéns, referred as Forsberg in this thesis, and Rolf Albriktsen[2], a strategy consultant working with Flodéns, referred as Albriktsen in this thesis. The dialogue was done through regular meetings, emails and spontaneous discussions at Flodéns office.

3.4 Processing of Collected KPIs

An identification of KPIs based on the literature study and empirical study was conducted and followed by a selection based on *integration*, *differentiation*, *ambiguity* and the fit with the company. *Integration* was used to remove similar KPIs by deselecting or merging similar ones. *Differentiation* was used to remove KPIs that are the exact opposites of each other since they will result in the same information. *Ambiguity* was used to remove KPIs that were overlapping, in order limit the number of KPIs and ensure that they are unequivocal. The final step in the selection process was the fit with the company and the data that they already are gathering or is easy to start gathering, in order to make the measurement process as useful and resource saving as possible. The selection of KPIs was done with guidance of Albriktsen, Forsberg and Koch.

The final collection of KPIs was then summarized in a matrix together with information needed to facilitate the measure process. For example, from where the data is collected, how often it is collected and a target. This was later delivered to the company to enable them to initiate an implementation.

3.5 Ethics

There were no obvious ethical issues in the conduction of this thesis. Since the thesis aims to help in the development of strategic work at Flodéns they have no reason to hide what could be considered flaws in the organization. However, it is inevitable not to question the existing strategy and there might be a split view of what is considered constructive criticism. Still, the authors of this thesis believe that the information presented is chosen unbiasedly and that the critique presented should be seen as constructive. Additionally, during the development of the thesis one of the authors, accepted a job offer at the company and will start her employment after the completion of this thesis. This could have had some impact in the unbiased view in the conduction of this thesis.

[1] Forsberg, Ronnie. Work manager at Flodéns. Mixed communication and supervision. 2017-11-27 - 2018-06-01

[2] Albriktsen, Rolf. Strategy consultant. Mixed communication and supervision. 2017-11-27 - 2018-06-01

4 Empirical Data Collection at Flodéns

The empirical part of this thesis was conducted at Flodéns and aims to identify and develop complementary KPIs to the theoretical study. In order to identify and thereafter select suitable KPIs for the company, the current workflow and strategy work was investigated and project success according to Flodéns was defined.

4.1 Introduction to Flodéns

Flodéns is a construction company that was founded over 90 years ago, see figure 4.1, by the building contractor Valfrid Flodén (Historical document, 2018). The company was registered as a limited company 1961 and 1989 the company was bought by Ernst Rosén. In the end of 2008 the management of the property portfolio and the construction operations was split. The property portfolio was allocated to Ernst Rosén while the construction operations continued at Flodéns. In 2011, the focus was changed to develop the built share and increase the proportion of self-developed projects. 2015 the ownership was expanded and the construction group bought 50% of Flodéns from Ernst Rosén. In 2017 Ernst Rosén bought the Building Group's share back and Flodéns was once again fully owned by them. However, in the autumn of 2017, 12 employees became part-owners and Ernst Rosén now owns 56%. The company's goal of creating a co-owned company is to strengthen the corporate culture and to promote a positive development (Flodéns, 2018f).

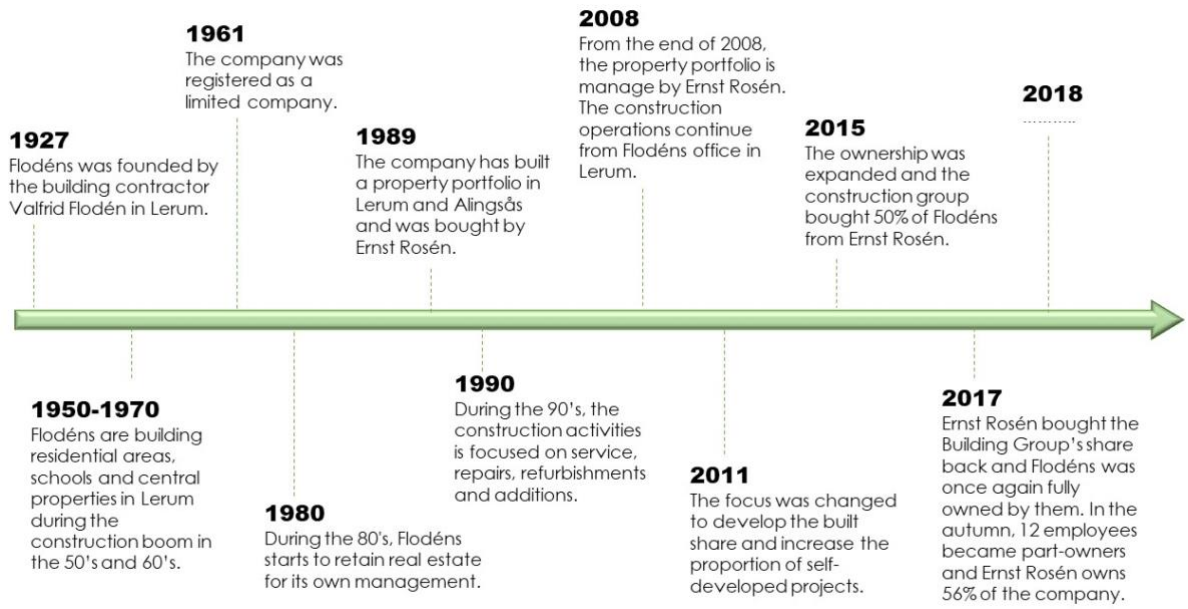


Figure 4.1 A timeline of Flodéns' history. (Historical document, 2018)

Between 2014 and 2017, the number of employees increased from 33 to 50, see table 4.1 (allabolag, 2018). During these years, the turnover has increased from 84 million SEK to 442 million SEK and the profit increased from -2,03% to 4,03% (allabolag, 2018).

Table 4.1 Key figures for Flodéns from 2014 to 2017 (allabolag, 2018)

Key figures	2014	2015	2016	2017
Number of employees	33	25	44	50
Turnover (KSEK)	84 169	65 002	305 584	441 685
Profit (KSEK)	-1 675	895	9 346	17 793
Assets (KSEK)	26 803	34 138	67 841	123 559
Profit margin (%)	-2,03	1,44	3,07	4,03
Solidity (%)	4,51	18,57	20,00	22,14
Liquidity (%)	100,21	120,80	122,87	128,00

Flodéns business idea is partly to develop and manage construction contracts, but also to develop and maintain buildings (Flodéns, 2018d). Three words that aims to describe the organization's values have been identified and are presented on the company's webpage together with a short meaning of the words (Flodéns, 2018d). *Helpful* implies that the people in the organization has a humble approach and uses each other's knowledge and experiences, but also that they are creative and prestige less (Flodéns, 2018d). *Loyal* means that they care about their suppliers and clients, and also that they rejoys each other's success. *Capable* implies that they are competent and possess great experience of the industry, but also that they value a respectful attitude towards both their clients and each other's (Flodéns, 2018d).

Flodéns are working with different types of projects and the current projects are; new construction and refurbishment of schools, refurbishment of both apartment buildings and offices, and new build of apartment buildings (Flodéns, 2018b). Currently Flodéns are working with three school projects, and since 2016 they have finished two other school projects and have another that will start soon (Flodéns, 2018c). The typical school project has a public client and are following the public procurement act. All the previous, current and upcoming school projects are design-build contracts and at the moment 55% of the orders in stock are generated by these projects (Flodéns, 2018b). Refurbishment of apartment buildings are also a common type of projects at Flodéns (Flodéns, 2018b). They are generating 22% of the total turnover and the two ongoing projects are procured as design-build contacts in collaboration (Flodéns, 2018b) & (Flodéns, 2018c). The clients for these types of projects are private and a mix of returning and new clients (Flodéns, 2018c). In the majority of the projects at Flodéns, the subcontractors are procured with a fixed price (Forsberg). Flodéns have a group of own carpenters which are used in some of the projects. However, in order to create uniformity in the measurement process those contractors are seen as one of the subcontractors for that specific project.

4.1.1 Strategic Work at Flodéns

To encourage continued development within the company, the strategic work has been in focus in recent years. In 2015 a strategy consultant, Rolf Albriktsen, started to work with strategic advice and analysis for the establishment of entrepreneurship at Flodéns. Previously Albriktsen was the director of strategy and market at Veidekke ASA, a position he had for almost 20 years. Additionally, Albriktsen was a visiting scholar at the department of economics at Stanford university 1984-1985 and has continuous involvement in research projects for SINTEF Building and Infrastructure, a Norwegian institute for building research.

In order to achieve the company vision, a set of performance measures was established in the company. The measures and the long-term goals are shown in table 4.2. For example, Flodéns are aiming for a profitability of 7% and that the overhead costs are less than 4% of the turnover (Strategy document, 2018a). The goal for satisfied customers are measured by looking at the ones that are returning, but there is no set time-period they have to be returning in. There is a high focus on the employees at Flodéns, and their wellbeing is measured by wanting to be top three as an appealing employer in the construction industry (Strategy document, 2018a). This ranking is based on the universum ratings for the construction sector in Sweden. Another long-term goal is to identify strategic and reoccurring suppliers and subcontractors, but there is no clear action-plan of how, or if, there should be a strategic collaboration between them and Flodéns. Albriktsen asserts that the strategic collaboration plan should be developed together with the strategic subcontractor or supplier, however there is no clear plan of how that type of collaboration should be used in the future.

Table 4.2 Some of the measures and long term strategic goals for Flodéns (Strategy document, 2018a)

Measure	**Long term goal**
Profitability	7 %
Revenue	1 200 MSEK
Solidity & Liquidity	> 30 %
Received Projects	> 50 %
Security	0 serious accident resulting in more than 14 days of absence
Client satisfaction	> 50 % returning clients
Quailty	100 % free from flaws at move in date
Well-being of emloyees	Top 3 as an employer
Complex Projects	Generating 50 % of the turnover

To reach these goals, sub targets have also been developed. Nearly all of the measures are linked to the projects that Flodéns are carrying out and in order to reach the targets, the projects have to generate outcomes in line with the goals. However, the measures that get monitored continuously at the projects are mainly financial (Forsberg). The other aspects from the projects are not measured during the process and the outcome is therefore difficult to anticipate and affect.

One of the strategic goals at Flodéns is to have a leading market position regarding the development of complex projects. The complexity can be dependent on aspects such as; size, tender sum, the location, specific solutions etc. (Albriktsen). Two years ago, school projects were regarded as complex projects at the company, but since a number of this type of project have been completed, they are no longer regarded as complex projects. Therefore, Flodéns has chosen not to define complex projects as a specific type of projects, but rather develop the definition in accordance to the previous experiences for the company and its employees.

Flodéns has developed an image that represent the direction of development that they are aiming for, see figure 4.2 (Strategy document, 2018b). The strategy should be embedded amongst the employees, through the value words that was mentioned earlier. The value words shall permeate both in the relation to the employees, clients, suppliers, owners and the society. As shown in figure 4.2, the development shall go through the employees towards the clients and suppliers. Flodéns believe that if they are focusing on the employees, it will transmit towards the clients as well in the development of successful projects. The society and the owners can be seen as guides in this work (Strategy document, 2018b). In order to fully use the competence in the company, Flodéns are involving the employees through the whole project process, from the selection of projects and the tender process all the way to the handover (Flodéns, 2018e). For example, they have a policy concerning quality, environment and workinvironmet, and are ISO 14001 certified.

Figure 4.2 Direction of development at Flodéns (Strategy document, 2018b)

4.1.2 Project Success According to Flodéns

In order to achieve project success, there is a need to define what the meaning of project success is at Flodéns. At the moment, they have three overall strategic goals (Flodéns, 2018d);

- The client is pleased with the collaboration and want to work with Flodéns in future projects
- Have a high volume of projects, continuous improvements and be profitable
- Have a leading market position on development of complex projects

In other words, the strategy is focused on: client satisfaction, profitability, continuous improvement and development of complex projects. At present, there is a clear focus on the financial aspects regarding project success, but aspects regarding the work environment and sustainability are also of importance to Flodéns (Flodéns, 2018e).

Based on this information, project success has been defined as;

> *Develop and manage profitable projects in a way that creates satisfaction among the participants, both client, employees and subcontractors, and encourage both social and environmental sustainability.*

4.2 Information Gathering and Identification of Missing KPIs

Information about discussed topics at different meetings where collected and analysed in order to create a view of what KPI-data that can be collected at meetings. The information gathering was conducted by taking part of internal strategic documents, participation in strategy workshops, discussions with employees and own observations from the encounters with the company.

Time plan, problems, changes, protection- and environmental rounds and level of injuries are some examples of things that was discussed at the observed meetings and workshops. Every other week a protection- and environmental round is conducted at each project to prevent accidents and damage. Information that is collected at these round concerns the overall order on site, fire protection gear, work environment etc. Some of these inbound parameters could be used in safety measures, and since the data is already systematically gathered, there would not be an increase in workload to use it for KPIs. The time plan was one of the main focuses of the meetings and involved questions regarding the different tasks. If they were completed or if they were expected to stay on time, if a task was delayed a new estimation was made. This is also information that can be used in the KPIs regarding time.

Accidents are a recurring topic discussed at Flodéns, both in the projects and the overall strategic goals. The long-term goal is to have no serious accidents that result in more than 14 days absence (Strategy document, 2018a). Albriksen asserts that it would be interesting to measure all accidents in the construction projects, but also to distinguish the more serious accidents that results in absence as an own measure. In order to see how Flodéns work with the prevention of accidents a measure of "almost accidents" could be used. However, the information regarding safety risks on site is not a routine they have today and therefore the information gathering-process would perhaps be time consuming and difficult.

The management at Flodéns has a fair insight on the economy in the projects, and the economical parameters are regularly being followed up (Forsberg). Forecasts are made quarterly and they are followed up and reported to the head of the company. There is a payment plan for all the projects which describe what expenditures Flodéns have, and how much they will invoice the client each month (Forsberg). The incomes from the clients should cover the costs for the material, subcontractors, salaries and other expenditures, but it can be difficult to get a clear overview of how much money there is in a project at the moment. The liquidity in a project can give an indication or warning if the project is going in the wrong direction and too much of the money is spent (Albriktsen). Additionally, Albriktsen have conducted a measurement of the overall productivity for the company. The productivity is presented as the total added value in relation to the used resources (Flodéns, 2018b). This is calculated by taking all the incomes and subtract the expenses for subcontractors and materials and divide that with the total amount of hours work (Flodéns, 2018b). This definition of productivity can be used on a company level. However, it is not a suitable productivity measure on a project level since it is more of a measurement of Flodéns ability to create good business deals (Albriktsen).

The long-term strategic goals enlighten the wish to find subcontractors and suppliers that are interested in a more strategic collaboration with Flodéns (Flodéns, 2018e). There is also a goal to have satisfied clients and a survey is sent to the client in the end of every project (Forsberg). Since the survey only is used in the end of the projects, the information conducted can only be used to increase the satisfaction in future projects and not in ongoing projects. Additionally, Flodéns are sending out a survey on emails to the employees ones a year, that aims to investigate how satisfied the employees are. The satisfaction of subcontractors is not measured in the present situation but could be used as a KPI in the future. The satisfaction of the client and subcontractors during the production process could be measured by handing out a survey at meetings regularly. A survey consisting of client-specified criteria and a few questions can be used to measure and create the ability to make changes during the construction process in order to meet the client's expectations. Forsberg describes that it is common that the communication between different subcontractors is limited and that the white-collar workers sometimes have to act as intermediators. To be able to measure what the subcontractors thinks about the collaboration in the project, a survey similar to the one for the clients could be handed out. The questions in the survey could include; how the communication and collaboration between the parties is experienced, if the involved parties have all the information needed to execute the tasks, and to what degree the work is uninterrupted. An example of these types of surveys is found in appendix A.

Flodéns are using an operating policy concerning quality, environment and working environment (Flodéns, 2018e). This policy includes a list of goals they are working with in order to create a well-functioning and safe work environment. For example; the waste from the projects are sorted and taken care of in accordance with the sustainability policy (Flodéns, 2018e). To control the objectives regarding waste, measures such as total amount of waste and the amount of sorted waste can be used.

There are many deliveries to a project site and the white-collar workers on site must receive these deliveries. Additionally, some of the deliveries includes wrong or defective products. There is no clear picture of how much time that is spent on receiving deliveries in the projects at the moment. In order to investigate if time and money could be saved by combine some of the deliveries, it might be favourable to measure how much time that is spent on receiving deliveries. Even if some products can be bought cheaper from one supplier, the total price of the delivery could be higher if the supplier often deliver wrong or defective products, or if the deliveries often arrives late. Wrong or defective products results in the need of an additional delivery which have to be received by a white-collar worker. Therefore, a measurement including the time and level of correctness regarding deliveries could be developed. However, in some cases, it is more important to receive a critical product on time rather than to wait and get all the products delivered at the same time.

In the handover of the finished product, the client orders an inspector to make an inspection of the building to assure that it meets the quality agreements (Forsberg). Those inspection rounds often generate inspection issues that have to be solved. The issues found in these rounds can also give an indication of the quality of the product. One recurring criticism in the construction projects is that they leave the site before the product is totally finished (Albriktsen). The number and severity of the issues vary between different projects. One of the long-term goals Flodéns are striving towards is to deliver the products 100% free from defects. Currently, there is no systematically

monitoring of the number inspection issues or how much extra time and other resources that is spent fixing these issues. The evaluation of the projects is often done in connection to the handover, and the evaluation aspects often include time, cost and quality. However, when the quality is evaluated it is difficult to find hidden flaws or the flaws that occur after the commissioning. Albriktsen asserts that the quality of the product can be viewed in-regard-to warranty issues as well. For 2017 Flodéns allocated one million SEK for warranty issues (Flodéns, 2018g). The usage of that money indicates that there are warranty issues in the projects, but it is difficult to track the costs to the specific projects. To get a view of the quality of a specific product over time, the number of warranty issues could be measured, but also the time and cost resulting from them. The warranty issues may in some cases change the view of a project that, at the handover, was viewed as successful.

5 Analysis and the Finished KPI Matrix

A compilation of selected and deselected KPIs are presented in following chapter. The selection is based on the definition of project success according to Flodéns, measurability, resources consumption and how well the KPIs fit the organisation and the projects. An overview of the selected KPIs are presented followed by a more detailed description of them. In addition to the white-collar workers, Flodéns also has carpenters employed by the organisation. To make the measures general enough to be applicable in different types of projects, the carpenters at Flodéns are considered a subcontractor in the measurement.

5.1 The Final Matrix and Information Needed

The selected KPIs are compiled in a matrix together with information that facilitates the measurement process, see figure 5.1. Additional information needed about the project are:

- Type of project (residence, school, refurbishment, new construction etc.)
- Procurement method (Design build/Traditional/Collaboration)
- Original contract sum
- Final contract sum
- Original contract period
- Project commencement date
- Practical completion date
- Total agreed extension of time (EOT)
- Total agreed extension of budget (EOB)

	Name of KPI	Unit	Frequency	Goal / Vision	Source of data
MEASURED DURING THE PRODUCTION PHASE	Project Liquidity	%	Monthly	-	Internal economical documents
	Sorted Waste	%	Monthly	100%	Report from waste collector
	Change Orders	Number	Monthly	-	Meetings with subcontractors and client
	Absence	%	Monthly	0%	Internal documents
	Satisfied Client Index, SCI	-	Quaterly	10	SCI survey
	Satisfied Subcontractor Index, SSCI	-	Quaterly	10	SSCI survey
	Plan Reliability	-	Monthly	< 1	Time Plan
	Productive Time	-	Monthly	< 1	White-collar workers
	Free-of-Disturbance	-	Monthly	10	White-collar workers, SCI & SSCI
	Reported Accidents	Number/ Month	Monthly	0	Accident Reports
	Accident Resulting in Absence	Number/ Month	Monthly	0	Accident Reports
	Delivery Time	Hours/ Month	Monthly	-	White-collar workers
	Correct Deliveries	%	Monthly	100%	White-collar workers
MEASURED IN THE END	Product Quality	-	End of Project	10	White-collar workers & SCI
	Number of Inspection Issues	Number	End of Project	0	Inspection Reports
	Cost of Inspection Issues	SEK	End of Project	0	Inspection Reports
	Number of Warranties Issues	Number	End of Project	0	White-collar workers
	Cost of Warranties Issues	SEK	End of Project	0	White-collar workers
	Unit Time	Hours/ sqm	End of Project	-	Time reports and project information
	Unit Cost	SEK/ sqm	End of Project	-	Project information
	Time variation	%	End of Project	-	Time Plan
	Profit Predictability	%	End of Project	-	Economic documents and input data

Figure 5.1 The final matrix developed in this thesis including the selected KPIs and information that facilitates the data collection.

The goal/vision in the matrix are set as the most favourable outcome and can be changed depending on what is relevant to achieve in the current project. To create a resource saving measurement process, the frequency of the measurement is set as monthly or more rarely for most of the measures during the process.

5.2 Compilation and Description of Selected KPIs

The selected KPIs are described in following section. 13 KPIs intended to be measured during the production process, complemented by 9 KPIs intended to be measured in the final stage of the projects. Frequency, unit, source of data, goal or vision and potential

pros and cons with the measures are presented as well as the formulas by which the measures can be calculated.

5.2.1 KPIs Measured During the Production Phase

Following KPIs should be measured during the production process in a construction project. By measure some parameters during the production, the development of the projects can be controlled. The measurement may also indicate if something should change in order to achieve the goals in the project.

<table>
<tr><td colspan="4">Project Liquidity</td></tr>
<tr><td colspan="4">Describes how much money that is available in a project at a specific moment.</td></tr>
<tr><td colspan="2">+ Shows if there are enough money in a project at the time</td><td colspan="2">– Strongly dependent on the time of the measurement</td></tr>
<tr><td colspan="4">$$Project\ Liquidity = \frac{Money\ in - Money\ out}{Reviced\ contract\ sum} \times 100\%$$
Where:
Money in = Incoming money from the client
Money out = Payed invoices to the suppliers and subcontractors and also white-collar salaries
Reviced contract sum = current contract sum</td></tr>
<tr><td>Unit</td><td>% of the total cost</td><td>Source</td><td>Internal economical documents</td></tr>
<tr><td>Frequency</td><td>Monthly</td><td>Goal/Vision</td><td>Is set in each project. Can vary during the process depending on risks etc.</td></tr>
</table>

<table>
<tr><td colspan="4">Sorted Waste</td></tr>
<tr><td colspan="4">Describes how much of all waste that is sorted.</td></tr>
<tr><td colspan="2">+ Can be beneficial to measure if the project is aiming for an eco-labelling or want to increase the sustainability status</td><td colspan="2">– Does not show the total amount of waste
– Demolition waste is not included</td></tr>
<tr><td colspan="4">$$Sorted\ Waste = \frac{The\ amount\ of\ sorted\ waste}{Total\ amount\ of\ waste} \times 100\%$$</td></tr>
<tr><td>Unit</td><td>%</td><td>Source</td><td>Report from waste collector</td></tr>
<tr><td>Frequency</td><td>Monthly</td><td>Goal/Vision</td><td>100%</td></tr>
</table>

<table>
<tr><td colspan="4">Change Orders</td></tr>
<tr><td colspan="4">Shows how many changes that are made during the production process that results in rework, extra work, time or cost change. A change may occur as a result of a fault but is not necessarily linked to faults. A change can be requested by both the client, Flodéns and subcontractors.</td></tr>
<tr><td colspan="2">+ Can explain changes in schedule and final contract sum</td><td colspan="2">– Can be difficult to distinguish between faults and changes</td></tr>
<tr><td>Unit</td><td>Number</td><td>Source</td><td>Meetings with subcontractors and client</td></tr>
<tr><td>Frequency</td><td>Monthly</td><td>Goal/Vision</td><td>-</td></tr>
</table>

Absence			
Shows the percentage of absence of the planned working time for a project group due to disease, care of children, doctor's appointments etc. Only considers the white-collar workers at Flodéns.			
+ Absence-% is a good probing of the atmosphere and well-being in a department or in a project group		– Do not consider the reason for the absence – Absence is not necessarily connected to atmosphere or well-being	
$$Absence = \frac{Absence}{Planned\ working\ time\ for\ a\ project\ group} \times 100\%$$			
Unit	%	Source	Internal documents
Frequency	Monthly	Goal/Vision	0%

Satisfied Client Index, SCI			
Creates a view of the client's perception of the collaboration during the production process. The satisfaction is measured through a survey where the client can grade different client specified criteria on a scale from 1-10. Additionally, the survey includes a few claims concerning communication and cooperation between the parties that also should be graded. See Appendix A.			
+ Provides an indication of how satisfied the customer is with the cooperation during production + Provides an opportunity for the contractor to affect and influence the client's satisfaction during the process		– By collecting information about things that does not work that well, you are also expected to make some kind of improvement, which is not always possible – May require some extra time for data collection	
Compiled value from survey			
Unit	-	Source	see survey
Frequency	Quarterly	Goal/Vision	10

Satisfied Subcontractor Index, SSCI			
Creates a view of the average subcontractors' perception of the cooperation during the production process. The satisfaction is measured through a survey where the subcontractors can grade different claims on a scale from 1-10. The claims will concern communication and cooperation between the parties, well-being and prerequisites for realisation of their work. See Appendix A.			
+ Provides an indication of how satisfied the subcontractors are with the cooperation during production + Provides an opportunity for the contractor to affect and influence their satisfaction during the process		– By collecting information about things that does not work that well, you are also expected to make some kind of improvement, which is not always possible – May require some extra time for data collection	
Compiled value from survey			

Unit	-	Source	see survey
Frequency	Quarterly	Goal/Vision	10

Plan Reliability			
Shows how reliable the planning for a specific period is, for example a month. It is measured by studying the relation between performed and planned activities and a result < 1 means that the project is ahead of schedule and a result > 1 means that the project is in line with the schedule.			
+ Shows how well the time plan is kept + Makes it possible to improve the reliability of the time plan		– The result does not necessarily depend only on how good or bad the planning is, but may also depend on how good or bad the performance is – Does not consider activities that have been moved or removed during the measurement period for some reason	
$$Plan\ Reliability = \frac{Performed\ activities}{Planned\ activities}$$			
Unit	-	Source	Time plan
Frequency	Monthly	Goal/Vision	≤ 1

Productive Time (White-collar workers)			
Describes how productive the white-collar work at Flodéns is performed. Will be 1 if everything follows the plan. < 1 = more productive than planned, > 1 = less productive than planned.			
+ Can be used to see how the white-collar workers perform in relation to the time plan + May be useful in future planning to adjust or possibly add extra staff at periods with higher work load		– Based on estimations which not necessarily is consistent with reality – Can be affected by other factors as well and does not necessarily need to give an indication of how productive the performance is	
$$Productive\ Time = \frac{(Consumed\ time\ +\ Estimation\ of\ time\ left)}{Estimation\ of\ total\ time}$$			
Unit	-	Source	White-collar workers
Frequency	Monthly	Goal/Vision	≤ 1

Free-of-Disturbance
Shows how free-of-disturbance the production process is experienced. It is measured by grading a scale of experienced free-of disturbance from 1 to 10 where 1implies that there is lots of disturbances and 10 implies that the process is free-of-disturbances. The project manager for example will grade and the result will be compiled with the free-of-disturbance result from the SCI and SSCI surveys. Disturbance is defined as something that affects the project flow in a negative way. For example, faults, errors, ground conditions, extreme weather conditions, conflicts, etc.

+ Indicates how productive a project is	– It might be difficult to define what a disturbance is since it is based on a feeling – The result may vary depending on who is grading
Scale: 1–10	

Unit	-	Source	White-collar workers, SCI & SSCI
Frequency	Monthly	Goal/Vision	10

Reported Accidents			
A measure of all accidents at a project site, including accidents that hit third parties. Measured monthly in order to compare the safety between different projects.			
+ Provides a view of the working environment and the safety at a project site + Can provide a warning flag for dangerous project sites		– Only consider accidents that actually occur, and do not consider accidents that have been prevented, accidents that "almost happened" – Only reported accidents are considered	
$$Reported\ Accidents = \frac{Number\ of\ reported\ accidents}{Month}$$			
Unit	Number/Month	Source	Accident Reports
Frequency	Monthly	Goal/Vision	0

Accidents Resulting in Absence			
Accidents resulting in more than 14 days absence.			
+ Provides a view of the working environment and the safety at a project site + Can provide a warning flag for dangerous project sites		– Only consider accidents that actually occur, and do not consider accidents that have been prevented, accidents that "almost happened"	
$$Accidents\ Resulting\ in\ Absence = \frac{Number\ of\ accidents\ resulting\ in\ absence}{month}$$			
Unit	Number/Month	Source	Accident Reports
Frequency	Monthly	Goal/Vision	0

Delivery Time	
The total time it takes for the white-collar workers to receive deliveries.	
+ Shows how much time it takes to receive deliveries + Can indicate whether it is worth consolidating deliveries despite cheaper prices if divided between different suppliers	– Only an estimation of time and is not necessarily consistent with reality

$$Delivery\ Time = \frac{Time\ spent\ on\ receiving\ deliveries}{month}$$			
Unit	Hours/Month	Source	White-collar workers
Frequency	Monthly	Goal/Vision	-

Correct Deliveries	
The proportion of deliveries that arrive at the agreed time and contain the correct products free from defects. These components are weighed together to see how the correct a delivery is. An incorrect product also includes damaged and non-delivered products.	
+ Provides a view of how correct the deliveries are	– The criteria concerning time and correct products are weighed equally, which not always is the case. In some cases, it is more important to get parts of a delivery on time instead of getting the entire delivery at the same time. – It might be difficult to determine what is meant by agreed time and how late the agreed time can be changed – Products purchased in large quantities, such as plasterboards, will probably decrease the average value
$$Correct\ Deliveries = \frac{Number\ of\ correct\ deliviries}{Total\ number\ of\ deliveries} \times 100\%$$ Where: $$Number\ of\ correct\ deliveries = \frac{time + products}{2}$$ and: Time = 1 if the delivery is delivered at the agreed time Time = 0 if the delivery not is delivered at the agreed time $$Products = \frac{Number\ of\ correct\ products}{Number\ of\ ordered\ products}$$	

Unit	%	Source	White-collar workers
Frequency	Monthly	Goal/Vision	100%

5.2.2 KPIs Measuring the Final Product

Some measures are more useful in the final stage of a project. Following KPIs should be measured in this stage and provide an indication of how the project has been carried out. They also enable comparison between different projects.

Product Quality
Compilation of Client's views on the Final Product and number inspection issues. This is weighed together on a scale of 1 to 10.

+ Provides a compiled image of the quality of the final product	– Only an estimation and may therefore vary depending on who makes the estimate

$$Product\ Quality = \frac{Client\ satisfaction + Inspection\ issues}{2}$$

Where:
Client satisfaction = Scale 1 – 10, value from the Client-satisfaction in the SCI- survey
Inspection Issues = Scales 1 - 10 (site manager evaluates and compare the amount of inspection issues and how serious the errors are, where 1 is worst imaginable and 10 are best imaginable)

Unit	-	Source	SCI and White-collar workers
Frequency	-	Goal/Vision	10

Number of Inspection Issues			
Number of remarks on the final inspection			
+ Provides a picture of how many faults the building contains during final inspection		– Only consider the number of inspection issues and not the severity of them	
Unit	Number	Source	Inspection reports
Frequency	-	Goal/Vision	0

Cost of Inspection Issues			
Total cost of inspection issues for Flodéns, for example, material and any additional labour costs.			
+ Provides a view of how much money is spent to correct inspection issues		– Does not consider how long it takes to fix the issues – Does not consider additional costs for subcontractors	
Unit	SEK	Source	Inspection reports
Frequency	-	Goal/Vision	0 SEK

Number of Warranties Issues			
Total Number of Warranties for a Project.			
+ Provides an updated image of the final product quality		– Difficult to motivate measurement after completed project	
Unit	Number	Source	White-collar workers
Frequency	-	Goal/Vision	0

Cost of Warranties Issues	
The cost for Flodéns to correct the warranty issues. This does not count the cost of fixing warranty issues that Flodéns are not responsible for, for example, defective appliances or wrong floor closure, as this will be forwarded to suppliers or responsible subcontractors.	
+ Provides a view of how much money is spent on warranty issues	– Difficult to motivate measurement after completed project

Unit	SEK	Source	White-collar workers
Frequency	-	Goal/Vision	0 SEK

Unit Time			
Shows how much time white-collar workers have spent in a project. More complicated projects can be expected to gain a higher value.			
+ Provides a clear comparison between different projects		− Does not consider the complexity of the project	
$$Unit\ Time = \frac{Total\ time\ spent\ by\ white-collar\ workers}{Gross\ floor\ area\ (sqm)}$$			
Unit	Hours/m^2	Source	Time reports and project information
Frequency	-	Goal/Vision	-

Unit Cost			
Final contract sum divided by total floor area.			
+ Provides a clear comparison between different projects		− Does not consider the complexity of the project	
$$Unit\ cost = \frac{Final\ contract\ sum}{Gross\ floor\ area\ (sqm)}$$			
Unit	SEK/m^2	Source	Project information
Frequency	-	Goal/Vision	-

Profit Predictability			
Measure how well the planned profit corresponds to the actual profit at the end of the project.			
+ Indicates how well the profit has been estimated + Can be used in the estimation of profit for similar projects		− Does not consider changes made during the project	
$$Profit\ Predictability = \frac{Actual\ profit - Planned\ profit}{Planned\ profit} \times 100\%$$			
Unit	%	Source	Economic documents and input data
Frequency	-	Goal/Vision	-

Time Variation			
Measures the percentage variation of the production time in relation to the planned production time.			
+ Shows how well the production time has been estimated		− Only considers the client's time limit	

$$Time\ Variation = \frac{Final\ Construction\ time - Revised\ contract\ period}{Revised\ contract\ period} \times 100\%$$

Where:
Revised contract period = original contract period + EOT
EOT = extension of time

Unit	%	Source	Time plan
Frequency	-	Goal/Vision	-

6 Discussion

Following chapter includes a discussion of the findings in this thesis. Advantages and unfavorable results of measurements are discussed, but also the validity and influencing factors for some of the selected KPIs. Additionally, the current strategy at Flodéns are discussed and factors that needs to be considered when using the KPIs are presented. Finally, a discussion about the reliability of the literature used and how the method may have affected the results is presented.

6.1 Discussion of Measurement and KPIs

Why should a company put resources on identifying, developing and conducting measurements if everything is going great? This is a complicated question. The turnover and profit shows that Flodéns are developing and continue to deliver better results each year. One argument to put resources on measurement even though there seems to be no clear need for it, is that it can help finding out why it is going in the right direction and apply that knowledge on all projects. Positive outcomes can depend on many different factors, the employees within the company may be one of them. If a company only consists of skilled and ambitious employees, the business is probably good. However, it could be risky to only rely on the employees' skills. Measurement can be used to guide the management to reach project success, and even if the employees are skilled, they might be skilled in different aspects. To ensure good performance in all aspects in all projects, measures can be a useful tool. The employees are important to Flodéns and they are expected to carry and convey the company's values. Additionally, the company may not always perform as planned, and if a standardized measurement was implemented during the "good times" it could possibly help the company to investigate the reason for impaired performances. Measure can provide a guidance in the search for solutions and arrangement to improve the performance. Another reason to spend resources on measurement is that experiences should not always be trusted on their own. It might feel like the company is performing in accordance to the goals but there could still be room for improvements. By measuring and keeping track of the most important aspects, a better view of the performance is created. However, there are weaknesses in measurements and they need to be considered in order to make the measures as useful as possible. For example, measurements can affect the employees negatively if they feel that the measurements are used to control their performance and implicates a limitation to their freedom in their work.

Construction projects are often viewed as unique with varying prerequisites and objectives. This makes it difficult to compare different projects and increase the productivity in the workflow. However, there are some aspects of repetition in all construction projects and the degree of repetition can depend on the individual approach. The finished projects can be seen as unique but the inbound parameters during the construction phase are often the same or similar. All constructions are made of steel, wood, concrete or a combination these materials and most buildings are compounded of walls, floors, and roofs. As mentioned in section 2.4.8, Josephson (2013) asserts that a higher level of replication and predictability is required in order to increase the productivity. Flodéns have a desire to be profitable and one way to increase the profitability is to increase the replication and productivity.

Since it is difficult to standardise the production process in construction projects and increase the level of replication, a standardised measurement could be used to create an opportunity to control and compare the process and results between different projects. Weather and ground conditions are two examples of prerequisites which are difficult to anticipate and may have big impacts on new production project in form of disturbances etc. Another example is the condition of, and knowledge about, the existing building in refurbishment projects. These are common aspects that have to be considered and handled in construction projects and contributes to a lower level of predictability and replication than in other production industries. Because of the challenges of producing outside without any weather protection, and not knowing exactly what will be found when the digging commences etc., a tool that helps creating a clearer view of when and how different disturbances starts to affect different aspects in the process could be favourable. Other disturbances, such as conflicts between different parties or accidents may also have a big impact on the process. Even if the management in a project is aware of that disturbances can affect the process, it can be useful to have a clearer view of how, and how much. If different aspects of the performance were measured, it could also help identify risks and preventing these risks to develop into bigger problems.

As mentioned in 2.2.3, Richmond et al. (2016) asserts that the definition of measures and how the data should be collected differs between different companies and in order to compare within the industry and between different projects, a clear standard of measures is needed. If there was a clearer standard for measures within the industry, the opportunity for competitiveness would increase. The standardisation should include a definition of units and a clear description of how, and from where, the data is collected. If the measures used are well developed and clear, the performance will show, and no one can pretend that their project performs better than it does. There can be parts of a project that performed well, but on the cost of other important parts of the project. If the measures cover the significant aspects in a project, there is no way to hide unfavourable parts and only highlight the ones that are successful. Measurement can visualise the performance in a clearer way.

Focus and motivation can be created by measuring different parameters. One can argue that measurement is needed to be able to control an organization. If you do not know exactly what the current status is, it is difficult to control and improve the performance. On the other hand, it may not be the measures themselves that generates the improvement, but rather the newly created focus. By selecting measures connected to the most important aspects in a project, a re-prioritization of the time could be done. Additionally, measures visualise results in a clear way which can contribute to an increased effort on the aspects that affects the measure results. People may want to perform better when the results of their work is visualised for other people. However, a risk of using KPIs is that in some measures there might be possible to manipulate the results in different ways to enhance the image of a well performing project. If good performance results in rewards, the urge to produce better KPI results, or hide the bad ones, might be higher than the will to actually improve the performance. For example, when measuring the productive time, the estimations can be modified in order to get favorable results. *Free-of-disturbances* are also based on estimations and can therefore be manipulated in order to create a better result. Another example is the reported accidents, if there is a reward to the project with few accidents, the management could discourage the reporting of the accidents rather than spending time on the prevention of accidents in order to get a better result. To avoid manipulation of KPI results, it might

be favourable to avoid rewards and penalties. Instead both good and bad results could be used as guidance in the continuous improvements in the strive towards project success.

As mentioned, there are several advantages of creating a focus on important aspects by using measures, but this focus could also lead to sub-optimizing. When a focus on an important aspect is created, the bigger picture can sometimes be forgotten. This could contribute to that things that already work well in a company gets less focus and thereby impaired results. Therefore, it is important to not only focus on the things that does not work and needs to be improved, but the overall performance. It is important to measure the aspects that already are meeting the goals as well. If these results would deteriorate it may also be favourable to have data of the same measures from when the results were good. Furthermore, the influencing factors can be compared and an investigation of what has changed can be conducted.

Continuous monitoring of projects can be helpful in the evaluation of projects at Flodéns. Many projects are evaluated at the end and since is it easier to remember the most recent events, it is difficult to properly evaluate the entire process. If the evaluations are used as a foundation to make changes in order to produce better or more efficient projects, it can be favourable to examine different aspects. The evaluation can either be done more frequently throughout the process or the measurements can be used as a reminder of the performance in the earlier stages of the process. KPIs can be used as a common language in discussions regarding the performance of the projects at Flodéns. Not only does it enable the comparison between different projects, but it also creates a clarity in the discussion since the involved parties share the same image of what is being discussed. However, there is a risk associated with using KPIs as the only foundation to the discussions. Some of the KPIs are weaker, more ambiguous or easier to manipulate and if they are the only focus of the discussion, the discussion loses credibility.

As mentioned in theory, project success can be viewed as; *the set of principles or standards by which favourable outcomes can be completed within a set specification* (Chan & Chan, 2004). The definition of project success should be the foundation for the KPIs since they are supposed to track the development towards it. Flodéns had no outspoken definition of project success. However, the general idea was presented in section 4.1.2. The selected KPIs should represent and be able to measure the progress for those objectives. One of the objectives at Flodéns include profitability which can be measured by keeping track of the financial aspects of the projects, but it can also be linked to the productivity. If the productivity increases and the price stays the same, the profitability can increase. Especially if the productivity is calculated in accordance with Flodéns and Forsberg (2008), by dividing the profitability with hours worked. In section 2.3.8 additional definitions of productivity was mentioned, Josephsson (2013) describes it as the ratio between output and input, The KPI Working Group (2000) asserts that it is the company value added per employee. However, Albriktsen asserts that Forsberg's (2008) and Flodéns productivity measure can be seen more as a measure of the ability to create good business deals. Meaning that if Flodéns can generate more money simply by being able to get paid more for the same work. Thereby the productivity measure will show a better result regardless the actual performance. Josephson's definition of productivity can be seen as more directly linked to productivity but is difficult to use in practice since there are many inconsequent inputs and outputs, and some of them can

be difficult to define. Josephson mentioned that, in order to get legitimacy in the measure, a big amount of data is required, and it is often resource demanding and difficult to collect. A standardized measurement of productivity should be conducted to ease the process. Unfortunately, the complexity of the construction projects aggravates the conduction of a measure that can be used on different stages and in different types of projects.

Some of the selected KPIs are based on estimations or impressions. This may contribute to a reduced reliability of the results. Estimations are, just as the word implies, only estimations and do not have to correspond with reality. This may result in inadequate results which in turn can be misleading in decision making. However, in order to measure important aspects, estimations may be necessary in some cases. In order to avoid inadequate and misleading results, it is therefore important to make estimations carefully and use all the available information that can improve the validity. The validity can increase if the estimations are based on more than one person's opinion. *Plan reliability*, *Productive Time* and *Delivery Time* are examples of KPIs that are based on estimations but can be used in order to control the performance regarding planning, productivity and deliveries if the estimates are accurate. KPIs that are based on an experienced feeling, such as *SCI*, *SSCI* or *Free-of-Disturbance* may also result in inadequate results which can be misleading in decision making. An experienced feeling does not only depend on the current situation in a project, which the measure aims to investigate. It can rely on many different factors and can vary depending on who communicates the experienced feeling. Aspects that can affect the in-data in these types of measures are for example a specific person's opinions and values, earlier experiences in other projects or other personal aspects, the current mood which can depend on a specific happening which may not have any connection to the project, etc. This means that the measures are strongly dependent on the person that is communicating the information, and therefore it may be important to consider what aspects that may have influenced the results. The result may also be more reliable if there are more people that communicates the experienced feelings. If there are several similar experiences, it may indicate of something that corresponds to reality.

The SCI and SSCI KPIs are both measured through a survey which is handed out to the client and subcontractors during the production process. The survey is conducted during meetings and includes criteria and questions the client and subcontractors have to grade and answer. This can be considered a time-consuming process and the client and subcontractor may not agree on the importance of the measure. When collecting this information, a frustration amongst the participants can be created. If there is no clear use for the collected information, it might seem unnecessary to spend time on it. It is therefore important that Flodéns communicate what the information will be used for and why it is favourable to collect it. On the other hand, the client and subcontractor can find it pleasant that they are asked to communicate their experiences and thoughts about the collaboration in the project. In that way, Flodéns show that they value their relationship with them highly and that it is important for them that it works well. This can create a feeling of importance among the subcontractors which could lead to a better work and a well working collaboration. If the collaboration works well, this can result in continuing collaboration in the future, which is a long-term goal for Flodéns. The SCI and SSCI surveys presented in this thesis, see appendix A, are based on the survey presented by the KPI Working Group (2000), but was modified in order to match Flodéns needs and success factors. These surveys are not tested and might therefore

need some changes when they are implemented. The client specified criteria are decided in the beginning of each project in order to make the measure as valid and tailored as possible.

Some of the KPIs may have to be fragmentized into more specific and detailed measures in order to give a clearer picture of the situation. An example of a KPI that could be fragmentized is the one that measure how free-of-disturbances a project is. By specifying a disturbance, the measure would tell exactly what is measured and it would be easier to identify suitable actions that can be taken in order to improve or prevent unfavourable results. This KPI could possibly be fragmentized when common disturbances have been identified. An advantage with a general disturbance measure is that it creates an overview of the experienced degree of how free-of-disturbances a process is. Absence is an example of a KPI that may already be fragmented from an overall well-being measure. Absence could be an indicator of the atmosphere and overall well-being in the workplace. However, there are many other reasons to absence as well. Still, it can provide an indication that something is not quite right and that there should be some type of investigation of the reason to an increased absence.

As described above there are many arguments favourable for using measurements. However, it is important to note that the measurement must be performed wholehearted. The management must be united in the communication and the belief of the importance of the KPIs. If the aim or the usage for the KPIs are questioned it could impact the results and decrease the validity, for example if the employees make less reliable estimations. There is a need for a clear structure and aim that everyone knows and understands. If there is no clear focus or understanding for the KPIs, they might as well not be used or implemented.

The number of KPIs selected in this thesis might seem a bit high. In section 2.2.2, Marr (2015) asserts that it is important to not choose too many or too few KPIs and Parmenter (2015) claims that most organisations will do fine with less than 10 KPIs. However, the complexity of construction projects can motivate that a higher number of KPIs are used in order to cover all the parameters in the projects. Additionally, as mentioned in section 2.2.3, Collin (2002, in Chan & Chan, 2004) asserts that it is important to only use a manageable amount of KPIs regularly in order to avoid a time-consuming process when measuring. In this thesis, 13 KPIs was selected to be measured during the production process to create the possibility to control and improve performance during the ongoing process. The selection was partly based on the will to create a resource saving and easy measure process which does not include any major changes in the workflow. Because of the relatively easy measurement process, the higher number of KPIs can be reasonable. Most of the information needed are already collected in different ways, which makes it both resource saving and easy to conduct the measurement. Additionally, 9 KPIs was selected to be measured in the end of the projects. These are only measured ones and will therefore not increase the workload significantly. Most of the information needed in these measures are already collected as well and by measure these KPIs, a possibility to compare different projects is created.

6.2 Discussion of Strategy Work at Flodéns

Measurements should be made as often as possible in order to track the smaller changes over time. The aim with this thesis was to find KPIs that will help Flodéns to control

their process, but also to create an efficient measurement process. In order to avoid a significant increase in the workload for the employees, a relatively low frequency was selected for the KPIs. However, the frequency can be changed over time. Additionally, the collection process can be a limitation to the frequency of the measurement, for example if the information is gathered in meetings once every fortnight, the frequency is limited to that.

One of the long term strategic goals, in section 4.1.1, shows that complex projects should generate 50% of the total turnover. Flodéns want to be market leading on complex projects, however, the definition of what constitutes a complex project is changing over time. If the definition of complex projects keeps changing, they are indirectly stating that they want to have a leading market position in a, for them, new market. This is very difficult, if not impossible. Additionally, if Flodéns want 50% of their turnover to be generated by complex projects but do not have a clear definition, this goal becomes relatively obscure. A possible solution could be to define what a complex project is for Flodéns, but to update the definition each year in order to keep up with the expanded knowledge and experiences.

As mentioned in section 4.1.1, one of the long-term strategic goals at Flodéns is to develop projects that generates pleased clients. However, the current measures used at the company aims to track the recurring clients instead of tracking the level of satisfaction amongst them. The measure is based on the assumption that; if the clients are pleased they will want to work with Flodéns again. However, there is no clear framework for what constitutes a recurring client nor the reason why they choose to return. Some of the clients are one-time clients, no matter how satisfied they are with Flodéns they cannot be reoccurring since they don't have any other projects to offer. The time can be of consideration as well, is there a time limit for when a previous client should be considered new rather than returning? There could also be clients that are satisfied with the performance at Flodéns but have another company that they for some reason prefer, and therefore do not use Flodéns again. Additionally, the public clients have to follow the public procurement act which obligate them use the contractor with the best tender according to pre-decided criteria and don’t have the opportunity to choose Flodéns.

6.3 Discussion of the Reliability of the Thesis

An abductive method was used in this thesis to enable an iterative process between theory and practice in the conduction of suitable KPIs. Because of the limited amount of literature specifically focused on KPIs in construction projects, it was considered favourable to go back and forth between literature and the empirical study in order to find suitable KPIs. If the abductive method would not have been used, the result would probably have been different.

The identification, development and selection of suitable KPIs was time consuming and became as a limitation for this thesis. It would have been favourable to include a test of the selected measures on different projects at Flodéns in order to gain better knowledge of the measurability and fit with the company. Because of the frequency, which it set to monthly for most KPIs, this would imply a long evaluation process. In this case, there was no time to do a proper and valid test of the measures, and therefore, the focus was set on carefully analysing and discussing the selected KPIs instead. If there would have

been time to conduct a proper test of the measures, the validity of the selection would increase. Preferably, the KPIs would have been tested during the whole production process in, for example, three different projects in order to evaluate the measurability and usage of the information collected.

As mentioned earlier, there is a limited amount of literature that is up to date concerning KPIs in construction projects which has contributed to the usage of some relatively old literature. Additionally, similarly literature from other industries have been used in order to complement the limited amount, and the findings might therefore not be completely suitable for construction projects. All literature concerning the construction industry did not have the exact same focus as this thesis, which might have impacted the validity even though this was considered during the theory collection. For example, the investigation made by Josephson (2013) only focuses on new production of apartment blocks and offices which asserts that the result found in this report not necessarily is applicable on refurbishment projects for example. It is also based on interviews with projects managers and local managers which asserts that personal feelings and experiences, which may not be relevant for the study, may have an impact on the result. The theory from the KPI Working Group (2000) had the British Construction industry in focus. Additionally, it was simply a suggestion of a number of different KPIs and did not provide any suggestions or recommendations for how to make a selection amongst them. Both The KPI Working Group (2000) and Chan Chan's (2004) contributions were conducted several years ago and the focus of the important aspects can have changed for the construction industry since then. Additionally, Chan & Chan's (2004) study is based on a literature review where the inbound information is even older and could be outdated.

7 Conclusion

Construction companies should measure performance in order to create the ability to control and improve performance. Measurement can also be used to create a focus on the most important aspects related to the objectives within a company. The complexity of construction projects is often seen as an obstacle for measurements and comparison between projects. If a standardisation of projects is undesirable, a standardisation of the measurement can be used instead. The standardised measures can be used to create a clearer view of how the projects are performing and what actions that could be taken in accordance to keep them on the right track. The performance of the projects can be compared, and both positive and negative results can be used to develop more efficient or successful projects in the future.

Project success according to Flodéns was defined as: *Develop and manage profitable projects in a way that creates satisfaction among the participants, both client, employees and subcontractors, and encourage both social and environmental sustainability.* KPIs based on this definition of project success and considered suitable for the production process of construction projects at Flodéns are presented in a matrix in the thesis. The selected KPIs should be measured during the production, but also in the end of the projects, in order to control and compare different projects.

However, measurement can also contribute to impaired performance. There are aspects that must be considered when, or if, KPIs should be implemented. For example, measurement can result in sub-optimization. Additionally, the measure process can be too resource consuming and create frustration amongst the people that collect the data. Furthermore, estimations can be manipulated in order to create good results if the focus is set on the result of the KPIs rather that the performance it selves.

The satisfaction of the client and subcontractors are important to create opportunities for future collaborations. The satisfaction can be measured by handing out a survey to the client and subcontractors during meetings. By measure the satisfaction regularly, an opportunity to make changes during the process in order to increase the satisfaction is created. The surveys should include a few questions concerning the collaboration, communication and prerequisites. Additionally, the client survey should include client-specified criteria that the client gets to grade during the process in order to make sure that these criteria are met. With minor alteration, both the matrix and the surveys developed in this thesis could be applicable on projects within several companies in the construction industry. The alteration should be done in order to fit the company's specific critical success factors.

Following aspects should be considered when using KPIs:

- Rewards and penalties can impact the results and validity
- Clear instructions for where and when the data is collected is needed
- Some KPIs can be more reliable than others
- Frequent measurements are needed in order to gain reliable results

Finally, if the KPIs are not used wholeheartedly, the data collection and measurement will be of less quality and the KPIs will be close to useless.

7.1 Further Recommendations

Due to the limited amount of time, this thesis only focused on identifying, developing and selecting suitable KPIs for construction projects within Flodéns. The thesis does not include any research of how the measurement should be implemented in order to reach a successful measurement process, or what actions to take in order to improve the results. Neither does the thesis include any research of how the results of the selected KPIs should be presented in order to create a fair view of the situation. Therefore, further research could focus on:

- How to successfully implement project based KPIs in construction projects
- What actions that should be taken in order to improve KPI results
- How to present KPI results in a way that creates a fair view of the situation

8 References

Allabolag. 2018. *Flodén Byggnadsaktiebolag.* Allabolag.se. https://www.allabolag.se/5560807389/floden-byggnadsaktiebolag (2018-03-26)

Ashley, D.B. & Alarcón, L.F. 1996, "Modeling Project Performance for Decision Making", *Journal of Construction Engineering and Management*, vol. 122, no. 3, pp. 265-273.

Bryman, A. & Bell, E. 2017, *Företagsekonomiska forskningsmetoder*, Upplaga 3. edn, Liber, Stockholm.

Chan, A.P.C. & Chan, A.P.L. 2004, "Key performance indicators for measuring construction success", *Benchmarking: An International Journal*, vol. 11, no. 2, pp. 203-221.

Creswell, J.W. 2014, *Research design: qualitative, quantitative, and mixed methods approaches*, Fourth, international student edn, SAGE, Los Angeles, Calif.

Doyle, C. & Oxford Reference (e-book collection) 2011, *A dictionary of marketing*, Oxford University Press, New York;Oxford.

Dubois, A. & Gadde, L. 2014, ""Systematic combining" -- A decade later", *Journal of Business Research*, vol. 67, no. 6, pp. 1277.

Ercan, T. & Koksal, A. 2016, "Competitive Strategic Performance Benchmarking (CSPB) model for international construction companies", *KSCE Journal of Civil Engineering*, vol. 20, no. 5, pp. 1657-1668.

Flodéns. (2018b). *Finansiell info*. Available: http://flodens.se/finansiell-info/ (2018-04-09)

Flodéns. (2018c). *Projekt.* Available: http://flodens.se/projekt/ (2018-02-26)

Flodéns. (2018d). *Strategi*. Available: http://flodens.se/om-oss/strategi/ (2018-03-26)

Flodéns. (2018e). *Policy*. Available: http://flodens.se/kvalitet-certifikat/ (2018-03-26)

Flodéns. (2018f). *Aktuellt*. Available: http://flodens.se/floden-byggnads-ab-utvecklas-till-ett-medarbetaragt-foretag/ (2018-05-04)

Flodéns. (2018g). Årsredovisning. Göteborg: Flodén Byggnads AB http://flodens.se/wp-content/uploads/2018/02/Flode%CC%81n-Byggnads-AB-A%CC%8Arsredovisning-2017.pdf (2018-03-26)

Forsberg, A., Byggkonstruktion och -produktion, Institutionen för samhällsbyggnad och naturresurser & Luleå tekniska universitet 2008, *Produktivitetsmätningar som förbättringsverktyg: en kartläggning av arbetsproduktivitetsmätningar på svenska byggarbetsplatser*Josephson, P. 2013, *Produktivitetsläget i svenskt byggande 2013, nybyggnad flerbostadshus och kontor*, Sveriges Byggindustrier, Stockholm.

Ishaq Bhatti, M., Awan, H.M. & Razaq, Z. 2014;2013;, "The key performance indicators (KPIs) and their impact on overall organizational performance", *Quality & Quantity*, vol. 48, no. 6, pp. 3127-3143.

Jha, K.N. & Tabish, S.Z.S. 2012, "Success Traits for a Construction Project", *Journal of Construction Engineering and Management*, vol. 138, no. 10, pp. 1131-1138.

Marr, B. & Books24x7 (e-book collection) 2015, *Key performance indicators for dummies*, First edn, John Wiley & Sons, West Sussex, England.

Parmenter, D., Books24x7 (e-book collection) & Ebook Central (e-book collection) 2015, *Key performance indicators: developing, implementing, and using winning KPIs*, Third;3; edn, Wiley, Hoboken, New Jersey.

Ramlee, N., Tammy, N.J., Raja Mohd Noor, R. N. H, Ainun Musir, A., Abdul Karim, N., Chan, H.B. & Mohd Nasir, S.R. 2016, "Critical success factors for construction project", *AIP Conference Proceedings*, vol. 1774, no. 1.

Richmond, C.M., Kielhauser, C. & Adey, B.T. 2016, "Performance measures for road managers facing diverse environments", *Benchmarking: An International Journal*, vol. 23, no. 7, pp. 1876-1891.

Swedish Standards Institute. (2018) *Detta är ISO 14001*. sis.se https://www.sis.se/iso14001/dettariso14001/ (2018-04-11)

The KPI Working Group. (2000). KPI Report for The Minister for Construction. London: Department of the Environment, Transport and the Regions. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/16323/file16441.pdf

Tahvilzadeh, N., KTH, Samhällsplanering och miljö & Skolan för arkitektur och samhällsbyggnad (ABE) 2015, "Understanding participatory governance arrangements in urban politics: idealist and cynical perspectives on the politics of citizen dialogues in Göteborg, Sweden", *Urban Research & Practice*, vol. 8, no. 2, pp. 238-254

8.1 Oral References

Albriktsen, Rolf. Strategy consultant. Mixed communication and supervision. 2017-11-27 - 2018-06-01

Forsberg, Ronnie. Work manager at Flodéns. Mixed communication and supervision. 2017-11-27 - 2018-06-01

8.2 Internal Documents from Flodéns

Historical document, 2018 - A document describing the history and development within Flodéns.

Strategy document, 2018a - An excel document with the short term and long term strategic goals, and present values.

Strategy document, 2018b - A description of the strategy work within the company.

9 Appendix A

9.1 Client specified criteria

The client specified criteria are filled out in the beginning of the project. Flodéns can develop the criteria by themselves, let the client develop the criteria, or they can develop them together. Thereafter the client gets to rank the criteria. These are used in the survey that is handed out to the client throughout the process.

Date of information gathering			
Project name		Type of project	
Client		Type of contract	
Contract time		Contact sum	

	Client specified criteria	Weight point (1-10)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

9.2 Client Survey, SCI (Satisfied Client Index)

The client should, continuously during the construction process, fill in a survey based on the client specified criteria to create a view of how they experience the collaboration with Flodéns.

Date of information gathering			
Project name		Type of project	
Client		Type of contract	
Contract time		Contact sum	

Client specified criteria		Totally dissatisfied			Neither				Totally satisfied		
		1	2	3	4	5	6	7	8	9	10
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											

View of following claims		Completely incorrect			Neither				Completely correct		
		1	2	3	4	5	6	7	8	9	10
1	The communication with Flodéns is good										
2	The collaboration with Flodéns is good										
3	All information needed to efficiently fulfill tasks is available										
4	The Project is free-of-disturbances										

9.3 Subcontractor Survey, SSCI (Satisfied Subcontractor Index)

All subcontractors in a project should continuously during the construction process fill in a survey to create a view of how they experience the collaboration with Flodéns, but also other parties on site.

Date of information gathering			
Project name		Type of project	
Subcontractor/ Supplier		Type of contract	
Tender time		Tender sum	
Other involved subcontractors or suppliers			

View of following claims		Completely incorrect			Neither				Completely correct		
		1	2	3	4	5	6	7	8	9	10
1	The communication with Flodéns is good										
2	The communication with the other subcontractors is good										
3	The collaboration with Flodéns is good										
4	The collaboration with the other subcontractors is good										
5	All information needed to efficiently fulfill the work is available										