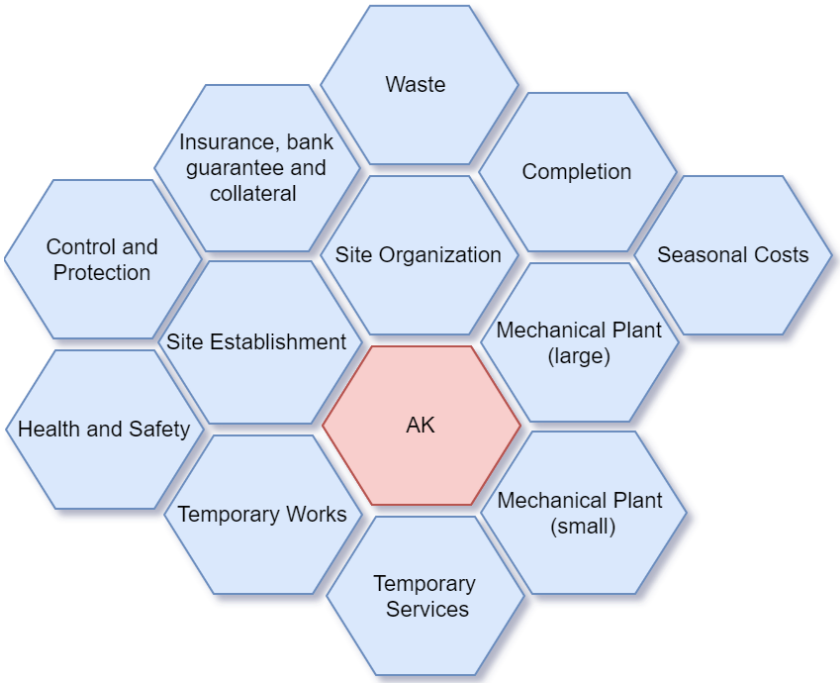
CHALMERS
UNIVERSITY OF TECHNOLOGY



Rethinking site overheads in a Swedish context

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

OLIVER DISNEY
OSKAR FAHLSTEDT

DEPARTMENT OF ARCHITECTURE AND CIVIL ENGINEERING

CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2020
www.chalmers.se

MASTER'S THESIS ACEX30

Rethinking site overheads in a Swedish context

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

OLIVER DISNEY
OSKAR FAHLSTEDT

Department of Architecture and Civil Engineering
CHALMERS UNIVERSITY OF TECHNOLOGY
Göteborg, Sweden 2020

Rethinking site overheads in a Swedish context

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

OLIVER DISNEY
OSKAR FAHLSTEDT

Examensarbete ACEX30
Institutionen för arkitektur och samhällsbyggnadsteknik
Chalmers tekniska högskola, 2020

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

Cover:
Honeycomb diagram of AK categories. Adapted from (RICS, 2018)

Department of Architecture and Civil Engineering
Göteborg, Sweden, 2020

Rethinking site overheads in a Swedish context

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

OLIVER DISNEY
OSKAR FAHLSTEDT

Department of Architecture and Civil Engineering
Chalmers University of Technology

ABSTRACT

Contractors need to use resources efficiently to avoid unnecessary costs as the construction market is highly competitive with low profit margins. Allmänna kostnader (AK) is a term used in Sweden by the Skanska construction company. Internationally it may be known as site overheads but there are several different definitions both in the literature and within Skanska. Skanska Gothenburg, Housing Department 1 believe that their AK have been increasing to unacceptable levels compared with competitors. Therefore, they aim to reduce these costs but were unsure where to start. Despite an official definition for AK existing within Skanska, employees define it very differently. This has resulted in managers categorizing resources differently from project to project, making them difficult to compare, which meant that it was hard to find efficiency improvements. The purpose of this thesis was to take the first steps to solving this problem by defining AK, categorizing resources and analyzing the current AK situation by collaborating with Skanska Gothenburg, Housing Department 1.

In the literature study the current climate of the Swedish construction industry was investigated, and an understanding was gained for what types of costs are included in the term AK. This was complemented by examining waste theory and costing methods. The empirical study focused on semi-structured interviews and a questionnaire with Skanska employees. These findings were compared and discussed, whilst using an abductive research method with systematic combining. A less ambiguous definition for AK was developed in accordance with RICS (2018) which was the cost of running the construction site, rather than any particular activity or zone. Costs were categorized in a honeycomb model, which presented a structured approach for allocating resource costs. Recent trends show that Skanska operate with more staff than competitors, which is one of the largest AK categories and work methods should be improved to lower overall costs. Activity-based costing and digital aids such as EquipmentLoop may allow employees to more accurately predict and improve the understanding of costs. This thesis has only scratched the surface of the topic. Therefore, suggestions for future research are presented to investigate potential cost savings.

Key words: Allmänna kostnader, preliminaries, Swedish construction industry, cost categorization, site overheads.

Omvärdering av allmänna kostnader (AK) i Sverige

Examensarbete inom masterprogrammet Design and Construction Project Management

OLIVER DISNEY
OSKAR FAHLSTEDT
Institutionen för arkitektur och samhällsbyggnadsteknik
Chalmers tekniska högskola

SAMMANFATTNING

Eftersom det är hård konkurrens inom byggbranschen med låga vinstmarginaler är det viktigt att entreprenörer använder sina resurser effektivt för att undvika onödiga kostnader. Allmänna kostnader (AK) är en term som används i Sverige av byggföretaget Skanska. Internationellt kan det kallas för 'site overheads' vilket kan hänföras till omkostnader för att driva ett byggprojekt. Det existerar emellertid många olika definitioner i såväl litteratur som inom Skanska. Vidare anser Skanska Göteborg bostad 1 att deras AK-kostnader har ökat till oacceptabla nivåer jämfört med likbördiga konkurrenter. Därför är det viktigt för Skanska att sänka dessa kostnader, samtidigt som de är osäkra på var de ska börja. Även fast en officiell definition för AK redan finns inom Skanska varierar definitionen av AK bland anställda. Detta har resulterat i att chefer kategoriserar resurser annorlunda från projekt till projekt vilket gör det svårt att implementera metoder för ökad effektivitet. Syftet med denna uppsats var att ta de första stegen för att lösa detta problem genom att frambringa en definition till AK och utföra en kategorisering av inkluderande resurser samt att analysera den rådande AK-situationen genom samarbete med Skanska Göteborg bostad 1.

I literturstudien undersöktes rådande klimatet inom den svenska byggindustrin och kunskap erhölls genom att förstå vilka typer av kostnader som ingår i termen AK. Detta kompletterades med undersökning av teorier inom effektivitet och kostnadsmetoder. I den empiriska studien samlades informationen in genom semi-strukturerade intervjuer och ett frågeformulär som anställda på Skanska har besvarat. Resultaten jämfördes och diskuterades samtidigt som en abduktiv forskningsmetod med systematisk kombination användes. En mindre tvetydlig definition av AK utvecklades i enlighet med definitionen av RICS (2018) som på svenska kan återges följande vis, kostnaden för att driva byggarbetsplatsen snarare än någon särskild aktivitet eller zon. Resultatet utmynnade också i att kostnader kategoriserades i form av en bikakafigur med tillhörande underkategorier. Figuren medförde ett strukturerat tillvägagångssätt för att fördela resurskostnader. Den senaste trenden indikerar att Skanska arbetar med mer personal än konkurrenterna som i sin tur är en de av de mest kostsamma AK-kategorierna, samtidigt som arbetsmetoderna borde förbättras för att sänka totalkostnaden. En kostnadsmetod som 'activity-based costing' samt digitala verktyg som EquipmentLoop kan hjälpa anställda att mer exakt förutse och förstå kostnaderna i projekten. Denna uppsats har endast berört ämnet ytligt. Således presenteras förslag på hur framtida forskning kan ta vid för att undersöka ämnet djupare och finna möjliga kostnadsbesparingar.

Nyckelord: Allmänna kostnader, genomförandekostnader, svenska byggsektorn, kategorisering av kostnader, omkostnader

Contents

Preface

This Master thesis is the final stage of our program at Chalmers University of Technology, Gothenburg, Sweden and was written in collaboration with the Department of Architecture and Civil Engineering. This project has been carried out with the support of Professor Christian Koch who has provided guidance on every step of the journey. His thoughts and knowledge have proved invaluable to this process. We would like to extend our gratitude to him.

The study was performed in collaboration with Skanska, Gothenburg. At Skanska, Anna Säfwenberg was our supervisor and Efraim Ljung provided guidance and direction. Without their help this thesis would not have been possible. They helped explain to us the issues the company was facing. Additionally, they provided excellent feedback, inspiration and a list of contacts. We would like to thank them for being so engaged in this process, as well as for all their help and support. This thesis would also not have been possible without the support from all the interviewees and survey respondents. Each of them took time out of their busy schedules and supported us. All interviewees engaged in interesting discussions about the topic and made us feel welcome. We must extend our dearest thanks to them as well.

Finally, thank you for our friends and family for their understanding, love and support during this time.

Göteborg May 2020

Oliver Disney

Oskar Fahlstedt

Glossary

Below is a list of terms that are used in this thesis and definitions for them are given.

Term	Definition
Allmänna kostnader	Used by Skanska to define overhead site costs that cannot be attributed to a specific activity, abbreviated to 'AK'.
EquipmentLoop	An app that is used to help construction companies increase efficiency and cost effectiveness by managing equipment processes.
ID06	Identification cards for site access.
Mechanical plant	Heavy machinery and equipment used during the construction process. There is some overlap with smaller items like hand tools.
Site organization	All expenses concerning the staff organization needed at the site.
Site preliminaries	Another name for site overheads, used more frequently in the UK.
Skanska Rental	A company within the Skanska organization that hires our machines and equipment for construction projects.
SPIK	Skanska's own calculation software used in both the bidding and production phase of construction projects.

1 Introduction

The Swedish construction market for housing has boomed in the last decade (Josephson and Björkman, 2010, Sveriges Byggindustrier, 2019a). There are ambitious urban investment plans, where up to 710 000 new homes need to be built between 2016-2025 to meet demand (Boverket, 2016). However, in Sweden, the cost of producing housing continues to increase and debates about this continue today (Josephson and Björkman, 2010). Since 2017, the number of new housing projects has declined and there are no indications that this trend will soon change (Sveriges Byggindustrier, 2019a, Business Region Gothenburg, 2019). Stricter amortization demands on mortgages and rising costs are arguments for why there has been a decline despite favorable market conditions. This tightens the competition for contractors to win bids and with the ongoing pandemic (COVID-19) it is not improbable to believe that competition will increase even more. It becomes important for large contractors to manage their overheads. Therefore, efficient use of resources and reducing non-value adding activities will become even more important than it is today. Construction projects are unique undertakings, performed by temporary teams in variable conditions, unlike a production line (RICS, 2018). Profitability should account for the return on capital employed to generate the required revenue from the company's activities. It should also account for the costs and risks associated with production (RICS, 2018).

Allmänna kostnader (AK) is a term used by the company that the authors of this thesis are collaborating with. It is not an industry standard term; its elements are not clearly defined, and it differs between companies and countries. A construction company must make a profit, cover direct project costs and overhead expenses of both the office and site. Site project costs are shown in Figure 1.1 below, where labor and material costs represent approximately 40% each of the overall costs. The last 20% are activities and resources which are AK. This thesis aims to examine how AK are defined, which resources should be included as AK, current AK trends and methods for handling AK. Current literature struggles to agree on an exact definition or even what to call AK, several words also exist in Swedish for this term. In English, AK might be called site overheads, indirect costs, site costs, preliminaries or field costs. In literature from the UK, preliminaries are perhaps the closest definition to AK, which are "the costs of running a site as a whole rather than any particular zone of the site or any particular activities" (RICS, 2018, p. xx). Another definition for preliminaries is "the cost of administering a project and providing plant, site staff, facilities site-based services, and other items not included in the rates for measured works" (RICS, 2015, p. 22). However, other definitions will also be discussed during this thesis.

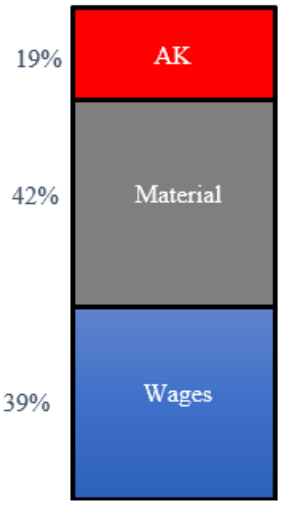


Figure 1.1 Construction site costs. Adapted from Sveriges Byggindustrier (2015, p. 55).

This thesis is made in collaboration with Skanska in Gothenburg and their housing department. Skanska are one of the largest Swedish construction companies and have a global presence. They operate in several different markets, including, construction services, infrastructure services, asphalt, concrete and rental equipment. The three biggest markets for Skanska Sweden are Malmö, Gothenburg, and Stockholm, where there are differences between each market they operate in (Sveriges Byggindustrier, 2019b, Skanska, 2019).

The topic for this study was chosen in collaboration with Skanska Gothenburg housing department 1. AK are important as they have found that rising costs have made them uncompetitive when submitting tenders for low to medium sized projects. When this study was performed, they had no structured way for tracking AK between projects as different estimators calculate project costs differently and site managers' report costs based on experience rather than a structured approach. This resulted in it being hard to track AK between projects and find room for improvement. An example of this might be a crane, which is an AK in some projects but a direct cost in others if the sub-contracted company supplies their own.

This study does not attempt to solve all the issues related to AK or even provide solutions. Instead, the aim is to increase understanding by defining AK and the resources that should be calculated as AK through a more structured approach and lay foundations for future research. This is achieved by conducting a literature review, semi-structured interviews and a questionnaire with employees from two departments in Gothenburg, Sweden. The interviews focused mainly on estimators and site managers working with housing projects, but the questionnaire incorporated a broader range of roles. This allowed us to make comparisons between how it is handled on-site and at the office. The study was complex as AK have not been in focus and no structured approach or definition exists between employees. The decrease in competitiveness has called for a greater understanding of the issue and this thesis lays the foundation for that.

1.1 Research questions

The purpose of this study was to aid Skanska's housing department in Gothenburg to reduce their AK and increase their market competitiveness. Employees today handle AK very differently from one another. The following research questions (RQ) were formed to create a more structured approach to AK:

RQ1: How are AK defined by Skanska employees and in literature?
RQ2: How can AK be categorized?
RQ3: Which areas of AK are increasing or decreasing, and which are become more efficient or inefficient?
RQ4: Are there any current methods or tools for handling AK?

1.2 Limitations

This study is limited in the following ways:

- The study focuses primarily on only one company and two departments both operating out of Gothenburg. Therefore, the results are heavily influenced by this and may be difficult to apply in other settings.

- Nearly all the interviewees worked for the house building department of the company, which means the results may differ in other settings such as infrastructure projects. Two departments were studied to try and provide some variety and to avoid bias within departments.

- One of the main reasons that this research is necessary is also connected to one of the main problems and limitations. Each project has an element of uniqueness, which has made consistent reporting of costs difficult to achieve. The goal of this thesis is not to solve these problems but to provide a more structured approach for determining which costs are AK. In addition to this each site manager or estimator reports and calculates cost differently, which made it impossible to track AK in previous projects and provided a wide range of interview responses. The results are based on our interpretations of the interviewee responses.

- The budget for AK may remain unspecified and sometimes as a percentage of direct costs. Therefore, it can be challenging to directly assess efficiency.

- AK is a topic that has largely been unexplored in Swedish literature. Therefore, a variety of international literature references were used to gain a broad understanding of the topic, then focusing more on the UK system.

- AK are an important part of the tender price when competing to win projects. Companies are often unwilling to share specific project data, limiting the authors access to research material.

- This thesis is limited in terms of time. Two students are conducting this study that both needed to familiarize themselves with the topic and perform research. Therefore, findings are limited to what is possible in a spring semester.

2 Methodology

This study aims to define AK and help illuminate some of the problems associated with AK today, as well as investigating potential improvements. To achieve this, a literature review was conducted, whilst simultaneously performing supporting interviews, primarily with estimators and site managers at Skanska. The findings were further developed by using a questionnaire and analyzed in relation to the framework developed in the literature study. Finally, a discussion of the subject is held, and conclusions are drawn.

2.1 Research design

During the writing of this master thesis the authors considered how the research should be developed and if it should be performed in a deductive, inductive or abductive manner. The research topic, AK and how to formulate the research questions came to be the deciding factors. The research topic was formulated in collaboration with Skanska. It should be mentioned that AK is an term that derives from the company itself and not a term that is an industry standard.

There was no collective name for the research topic in the literature and aspects included in one definition were not necessarily in another. Therefore, a variety of academic literature was used to provide a basis for understanding and defining the topic, including aspects related to bidding, cost estimation, preliminaries, overheads, and indirect costs. The Swedish market was also reviewed to understand the relevance of AK in construction projects. It was necessary to review a range of literature because Skanska had difficulties defining AK. Early indications were that the literature was fragmented and needed to be collected from a variety of sources to improve the understanding of the term. Valid points exist for using both inductive and deductive theory to build the hypothesis on, which could also be an argument for using an abductive research design (Bryman and Bell, 2015, Bryman, 2006).

2.1.1 Qualitative research

The thesis was based primarily on a qualitative study as the concept of AK remains relatively undefined and there was nothing concrete to measure or analyze (Bryman and Bell, 2015). The aim was to identify the existing AK problems with Skanska and interpret how the problem should be managed in the future. There is limited research on the topic in Sweden and although the company, has investigated the problem before, it has not been done in this manner. A partial aim of the thesis was to provide general knowledge about the problem by using qualitative research methods. Thus, the results are dependent on understanding the experiences the employees have about working with AK (Flick, 2014, Taylor, 2016). Even though an inductive research approach is frequently mentioned as being qualitative in nature it was not suitable for this thesis (Lodico et al., 2006, Brinkmann, 2013, Flick, 2014, Bryman and Bell, 2015, Taylor, 2016).

In this thesis, the research method needed to be flexible due to the nature of the topic being complex. The qualitative research method enabled a continuous improvement process by learning from empirical research (Taylor, 2016). Qualitative methodology provided the possibility for changes as the thesis progressed, since nothing was taken

for granted (Taylor, 2016). Moreover, new insights about the research topic were discovered by using snowball sampling when conducting interviews, which guided the research to suitable interviewees and was a preferable method for collecting data when existing theory was limited (Taylor, 2016).

The investigation into AK needed a qualitative approach since a unified understanding within the organization and in the literature was lacking. Thus, this thesis took the first steps into rethinking AK. Therefore, it was dependent upon opinions and experiences of people rather than testing existing theories (Bryman and Bell, 2015).

2.1.2 Abductive reasoning

There were motivations for using both inductive and deductive methods. However, limitations exist with both and to best approach these issues, abductive reasoning was chosen. The adoption of the abductive research method was suitable since it enabled an improved understanding by having an iterative process (see Figure 2.1) between empirical and theoretical research (Dubois and Gadde, 2002).

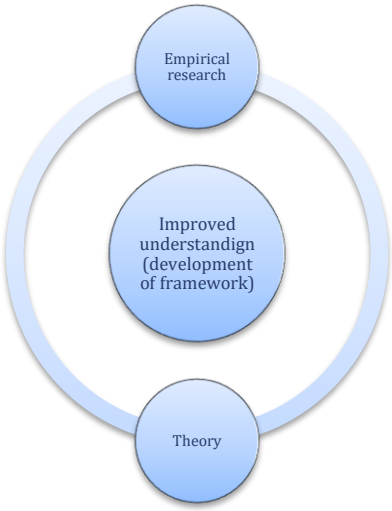


Figure 2.1 *Interpretation of abductive reasoning. Adapted from* (Dubois and Gadde, 2002, Bryman and Bell, 2015).

Abductive reasoning helped to develop the thesis by comparing findings of important aspects discovered during the interviews that then guided the authors towards important theories to consider (Bryman and Bell, 2015). Dubois and Gadde (2002) argue that abductive research methods create a better understanding of empirical findings and theory. Moreover, Dubois and Gadde (2002, p. 555) write that "theory cannot be understood without empirical observation and vice versa," and names this matching process as a part of "systematic combining." The model of systematic combining (shown in Figure 2.2) was partly adopted in this thesis since constitutes a solid ground for the structure of the thesis.

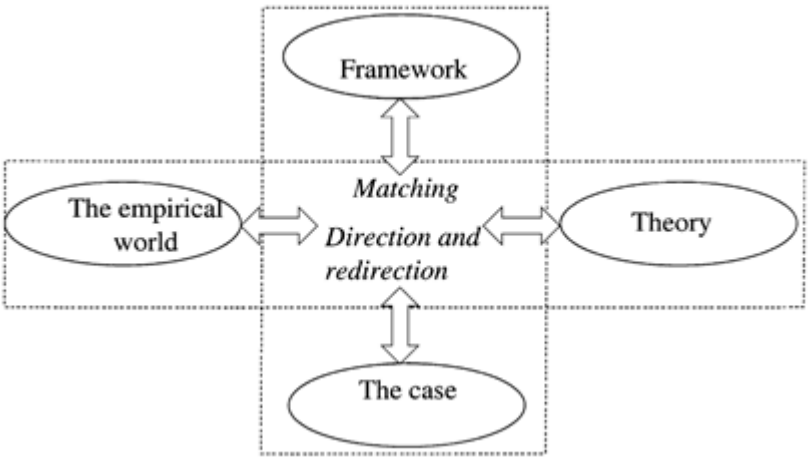


Figure 2.2 Systematic combining. (Dubois and Gadde, 2002).

The adoption of the model enabled the authors to investigate potential useful theory and implement the framework in empirical research. New insights were gathered from the empirical research that helped the authors to either expand, narrow or change the direction of the theory (Dubois and Gadde, 2002). The primary method for gathering empirical data was done through interviews. Although, it should be mentioned that other interactions with experts both inside and outside the organization also contributed to the thesis, which were:

- General discussions about AK with people within the company that guided the thesis to uncharted areas of research.
- Consultation with industry professionals about their definition of the topic and useful literature.
- Regular consultation and guidance from professionals within the researched company.
- Direction from researchers to potential interviewees with the right knowledge about AK.
- Interviewees showing spreadsheets, financial tools, calculations, goal documents, and work methods that cannot be used in the thesis due to confidentiality. Nevertheless, it brought a greater understanding of important aspects to consider and investigate within the topic.

By having an open mind towards the collection of data, new findings could be obtained that were previously not sought for, which then could direct or redirect the thesis. Therefore, empirical research was not strictly dependent on findings in the literature and constructed frameworks. Instead, the theory and empirical research were developed in symbiosis in the writing of this thesis (Dubois and Gadde, 2002).

It should be mentioned that no case study was conducted which contrasts with the systemic combining approach adopted by Dubois and Gadde (2002). The interviews were expanded instead of being complemented with a case study and a questionnaire was developed in order outline areas of AK that are most important to consider. It was felt that this method was more suited to defining AK and outlining aspects that had the most opportunity for improvement in the future. It also provided better guidance and direction towards potential future research of central aspects that could be studied in a

case context. In accordance with this the research model of Dubois and Gadde (2002) was then modified (see Figure 2.3) to fit the context of this thesis.

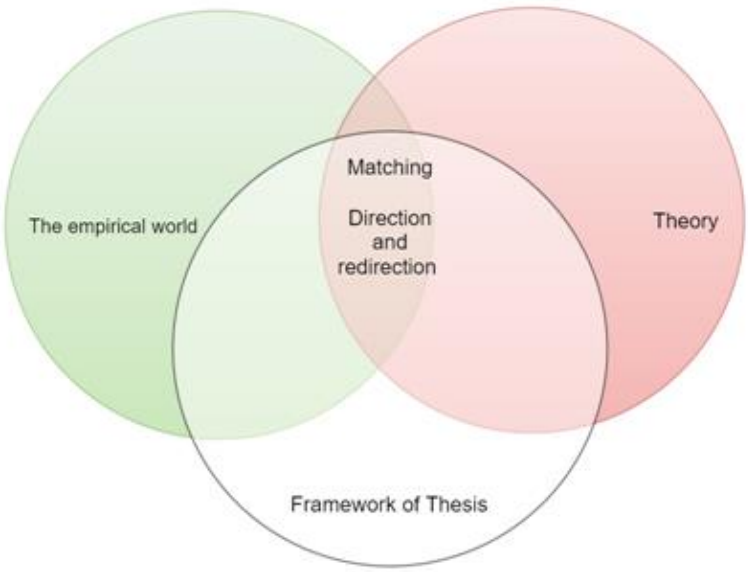


Figure 2.3 Altered systematic combining. Adapted from Dubois and Gadde (2002).

2.2 Literature

A review of relevant literature was conducted focusing on two main areas, the Swedish construction market and AK. Due to difficulty defining AK, literature was chosen to analyze existing theory to try and find possible solutions to the issue.

Research material was predominantly gathered online by using the online search engines Chalmers Library and Google Scholar. Chalmers head library and Architecture and Civil Engineering (ACE) departmental library were also used to review research material.

2.2.1 Swedish market

In order to develop an understanding of why AK is an important aspect in construction projects, a literature review of the Swedish construction market was performed. The aim of this part of the literature study was twofold. Firstly, the authors tried to gain an understanding of the mechanism of the Swedish construction market, where the idea was that a greater understanding of the market would enable more adequate interpretation of findings in the empirical research (Flick 2014). Secondly, the understanding of market mechanisms was important from another perspective as well. It facilitates understanding of why Skanska thinks AK is such an important aspect to consider in projects. Thus, market challenges can be illuminated and investigated to highlight the importance of managing AK in construction.

The review of the Swedish construction market was done by investigating literature concerning the past and present state of the market. Information was gathered from reports written by agencies and institutions, which provided statistical information, forecasts, and explanations as to why the market behaves in a certain manner. Additionally, information was gathered from academic sources. This literature was

primarily focused on research that concerned waste on construction sites. In this context, waste was identified as activities that do not contribute any direct value in construction projects (Womack and Jones, 2003). This area of research was investigated because initial discussions about AK often related increased AK to increased waste and decreased efficiency.

Findings in the literature about the Swedish construction market were then structured and presented in the following manner. Firstly, the current and historical state of the construction market was investigated as well as impacting factors. Secondly an investigation occurred concerning waste. The idea was that the efficiency research is conceived as the industries effort to orient itself in the market. In other words, to identify how concepts like AK have been managed and described so far. Additionally, this theory was also used to investigate what previous effort has been made and what the drivers are behind activities that can perhaps be recognized as AK.

2.2.2 Price adjustment indices

Previously in this chapter it was mentioned that this thesis adopted an abductive research approach. It was also mentioned that consultation with industry professionals was one of the empirical methods used. This resulted in a tip leading to findings of "The Swedish Construction Federation (TSCF)" and their tool for index adjustments (Byggföretagen, 2020a, Byggföretagen, 2020b). In the theory there is a deeper investigation of how TSCF's index adjustments aid Swedish construction companies to manage costs associated with AK. The index adjustment information and user guidelines were sourced from TSCF's website.

2.2.3 Activity-based costing

The study of activity-based costing (ABC) arose in the same manner as index adjustments, i.e. an industry professional thought it would be useful in our thesis. In this thesis, only certain aspects of ABC were considered because of time constraints and other primary points of focus. The investigation into ABC was aimed at determining if the method could be used to reduce non-value adding work and therefore help construction companies in their management of AK. Information covering the ABC method in construction was collected from scientific papers and books available in the Chalmers library service and Google Scholar.

2.2.4 AK

This study began with the students having very limited knowledge about what AK was and which resources were typically included in AK calculations. Therefore, a literature review was conducted, initially in Swedish to try and establish a definition. It was also hoped a translation to English would be discovered so that additional sources could be included to give a broader definition of the term. However, after extensive online searching the only academic sources discovered were two student bachelor theses that were also conducted in collaboration with Skanska. Both of which provided slightly different definitions of the term. Search terminology was then expanded to include other definitions in Swedish which were perhaps not so limited to the singular company, such as overheads and common costs, but this also generated few results. The next step in the research process was then to translate these terms into English and generate search

results. An extensive list of articles was generated about the construction industry, particularly concerning estimation, bidding, overheads and general conditions costs. After reviewing the literature and comparing the content to the first few interviewees, satisfaction with the content was not achieved. Therefore, help was sought from a construction contract specialist living in the UK. They suggested the search terminology should be expanded to include construction preliminaries, specifically site prelims, whilst also recommending the Royal Institute of Chartered Surveyors (RICS) as a key resource. Site overhead cost literature complemented the existing literature sources to provide a solid framework for defining AK in the Swedish market.

Each country and company define AK differently, even individuals within the same company define AK differently, which is why this study is important. However, this meant that providing an academical theoretical framework was challenging. Although, all literature sources used to review AK theory might not be directly relatable to the Swedish market, it was felt that they help provide a general understanding of the topic, which was deemed important to the overall lack of understanding that exists. The AK literature review begins with trying to define what AK is, then tries to establish why it is important to consider, progressing to how it is calculated, and finally which resources are included in these calculations. The AK literature used begins with a wide international perspective but later focuses on the UK construction industry as a basis for comparison. The initial widespread nature of the literature was deemed acceptable as every construction project includes the resources included in AK calculations and the lack of Swedish studies that exist.

A distinction was made in the AK literature between site overheads and office overheads. Office overheads are mentioned but the study focuses on AK related to the construction site. It was also hard to find perspectives on how AK is managed by site managers, instead the literature focused more on the views from estimators.

2.3 Interviews

Interviews were a vital source of information in this thesis because of the adopted abductive reasoning approach. The interviews performed in this thesis were semi-structured with open ended questions to avoid yes or no answers and to make room for supplementary questions. This also made leeway for the interviewees to add consideration to their answers which made the interviews more fruitful (Bryman and Bell, 2015).

The interviews had 21 standard questions that were asked to all the interviewees. Although, depending on the interviewee's profession the questions were tweaked to make more sense for that person. For example, if a question was more focused on a specific field, the question changed from "what is" to "what do you think is?"

At the end of each interview, all interviewees were asked to answer yes or no to 27 standardized questions like a quantitative interview. The interviewees were asked if they thought a specific resource should be categorized as AK or a direct cost. These questions were then analyzed after all the interviews were conducted and gave a general overview that was presented in a table. Since, the topic is ambiguous it was difficult to identify important interviewees. This, in turn was then partly solved by using snowball

sampling. The interviewees where asked if they thought someone should be interviewed because of their knowledge in the area (Taylor, 2016).

All the interviews were recorded and transcribed by using a template. The interviews were as mentioned semi-structured which meant that transcribing them word for word would take considerable time. Instead, the most important parts of each interview were transcribed which ended up saving valuable time that was instead used for analysis (Flick, 2014).

Before the semi-structured interviews were conducted, empirical research took place in the form of unstructured interviews with six key people within the organization (Bryman and Bell, 2015). The purpose of this was to get an overview of the problem and formulate future interview questions. The meetings were roughly 40 minutes to 1 hour in length to discuss the research topic. They also helped selecting important people to interview and an understand the scope of the project.

The interviewees were selected after discussions with people within the company. It was decided that the most appropriate approach was to interview site managers and estimators. This was done to see potential similarities, differences or ambiguities in the management of AK amongst site managers. Moreover, estimators have a central role in a project's economy which also made them important to consider when investigating AK. The estimators have their definition of AK and therefore it was of interest to investigate if AK in projects are managed in the manner they prefer. The Figure 2.4 below demonstrates the interviewees and their relationship to each other. Table 2.1 shows the date and length of the interviews.

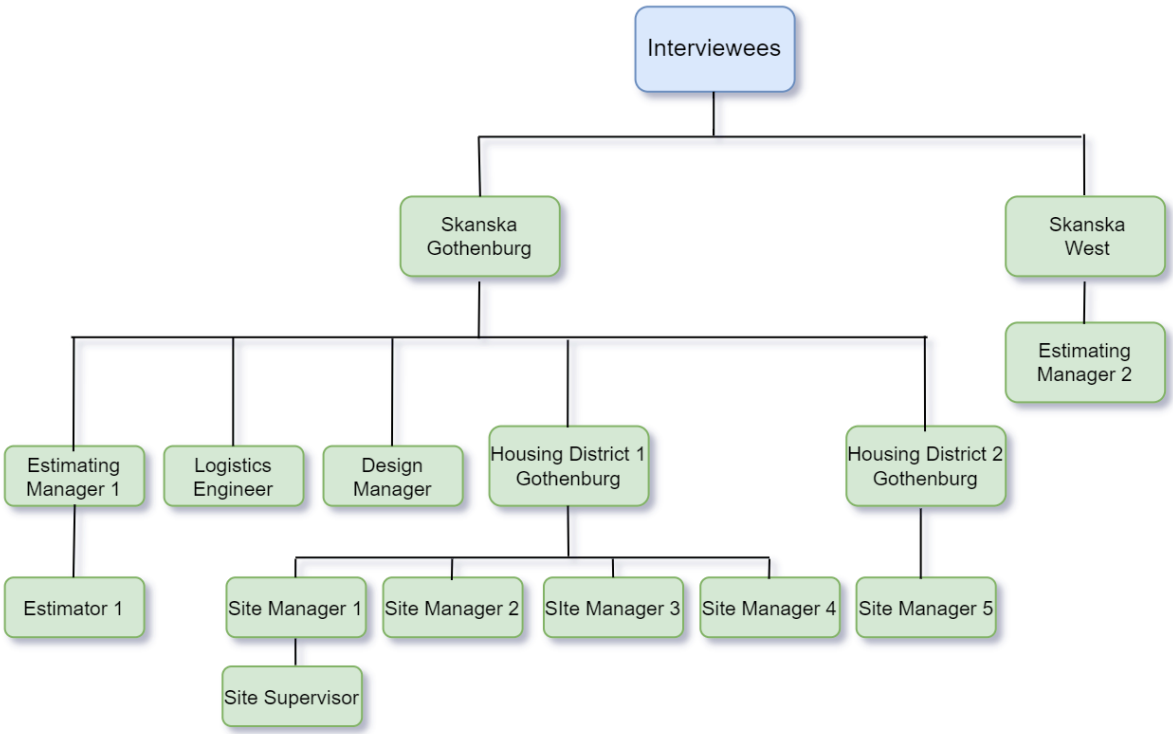


Figure 2.4 Interviewee organizational structure.

Table 2.1 Interviewee table.

Title	Date of interview	Length of interview (h/m/s)
Estimating manager 1	20/02/2020	01:37:41
Estimating manager 2	26/02/2020	01:14:48
Estimator 1	27/03/2020	00:43:07
Design manager	26/02/2020	00:57:35
Site manager 1	04/03/2020	01:16:03
Site manager 2	06/03/2020	01:09:00
Site manager 3	11/03/2020	01:17:57
Site manager 4	16/03/2020	01:58:50
Site manager 5	31/03/2020	Online response
Site supervisor	04/03/2020	01:16:03
Logistics engineer	03/04/2020	01:39:53

The coding of interviews started with a transcription. The interview questions were assembled in a matrix with two empty columns used to fill out the answers and time. When the authors registered something interesting from the interviewees, they noted it together with the time in the matrix. During the interviews these notes were kept short but often complimented during transcription. If any new discoveries occurred during the processes of transcribing it was noted together with the time it occurred in the recording.

Once all the interviews were transcribed, they were read through and coded. The coding was partly done by using NVivo's (a software that analyzes qualitative data) 'automated coding,' with the questions in one heading and answers in another. This allowed for a quick way of sorting the different answers to the same question under one heading. Since the interviews were semi-structured, they sometimes led to discussions or long out of context ramblings with no relevance to the question at hand. Hence, the next step was to analyze and sort out the answers and filter the significant responses into a compiled document that then was extracted into a Microsoft Word file. This made it quick and easy to get an overview of who said what and to make new notations of findings that should be mentioned in the results.

2.4 Questionnaire

In this thesis the authors sought to find a definition of what AK are and which resources it includes. Some costs within AK are believed to outweigh others, and therefore a central part of AK is to identify the costs that are more important to manage than others. The interviews and literature studies were complemented with a questionnaire to help understand what some of the key drivers of AK are. It was sent out to all the interviewees and additional people within the company.

The questionnaire helped fill some of the gaps that were left after conducting the interviews and allowed further investigation into questions that seemed important to answer. Bryman and Bell (2015) write that one of the problems with interviews is the 'interviewer effect' which can cause the interviewee to be biased. It was hoped the questionnaire might mitigate the possibility of respondent answering interview questions in a way that they believe conforms with company policy. Additionally,

another goal was to avoid the possibility of the interviewer affecting the answers of the interviewee. The questionnaire also made the data structured and easier to interpret afterwards (Bryman and Bell, 2015).

The questions (see Appendix 9.2) were based on findings from the first six interviews that were conducted. Inconsistencies between answers amongst interviewees were explored further by using the questionnaire. To achieve an acceptable sample size the questionnaire was not only sent to people that had previously been interviewed, but also to other managers within the company.

The questions were limited to 18 to avoid overworking respondents and maintain a high quality of responses. The questionnaire was also designed so that it would be simple and quick to answer. Respondents were asked to answer based on scales, ranks or simply selecting alternatives. Consequently, it was hoped that the questionnaire would be something that made sense and was attractive to answer. Asking the questions in this structured format allowed the data to then be coded and presented well in the empirical section, which would then be easier to analyze.

2.5 Analysis

Bryman and Bell (2015, p. 27) write that "abductive reasoning involves seeking to identify the conditions that would make the phenomenon less puzzling, turning surprising facts into matter of course." AK has been a puzzling phenomenon and the authors attempt to simplify it in the analysis. This is achieved by analyzing the empirical findings and prevailing literature concerning the topic. The analysis has been performed like the ideas of the hermeneutic circle (see Figure 2.5) to understand how small aspects affect the whole concept of AK (Bryman and Bell, 2015). Furthermore, the authors synthesized important aspects from the literature and empirical study to answer each of the research questions. The process aimed to find similarities, differences or ambiguities between empirical findings and theoretical research, whilst also remaining open minded to new concepts. The analysis ends with a discussion about where Skanska are today and what they might move towards in the future to improve AK management.

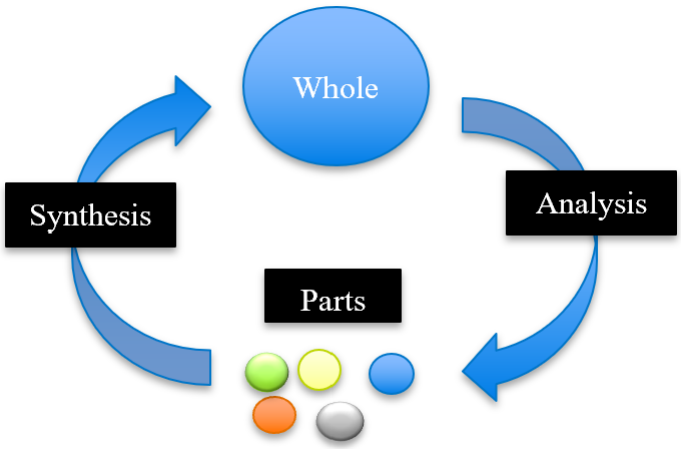


Figure 2.5 Hermeneutic circle. Adapted from (Timmer, 2015).

2.6 Ethical issues

Considering ethical challenges whilst conducting qualitative studies is an important part of the research process (Flick, 2014). Participants in the research shall not be named or caused any harm. Anonymization is an important aspect to ensuring this and instead subjects are referred to by their generic job titles (Flick, 2014, Bryman and Bell, 2015). Even if the risks naming the participants are not directly visible, referring to them in this way helps prevent unforeseen risks (Bryman and Bell, 2015). Personal details of individual participants in this study were not be included, to avoid risk of invasion of privacy, protecting their identity and compromising data protection laws. The company that the study is conducted with, was included as part of the thesis, due to the specific nature of the topic. However, with the anonymization of the employees it was hoped that they felt free to express themselves.

According to Flick (2014) participants in the study partook on the basis that the information presented to them is trustworthy, so that they could make an ethically informed decision. This decision was based on informed consent (Flick, 2014). The information presented to study participants should not deceive them in any way. Interviewees were contacted in advance and sent a list of pre-prepared questions. Additionally, a document was sent to all potential interviewees containing a brief explanation and aim with the thesis. Thus, enabling interviewees to make informed decisions and responses (Bryman and Bell, 2015). By doing this the aim of the study was also clearly communicated and more comprehensive results achieved.

The data from the study was collected and analyzed in a fair and representative way, to give justice to the opinions of those in the study (Bryman and Bell, 2015). The interviews were recorded and reviewed so that information was not missed during note taking. Permission for this was granted by the interviewees as well as the possibility for quoting them. Recording the interviews also meant that accurate citations could be provided in the empirical part of this study.

Before starting this study, the authors of this paper signed a non-disclosure agreement to not release any confidential data publicly and Skanska can review this thesis. AK is a term that differs from company to company as well as in an international setting. Each company calculates these costs in a different way. Therefore, a best effort approach was taken to find representative literature. The lack of existing literature may also reflect the sensitive nature of these costs as they are usually one of the main competitive aspects of the bid price (Siskina and Apanaviciene, 2009).

3 Literature Study

The literature study seeks to explore the concept of AK. This is achieved by analyzing the Swedish market to establish a basis for why AK are an issue today. Index adjustments and the ABC-method are discussed to understand trends with AK calculations. Finally, a review of overhead costs was conducted to try and provide a theoretical framework for establishing what AK are and how they should be categorized.

3.1 The Swedish construction market

The Swedish construction market has flourished during the last decade with a steady increase of buildings being produced since 2010 (Josephson and Björkman, 2010, Sveriges Byggindustrier, 2019a). In the last decade construction of new housing reached heights not seen since the 70s and 90s, peaking in 2017 (Sveriges Byggindustrier, 2015, Sveriges Byggindustrier, 2019a, Sveriges Byggindustrier, 2019b). However, recent reports show that a decline has started and there are no indications of change for the better (Sveriges Byggindustrier, 2019a, Sveriges Byggindustrier, 2020).

Since the peak in 2017, the number of started housing projects (apartments) has declined, and estimations show that it can be as much as 40% between the years of 2017-2019 As aforementioned, there is no indication that the trend will change in the forthcoming years (Sveriges Byggindustrier, 2019a, Sveriges Byggindustrier, 2020). The volume of started housing projects is decreasing despite favorable conditions, low-interest rates, low unemployment, population growth, engaged municipalities, and the positive stock market (before COVID-19). Arguments for why the number of built housing is declining is either that the market is saturated or due to stricter amortization demands, making it harder for people to take loans. To provide some background, Sveriges Byggindustrier (2019b) explains how changes in the law during the last 10 years have affected the Swedish housing market:

- In 2010 it was decided that loans can only be granted up to 85% of a property's total market value. The rest needs to be financed from own capital or other loans.

- In 2016 the first amortization demand was acquired. Everyone with a loan to value ratio higher than 50% must make running amortization payments. If it is between 50-70% then an amortization of 1% per year is required and if it is higher than 70% it is 2%.

- In 2018 a second amortization demand was implemented. If the loan is 4.5 times higher than yearly income before tax, households need to pay an additional 1% amortization per year.

- Furthermore, several banks started to limit the size of the loans in 2016-2017, even though the loan holder demonstrated satisfactory incomes. This occurred because Sweden's financial supervisory authority required banks to ensure that households would manage interest rates of 6-8%.

In response to this, the banks have imposed stricter demands upon households that need to be fulfilled for them to be eligible for loans. Furthermore, stricter demands not only affect the market in the sense that fewer households were able to buy housing, the action of the banks in 2016-2017 caused prices of newly built houses to drop. Thus, creating risks for people willing to invest in newly built homes with a plan to sell them quick (i.e. speculation) since prices dropped below the established housing market. This is believed to be a reason for the decrease in demand for new housing, despite the market already being saturated (Sveriges Byggindustrier, 2019b).

The decrease in new construction projects includes rental apartments, condominiums, and houses. As mentioned above, the stricter amortization demands have made it more difficult for people to buy homes and can partly explain the decline in new purchases. The stricter amortization demands result in up to 80% of young people in the age group 25-35 being unable to afford a one-bedroom apartment in central Stockholm. The banks limit who can buy an apartment. This is done by using a calculation (see Figure 3.1) that concludes if the lowest disposable income exceeds 35% of the income after tax then no loan is granted (Evidens, 2018). The results of the stricter demands are presented in Table 3.1 below:

Table 3.1 Purchasing power. Adapted from (Evidens, 2018).

City	Unable to buy. Age 25-35, living alone (30m^2)	Unable to buy. Age 25-35, living with partner or similar (50m^2)
Stockholm, City	79%	49%
Stockholm, Outer city	69%	45%
Gothenburg, City	88%	62%
Örebro*	46 %	10%
* Örebro represents an average sized city in Sweden		

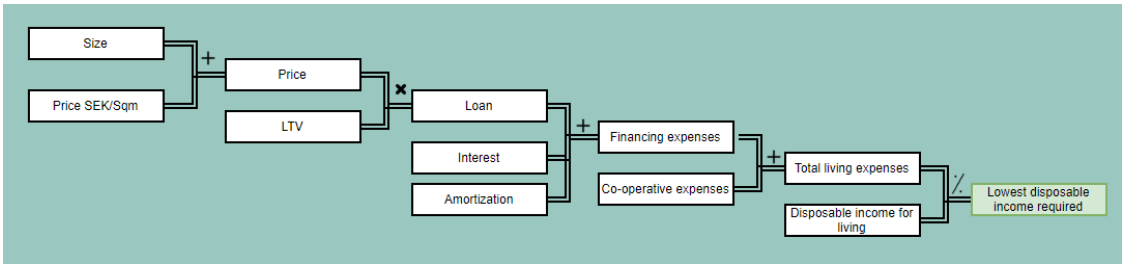


Figure 3.1 Lowest disposable income required calculation. Adapted from (Evidens, 2018).

The largest portion of the market that is in decline is the construction of owned housing. Although, construction of rental apartments is declining as well (Sveriges Byggindustrier, 2019b). The decline of rental apartments can partly originate from the lower prices in the market due to the amortization demands and a saturated market, which lowers the yield for building rental apartments (Sveriges Byggindustrier, 2018). Another reason for the decline of built rental apartments was due to beliefs that beneficial economical subsidies from the Swedish government would be terminated, but instead the old subsidies package was reformed. The subsidies from the Swedish government aid municipalities in their investment of rental and student apartments

(Sveriges Byggindustrier, 2019b, Regeringskansliet, 2019, Evidens, 2019, Sveriges Byggindustrier, 2019a).

In contrast to trends in the rest of Sweden, the market in Gothenburg has seen increased investment in housing projects. One explanation for this is the fact that in Gothenburg there are a lot of rental apartments (Sveriges Byggindustrier, 2019a). Furthermore, the region which Gothenburg is a part of is the region that has received the highest subsidies from the Swedish government for building rental apartments (Evidens, 2019). Moreover, the construction of rental apartments is the reason the Gothenburg market has remained healthy. Albeit subsidies or not, some believe that new projects would have been started anyway (Sveriges Byggindustrier, 2019a) This shows that special consideration needs to be made when investigating local markets. However, there is a belief that the Gothenburg market will follow the same trend as the rest of Sweden with a decline in both building categories in the coming years (Sveriges Byggindustrier, 2019b).

In Figure 3.2 below statistics covering started housing projects and building permits granted are presented. Stockholm refers to Stockholm county with 2.3M inhabitants (SCB, 2019a). The statistics covering Gothenburg represent greater Gothenburg with 1M inhabitants (SCB, 2019b).

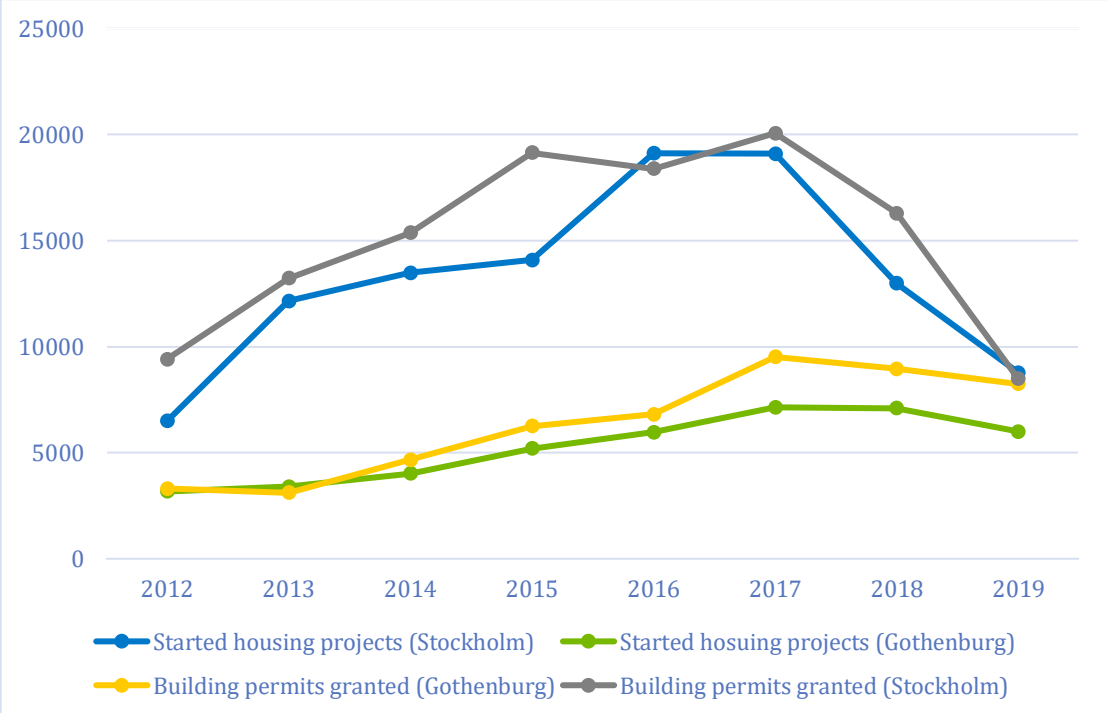


Figure 3.2 Started housing projects and building permits granted. Adapted from Byggföretagen (2020c).

The net-profit margins for Skanska are around 3.4% percent meaning that the market demands agility and competitiveness from companies (Skanska, 2020a). The cost of purchasing land has also been drastically increasing, which further increases prices for building, thus making resource efficiency important (Josephson and Björkman, 2010, Sveriges Byggindustrier, 2015).

To achieve acceptable profit margins, construction companies need to focus on cost. It is on this mechanism that they primarily compete with other firms and competitiveness is based on how efficient they are managing resources, i.e. mitigating waste and increasing productivity (Josephson and Saukkoriipi, 2007, Josephson and Björkman, 2010). According to Josephson and Björkman (2010) 10 percent of resource usage does not contribute any value in construction projects and should, therefore, be regarded as pure waste. Moreover, waste in this instance is regarded as "any activity which absorbs resources but creates no value" (Josephson and Björkman, 2010, p. 21).

There are arguments that production cost in the Swedish construction industry is more expensive than other countries and therefore it is difficult to lower costs (Josephson and Saukkoriipi, 2007). However, research shows that this statement is false, compared with other European countries (Josephson and Saukkoriipi, 2007, Boverket, 2014). It is important to understand the basis for comparison when discussing cost and different methods for measuring the cost. The report produced by Boverket (2014) highlights this by providing examples of different methods used for comparing construction prices between countries. The report presents an example of how Eurostat uses the construction price index to compare countries. Eurostat OECD (2012, p. 30) perform so-called 'purchasing power parties' (PPP's) to measure differences in price levels of products with the same quality between countries where construction of houses is included. Moreover, the following example is provided by Eurostat OECD (2012, p. 30):

> *"For example, if the price of a hamburger in France is 2.84 euros and in the United States it is 2.20 dollars, the PPP for hamburgers between France and the United States is 2.84 to 2.20 dollars or 1.29 euros to the dollar" (Eurostat OECD, 2012, p. 30).*

Thus, products or services associated with construction should be comparable between countries, i.e. a hamburger should be compared with a hamburger and not a hotdog. Furthermore, the prices that are compared should be transactional prices that the purchaser pays to construct the building (Eurostat OECD, 2012). The result is presented as an index, which is based on the economic climate within the country and is determined by the cost of labor, materials, and equipment as well as overheads (Boverket, 2014). Furthermore, costs are based on the national currency and no consideration is made towards seasonal changes (Eurostat, 2020a, Eurostat, 2020b). Boverket (2014) explains that the idea was to measure the price of the same product with the same quality at the same point in time. Eurostat OECD (2012) does not perform the investigation themselves, instead, each participating country provides prices based on a bill of quantities. The countries are asked to value a set of fictional building types that entail different work methods for subcategories that need to be performed to construct the fictional building. Thus, every building type has its specifications and set of circumstances for ground conditions, location, etc.

In 2011 it places Sweden fourth of countries with the highest construction cost index (Boverket, 2014). Statistics from comparable countries within Europe places Sweden as the country with the second-highest construction in the fourth quarter, both in 2019 and 2018 (Eurostat, 2020a, Eurostat, 2020b).

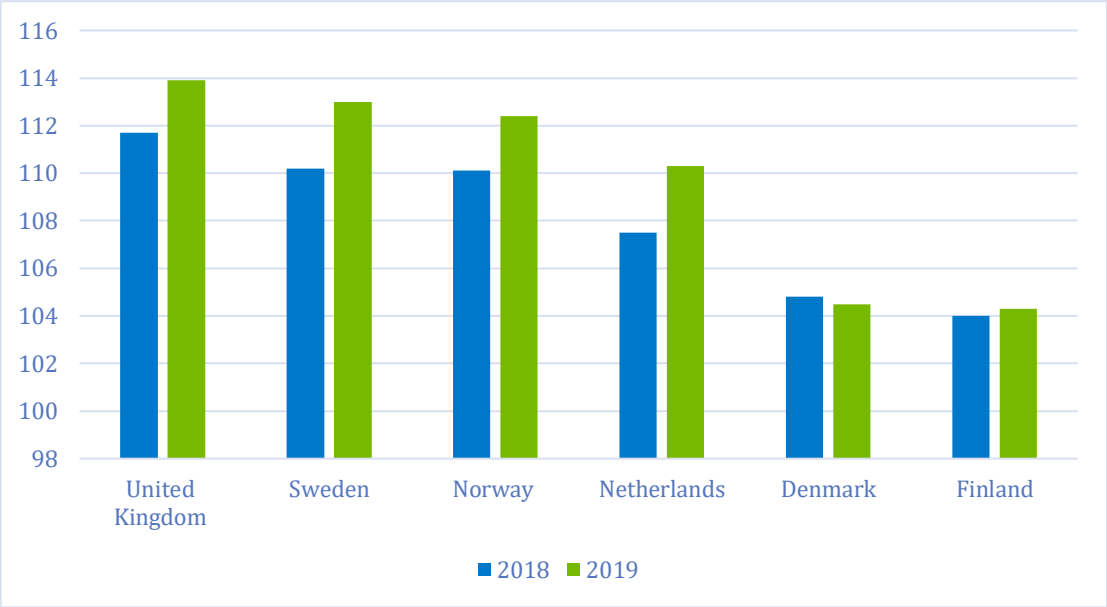


Figure 3.3 Construction cost of new residential buildings Q4 2018 and 2019. Adapted from Eurostat (2020a), Eurostat (2020b).

Another example of how the cost of construction is compared between countries is to measure the actual cost of built objects in countries by calculating the cost per square meter. This placed Sweden in sixth place in 2012 amongst the countries with the highest construction cost of high-rise apartments (Gardiner and Theobald, 2012). However, this method is also criticized since the configuration of the houses is different in each country, therefore it is difficult to provide a fair reflection (Boverket, 2014). Regardless of Sweden's ranking, construction costs remain high and there is a lot that can be done to be more effective, such as reducing the amount of non-value adding activities on-site (Josephson and Saukkoriipi, 2007, Josephson and Björkman, 2010).

Opinions of what defines waste are different (see Table 3.2 below) therefore Josephson and Saukkoriipi (2007) try clarifying this by dividing work at a construction site into three concepts: value-adding work, preparations, and waste. The first is self-explanatory, preparations are work that does not contribute to any direct value but needs to be conducted to perform value-adding work. The concept of waste is then defined as anything that is not contributing value and therefore should be mitigated as much as possible (Josephson and Saukkoriipi, 2007, Josephson and Björkman, 2010). A solution to mitigate waste on construction sites is to be more efficient in the use of resources (Ndihokubwayo and Haupt, 2009, Josephson and Björkman, 2010).

Table 3.2 Definitions of waste. Author's own elaboration.

Definitions of waste	Title	Author & year
"Any human activity which absorbs resources but create no value"	Lean thinking: banish waste and create wealth in your organization	(Womack and Jones, 2003)
"Waste (ineffective work, recoverable work)"	Why do work sampling studies in construction? The case of plumbing work in Scandinavia	(Josephson and Björkman, 2013, p. 2)
"Eliminate all waste that is not adding-value to the process"	The Toyota way to continuous improvement	(Liker and Franz, 2011)
"Non-value adding activities"	Lean Construction Management	(Gao and Low, 2014a)
"Reduce the share of non-value-adding activities (waste)	An exploration towards a production theory and its application to construction	(Koskela, 2000)
"Waste is any activity that consumes resources but creates no value for the customer"	Applying Lean Production in Factory Homebuilding	(Jordan Dentz., 2009)
"Waste, i.e. eliminate tasks that are performed but that do not add any value to the customer"	31 recommendations for increased profit-reducing waste	(Josephson and Björkman, 2010)

In a report by Josephson and Saukkoriipi (2007), it is concluded that the cost for machinery and equipment (storage, waste containers, crane and scaffolding, etc. represents 10% of production cost. Boverket (2014) writes that costs for machines, transportation and overheads constitute 12 percent of the total production cost and 19 percent of the construction cost. The authors Josephson and Saukkoriipi (2007) investigate the 10 percent further by observing machinery and equipment usage, concluding that 2-5% of total production cost is direct waste Additionally, there are arguments that cost for machinery is 3-5% of contractors total building cost in a traditional construction project (Nordstrand, 2008).

The most common explanation as to why it is difficult to standardize and lower waste in the construction industry is that all construction projects are believed to be unique (Koskela, 2000, Josephson and Saukkoriipi, 2007, Josephson and Björkman, 2010, Gao and Low, 2014a). Josephson and Saukkoriipi (2007) write in their report that in the Swedish construction industry it is not just that the projects are believed to be unique, they also repeatedly received comments from industry professionals asserting that the construction industry is conservative and unwilling to implement changes in their organizations. Furthermore, Josephson and Saukkoriipi (2007) describe how widespread this notion of the industry is by highlighting how lean construction is perceived:

"Lean Construction, which has more or less been translated from Lean production, in other words the philosophy that is founded on the work method of the Toyota car company. It is a good thought intended to create a broader acceptance within the sector, but at the same time it strengthens the notion that building has its own culture and its own way of working" (Josephson and Saukkoriipi, 2007, p. 47).

This indicates that the industry views the non-repetitive production to always be unique, which makes it hard to implement new ways of working, especially for the ones originating from the manufacturing industry (Koskela, 2000, Josephson and Saukkoriipi, 2007, Gao and Low, 2014b). Additionally, Gao and Low (2014b) conclude that implementing the Toyota framework into construction is challenging since the uniqueness of manufacturing activities do not coincide with construction. (Koskela, 2000, Josephson and Saukkoriipi, 2007, Gao and Low, 2014b).

The arguments that the construction industry is unique and conservative are not a valid argument for why waste and inefficiency remain present in construction projects (Koskela, 2000, Josephson and Saukkoriipi, 2007). Josephson and Saukkoriipi (2007) argue that projects and processes are more alike than unique and there is no evidence supporting the notion of it being conservative. This is supported by Koskela (2000) arguing that some aspects of construction projects are unique like for example site conditions, design, and demands from clients. Nevertheless, the work methods for contractors are mostly repetitive and in comparison, with, for example, the IT-industry, construction cannot be considered unique (Koskela, 2000).

An interesting aspect that perhaps originates from the idea that construction projects are unique is that companies tend to build in an uncertainty factor in construction projects (Koskela, 2000). The reason for this is that site managers need to spend a fair amount of their time, solving problems that cause interruptions to ordinary work patterns, to a further extent than is normally defendable. This creates a culture that accepts uncertainty and risk because a part of the site manager's identity is to solve problems ad hoc. Furthermore, it also creates a belief amongst site managers that their performance is valued based on their ability to solve unforeseen problems as they arise. Therefore, unpredictability is welcomed rather than mitigated, since it enables managers to demonstrate their competencies and value for the company (Josephson and Björkman, 2010). For construction projects to become more efficient there is evidently a need for a change of attitudes and culture. Hence, indications exist that culture perhaps is stronger than project uniqueness.

3.2 TSCF index adjustments

In Sweden, a federation exists that is called the "The Swedish Construction Federation" (TSCF) which represents the interests of the construction industry. Furthermore, they describe themselves as a "trade organization for private construction companies and employees" (Byggföretagen, 2020b) The federation provides different forms of counseling, technical support, agreements, work environments, prognoses over market investments and more. However, it is another service provided by the organization that interests the authors of this paper in the investigation of AK, which is the index adjustment service available for contractors to regulate project costs (Byggföretagen, 2020a).

In construction, projects vary in length and fixed prices do not follow inflation, which in turn decreases profit margins. Additionally, adjustments based on the consumer price index (CPI) are not a fair representation of performed tasks (Nordstrand, 2008, SCB, 2017). To prove the difficulties with this, SCB (2017) writes that the price of a product in the consumer market with no relation to a construction project can cause the CPI to increase. However, an increase in consumer goods not related to work at a construction site cannot be considered a fair representation of work-related costs. This, in turn, will drive up the project costs without being directly related to the project costs. Therefore, to avoid this, TSCF developed an index adjustment tool for construction projects (SCB, 2017, Byggföretagen, 2020a). Thus, the contracting parts can agree upon "a fixed priced with index adjustments" to deal with potential price increase (Nordstrand, 2008).

Byggföretagen (2020a) categorizes work activities so that time index adjustments can be made in contracts for the selected activity. One of these categories is called "other expenses" and the subcategory option "allmänna kostnader" (AK) is available, but detailed information on what these costs entail is not presented. The only information available describes "other expenses" as being administrative costs deriving from the worksite and head office. Additionally, calculations based on the CPI exclude value-added tax (Byggandets Kontraktskommitté, 2011). They also describe that projects can either decide on a percentage or fixed value (in SEK) for AK. The active AK index is then adjusted for the month the sum was agreed on against the prevailing index when the service was performed (Byggandets Kontraktskommitté, 2011).

3.3 Traditional or activity-based costing

Increased competition, low margins, and substantial waste are challenges construction companies are faced with every day. To maneuver in this environment, construction companies require adequate methods for managing costs. Efficient cost methods can be used proactively to reduce waste and enable better allocation of overheads. Moreover, traditional accounting methods in construction fail to address the intricate characteristics of AK in work activities, hence failing to proactively manage them (Al-Hajj and Zaher, 2012).

The traditional accounting or the cost management method is most often referred to as resource-based costing (RBC) or traditional costing (Al-Hajj and Zaher, 2012, Kim, 2017, Kim and Ballard, 2001). In RBC, calculations are based on volumes of products or services produced that directly consume resources (Al-Hajj and Zaher, 2012, Kim, 2017, Stašová, 2019). Kim (2017, p. 16) phrase it as 'one-stage costing' with the notion that all products or services consume resources directly. Consequently, the allocation of overheads becomes purely based on direct hours or labor costs used to produce the product or provide the service (Al-Hajj and Zaher, 2012, Kim, 2017). This means that by using RBC there is limited possibilities to know which aspects drive the costs of the product or service up or down (Al-Hajj and Zaher, 2012).

Although, RBC provides an overview of which costs are higher than others it does not provide information about how they affect project costs, e.g. a resource can be expensive but without that resource, it would not be possible to provide the product or service. Thus, RBC is an insufficient method for determining which costs to cut or for making accurate cost estimates (Kim, 2017, Stašová, 2019, Al-Hajj and Zaher, 2012).

To cope with the flaws of RBC, the literature advocates activity-based costing (ABC) (Stašová, 2019, Kim, 2017, Kim and Ballard, 2001). The ABC method recognizes processes and activities performed to produce a product or service rather than direct hours (Kim, 2017). Kim (2017, p. 20) describes ABC in the following way, "ABC assigns the costs of each activity to cost objects in proportion to the actual consumption of activities by each cost object." In other words, ABC assigns costs to processes and investigates cause and effect relationships, rather than allocating a cost percentage based on direct cost or hours of work (Stašová, 2019, Kim, 2017). However, ABC is not a replacement for RBC, it is rather an extension (Al-Hajj and Zaher, 2012, Stašová, 2019). The objectives are to remove cost distortions and identify non-value adding activities (Kim, 2017). Stašová (2019) note that ABC is a method for allocating indirect costs as well as increasing the understanding of production processes. However, it has no effect on direct costs related to labor or material.

Instead of allocating cost to a specific building project, ABC allocates costs to specific work tasks. Hence, specification of work-related costs becomes more accurate and makes it possible to mitigate non-value adding activities through implementation of better work methods (Stašová, 2019). Implementing ABC in construction can help detect non-value adding activities that indirectly cause AK to rise and potentially improves the ability to categorize AK (Kim and Ballard, 2001). Furthermore, ABC can be used to identify increased activity costs, which would not be detected when using the RBC method, enabling a better understanding of which AK are important to focus on (Kim and Ballard, 2001).

The implementation of ABC is interesting due to its ability to detect non-value adding activities that indirectly cause AK to rise (Al-Hajj and Zaher, 2012, Kim and Ballard, 2001). Thus, it is possible to set a price to a specific factor causing costs of activities to increase or decrease, which enables better understanding of why certain AK are important to consider. Information related to costs also becomes easier to communicate (Kim and Ballard, 2001). Instead of allocating cost to a specific building project ABC allocates costs to specific work tasks. Hence, specification of work-related costs becomes more accurate and makes it possible mitigate non-value activities through implementation of better work methods (Stašová, 2019).

Although, ABC is a useful tool for accurate costing and reducing non-value adding activities, there are steps to overcome to successfully implement an ABC system, which are listed below.

- The system demands extensive planning and mapping of resource usage. Data collection is necessary to understand all elements of work (Al-Hajj and Zaher, 2012, Kim, 2017).
- It needs to be decided if the ABC system should be implemented at office or project level, i.e. decide the cost object (Kim, 2017).
- The system must clearly define what the cost drivers are and their link to activities (Al-Hajj and Zaher, 2012). In other words, the level of detail is important to consider when building an ABC system. Too detailed creates too complex a system whilst not detailed enough causes confusion amongst employees (Kim, 2017, Al-Hajj and Zaher, 2012).
- Kim (2017) highlights the importance of defining something as an activity, daily work or a process. Activities affect cost negatively or positively and should

therefore be identified and managed in the ABC method. Work processes can be broken down to activities but dismantling a process into daily activities becomes to detailed and complex to handle.

3.4 Allmänna kostnader (AK)

AK allocation and categorization is known to be highly subjective and are therefore difficult to define. In the following sections existing literature is considered and discussed to establish a framework for defining AK and why it is important to do so.

3.4.1 What are AK?

Construction project costs can be separated into two basic categories. These are direct and indirect costs. Direct costs are those costs for the contractor which include materials, labor, subcontractors and installed equipment (Cilensek, 1991). Indirect costs are those which are not incurred by the actual construction of the object but are needed to support the work (Cilensek, 1991). Indirect site costs are usually categorized as 'allmänna kostnader' (AK) at the company Skanska, in Sweden. Plebankiewicz and Leśniak (2013, p. 142) define an overhead cost as "a cost that cannot be identified with or charged to a construction project or to a unit of construction production."

Overhead costs can generally be divided into two distinct categories, project overhead and company (general) overhead costs (Assaf et al., 2001, Nabil and El-Riyati, 2015, Plebankiewicz and Leśniak, 2013, Siskina and Apanaviciene, 2009). Project overhead costs are all the costs the contractor incurs on the construction site required to complete the work, which are not the standard costs of labor, materials or installed equipment (Plebankiewicz and Leśniak, 2013). They are also sometimes called field or site overheads and largely consist of costs expended to manage and administer a project (Nabil and El-Riyati, 2015). Company overhead costs are usually considered fixed expenses of the company (Siskina and Apanaviciene, 2009). They cover the office costs for supporting the company's construction program, the corporate functions required to run and support the field operations (Nabil and El-Riyati, 2015). Nabil and El-Riyati (2015) describe company overhead costs as those incurred by the company for the benefit of all projects in progress, they are necessary and essential for doing business. Overhead costs reflect the organization's management system, use of resources and optimization of its business activities (Siskina and Apanaviciene, 2009).

RICS (2018) write for the Chartered Institute of Building that project overheads can be called site overheads, general cost items or expenses. They are site-specific project costs that cannot be allocated to individual activities and the required characteristic to be categorized as a project overhead is that the cost serves more than one activity (RICS, 2018). However, RICS (2018) say that in practice sometimes resources that could be allocated to an activity such as scaffolding are instead included in the preliminaries because of preferred pricing methods.

Preliminaries are the cost of running the construction site, rather than any particular activity or zone (RICS, 2018). They may also be referred to as site overheads, site prelims or field costs. The contractor's preliminaries are the costs of running the site but exclude the costs associated with subcontractor's work (RICS, 2018). Another definition is given by Bowen et al. (1996, p. 1), they write that site overhead costs can

be defined as, “those items that are not directly related to individual items of measured work.” Examples of site overhead costs include accommodation, plant, temporary services, insurances and scaffolding (Bowen et al., 1996). They can be either grouped into items that relate to the contractor’s overheads of the client’s requirements (Bowen et al., 1996). Site overhead items may be either fixed costs or time related. Fixed costs can be value-related, method-related or quantity related, including things such as signage and temporary works (Bowen et al., 1996). Whereas time-related costs relate to how long a resource is in use, for example, rented site accommodation. Many resources overlap between categories, such as a tower crane requiring fixed costs to transport and erect, but variable time costs for how long it is used.

3.4.2 Why is it important to consider AK?

Increased competitiveness in the construction market has led companies to pay more attention towards reducing their management expenses (Siskina and Apanaviciene, 2009). In construction, the bidding price of a project remains the primary tool for measuring competitiveness (Siskina and Apanaviciene, 2009). Construction project site overheads are a significant percentage of overall costs 11-19% involved in completing a construction project (Chan and Pasquire, 2006).

Construction companies are often under pressure to cut bids, resulting in increased risk and a need to reduce costs so that profit levels can be achieved (Chao and Liaw, 2017). Often managers at construction companies target reducing site overheads as they are frequently the fastest growing and most wasteful areas of an organization (Siskina and Apanaviciene, 2009). Quality, service, and flexibility may also be improved by reducing the causes of overhead costs (Siskina and Apanaviciene, 2009). One of the primary tools for determining the competitiveness of construction companies is to compare overhead costs against rival companies (Siskina and Apanaviciene, 2009). However, contractors are often unwilling to calculate overhead costs in detail and instead add a percentage sum to the bid price (Plebankiewicz and Leśniak, 2013). Construction companies perform extra work calculating project overheads due to difficulties and uncertainties around estimating project overheads, despite this extra work the accuracy achieved is still comparatively lower than direct cost estimates (Chan and Pasquire, 2006). Inaccurately estimating project overhead costs transfers significant risk to the construction company as it is them that have to bear the cost, which affects project performance (Chan and Pasquire, 2006).

Assaf et al. (2001) write that the construction market is notoriously unstable, which makes it difficult to decide on optimum levels of overhead costs to successfully manage large projects and win public tenders. This becomes increasingly important as many contractors do not know their actual site overhead costs, which poses great risk to construction companies (Siskina and Apanaviciene, 2009). Holland and Jr (1999) outline the extreme difficulty contractors have defining what site overheads are and how they should be categorized, both whether they are a direct or indirect cost and if they are a project or company overhead cost. In their study Assaf et al. (2001) found that only 13% of the contractors sampled could accurately define what overhead costs are. Despite this most contractors acknowledge that their current overhead cost levels are neither acceptable nor sustainable, which can affect project performance (Assaf et al., 2001). Previous studies about overhead costs have struggled to gain widespread

responses from practice due to the competitive and secretive nature of the tendering process (Tah et al., 1994, Holland and Jr, 1999).

3.4.3 How are they calculated?

A construction company prepares a bid for a project, which comprises of direct cost, overheads and profit margin (Chao and Liaw, 2017). Direct costs cover the majority of the project costs, around 80% in the Swedish market and are usually calculated in detail (Sveriges Byggindustrier, 2015). Detailed estimation of overheads is usually unfavored and instead a percentage of the direct costs are usually added to cover site overheads, which may be left undetermined until construction (Chao and Liaw, 2017). The experience of the estimator usually has a large effect on the accuracy of these overhead costs. Company overheads are usually also determined at a fixed rate, by comparing the firm's annual total home-office costs to the annual home-office revenue (Chao and Liaw, 2017). Finally, profit levels are calculated and added as a markup based on project conditions for the firm and the market (Chao and Liaw, 2017). In some cases, companies may be willing to accept lower profit margins for flagship projects. The bid price equates to estimated direct cost + estimated overhead cost + charged profit (Figure 3.4). However, Chao and Liaw (2017) state that because contracts, especially public ones are usually awarded based on the lowest bid, contractors face pressure to cut their bids in order to compete, which greatly increases risk. Therefore, it is important for contractors to obtain a balance between chance of winning the contract and loss risk, which often means bids are made subjectively, whilst the focus remains largely on direct cost estimation. In most cases companies may price site overhead items twice to ensure that items are not neglected or forgotten about, whilst other companies may deliberately neglect some site overhead items in order to win a contract by submitting the lowest bid (Wilmot-Smith, 2006).

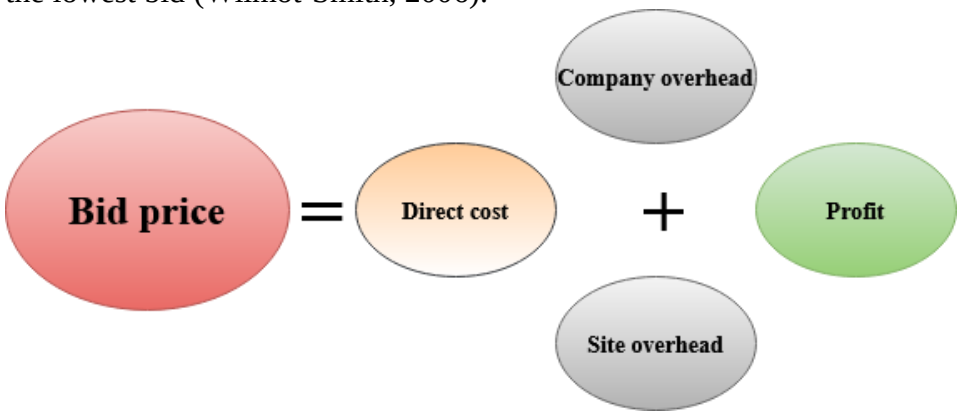


Figure 3.4 Bid price equation. Author's own elaboration.

Determining whether an activity is a direct cost, indirect cost or site overhead is not always straightforward. Even the distinction between the categories is sometimes blurred. To try and understand which elements AK are comprised of the following (Figure 3.5) and explanations are provided. Direct costs are materials and labor that are directly involved in producing a part of the construction. Indirect costs are all the costs that are not directly related to production, but production could not occur without them, which includes both site and head office overheads (RICS, 2018). However, some overhead costs can be attributed to the project and treated as direct costs, site overheads are usually calculated as part of the preliminaries (RICS, 2018). The distinction between overhead items and preliminaries is examined further in the following section.

The tender price is then usually a percentage of the total project cost, with allowances made for profit and risk.

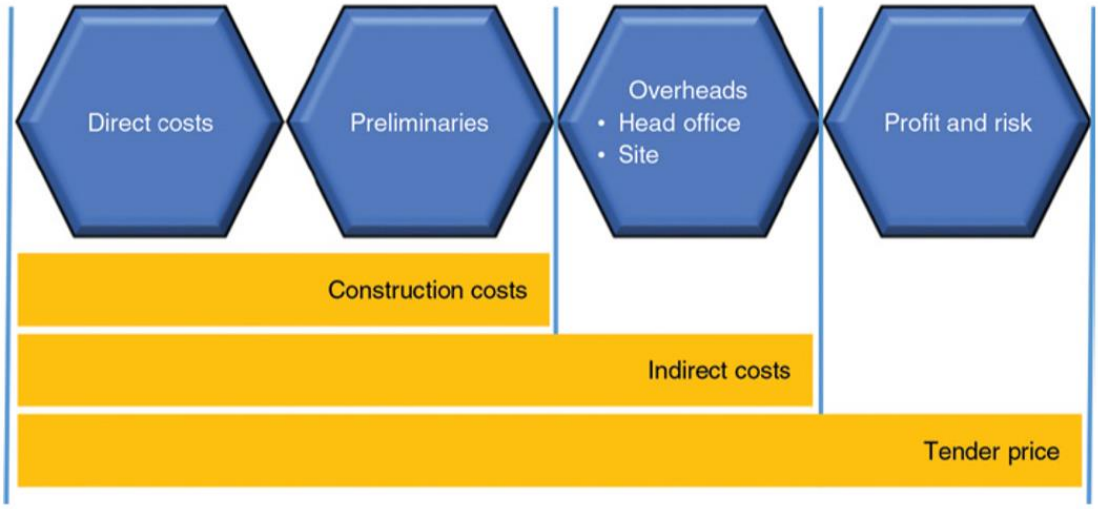


Figure 3.5 The cost build-up. (RICS, 2018, p. 176).

Assaf et al. (2001) focus on company overheads in their study, which according to them is one of the main reasons why contractors struggle to stay in business and realize a profit. Company overhead costs vary considerably but according to Assaf et al. (2001) range between 8-15% of project costs. One area companies struggle with accuracy in calculating company overheads is the additional cost allocated to a project for other failed bids (Assaf et al., 2001). Companies may struggle to compete when competitor's prices are unrealistically low, especially when there are signs that overhead costs are reaching unacceptable levels (Assaf et al., 2001). Assaf et al. (2001) give 5 reasons why it is difficult to measure and thus reduce overhead costs. 1) Overhead costs are not clearly defined as they are generated from indirect activities. 2) These indirect activities are considered vital and therefore are hard to reduce. 3) It is hard to foresee the costs of indirect activities. 4) A reduction in overhead costs usually affects executives first, so many of them try to shift the focus to other causes. 5) There is a lack of long-term business planning and instead a focus on projects. The percentage of company overhead costs is usually determined on a senior management level (Tah et al., 1994).

Chan and Pasquire (2006) say that in theory site overheads are prepared by thorough calculations but in practice it is the estimator's professional judgement and intuition that has the strongest impact on the final sum. Similarly, to company overheads, project overheads are also highly subjective and largely determined by management decisions, rather than project conditions (Chan and Pasquire, 2006). The result of this is that estimations often contain a large amount of inaccuracy, especially when compared with the accuracy in direct cost estimates (Chan and Pasquire, 2006). Chan and Pasquire (2006) found in their study that project overheads were between 11-19% of total project cost, where site management were the majority of this and made up around 36% of the cost.

One of the reasons for using a percentage of direct costs as a way of calculating overheads is that to calculate them is a time-consuming and inexact task (Nabil and El-Riyati, 2015). Peurifoy (1975) criticized the method of multiplying direct costs by a

percentage to get overhead costs as it is not sufficiently accurate and many indirect cost items do not scale linearly based on the size on the project. There are more accurate, modern methods available for calculating overhead costs such as advanced neural networks, simulations and fuzzy modelling but they are seldom used (Nabil and El-Riyati, 2015). Instead estimators prefer to use their own experience, which is based on historical project data, future activity forecasts, competitive conditions, the size and nature of the project, levels of risk, and ratio between the main contractor's and subcontractor's work (Nabil and El-Riyati, 2015). They may also have checklists to make sure that items are not left out (Tah et al., 1994). Other project variables such as duration, location, site conditions, project type and size also affect overhead cost levels (Nabil and El-Riyati, 2015).

Site overheads represent a significant portion of the project's total cost. They often occur early in the project and cost estimations are approximations, which should be evaluated often as the project progresses and more information becomes available (RICS, 2018). Anticipating weather conditions can have a huge impact on preliminary costs and is important to make allowances for (RICS, 2018). Weather conditions may affect crane use, drainage, heating and concrete drying etc. Inyang-Udoh (2013) showed in their study that in projects the higher cost site overhead items, such as scaffolding, mechanical plants, site accommodation etc. are frequently priced components. However, their study showed that there was a high correlation between total project cost and percentage of site overhead costs for high rise building projects (Inyang-Udoh, 2013). Therefore, they suggest that only very few site overhead components should be priced in order to save time and paperwork, but that estimators should be properly experienced and trained to judge what is necessary (Inyang-Udoh, 2013). Bowen et al. (1996) also note that 90% of the value of site overheads can be found in only six items, plant, staff, scaffolding, site accommodation, cleaning and electricity, where on average only sixteen sire overhead cost items were calculated. Without estimators becoming more aware and involved in construction projects it is unlikely that their methods of pricing site overheads will improve (Bowen et al., 1996).

3.4.4 What is included?

Each organization defines their site overheads differently. There is also no direct translation from the Swedish 'allmänna kostnader' but it is understood that site overheads come rather close. The literature struggles to adopt a standardized approach to what is included in this calculation as it differs between location. Therefore, this section begins with a definition given in a Swedish textbook (shown in Table 3.3) and is compared with other international sources.

Table 3.3 Examples of site overhead categories for a project and what is included in each category. Adapted from Révai (2012).

Category	Included costs
Work with temporary roads	Creating and maintaining site access, roads; Road closures and traffic warnings
Establishing and winding up	Transport, unloading, set-up, completion work, removal work, offices, storage, fencing and land rental
Work with temporary installations	Electricity, water, sewage and pressurized air
Work with machines	Transport, unloading, mounting, connecting, running, maintenance, repairs, inspections and removal
Storage and safety	Tools, equipment, personal safety equipment, first aid, fire safety, protection of trees, buildings, cables and materials, safety railings, scaffolding, consumable materials
Transport	Costs to transport to and from site, internal transport and creation of temporary storage space
Cleaning	Cleaning inside and outside the construction, offices, waste sorting and final clean
Winter and Summer work	Drying, heating, waterproofing, snow removal, waiting and sanding
Offices	Furnishing, office equipment, telephones, computers, office supplies, security

RICS (2018, p. xviii) write that site preliminaries include costs such as "management and staff, site establishment, temporary services, security, safety and environmental protection, control and protection, common user mechanical plant, common user temporary works, the maintenance of site records, completion and post-completion requirements, cleaning, fees and charges, sites services and insurances, bonds, guarantees and warranties." This is shown in the Figure 3.6 below. In Table 3.4 another breakdown of preliminary items is shown. The Royal Institute of Chartered Surveyors (RICS) are based on UK practice. They wrote the rules and guidelines for measuring and describing construction work with the purpose of obtaining tender prices. The purpose is that they can be applied to both standard and bespoke solutions and although created for use in the UK, have worldwide application (RICS, 2015).

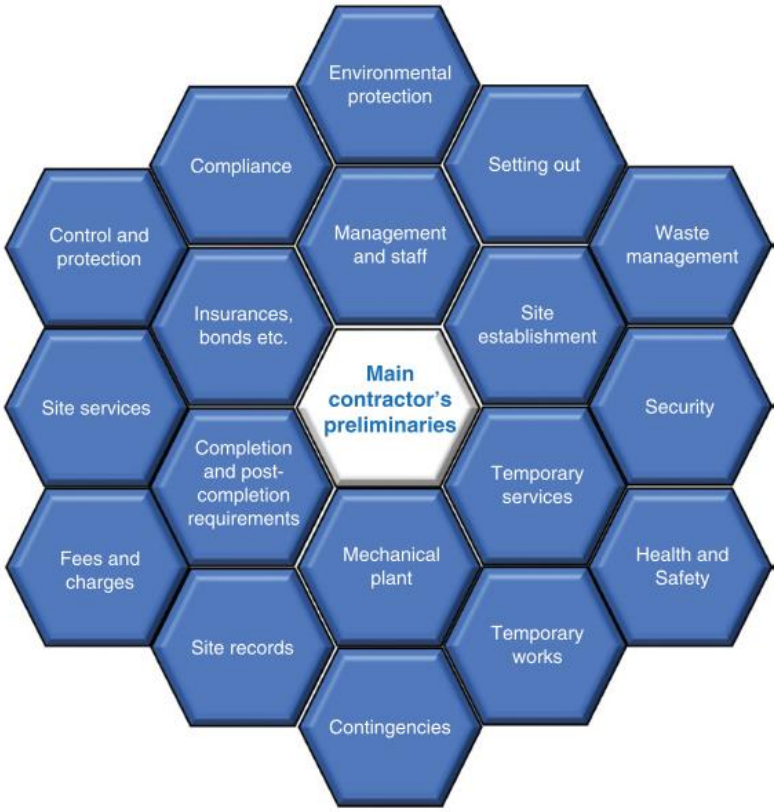


Figure 3.6 Preliminaries. (RICS, 2018, p. 52).

Table 3.4 Preliminaries. Adapted from RICS (2015, pp. 109-119).

Category	Component
Management and staff	Project specific management and staff
	Staff travel
Site establishment	Site accommodation
	Temporary works in connection with site establishment
	Furniture and equipment
	IT systems
	Consumables and services
	Sundries
Temporary services	Temporary water supply
	Temporary gas supply
	Temporary electricity supply
	Temporary communications system
Control and protection	Survey, inspections and monitoring
	Setting out
	Protection of works
	Samples
	Environmental control of building
Mechanical plant	Mechanical plant
Temporary works	Access scaffolding
	Temporary works
Site records	Site records

Completion and post-completion requirements	Testing and commissioning plan
	Handover
	Post-completion services
Cleaning	Site tidy
Fees and charge	Charges
Insurances, bonds, guarantees and warranties	Insurances

The preliminaries shown above represent 11-19% of the total project cost (Chan and Pasquire, 2006). However, four of these preliminaries make up around 80% of the total preliminary costs, which are, staffing, mechanical plant, access/scaffolding and site accommodation (RICS, 2018). This is shown in Figure 3.7 below. According to RICS (2018) safety is an important element of the preliminaries that is non-negotiable.

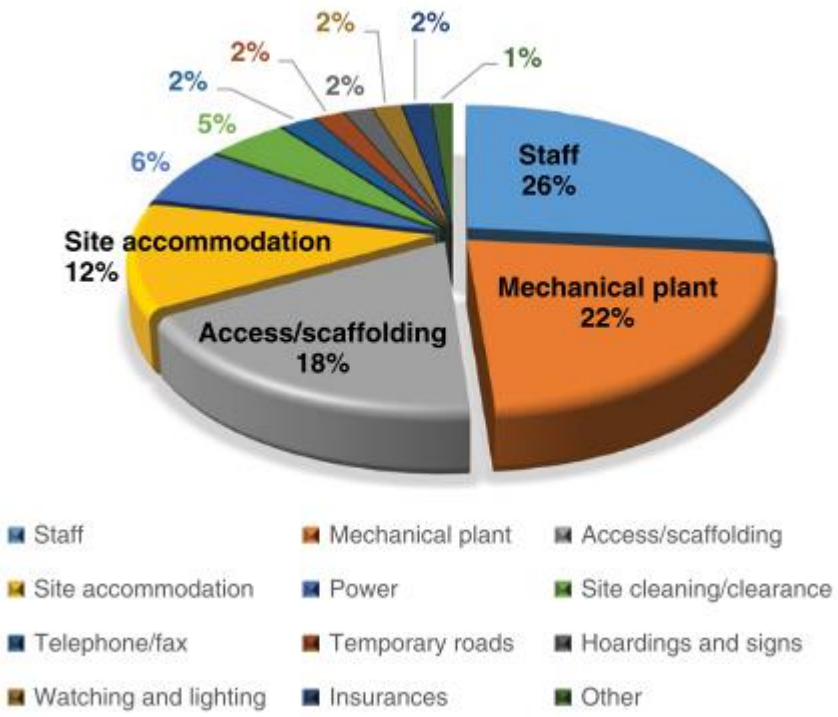


Figure 3.7 Breakdown of preliminaries. (RICS, 2018, p. 52).

As the term mechanical plant is not used in Sweden, a more detailed summary of what this category includes is provided. Mechanical plant is all the mechanical equipment that is used to perform the construction. Some examples of this are cranes (both mobile and tower), bulldozers, dump trucks, excavators, fork-lift trucks, power tools, shovel loaders, power rollers, tractors and trenchers (RICS, 2018). The costs that are included for each type of machine or tool are the base cost (fixed or time based), delivery, establishment and removal costs, protection systems, operator costs, safety check/inspection costs and other specific costs (RICS, 2015).

Site expenses can be distributed in many ways. Each company has their own accounting system and resource costs are distributed into corresponding accounts. However, it is difficult to maintain consistent accounting methods without distinct definitions of

which types of cost correspond to which resource. This is shown in the study performed by Tah et al. (1994), where seven contractors were questioned about the distribution of site expenses. The results are shown in Table 3.5 below. As shown, only two contractors provided the same results, where each item was listed as a preliminary expense. The wide range of responses make site expenses an area that is difficult to improve in terms of cost estimation as it remains relatively undefined. As shown below, the distribution of cost largely depends on the contractor's own judgement.

Table 3.5 Distribution of site expenses. (Tah et al., 1994).

Item	C1	C2	C3	C4	C5	C6	C7
Site cleaning	p	p	p	s	p	p	s
Clearing rubbish	p	p	p	s	p	p	s
Site accommodation	p	d	p	p/s	p	p	p/s
Site transport	p	d	p	p/s	p	p	p/s
Mechanical plant	p	d	p	d/s	p	d	s
Scaffolding and gantries	p	p	p	s	p	p	s
Temporary services	p	p	p	s	p	p	s
Service charges	p	p	p	s	p	p	s
Small plant	p	d	p	d/s	p	p	s
Defects and liabilities	p	d	p	-	p	p	s
Final clearance and handover	p	h	p	s	p	p	d/s
Abnormal overtimes	p	d	p	d	d	d	s
Insurance	p	h	p	s	d/p	p	s
Bonds	p	d	p	p	p	p	s
Payroll and taxes	p	d	p	s	p	d	s
Wages and taxes	p	d	p	d	d	d	s
p: preliminaries, s: site overheads, h: head office overheads, d: direct costs.							

3.5 Summary of literature review

The housing market in Sweden was flourishing until towards the end of the last decade, when the number of new construction projects started to decrease. This trend started in 2017 when the amortization changes came into effect and made it increasingly difficult for young people to purchase homes. Despite this, the market in Gothenburg has remained healthy but national trends are affecting company decisions, which has led to a greater focus on costs. The construction industry is notorious for being inefficient, even though the primarily means for competing to win tenders is based on cost. The high levels of inefficiency are often explained away by saying that projects are unique, and the industry is conservative, which Josephson and Saukkoriipi (2007) and Koskela (2000) do not necessarily agree with.

Construction costs are separated into two basic categories, which are direct and indirect costs. Additionally, construction companies make allowances for profit and risk when submitting a tender. Indirect costs generally comprise of overheads and project overheads. The focus of this study is primarily on project overheads that can be further broken down into preliminary cost items, which closely relate to the Swedish term 'allmänna kostnader' (AK). Preliminary costs are the cost of running the construction site, rather than any particular activity or zone (RICS, 2018). It is important to consider

indirect costs because it is in this area that tenders are often won or lost. There are many ways to calculate indirect costs but often a percentage sum of the direct costs is used, based on the experience of the estimator. However, it is argued that this method may not provide accurate enough estimates and inefficiencies occur. There are four main preliminary cost items that contribute up to 80% of total site overhead costs, which are site organization, mechanical plant, access/scaffolding and site accommodation. It is often difficult to categorize costs as AK because there are no clear accounting methods for site managers. Instead they rely on personal experience and the results vary from project to project, which makes lowering costs and improving efficiency difficult. Each country and company have their own ways of managing cost structures, but this thesis most closely follows that of the UK's RICS. ABC and index adjustments were also explored as methods for more accurately predicting AK in projects.

The study primarily focuses on the site overhead literature to define and categorize AK. The Swedish market study is used to understand why these costs are relevant and how tougher market conditions have affected Skanska's desire to work efficiently. Finally, ABC and index adjustments are explored as ways of improving work methods.

4 Empirical Study

The empirical study presents findings from the interviews and a questionnaire with Skanska employees. The empirical study explored current understandings of AK in practice, how it can be defined, which areas can improve most and methods of working with AK.

4.1 Interviews with Skanska housing managers

The interviews were all performed with people working at Skanska. They were conducted with employees working both in office and on-site roles. In Table 2.1 a list of interviewees, dates and times are provided. In the section below key points from the interviews are presented based on the authors research questions and interesting findings.

4.1.1 Backgrounds

Two estimating managers and one estimator were interviewed that have experience working with AK issues. Between them they have 55 years' experience working in the construction industry, where 48 of them have been working in an estimating capacity. This study focuses on AK in Gothenburg but one of the estimating managers works for another region. This manager was able to also provide insight into how these types of costs are handled in another large Swedish construction company. Estimating manager 2 describes AK as "both the easiest and hardest part to work with."

The biggest group of interviewees represented are site managers with different levels of experience in their position. Common to all the site managers is that they work with housing at Skanska in Gothenburg. None of the site managers have worked at any other company except site manager 5 that has experience from working as a project manager abroad. It should be mentioned that due to ongoing COVID-19 pandemic some interviews were cancelled. Site manager 5 cancelled the interview but agreed to fill in the answers by email.

The site supervisor has the second longest experience of working in construction and has always worked with housing projects. One design manager was interviewed to provide a wider perspective from a discipline that does not necessarily work as closely with day-to-day AK. However, the design manager had some prior AK knowledge from previous work at another Skanska department that focuses on innovation and civil engineering works. The logistics engineer has previously worked at another company but was recruited by Skanska with the task of manage AK and logistics. 70% of the logistics engineer's work focuses on AK and 30% focuses on logistics. Unlike most of the interviewees the logistics engineer works with construction of large public projects.

4.1.2 Experience of working with AK

The interviewees had different experiences of working with AK and were asked to describe their experiences with AK. The results are summarized below (see Table 4.1).

Table 4.1 Interviewees experience of working with AK.

	Interviewee	Experience with AK
Office employees	Design Manager	"It is a concept that has always been there but in my previous role as a structural engineer I never really thought about it. Now, as a design manager, I have started to think more about it, but I have no idea how it is calculated."
	Estimating Manager 1	Frustrated because Skanska are not being as cost effective as they can be, since AK are too high. They think that a step in the right direction would be that for projects to start to calculate AK in the same way. They are also involved in a project where the goal is to implement a common way for calculating AK across all projects in Sweden.
	Estimator 1	Calculates and budgets AK, then controls the bills.
	Estimating Manager 2	Their experience has resulted in an understanding that you need to use a mix of guessing and thorough calculations, "calculating and budgeting AK" are regular aspects of work. They also explained the mindset needed when considering AK, "80/20 with the big stuff. If a crane is going to be used 80% of the time at one place, then there is no reason to move it somewhere else since it becomes too expensive. Hire a mobile crane for the remaining 20% of the work."
Project employees	Logistics Engineer	Introduced to AK when starting to work for Skanska and sees a connection between how AK and logistics are managed at the site.
	Site Supervisor	Explains AK as "it is something that is often missed, you can easily be lazy about it," and thinks everyone probably has their individual work methods.
	Site Manager 2	They have managed AK in a bad way with no defined guidelines which leads to ineffective work methods.
	Site Managers 1 and 3	Both consider AK as a percentage calculated by estimators and think that all projects have prerequisites to consider when managing it.
	Site Manager 4	Has "a bit of experience from site manager 2 who has taught me to think the right way from the start and to be active in my working with AK." Note: Has only worked as a site manager for less than a year.
	Site Manager 5	Has "only participated in two projects so far and the first project had already started when I came along, so I do not have that much experience with AK."

4.1.3 Definition of AK

The following Table 4.2 demonstrates the definitions provided by the interviewees when asked to define what AK.

Table 4.2 Interviewee's definition of AK.

Interviewee	Definition of AK
Estimating Manager 1	"Material and aid that cannot be attached to any specific work that is used by several contractors."
Estimating Manager 2	"Things that are left when the project is done are direct costs, AK are the other costs."
Estimator 1	"Think of a house, then you take it away and then take the ground away, the things that are left are AK."
Design Manager	"AK = support for carrying out the project."
Site Manager 1	"Costs which are not directly built into the buildings. For example, site offices, crane, containers, lifts etc."
Site Manager 2	"Machines, site offices, form material, scaffolding"
Site Manager 3	"Costs which are not built into the building, for example, help material, cranes, machines, transport etc."
Site Manager 4	"Material that is not built in (formwork, scaffolding, machines, gates, fencing, barracks etc.)"
Site Manager 5	"Costs concerning site offices and all temporary structures required to build the permanent part, everything that disappears when the building is finished."
Site Supervisor	None given.
Logistics Engineer	"Anything that is not left behind when we leave the site (i.e. when the project is done)."

Estimating manager 1 explained that they tried to paraphrase an already existing document available to aid estimators when calculating AK for projects. After the interviewees had defined AK, they were asked if it was their personal definition or if it was something they learnt from Skanska. All the interviewees except estimating manager 1 stated that the definition they provided was their own. None, of the interviewees (except estimating manager 1) mentioned the existing PowerPoint with definitions of AK that the authors had been provided (described below in this section). However, site manager 4 explained that their definition of AK derives from school and feelings when working with people at Skanska. The design manager answered the question if the personal definition in the following way, "yes, that is how I have interpreted after hearing discussions about it, maybe there is a proper definition out there?"

Skanska's housing department 1 had a pre-existing definition of AK for employees. It took the format of a short, 4 slide PowerPoint file that was created in 2016. An estimator working with the department provided it to the authors. Other interviewees from housing 1 were generally unaware of this document. AK is defined in this document by the following three statements:

- Cannot be attributed to a specific work
- Arises because of a chosen point in time for the project's implementation
- Are common to the implementation of the whole project

The document then lists the following resources that are always or never calculated as AK, see Table 4.3 and 4.4 below.

Table 4.3 Always an AK according to Housing 1 internal document.

Resources	
Site organization	Traffic control and barriers
Storage	Hours for protective work
Time spent training employees	Temporary services
Personal equipment, worker protection and hand tools	Large machinery serving the entire site for internal transport
Site accommodation, establishment areas, including fencing	Fixed/mobile crane, including establishment, operation and driver
ID06	Small machinery, concrete and reinforcing equipment
Sound, noise and vibration measurements and inspections	Insurance costs, bank guarantee and collateral
Scaffolding and lifts	Winter costs, gravel and sanding etc.

Table 4.4 Never an AK according to Housing 1 internal document.

Resources	
Fastening materials	Hours for completion work (hole punching, fire sealing)
Design	Concrete pump
Project manager (external and internal)	Extra winter costs for concrete
Other consultants (sound, fire, accessibility, moisture)	

This information was provided to the authors in the early stages of the project. It was used to develop the interview questions and to ask employees for their reflections as to which resources they thought should be included as AK. Even though this document existed it was not widely known about internally. Therefore, it provided an opportunity to compare interview answers with those developed internally by one department.

4.1.4 AK interview table

At the end of each interview the interviewees were asked to give their opinion on whether different resources were considered an AK. This part of the study was performed with 3 estimators, 1 design manager, 1 logistics manager and 6 site managers. The same questions were presented verbally to each interviewee. It was asked if they considered each resource to be an AK or a direct cost. In some cases, the interviewees were unsure, or they said a resource could be both depending on the situation. Notes were recorded in these instances.

In Figure 4.1 below the overall responses are given. An interviewee stating that a resource is an AK is scored as 1, not an AK is scored as 0 or if it was ambiguous 0.5. The totals are shown as percentages.

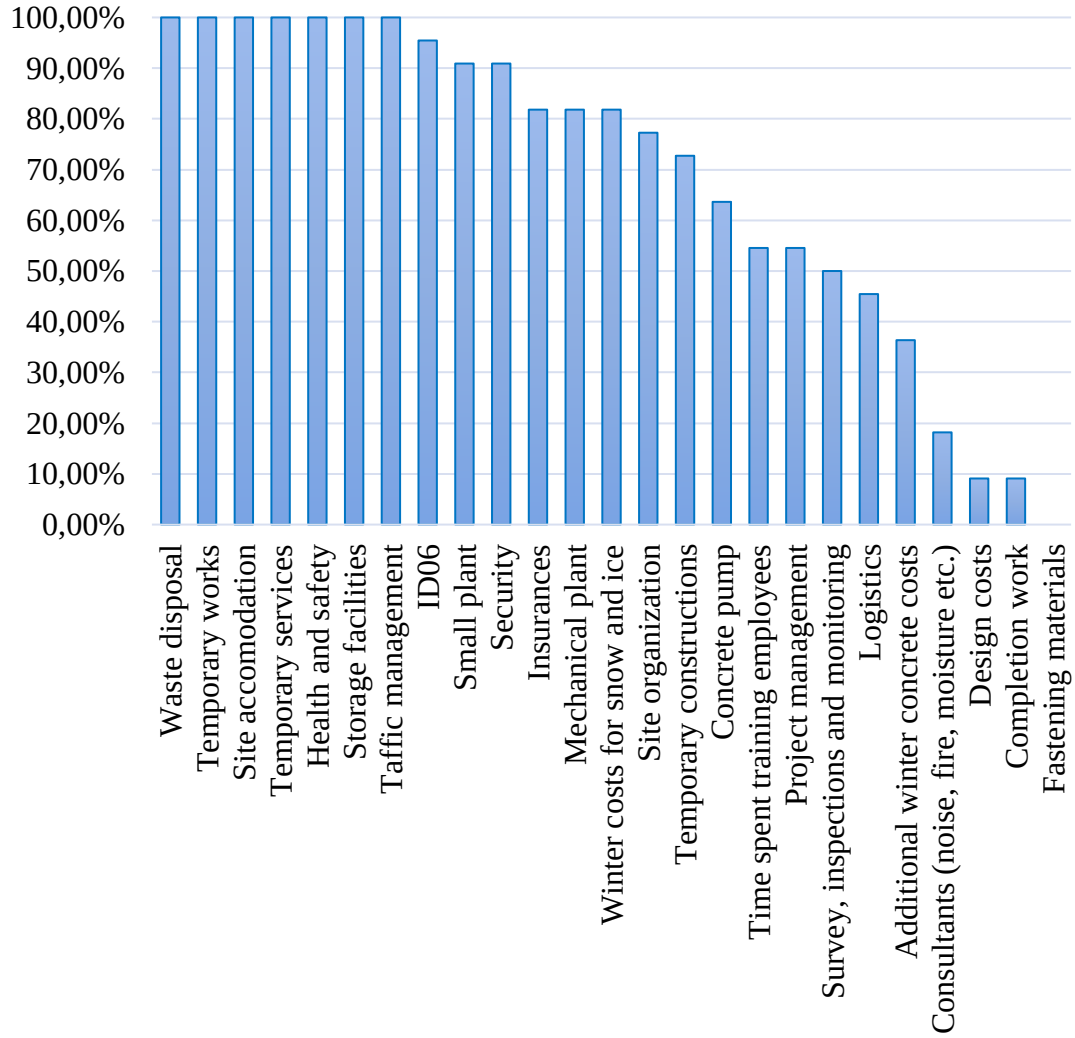


Figure 4.1 Interviewees answers for what are AK.

All interviewees agreed that waste disposal, temporary works, site accommodation, temporary services, health and safety, storage facilities and traffic management were AK. Over 70% of employees said in addition to the above that small plant (small machines), ID06, security, insurances, temporary constructions (scaffolding etc.), winter costs for snow and ice, mechanical plant (large machines) and site organization were AK. According to the people asked, less than 40% said that the following six resources were AK, additional winter concrete costs, consultants (noise, fire etc.), design costs, completion work and fastening materials. The activity that most interviewees were unsure about was on-site logistics, where many people said that it could be a mix between being either a direct cost or an AK. For example, a couple of interviewees said that carrying parts around to construct a kitchen is usually included as a direct cost but delivery and movement around the site is an AK. Concrete pump was another item that was highly contested due to it not always being needed. Other ambiguous categories were time spent training employees, project management and surveys, inspections and monitoring. Employees generally entered this section of the

interview confident in their own definition of AK, but then found it difficult to say whether a resource was an AK or not.

The sample size is not large enough to state differences between employees that work in an office role or on site definitively. However, site workers tend to categorize temporary constructions, concrete pump and time spent training employees as AK more often than those working in an office role. Office workers categorize site organization and consultants (noise, fire etc.) more frequently as AK. Overall the views were relatively similar.

4.1.5 How they calculate and manage AK

The interviewees were asked to describe how they manage AK in their projects. In this instance 'manage' is used as a wide term to describe how AK is calculated, how specific processes or tools are used, leadership and any other method used to minimize AK.

Site managers 2 and 4 defined AK in a similar manner, perceiving it as resources that are not "built in," mostly regarding it as equipment or aids used to perform work. They think that it is important to allocate and explain how different work methods affect the AK in projects. Site manager 2 explains, "I usually make sure that my site supervisors make their cost calculations and keep track of the equipment they are responsible for." This view of allocating work is shared by site manager 4 who considers it important to make site supervisors plan their work methods with regards to the equipment and aids needed. Some work methods might be easier, but they require use of things such as scaffolding to a larger extent than others and hence increase AK. Site manager 4 described it in the following manner, "I give the site supervisor quite a lot of freedom, but I also ask them to decide the work procedure they think is best and if they know how much it costs." This sets out a premise for them to consider how the hours spent using equipment affects the whole budget for the project."

The interviewees were asked if they use any specific tools to aid their work with AK. Site manager 2 explained that supervisors encourage them to use a scorecard for setting out budget goals, which is then used in follow-up meetings. Furthermore, site managers are required to set an AK percentage goal on the scorecard. Although, it might be useful, site manager 2 expresses some frustration over the AK aspect of the scorecard, "you do not really know what the goal is telling you. They sometimes ask us how many percentage points we have lowered AK by, and I just shrug my shoulders. We just filled out the form." Site manager 2 further says, "having a percentage of the project as AK does not tell anything since you do not what is included in the AK, which means that it is difficult to know if you have high or low AK in your projects."

Another notable tool that both site manager 2 and 4 use is EquipmentLoop which is an app used for renting, tracking and cost estimating equipment on-site. Site manager 2 explains that he uses the tool to keep track of all the equipment on-site. The app tells the user when rented equipment needs to be sent back and lowers the risk of having unused equipment laying around. It is also possible to delegate responsibility since the app provides an overview of who rented what. By doing this they save time not looking for equipment and ensure they are not paying for unused equipment. The app is connected directly to Skanska Rental but in future updates other vendors will be included, which allow managers to compare renting versus buying the equipment. Site

manager 4 describes the benefit of EquipmentLoop, “I can almost prove that equipment costs have been lowered. We spend 30 000 SEK/month less on equipment now than before.” Site manager 4 believes that it is not solely the app itself that has lowered equipment costs, noting that, “the app has made people more aware and made time consuming administrative work easier, which has also helped lower the cost for equipment.”

Two of the site managers interviewed did not like the idea of differentiating AK and direct costs. Site manager 3 described it by saying they have 200-300 resources that need to be managed in an efficient manner and it does not make any difference if they are AK or not. They continued by saying that instead of grouping resources together one should focus on optimizing every resource as much as possible. Site manager 2 explained earlier that you do not know what is included in AK. Hence, there is no reason to package some of the costs as AK. Moreover, site manager 2 states, “focus on the budget for each specific resource and make sure that it does not go over budget.” Thus, using the same tactic as site manager 3 when optimizing every resource instead of categorizing some of them as AK.

The manager that was the least concerned when describing the method for handling AK was site manager 1. They always try to make sure that AK stays within the percentage limit provided by the estimators in the project budget. They say, “you only have to look at the resources in the accounts that hold costs related to AK, add them together and divide it with the total predicted project cost. As long you are within the percentage limit provided by the estimators you are fine.” Although it may sound simple, site manager 1 explains that you need to consider how you procure equipment and provides an example with hand held tools, “if you need them longer than 15-18 months it is often cheaper to buy them and throw them away instead of renting.” Site manager 1 also explains how they perform certain work tasks themselves to reduce AK, if they have time. For example, they installed the site offices themselves on the last project.

The logistics engineer is the only one that is responsible for managing AK as a part of their job description. As mentioned earlier, the logistics engineer approximates that work is divided into 70% AK management and 30% logistics management. The authors were urged to interview the logistics engineer because of his knowledge about AK and how to manage it. During the interview, the logistics engineer briefly explained their work method as the following, “I learned from Skanska Region West or South how to work in Excel with AK. I started to make monthly AK budgets that I then followed up every month.” This enables the logistics engineer to perform a prognosis of how much they will spend on different resources, which is then optimized against the sums calculated from the estimation department. “This way of working enables me to work proactively instead of reactively,” says the logistics engineer. However, they also say it is always hard to consider everything “I always add 10% for AK at the end because its most likely that I have missed something.”

Even though some AK are generally more expensive than others, it is important to consider the small stuff as well, explains the logistics engineer, and provides an example by saying, “all resources count, we ended up wasting 400 000 SEK on water pumps on my previous project. We planned it wrong from the beginning and massive amounts of water filled the shafts due to a nearby mountain causing us to go 200 000

SEK over budget. So, for this project water pumps are budgeted for 500 000 SEK even though we now only use 3 instead of the 15 we had in the previous project."

"In the production estimation phase, you have the opportunity to decide the work method you will use at the construction site, which impacts AK," noted estimating manager 2. Therefore, decisions such as using, prefabricated concrete or casting on-site as well as which sub-contractors to use affects your efficiency on the site. Estimating manager 2 stresses the importance to communicate with the site managers that will perform the work saying, "it is also important that the site manager can use the work methods they feel comfortable with to achieve good results. For example, some hate working with prefabricated concrete therefore the projects need some individual planning depending on the site manager, although it is sometimes difficult to achieve." Site manager 1 explains that the percentage calculated for AK in the tender can be underestimated by the managers working with the bid since they need to be competitive to win projects.

The site supervisor works together with site manager 1 and says that the approach is often reactive instead of proactive and say it is easy be lazy about aspects. Site manager 1 receives lists from vendors containing equipment they have not sent back. Then they go look for it and send it back, which they say needs to be managed better. The design manager tells the authors that consulting with other people sometimes helps understand how their actions affect AK. However, no proactive work is performed to lower AK since the focus is on the client's demands.

A follow-up AK management question was asked by the authors, "do you think other people manage AK in the same manner?" The responses varied but most of them thought that everyone manages AK differently. Site manager 2, site manager 4, estimator 1 and the logistics engineer, said that they think everyone manages AK differently. Site manager 1 and the design manager think that everyone works somewhat in the same manner and site manager 3 believes that everyone manages AK in the same way. Estimator 1 added that "there should be a standard method of doing things."

4.1.6 Changes to AK

The interviewees were asked to explain the problems they see with AK today and how they perceive any potential changes that have occurred, i.e. are there any aspects of AK that have increased or decreased? Site managers 2 and 3 consider the lack of direction on how to manage AK a problem, they need to figure out best practices themselves. Site manager 2 says there is, "no definition of what AK is or how to measure it, I am missing tips and tricks on how to handle it better." Site manager 3 adds, "something I miss from working at Skanska all these years is a working manual, because now you must learn a lot from trial and error."

Estimating manager 1 and 2 likewise consider the site managers inability to be consistent in their cost management a problem, with estimating manager 2 noting, "some site managers do not follow the cost breakdown structure, they shift costs around and when one account is full, they start filling the next one." Another example of inconsistency amongst site managers is given by estimating manager 1, "safety work includes some material (e.g. wooden planks used as safety railing), but if the site

manager adds this cost to the material account it becomes a direct cost instead, which gives an incorrect AK value." The logistics engineer also explains that since everyone has their own work methods it is difficult for estimators to analyze AK in projects. It is necessary to manage costs so that it is possible to make improvements afterwards, says the logistics manager. Then provided the following example, "in a project, we bought electricity equipment for 2.2M SEK that we are also using in this current project. However, I never allocate all the cost to the first project since it is not a fair representation." Without doing this there is a potential to portray high electrical equipment costs (i.e. AK) in the first project, whilst upcoming projects have no AK for electrical equipment. Thus, causing projects to provide inaccurate numbers when following up.

Estimator 1 thinks that AK are at a reasonable level but the standardized values they use (cost/sqm or cost/h) should be updated if they want to achieve greater accuracy with their AK calculations. Site manager 1 also believes that the estimating department needs to update their estimating values, "a lot of unit times are from the 70's and 80's and are not up to date. There are stricter demands and regulations now, the values used for calculating are often based on office hallways, which are much easier to work with than apartments." "We always get too few hours for completing interior work. There have been arguments between estimators about this," explains estimator 1. Site manager 4 also shares this view, "the estimation does not always reflect the project when they just work out costs from a table," when referring to how estimators perform their work. This view is not shared with estimating manager 2 who claims that the hours for plastering walls are not the problem, in fact, they are enough, "the problem is that everyone works differently when plastering walls. If there is no consistency in work methods amongst carpenters, it will cause repercussions for other work categories, thus causing AK to increase.

Estimating manager 2 also thinks that inefficiency is a greater problem than their estimated work times, which is shared by estimating manager 1 who says that, "we use a lot more staff than our competitors. Everyone needs to think about what they are doing with their time. If production is inefficient, then 50% of the day goes to solving problems." Moreover, estimating manager 1 explained to the authors that there is a need to reduce the number of managers performing administrative work and people should trust each other more.

Some of the interviewees considered that the increased quality and safety in projects is part of the reason why AK have also increased. This highlights the complexity of investigating AK, for example, during this research the authors discussed with one employee at Skanska who stated, "they tell me to lower AK, does that mean that I should lower the safety level at the sites, even though it is one of our strongest values and marketing points?" Site managers 1, 3, and 4 believe that part of the reason why AK have increased is due to safety precautions. Site manager 1 says, "all the costs that come from working safely have increased" and points out that focus on the quality of the work environment is increasing as well. Increased safety often equates to an increased usage of safety equipment to mitigate risk, site manager 3 noted, "safety requirements make some parts cost more, such as wider use of scaffolding." Skanska has a motto stating, "We work safely, or not at all" (Skanska, 2020b). Site manager 4 claims this is great but shares some of their thoughts about this, "in order to make it safe you need to take risks sometimes." They enforce this example by describing how

a roof was constructed at the ground level, “we constructed the roofs on the ground and then lifted them into place, so, instead of working on the fourth floor they worked from a maximum of 4 meters. Nevertheless, the rule of thumb is when you approach 2 meters you can fall and injure yourself badly. We then require some safety railings at the end of the roof, but somebody needs to put it there and they will be at risk. The workers need to attach themselves to a safety harness to install the railing, detach the harness, return to work, and then back up to remove the safety railing before it is lifted into place. Therefore, it becomes ineffective and AK increases, although we need to do it in order to be safe.”

Estimating manager 1 and the logistics engineer share the view that increased safety requirements equate to an increase in AK. However, they also mentioned higher quality demands on-site as part of the reason why AK are increasing. Workers expect modern site offices that are comfortable, and they also use more electricity. However, improved working conditions can also impact AK positively, “lighting was very expensive but is going down now thanks to LEDs,” says estimating manager 1.

Another problem that was often shared by interviewees concerns whether to buy or rent equipment. Site manager 3 explains that they are urged to rent equipment and machines from an affiliate company called Skanska Rental, but they feel the prices are too high to make ample profit. Therefore, they are stuck with renting expensive equipment, which increases AK. Skanska Rental is a service company that provides equipment and installation services at construction projects throughout the whole Sweden (Skanska Rental, 2020). Site manager 3 continues, “Skanska Rental provides good services, but the prices are too high.” Site manager 2 also feels that there is a pressure to use Skanska Rental services since it is a good for Skanska Sweden but feel that it is hard to motivate the use of Skanska Rental on project level due to their high price level compared with other vendors. Estimating manager 1 aims some criticism towards site managers because of their use of Skanska Rental, some aspects are not handled well, for example, renting site offices when it is potentially cheaper to buy them.” The logistics manager, on the other hand, argues that this is not necessarily true and thinks it is important to consider the whole picture and all the services that are included. For example, when they rented a crane, Skanska Rental said that they needed to rent the crane from them otherwise they would not be allowed to use any of their other services provided by them. This resulted in them selecting a crane from them even though they had a higher price than competitors. However, since it was a package deal, they ended up saving 600 000 SEK when all other equipment needed for the project was considered.

4.2 AK questionnaire with Skanska employees

The questionnaire is presented in the Appendix 9.2. It was sent to 95 Skanska employees, 49 responded from the departments housing 1 and 2, giving an acceptable response rate of 52%. In Figures 4.2. 4.3 and 4.4 below the results of the questionnaire are presented. The survey participants included more diversity than the interviews.

4.2.1 Pie-charts

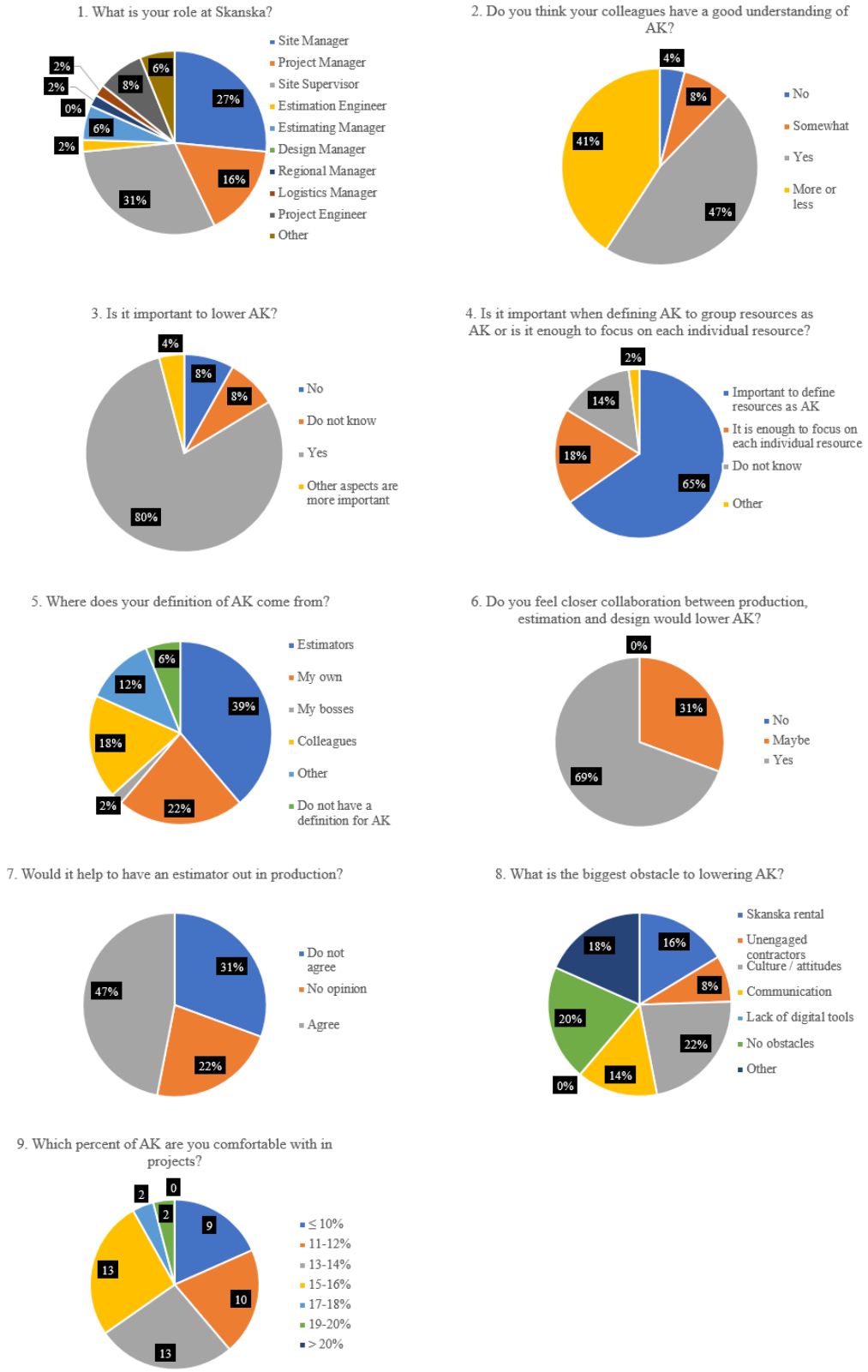


Figure 4.2 Pie-charts developed from the questionnaire.

In Figure 4.2, the results of the questionnaire displayed in a pie-chart format are shown.

1. A variety of different roles answered the survey, but out of 49 responses the majority consisted of, 13 site managers, 8 project managers and 15 site supervisors.
2. It was generally thought that people's colleagues had a good understanding of AK, 47% answered yes, 41% more or less, only 4% felt no and 8% somewhat.
3. The overwhelming majority, 80% thought that it was important to lower AK. 8% thought that it was not, 4% that other aspects were more important and 8% did not know.
4. One of the issues discovered from the interviews was that people had very different interpretations of which resources are AK. 65% of people answering the survey thought it was important to define specific resources as AK. 18% felt that no overall name was needed but that focusing on lowering the costs of each resource individually was enough. 14% did not know and 1 person had a different view.
5. The employee's definitions of AK came from very different sources. 39% said that their definition originated from estimators, 22% that it was their own, 2% their bosses, 18% from colleagues, 12% other and 6% did not have a definition for AK.
6. Nearly everybody felt that it was possible that closer collaboration between production, estimating and design would help lower AK. 69% said yes, 31% said maybe and nobody said no.
7. Following the last question, it was then asked if having an estimator on-site in production would help lower AK. 47% thought that it would, 22% had no opinion and 31% did not think it would help lower AK.
8. In response to what is the biggest obstacle to lowering AK, the answers were very mixed. 22% thought that it was the culture/attitudes of people, 20% felt there were no obstacles, 18% felt that it was something other than the options provided, 16% said Skanska Rental, 14% thought that it was because of bad communication, 8% unengaged contractors and nobody thought it was because of a lack of digital tools.
9. To try and understand what percentage of a project's cost should be assigned to AK it was asked what employees were comfortable with. Most people thought that AK should be lower than 16%, only 4 out of 46 people asked said it should be more than this. However, this answer largely depends on the type of project and which resources they thought were AK.

4.2.2 Bar-charts

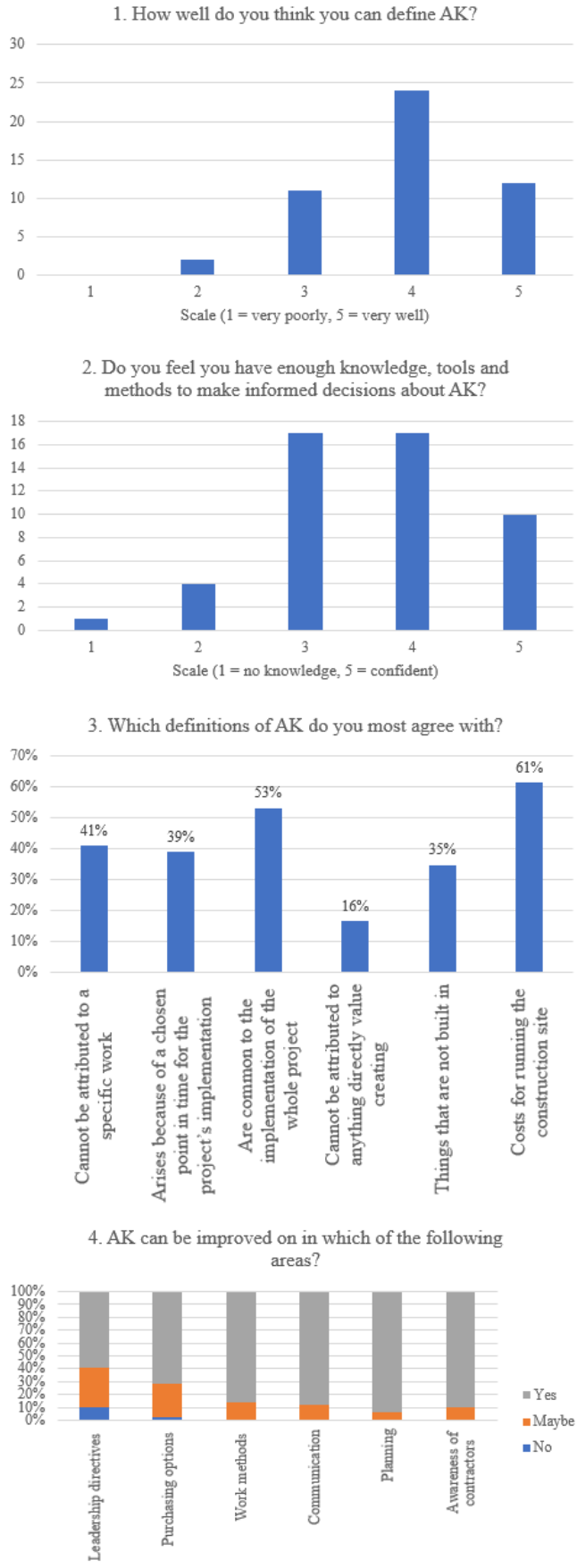


Figure 4.3 Bar-charts developed from the questionnaire.

In Figure 4.3, the results of the questionnaire displayed in a bar-chart format are shown.

1. The first question in the survey asked employees to rank on a scale of 1 to 5, how well they thought they could define AK, where 5 was the best. Most people thought they could define AK well or very well. 11 people thought they had a reasonable definition of AK and only 2 people thought their had a poor understanding.
2. The result of asking employees if they felt they had enough tools and knowledge to make informed decisions about AK showed again that most people thought they had fair to good resources available to them. Only 5 people rated 1 or 2 on the scale.
3. Employees were asked to select from a list of 6 definitions of AK that they agreed with, multiple answers could be selected. The first three definitions, cannot be attributed to a specific work, arises because of a chosen point in time for the project's implementation and are common to the implementation of the whole project came from list of agreed definitions from housing 1. The next two definitions cannot be attributed to anything directly value creating and things that are not built in came from the interviews. The final definition came from the literature study, which was costs for running the construction site and is the one most people agreed with. Concerning the definitions from housing 1, 41%, 39% and 53% agreed with these respectively. Only 16% and 35% agreed with the ones derived from the interviews. However, 61% agreed with the definition from the literature. Very similar answers were given when comparing site vs office workers, except site workers more frequently said that AK cannot be attributed to a specific work and cannot be attributed to anything directly value creating.
4. For each category, leadership directives, purchasing options, work methods, communication, planning and awareness of contractors, people were asked to say if they think AK could be improved. Most answers were yes, for all categories, around 10-30% were maybe, and about 10% of people said no to leadership directives, with one person saying no to purchasing options.

4.2.3 Scale-charts

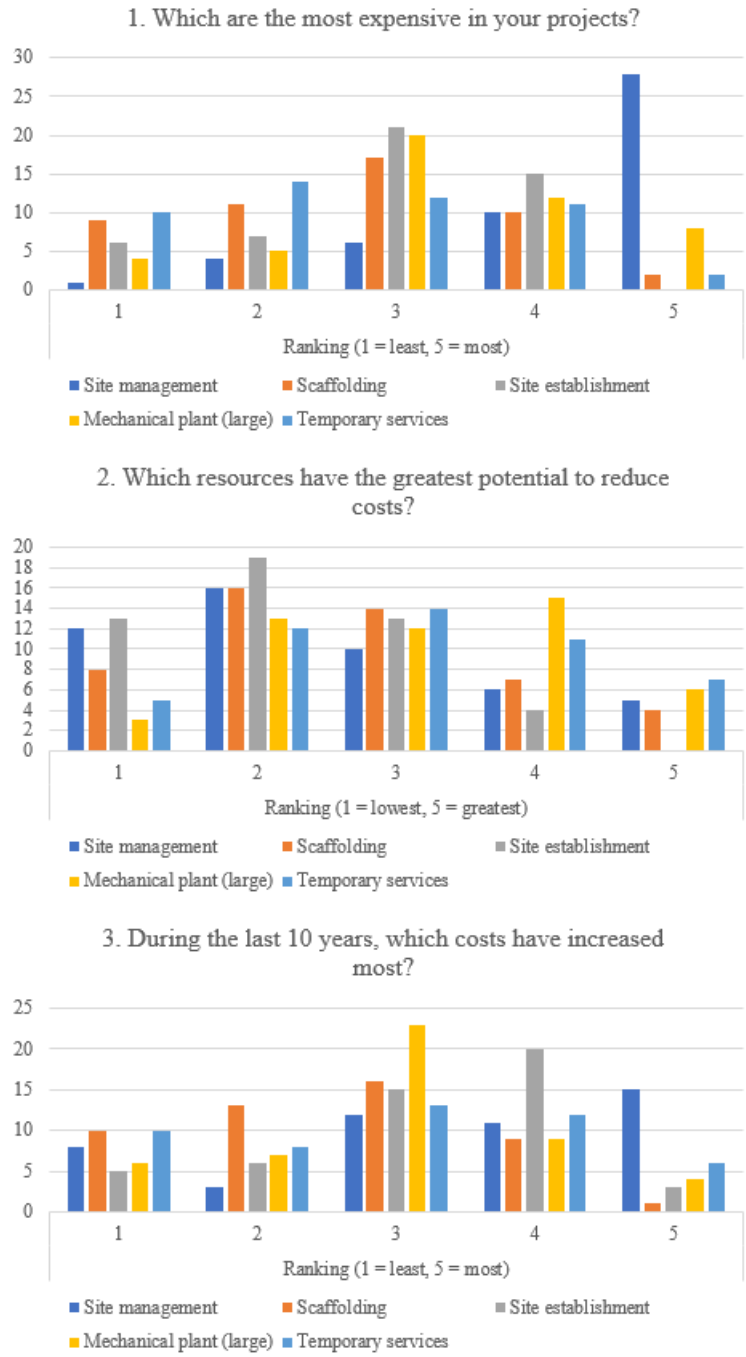


Figure 4.4 Scale-charts developed from the questionnaire.

In Figure 4.4, the results of the questionnaire displayed in a scale-chart format are shown. In each of the three questions employees were asked to rank the categories, site management, scaffolding, site establishment, mechanical plant (large) and temporary services, from 1-5. Resources could be ranked equally.

1. For the question, which are the most expensive in your projects, the results do not provide a clear picture overall, but site management is viewed as the most

expensive. Temporary services are perhaps considered the least expensive. 57% of people asked said that site management is the most expensive.

2. The resources that have the greatest potential to reduce costs are ranked quite equally, with most people thinking that there is generally a low potential to reduce costs. However, there may be slightly greater potential to lower mechanical plant (large) and temporary service costs over the other categories.
3. Regarding which costs have increased the most during the last 10 years, people viewed most categories as having increased. Site establishment and site management have perhaps increased more than others. 31% of people ranked site management as the cost that has increased most during the last 10 years. Scaffolding costs were said to have remained relatively constant.

4.2.4 Open answers

The final section in the questionnaire was left open to allow employees to add additional thoughts and comments. Below in Table 4.5 is a selection of these. There were three main categories of responses that were received. The first of these were that AK depends greatly on the type of project. Secondly, people described methods for lowering AK, which included good planning, communication, improving efficiency, purchasing options and standardizing AK within the company.

Table 4.5 A selection of open answers from the questionnaire.

Category	Open answers
What AK depend on	"The AK percentage of a project depends greatly on the type of project (prefab or on-site construction) and the available organization." "I think the answers are very different depending on the type of project. We can reduce AK based on the conditions we have. The fact that AK becomes more expensive over time may be because we want to work safer, have better machines, tools and nicer offices. Increasing employee awareness and reviewing schedules would improve things." "AK depend a lot on the type of project. A small housing project and a hospital cannot be compared. Skanska Rental can be more competitive. AK are high because we focus on safety and support etc., which costs money." "AK greatly depend on project planning before construction starts. It would help for site supervisors to work with design leaders in the early phases of the project to establish a picture of how the site should be run from start to finish."
Improvement strategies	"It is important to focus on the few resources that make a large difference to AK, such as scaffolding or a crane. Reducing the time that these are used by one week means a lot. It is also important that the company culture is right so that AK is not just an acceptable cost but something that everybody can influence through good cooperation."

	"To be able to lower crane and scaffolding costs, good planning should occur both in design and production to increase efficiency and aim for a shorter use time." "To understand AK is crucial if we want to lower project costs and be able to see which projects managed to keep their AK low." "With regards to the question about the biggest obstacles to lowering AK, I can develop my answer by adding that it is primary the communication between the site and estimators. There are often things that have been missed in the design that could have been avoided by talking with people from previous projects to avoid the most common errors." "AK increase because of city densification and tighter working conditions, where production order is often controlled by the client, who does not understand AK. I also believe that buying equipment is often cheaper than renting. Skanska rental should also provide the option to purchase from." "The most important thing is that everybody has the same definition of AK so that we can compare projects. Maybe we should clarify in SPIK (a cost calculation program) what items are AK."

5 Discussion and Analysis

In this section the authors attempt to answer the research questions set out in the beginning of this thesis by analyzing information from the literature and empirical studies. The authors define and categorize AK. AK dynamics are then discussed, and the chapter ends with an analysis of current tools and methods used for handling AK.

5.1 AK definition

The interviews and survey highlighted a lack of cohesive understanding what AK are. This section seeks to compile findings from the empirical study and literature to perform an analysis and establish a relevant definition of AK.

In Section 3.4.1 the literature study differentiates between direct and indirect costs. Overheads are an element of indirect costs and this study focuses primarily on project overhead costs, which are comprised of preliminaries or AK in the Swedish context. In Table 5.1 below the most common definitions of AK from the literature and empirical study are shown. One definition was taken directly from the literature study, two from the interviews and three from the internal company PowerPoint. The RICS (2018) definition is similar to two from the company PowerPoint, where they describe common costs to the whole project and costs that cannot be attributed to a specific work.

Table 5.1 AK definition comparison.

Literature study	Empirical study
Costs which are not incurred by the actual construction of the object but are needed to support the work (Cilensek, 1991).	Costs that are common to the implementation of the whole project.
A cost that cannot be identified with or charged to a construction project or to a unit of construction production (Plebankiewicz and Leśniak, 2013).	Costs that cannot be attributed to a specific work.
The cost of running the construction site, rather than any particular activity or zone (RICS, 2018).	The cost of running the construction site, rather than any particular activity or zone (RICS, 2018).
	Costs that arise because of a chosen point in time for the project's implementation.
	Costs that cannot be attributed to anything directly value creating.
	Costs that are not directly built into the building

The questionnaire asked Skanska employees to vote on which AK definitions they most agreed with. The definition that most employees agreed with was the one taken from the literature study, which leads the authors to believe that an updated definition of AK should be provided by Skanska. Furthermore, there was a wide distribution in responses to this question and therefore it is believed there is currently no cohesive definition. This is an issue because without a cohesive definition it is difficult for employees to categorize resources as AK, when working in projects. Currently it is likely that each

project has their individual definition for what AK are. They categorize resources differently and it is difficult for management to lower costs because they are impossible to compare between projects.

During the interviews, no employee other than the one that provided the PowerPoint mentioned that they had seen it, or that they knew how AK was defined by management. This PowerPoint contained three principles for defining AK. However, in the questionnaire they averaged a 44% rate of acceptance as acceptable definitions. The two definitions derived from interviewees averaged a very low acceptance rate of 26%. 61% of people agreed with the definition from the RICS (2018) for preliminaries, which leads the authors to believe that even though AK is a term used only by Skanska Sweden, there are strong similarities with other industry standards. Perhaps moving towards a more widespread term for these types of costs would help improve understanding and in the long-term lower AK. It would also make it easier for new employees arriving at Skanska to use a term that is more of an industry standard. It is vital that Skanska standardize how they define AK and communicate it to employees if they are to have a chance of categorizing resources as AK. If people do not even have a common understanding of what AK is, it becomes increasingly hard to work with.

The questionnaire also asked employees to rate how well they thought they could define AK. Except for a couple of people that said they did not work with AK, everybody said that they had a fair to very good definition. This was reflected in the interviews, where people initially felt like they had a good understanding of what AK was, but then struggled more as the interview progressed, especially with categorization. The results show a confidence in defining the term, but the varied definitions show that it is perhaps overconfidence or perhaps people are just very confident in their own definitions. Bar-charts 1 and 3 in Figure 4.3 highlight these discrepancies well. The authors believe that a standardized definition needs to be recommunicated from managers and estimators at the head office in Gothenburg to site workers.

During the interviews the most common definition was things that are not built in, i.e. not materials and installed equipment. However, in the questionnaire approximately only a third of Skanska employees agreed with this. This may have occurred because the interview primarily focused on employees from housing department 1, but most questionnaire responses were from housing department 2. The authors of this paper find that AK is very closely related to the RICS (2018)'s definition of preliminaries. In Figure 3.5 the construction costs are comprised of direct costs and preliminaries. An interpretation of this might mean that preliminaries are those construction costs which are not direct costs. In one sense this is like the definition of things that are not built in. However, the RICS (2018) chose to define it as the cost of running the construction site, rather than any particular activity or zone, which most surveyed employees agreed with. The authors' understanding is that even though multiple definitions may have the same meaning; the results differ. One centralized definition is required to implement the desired changes to lowering AK. The recommendation is to follow the one provided by the RICS (2018).

5.2 Categorizing AK

The following section attempts to categorize AK based on findings in the literature, interviews and questionnaire. At the beginning of this research the authors thought that after defining AK the next step would be to try and categorize it. This is due to the belief that without a proper categorization of costs, it is difficult to calculate and optimize them. Findings from the literature provided a structured categorization of AK, which were referred to as 'main contractor preliminaries' and by using the empirical data collected it is possible to do the same for Skanska. This can potentially be used to develop a guiding document for Skanska employees to get a quick overview of what AK includes.

At the time of writing, no guiding document was used by Skanska to facilitate a structured categorization of AK. Estimating manager 1 provided the authors with an existing PowerPoint, which defined AK and gave a general categorization. However, the results from the AK interviews indicated something else (see Figure 4.1). They showed that the interviewees were unaware it existed and instead used their own methods for categorization. Without change, it is likely that employees will continue to use their own methods and beliefs, which makes lowering AK a strenuous task. A clear categorization would make it easier for estimators to follow-up costs, enabling them to update their experience values to perform better cost prediction for projects. This will not only benefit them in terms of saving money, it will also increase their competitiveness.

The categorization is inspired Royal Institute of Charted Surveyors (RICS) and their 'honeycomb' design because of the clarity it provides (RICS, 2018). Firstly, the categories are presented as a honeycomb and it was attempted to position the most expensive categories closest to the middle, then build outwards. However, in this instance it is only a suggestion since the authors lack data and insight to make concrete claims. Secondly, the categories are presented individually with a list that explains what they include. The different categories and what they include are based on findings in literature and from the table provided by estimating manager 1 (RICS, 2018, RICS, 2015, Révai, 2012, Tah et al., 1994). An additional note is that concrete pump and logistics are not included in any of the categories. This is because no findings in literature indicate where they belong. Moreover, the results from the empirical research were too scattered for the authors to make any decisions on whether to include these aspects of AK in any of the categories. Therefore, it is up to Skanska to determine how they should be categorized, if they choose to implement them. The results of the categorization of AK are presented in Figure 5.1.

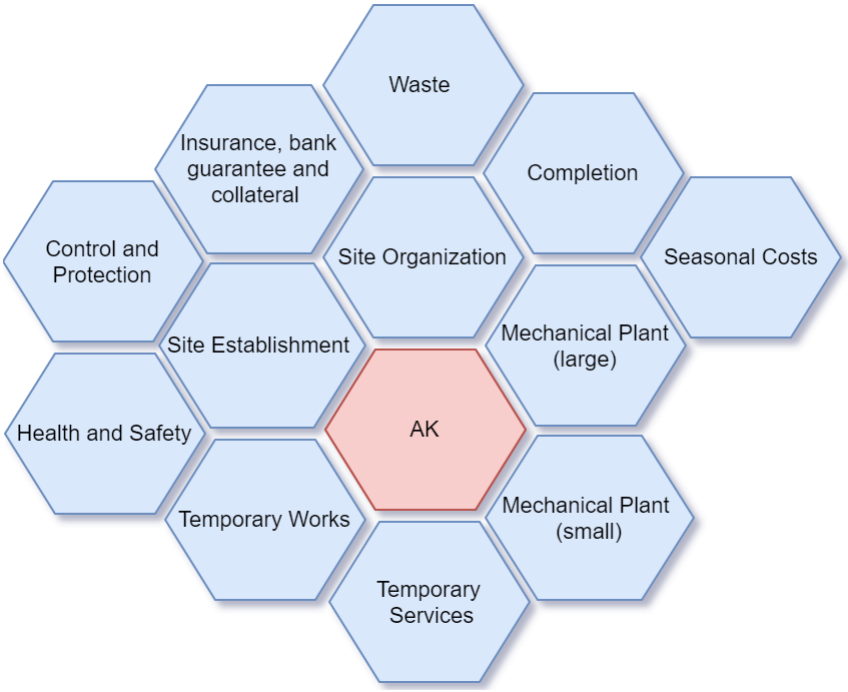


Figure 5.1 Honeycomb diagram of AK categories. Adapted from RICS (2018).

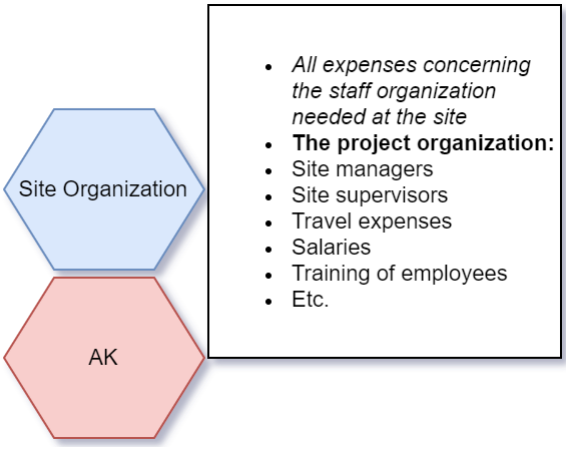


Figure 5.2 Site organization.

Site organization

Site organization refers to what the RICS (2015) describes as "management and staff" which according to the literature is the highest cost category (RICS, 2018). It is evident that Skanska operates a large organization with many white-collar workers both at the office and at the sites. Estimating manager 1 mentioned the amount of staff within the organization, as a way of highlighting how inefficient they are. Estimating manager 1 also said that many managers are spending too much time on administrative work and that 50% of the work in projects goes to solving problems ad hoc. The results in Section 4.2.3 enhance the argument for stating that site management is one of the most important AK elements to consider on-site. However, results from Section 4.2.3 also show that many respondents believe that there is little potential for reducing site organization costs. This is interesting since Assaf et al. (2001) argues that reducing overhead costs affects people in management positions first and therefore they try to shift the focus to something else. Furthermore, all the interviewees and respondents worked as managers which is a potential explanation as to why efficient use of equipment, cranes scaffolding, etc., are often illuminated as the reason for high AK, since they avoid seeing themselves as part of the problem. The only one that stated that the site organization is part of the problem was site manager 1.

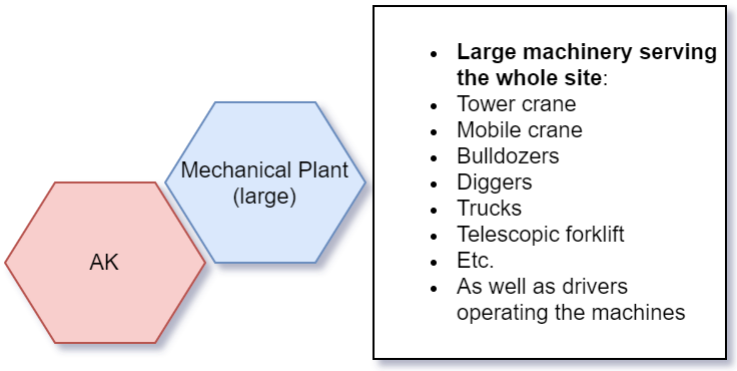


Figure 5.3 Mechanical plant (large).

Mechanical plant (large)

The term 'mechanical plant' is adopted from the literature since it is suitable to describe the included costs (RICS, 2018). However, a distinction from the literature is made as the authors decide to categorize two mechanical plants, one 'large' and one 'small'. Large mechanical plant refers to big machines that are needed to keep the project going at the site. Mechanical plant small is described later in this section.

RICS (2015) described the costs for machines as fixed or time based, delivery and removal costs, protection systems, operator costs, safety check/inspection costs, and other specific costs. The list provided from estimating manager 1 mentioned operation and driver costs in acquaintance with AK concerning big machinery. Moreover, estimating managers 1, 2 and estimator 1 also mentioned using fixed, time based and area-based variables when calculating costs, which further strengthens the assumption that cost for machinery are calculated in the same manner.

Many of the interviewees mentioned larger machines when asked how they defined AK. The answers from Section 4.1.4 also indicate that large machinery and mechanical plant are AK. Crane usage management was brought up as a key factor that determined if a project ends up with a high or low AK. Estimating manager 2 provided an example that describes the importance of managing large machinery by advocating an 80/20 tactic. In other words, position the most expensive crane where you will work 80% of the time and use a mobile for the remaining 20%. This indicates that large machinery is often calculated based on time. Josephson and Björkman (2013)'s concept of waste and time management therefore becomes a relevant aspect to mitigate costs concerning the mechanical plant (large).

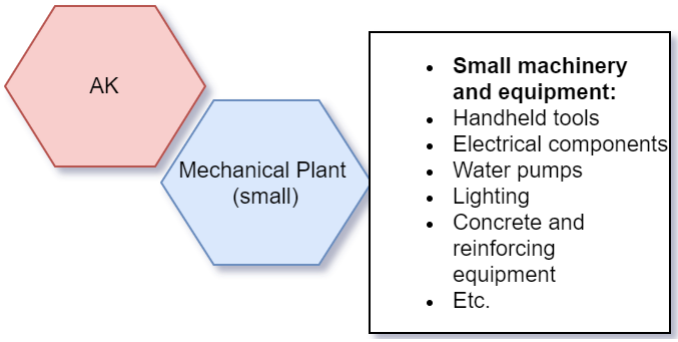


Figure 5.4 Mechanical plant (small).

Mechanical plant (small)

The logistics engineer used spreadsheets to actively manage and predict costs for equipment on the site. This method was embraced by another region within Skanska, but the logistics engineer did not remember which. Determining which region created the spreadsheets for calculating equipment is not interesting. The interesting aspect is that a Skanska employee within the Gothenburg region uses a work method that allows one to work proactively against the wasteful use of equipment, which seemingly no one else knows about. Arguably an effective method like this should have been widely adopted

within the organization but as discovered most of the interviewees had their own methods of working, including the logistics engineer. Furthermore, the method is time consuming and the logistics engineer was the only interviewee who had managing AK as a part of their job description. Thus, this work method would require even more administrative work and likely increase the site organization costs, which are already one of the highest AK in projects (RICS, 2018).

Site managers 2 and 4 use EquipmentLoop as an aid to keep track of equipment and return it in time, which the site supervisor explained as something they need to be better at. The belief from site manager 2 and 4 is that EquipmentLoop has created an awareness to work proactively against unnecessary equipment costs. It has also saved a lot of money and time spent on administrative work.

Adopting the method used by the logistics engineer would not be sustainable considering management costs are already high in projects. Consequently, initiatives like EquipmentLoop will perhaps be a step in the right direction. It can reduce time spent by site managers going through lists every month like site manager 1 did. Instead, site managers can allocate the work to the site supervisors. However, it is hard to tell if EquipmentLoop will keep supporting reducing AK long term or if it is a temporary solution that employees think is exciting because they get to work with a new digital aid. Do the reduced equipment costs outweigh the time invested in app management?

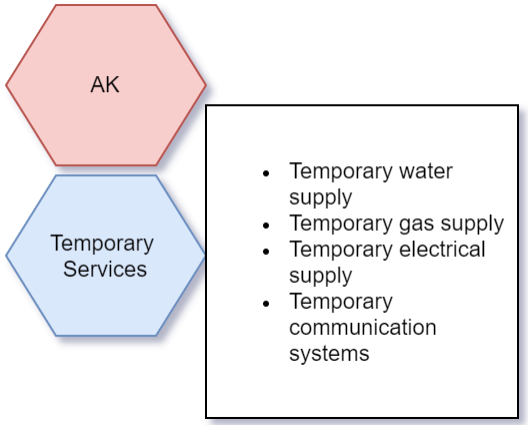


Figure 5.5 Temporary services.

Temporary services

Temporary services are an AK as they are required for running a construction site (RICS, 2018). Estimating manager 1 mentioned that the use of electricity has increased in recent years due to the modern standard of site offices and this view was shared by the logistics engineer. Furthermore, it is not farfetched to believe that the industry will increase its use of electricity when inevitably transforming from fossil fuels to greener options and arguably another reason for stating that temporary services need to be considered significant.

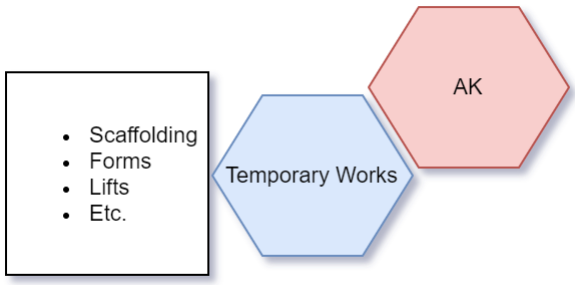


Figure 5.6 Temporary works.

Temporary works

RICS (2018) described access and scaffolding as one of the biggest AK to consider and they categorize scaffolding as something called temporary works (RICS, 2015). Scaffolding was also one of the first things mentioned when site managers were asked to define AK and was often brought up as an important example. The results in the scale charts 4.2.3 showed scaffolding as one of the

highest costs in projects. Temporary works is not only scaffolding it also concerns temporary structures that are needed to perform the work but can be removed as soon as the activity is finished. This might resemble the general definition of what many employees at Skanska view as AK but there is a difference. When all the work needed on the outside of the building is complete the scaffolding can be removed and sent back. Although, the same thing does not apply to fencing that is only removed when the whole project is done and there are no third-party safety risks involved.

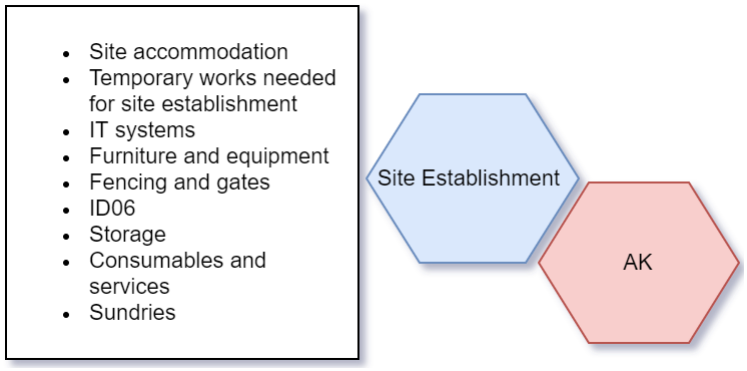


Figure 5.7 Site establishment.

Site establishment

Site establishment is all the resources needed to establish the site. The list of items is based on findings from the literature study (Tables 3.3, 3.4 and 3.5) as well as empirical findings. In 4.2.3 site establishment is ranked as one of the costs that have increased most in the last ten years and was also mentioned by estimating manager 1 as a cost that has become increasingly expensive. The costs shown in the list were defined by many as AK in the interviews (Figure 4.1). They were also mentioned in the interviews when asked how they would define AK. The costs concerning site establishment are often based on the size of the project, site and number of people.

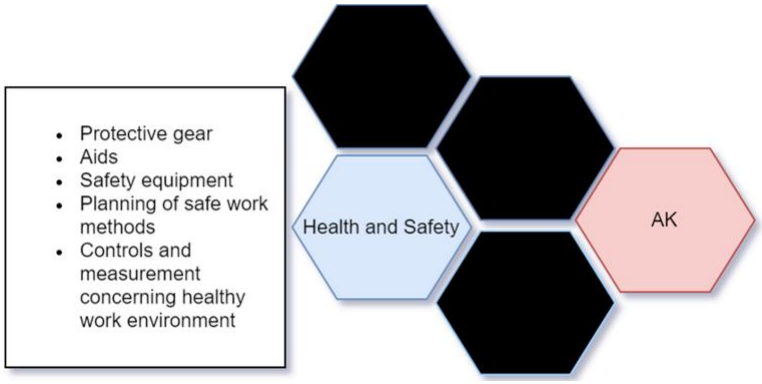


Figure 5.8 Health and safety.

Health and safety

Skanska work by the saying, “we work safely or not at all” (Skanska, 2020b). No exceptions in safety are accepted. The literature coincides with the argument when stating that it is non-negotiable (RICS, 2018). Site managers agreed with this as they said that you are never allowed to cheat with safety. However, the site managers pointed out that improved safety levels at sites comes with increased AK, because increased planning, aids and time are needed. Therefore, the authors think that health and safety is an important cost to categorize. Health and safety, like other costs need to be considered at an early stage since bad planning will often cause costs to rise. It should be mentioned that neglecting this aspect could end up costing more as workplace accidents are expensive.

The categorization of health and safety does not only concern the safety precautions used at the site. It is also including costs that are associated with the health of the workers. Measures taken to provide both a physically and psychologically healthy work

environment should be considered in this category. Estimating manager 1 described a problem where some material used at the sites should be categorized as safety equipment and not direct material costs. Therefore, this categorization will hopefully provide site managers with the right information to allocate costs accurately, which enables estimators to perform follow-ups on cost structures.

Remaining categories:
The remaining categories presented in this section are not described in detail since information about them in the results is insufficient. Nevertheless, estimating manager 1's list with AK guided the authors in the categorization of the remaining costs. They were analyzed with the costs available in the literature and categorized below (RICS, 2018, RICS, 2015, Révai, 2012, Tah et al., 1994). The remaining costs do not create a complete honeycomb, like the one presented in the literature study (RICS, 2018). This is due to the authors lack knowledge and that further categorization would require further study. Thus, the remaining costs are left for future research or up to Skanska to decide.

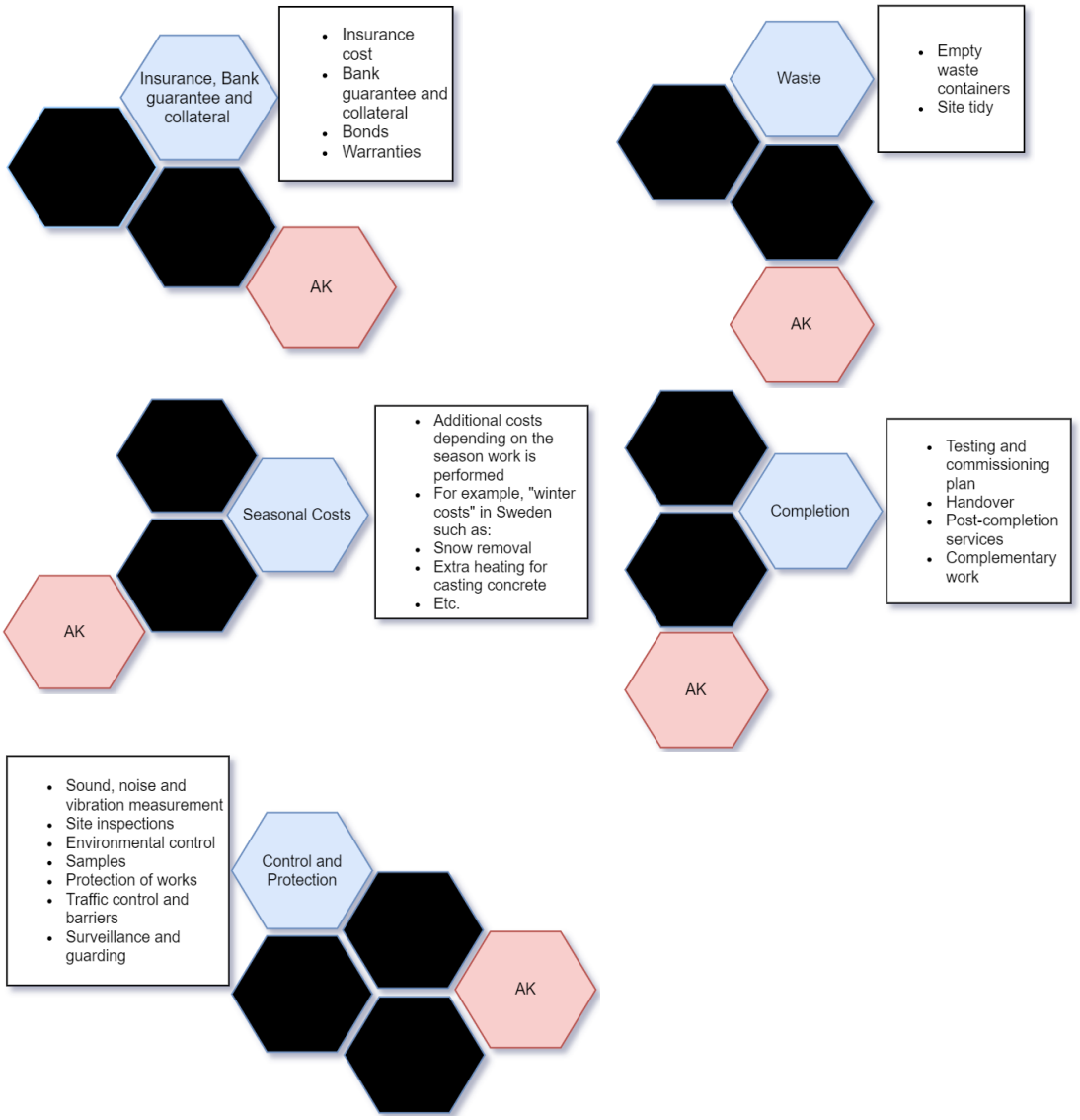


Figure 5.9 Remaining AK categories combined.

5.2.1 Categorization review

The literature study determined that the Swedish construction market is becoming more competitive since market trends point downwards (Byggföretagen, 2020c). Keeping track of direct costs, company overheads, project overheads, and profit become decisive in winning bids (RICS, 2018). Although authors like Assaf et al. (2001) state that keeping track of overhead costs is important to maintain profits, two site managers did not like the idea of separating overhead costs (AK in this context) from other costs. Instead, they argued that every project has a certain amount of resources that need to be optimized as much as possible. This argument contradicts the literature that highlights the importance of proper allocation of cost, especially if ABC is used (Stašová, 2019, Kim, 2017, Al-Hajj and Zaher, 2012). One possible reason for this could perhaps be due to frustration not having proper understanding and tools for managing AK.

Site manager 2 said that they were urged by executives to use a scorecard as a method for lowering AK but did not see the benefit of it since they did not know what AK entails. Their interest in actively managing AK only goes so far as to make executives happy, thus according to them, the percentage representing AK in the scorecard does not hold any truth to reality. This strengthens the argument as to why the categorization of AK is needed since, site managers recognize that as long the project's result is good there is no real reason to consider AK, limiting potential cost savings.

The results indicate that AK is not just something that can be derived from tangible things. Intangible aspects such as management also affect AK in construction projects and the literature concerning waste strengthens this argument. The suggested solution to mitigate waste from the literature was to be more efficient with resources and hopefully the categorization will help Skanska to become more efficient with resources (Josephson and Björkman, 2010, Ndihokubwayo and Haupt, 2009). Furthermore, the results from the questionnaire show that Skanska employees think it is important to categorize some resources as AK and that it is important to lower AK albeit without any idea what to improve.

From Section 4.1.4 it was obvious that some AK can be avoided if they are calculated as a direct cost. For example, a concrete pump can be allocated as a direct cost to the work of casting a wall. This can be used by managers to give the impression of reduced AK on paper even though it costs the same as before. Estimating manager 2 stated that "you need to use a mix of guessing and thorough calculations" when working with AK. This shows that best work methods for managing AK are not yet developed and some work aspects are so difficult to foresee that guessing is a part of the equation. Additionally, estimating manager 1 said that, "Skanska are not being as cost-effective as they can be" and that cost calculations need to be performed consistently, the above categorization can help with that.

5.3 AK dynamics

This section aims to provide an analysis to determine if AK are increasing or decreasing and if these costs are being handled efficiently or inefficiently. This is contextualized by evaluating whether it matters to consider these AK issues.

The literature study begins by describing how up until 2017 the construction industry was booming, but in the last few years has started to decline (Sveriges Byggindustrier, 2019a, Sveriges Byggindustrier, 2020). The reasons given for this were primarily due to the new amortization demands, despite favorable market conditions pre COVID-19 (Sveriges Byggindustrier, 2019b). This has affected buyers' purchasing power and affected all types of properties. The exception to this is Gothenburg, where due to Government subsidies and a high proportion of rental apartments the market has remained strong (Sveriges Byggindustrier, 2019a, Evidens, 2019). However, the interviewees suggested caution and claimed that they too were feeling the effects of the change to amortization payments. Skanska's net-profits were approximately 3.4% for the last 10 years, which leaves little room for maneuvering if market conditions change (Skanska, 2020a). This has led to an increased focus on cost even though as site manager 3 described, they learn a lot from trial and error. They lack a working manual and the estimating managers struggle with the inconsistent cost management practices of site managers. The costly practices of learning by trial and error and difficulties conducting follow-up studies due to poor practice indicate significant opportunities for improvement. The authors of this paper were told how Skanska struggle to compete with the medium sized construction firms, that AK are increasing and that these costs are a key reason why they are uncompetitive in smaller projects. The findings indicate that the company would significantly benefit from increased consistency and perhaps the development of an AK manual. However, they must also find a way to engage employees with this manual, rather than ending up in the same situation as today, with the AK PowerPoint.

According to Josephson and Björkman (2010), 10% of resource usage in a construction project is pure waste and a company's competitiveness is based on how efficiently they manage their resources. Waste is defined as anything that is not contributing value to the customer (Josephson and Björkman, 2010). Therefore, it is in both Skanska's interest and the customer to improve effectivity by managing their resources more efficiently. Sweden's construction costs remain high and a lot can be done to become more effective by reducing the amount of non-value adding activities in projects (Josephson and Saukkoriipi, 2007, Josephson and Björkman, 2010). Josephson and Saukkoriipi (2007) discuss the beliefs that industry professionals have about construction projects being unique and an unwillingness to change. Josephson and Saukkoriipi (2007) later dismiss this claim by saying that many projects and processes are more alike than unique and there is no evidence of the industry being conservative. Koskela (2000) describes the uncertainty factor built into projects, the culture that exists and that it has become the manager's identity to solve problems ad hoc. The logistics manager described this in practice, they calculated AK in detail and then added an arbitrary 10% for things they forget. During the interviews the estimators all agreed that AK work methods could be improved by standardization. They had difficulties updating their experiential values used for calculation because everybody works differently, and stricter functionality demands have made work such as plastering more complex than before. The lack of AK standardization again hinders this process by

making it difficult to compare projects and implement improvements. Waste and inefficiency remain high, relying on the site managers expertise to solve problems down the line, which as described has become part of their identity. Estimating manager 1 said that Skanska use a lot more staff than their competitors, which are often used for problem solving things that should have been resolved much earlier. AK could be lowered by improved planning and conducting more accurate estimations pre-production, but to achieve this there needs to be more consistent work methods on-site.

The interviewees agreed that AK are increasing partly because of increased safety precautions and work environment quality. AK cannot be arbitrarily lowered, as certain expectations and requirements exist today that had not previously. For example, site accommodation, lighting and safety equipment are all areas that workers demand higher standards of today. An area of concern though is highlighted by the examples given by the logistics engineer, where the budget for water pumps increased from one project to the next, even though they use 80% less, or the fact that costs are calculated in detail but then 10% is added for things they forget, which is in contrast to waste theory (Ndihokubwayo and Haupt, 2009, Josephson and Björkman, 2010). Resources should be used efficiently and things that do not contribute value mitigated. However, this does prevent opportunities for the company to lower AK, if they can improve project planning.

The literature study found that there are four significant preliminary cost areas, which in descending order are staff, mechanical plant, access/scaffolding and site accommodation (RICS, 2018). Combined, these four categories cost up to 80% of the budget for site overheads. According to Inyang-Udoh (2013) these high cost categories are frequently priced in detail where smaller categories are not. Site overheads are often between 11-19% of a project's total cost (Chan and Pasquire, 2006). A section of the survey asked employees to rank resources on a scale of 1-5. This covered three questions, but the findings were largely inconclusive. However, like the RICS (2018) the survey also shows that people tend to view site organization as the most expensive category in projects, followed by mechanical plant. Chan and Pasquire (2006) found that site organization makes up around 36% of the site overhead costs. Mechanical plant and temporary services are the areas that are believed to offer the greatest potential to reduce costs, which reflects what has been learnt about crane and increased electricity usage. The AK that have increased most during the last 10 years according to the categories provided were site establishment and site management. This again emphasizes that workers demand higher quality site offices than in the past and Skanska use more staff than competitors, which adds extra cost to projects. Assaf et al. (2001) stated that overhead costs may be difficult to reduce because it usually affects staff first. Therefore, it should be met with some caution. However, they also stated that there is too great of a focus on projects, instead of long-term planning, which the authors believe would significantly help and one way to achieve this is through defining and categorizing AK. It is also recommended to initially focus on the high cost categories as described in both the literature and open survey answers.

According to the interviewees, equipment is often cheaper to buy than rent if it is to be used longer than 15-18 months. Concerns were widely shared about Skanska Rental; production managers were told that they should rent equipment from them but felt that they were too expensive. There were conflicts between what was best for the company and what was best for the project. Projects and Skanska Rental are both expected to be

profitable, which makes the situation difficult to manage. However, others thought that the high levels of service provided were worth paying for. Estimating manager 1 complained that the site manager sometimes used Rental's services because it was easy even though they were costly. Communication seems to be lacking between head office and projects since site managers complain that they must use the service even though they think it is too expensive. At the same time, people at the office like estimating manager 1 do not understand why projects choose such expensive alternatives. In the survey, Skanska employees could answer with additional comments. In addition to the above, they recommend focusing on the key cost areas such as cranes and scaffolding to try and keep project costs low. By doing this they are trying to increase efficiency in projects. The reality is though that AK budgets continue to increase and need to be rethought.

Most people that answered the survey thought it was important to lower AK, and one way to do this would be to have closer collaboration between production, estimation and design. The responses to whether having an estimator out in production more frequently were very mixed, which suggests that the focus should be on improving project planning by increasing communication and collaboration. This is backed up by the responses to the survey question about in which areas AK can be improved. The overwhelming majority thought that improved communication and planning would help to lower AK, work methods and contractor awareness were other dominant categories. The employees also had varied thoughts about the biggest obstacle to lowering AK. The only category that they felt was not an issue was a lack of digital tools, which makes us question their awareness of applications such as EquipmentLoop because in the projects it had been implemented in, they found it very effective. AK depend to a large extent on the type of project, as stated in both the survey and interviews. Therefore, it is believed that this is the reason people were quite divided on the acceptable AK percentage in projects. However, when net-profit margins are low, around 3.4% over the last 10 years, a difference between 16% and 14% of AK has a massive effect on the project's profitability (Skanska, 2020a). AK is an area worth focusing on to improve efficiency in order to be more competitive.

5.4 Tools and methods for handling AK

5.4.1 AK today

Chao and Liaw (2017) inform us that detailed calculations of site overheads are often unfavored, instead they are calculated by taking a percentage of the direct costs, often relying on the experience of the estimator to make reliable calculations. It is a time consuming and inexact task (Nabil and El-Riyati, 2015). Chan and Pasquire (2006) support these claims by noting that site overheads are prepared through detailed calculations, but it is the estimator's judgement that most strongly impact the final sum. Estimator 2 said that through experience, they have an understanding of the process and solve tasks with a mix of guessing and thorough calculations. Wilmot-Smith (2006) adds that most companies price their site overhead items twice to avoid forgetting items. Chan and Pasquire (2006) also add that the result remains largely inaccurate when compared with direct cost estimates. During the interviews, the authors were told similar stories from both on-site and office roles where the site supervisor says things are often missed and the logistics engineer describing adding 10% to the AK budget for items forgotten about. The result of this is depicted well by site manager 2, who says

that with no defined guidelines, ineffective work methods occur frequently. They also criticized AK as a percentage, especially when referring to scorecards as they do not say what is included, which makes them irrelevant. The empirical study largely reflects the theory in this section. Estimators are relied upon to use their personal judgement, which use a mix of a percentage and thorough calculations. However, due to the unstructured approach on-site work methods are often inefficient and could be improved.

When submitting a tender, companies are often under pressure to cut their bid price to win the contract. This may mean that companies accept lower profit margins, aim to reduce costs and accept more risk. Estimators use their experience based on historical data, market conditions, risk, size and nature of the project etc. to predict the final cost (Nabil and El-Riyati, 2015). Estimator 1 expressed during the interviews their frustration at Skanska not being as cost effective as they can be. To try and increase experience levels site manager 4 liked to give site supervisors responsibility over smaller project tasks. The manager mentioned that this often resulted with an increased focus on costs as supervisors had to choose between different work methods themselves. In the bar-chart 2 of the survey only 5 out of 49 people said that they did felt uncomfortable making informed decisions about AK. It is the authors understanding from the interviews that nothing can replace first-hand experience. Many people felt confident defining AK and in their own work methods. They felt this even though they knew most people worked differently with AK to them and received different definitions from different sources. As previously mentioned, employees have their own understanding of AK but if Skanska wish to work more effectively with these costs, they must redefine the term for employees and categorize its elements.

According to (RICS, 2018) preliminaries represent a significant portion of a project's total cost and should be re-evaluated often 90% of preliminary costs can be found in six items, which are mechanical plant, site organization, scaffolding, site accommodation, cleaning and electricity (Bowen et al., 1996). Bowen et al. (1996) add that estimators need to be more involved in projects or it is unlikely their pricing practices will improve. As mentioned in the results, two site managers thought that the term AK is not needed, in the context that resources do not need to be grouped into district categories, such as direct costs and AK, instead the focus should be on lowering every single cost. However, others were more comfortable viewing AK as a percentage. In pie-chart 4 of the survey roughly two thirds of people thought it was a good idea with the grouping, but 18% felt it was better to focus on individual resources. Whilst, these differing views do not cause problems today, they will in the future if Skanska focus on lowering AK. A more consistent approach would make it easier to compare AK between projects.

EquipmentLoop was an app used by site managers 2 and 4, it can be used for renting, tracking and cost estimating equipment. It is in its early stages of implementation but can save time and money. By grouping equipment into categories or activities, estimators can then perform an analysis and improve future project calculations by gaining a better understanding of what resources are needed for which activities. Another benefit with EquipmentLoop was that it has increased employees' awareness of AK by making them more visual. There are two other main methods used today for tracking equipment costs. The first is simply tracking costs by reading the bill each month and then returning items that are no longer needed. This reactive method was

used by site manager 1. The second was used by the logistics engineer, estimator 2 and others, where they create detailed spreadsheets with lists. One of the problems working with AK has been that unnecessary costs make the company uncompetitive on smaller projects and reduce profit margins. Working more proactively to manage these costs is one way to reduce them both on-site and by better planning. EquipmentLoop is a tool that can be used to achieve this, both in the short and long-term. Working with spreadsheets is essentially an attempt to work costs in a similar way to EquipmentLoop but without the benefits of being accessible and intuitive for everyone. Assessing the bill at the end of every month to see what you have been paying for seems outdated and ineffective, the site supervisor even said it was easy to be lazy about.

5.4.2 Index adjustments

This thesis was performed by using an abductive research approach, meaning that literature and empirical findings were matched and tested against each other, i.e. systematic combining (Dubois and Gadde, 2002) During this process, a tip came from the authors' supervisor to investigate the index adjustment service provided by The Swedish Construction Federation (Byggföretagen, 2020b). The literature review in 4.2 presented findings describing how different index adjustments can be used by contractors to achieve accurate cost estimations in their projects (SCB, 2017, Byggföretagen, 2020a). One of the index adjustments available for contractors covered AK, but with insufficient information on what it includes. The information available described it as "other expenses" for administrative costs deriving from the worksite and head office (Byggandets Kontraktskommitté, 2011).

The authors did not discover that the interviewees or respondents used index adjustments in their cost calculations. The ambiguity of the AK definition provided by Byggandets Kontraktskommitté (2011) resembled the answers provided by interviewees and survey respondents. Therefore, this could be used as an argument stating that there is no common definition for AK within the Swedish construction industry. However, it should be mentioned that Skanska employees probably use index adjustments when calculating bids, but this was never researched or discussed. The logistics engineer added 10% to cover for eventualities which indicate a similar mindset as to using a construction index. No discoveries were made indicating that they adjust their AK calculations using index adjustments for "other expenses" (Byggandets Kontraktskommitté, 2011). The question then arises, should Skanska consider using index adjustments to manage 'other expenses'? The authors' answer to that question is no. Although, using index adjustments is not a bad method because fixed price contracts with index adjustments protects Skanska from unexpected cost increases in projects. This is beneficial for Skanska when working with projects that span over several years (Nordstrand, 2008). However, the authors do not see any point in using the 'other expenses' category to adjust their costs since there is no clear definition of what it entails (Byggandets Kontraktskommitté, 2011). Thus, using the category of adjustments is not much different from the methods Skanska employees are using now.

5.4.3 ABC – part of the solution

In the literature, the concept of activity-based costing (ABC) was noted as a method for allocating overheads and making accurate cost estimates (Stašová, 2019, Kim, 2017, Kim and Ballard, 2001). ABC allocates costs to the processes needed to perform the

work instead of performing calculations based on standardized values (i.e. hours or per sqm) which estimators at Skanska use (Stašová, 2019, Kim, 2017). This method of cost calculation changes the focus from projects to the activities of work being performed, which can potentially make AK more tangible for the site managers at Skanska. Instead of having a percentage that represents AK, the project could be analyzed by each activity and AK could then be allocated with regards to the performance of each activity, which makes work methods easier to analyze (Stašová, 2019).

An analysis of the data from both the literature and empirical study shows that efficient use of AK has a strong relation to the mitigation of non-value adding activities (Stašová, 2019, Josephson and Björkman, 2013, Josephson and Saukkoriipi, 2007). The logistics engineer claimed to have optimized resources relating to the mechanical plant and said that any further improvements would be to investigate how to optimize the way workers conduct their work. Furthermore, site managers 1 and 2 complained that estimators use inaccurate standardized values for cost calculations while estimating managers 1 and 2 claims that they are accurate and that site managers need to work on their time management. Kim and Ballard (2001) say that the use of ABC would create a better understanding of why certain aspects of AK are important to consider, which could perhaps be part of the solution to the discrepancies between site managers and estimators.

By using ABC, it could help site managers clarify how their choice of work methods affects AK since costs are directly connected to the task at hand instead of fixed variables that do not represent reality (Stašová, 2019, Kim and Ballard, 2001). Site manager 2 expressed frustration that bosses want them to present a fixed AK percentage even though they do not know what it represents. Therefore, if ABC is used it enables estimators to allocate costs to specific activities and the site managers would understand how their choice of work methods affects AK in more detail. Instead of using the 80/20 principle that estimating manager 2 described, they could use ABC to mitigate non-value adding activities that cause AK to increase (Kim and Ballard, 2001). Moreover, ABC helps mitigate the inhibitory notion of uniqueness in projects, since information regarding costs is easier to communicate (Kim and Ballard, 2001, Josephson and Saukkoriipi, 2007). This would make it easier to follow-up AK, which estimating managers called for and data that is based on activities would further help with the feeling of uniqueness (Josephson and Saukkoriipi, 2007, Koskela, 2000).

5.4.4 AK changes

Skanska currently works with AK differently both in planning and on-site. Estimators each work differently as do site managers. The only common thing is the calculation software used, which is an internal software program called SPIK. This program though is not an effective way of comparing projects if everybody calculates and works differently. It is the authors' opinion that short term goals should be to define AK and determine the resources that are included, which this thesis has attempted to achieve. Hopefully, consistent work methods can then be adopted so that it is easier to compare projects and find areas where AK can be lowered. In time tools and methods such as ABC and EquipmentLoop can be used to further facilitate accessibility and intuition for those involved in projects.

5.5 Swedish construction costs

The literature study covers (Section 3.1.1) how expensive it is for contractors to build houses in Sweden compared to other European countries (Eurostat, 2020a, Eurostat, 2020b, Gardiner and Theobald, 2012). However, Josephson and Saukkoriipi (2007) explain that the above statement is not necessarily true. The literature also tells us that it is important to use the same basis for comparison as each country measures costs differently. The authors did not investigate this aspect any further in the empirical section of this thesis. Instead, this literature was used to describe why Skanska and similar companies think it is important to lower AK in projects.

6 Conclusion

This chapter concludes the findings from the theoretical and empirical parts of this master thesis, which were developed in the discussion and analysis. The discoveries are presented with respect to the research questions developed in the introduction. The chapter ends with a summary of general arguments and a statement of purpose for the findings.

AK was defined very differently throughout the organization, even though an official definition existed. Few employees used or even knew of the prevailing definition of AK. The results showed that employees had their individual definitions based on their own experience and who they worked with. Therefore, the authors of this thesis reviewed definitions given in the literature, interviews and officially by Skanska with the aim of developing one that would be more widely accepted. After an analysis of these and in combination with the survey the authors recommended that AK is defined as in the RICS (2018) literature, "the cost of running the construction site, rather than any particular activity or zone." Hopefully, by adopting this definition the term AK can be less ambiguous and can aid Skanska Gothenburg in adopting a more structured approach towards AK.

One of the aims of the thesis was to develop a categorization of AK. The categorization is for project employees to take a consistent and structured approach to costing, which can later be used to compare projects and find cost savings. This was necessary because employees were all working differently with AK. The way resources were categorized in projects varied, which made it impossible to compare AK between projects. By categorizing and comparing AK the hope was that costs could be reduced by working more effectively. The authors' response to this was to take what had been learnt in the literature and empirical studies, to combine it with knowledge gained during informal meetings and develop the honeycomb figures presented in Section 5.2 The model also provides an overview of project costs by positioning higher cost categories closest to the center. The authors do not claim that this model is complete, but an underlying structure is presented that can be further developed by industry professionals with far greater experiences of cost categorization.

Skanska felt that they were uncompetitive compared to small companies on small to medium sized projects due to their higher than average AK. Therefore, recent trends were studied to determine the attributing factors. AK is a combination of multiple resources and activities and cannot be arbitrarily lowered as it includes things like safety costs. Therefore, as market conditions tighten it was important to understand the changes that have occurred. There are four predominant AK categories which comprise 80% of an AK budget, these are site organization, mechanical plant, temporary works and site accommodation (RICS, 2018). If large savings want to be realized it is important to focus on 'the big four.' There is a high portion of waste in construction due to non-value adding activities and a belief that construction projects are unique. The reality is though that most people interviewed in this thesis believed that AK work methods could be improved through standardization. Safety and work environment costs are increasing as employees and society have higher expectations. Additionally, risk and uncertainty costs are built into projects adding to the increasing list of AK expenses. Despite site organization costs being the largest AK category, the authors were told that Skanska operates with more on-site staff than competitors, which often

work with solving problems ad hoc. However, surveyed areas such as temporary services and mechanical plant (especially crane) were often mentioned as areas where costs can be reduced, which are easier to blame than their personal responsibility to be efficient. Closer collaboration between planners and on-site staff was also noted as a way to improve efficiency and criticism was aimed towards Skanska Rental, which provided projects with equipment but at a premium.

AK is one of the areas on which a company's competitiveness is often based and estimators at Skanska all had different methods for calculating AK. Tools and methods for handling AK were studied to examine if work procedures could become more efficient and standardized. Each resource can be calculated in detail, a fixed percentage of direct costs given, or a combination of the two can be used for estimating AK. Problems occur when these calculations are made but then the budget is reduced for extra profit or resource costs were forgotten. The situation today relies heavily on the estimator's experience and knowledge. Site managers also face similar challenges and use their individual work methods for handling AK. Therefore, a more structured approach is essential for the long-term lowering of AK. EquipmentLoop is a tool for handing AK, where its goal is to lower costs in the short-term by improving equipment management but in the long-term, it can be used to compare equipment use between projects. Another method for calculating AK is to use index adjustments, which were not directly mentioned by employees during the empirical study but found to be like adopted procedures. However, index adjusting AK can be disregarded. Findings revealed that TSCF used AK as a general term with no explanation as to what it entails, which does not provide Skanska with any better understanding of AK than they already possess. In the future ABC could be used to more clearly define how AK are connected to activities. This may be a way to more accurately predict costs and to also increase site workers understanding of how AK are affected by resources required for activities. It was recommended in the analysis that short and long-term goals be developed to improve AK work methods.

This study focused on one small part of a multi-national construction company. The results reflect the discoveries during this research process as accurately as possible. However, there were many limitations to this research as discussed in Sections 1 and 5.

During the interviews employees initially felt confident in their work methods and definition of AK but as the conversation developed, they became less certain. It is important to understand this ambiguity because Skanska must refocus on basic AK concepts such as its definition and categorization of resources for work methods to change. Otherwise, without this commonality, it is problematic to expect any improvements. If they adopt a more structured approach then it will be easier to compare projects, find non-value adding activities, reduce costs and optimize work methods. This structure could be developed in terms of a guiding document, incorporating both office and site workers. AK is a term that is specific to Skanska, but these types of costs have not been extensively researched in Sweden. Therefore, this research can be used to benefit both Skanska and the Swedish construction industry in cost estimation practices. There are currently many inefficiencies that exist when working with AK, both the literature and empirical studies offer imprecise definitions and categorizations of resources. It is hoped that this thesis provides some of the foundations needed for change.

7 Future research suggestions

This thesis has embarked on the first steps to rethinking the concept of AK for Skanska. The authors have defined and suggested an AK categorization. However, this is just a beginning, more can be done to perform work more efficiently and questions concerning AK still need answering. This chapter highlights some of these and is dedicated to suggestions for future research.

This research project focused on only one construction company in Gothenburg that built housing. The results may have been different if other factors (project type, company, location etc.) were investigated, which is important to consider. However, the authors believe that the principles developed can be applied to all areas of construction.

This thesis has not answered any questions regarding which AK categories are feasible to lower. High cost categories have been mentioned as important areas in which to maintain focus, due to the high cost saving potentials. However, this does not mean that these are the least efficient. If the authors have started creating a roadmap then there is still room to analyze the destinations. Where do Skanska want to be in the future and how do they want to get there? Categorizing AK could be further developed with more knowledge and time. It was written in the analysis that the honeycomb was just a start and something that could be refined over time. A long-term goal would be to definitively state which resources are AK and which are not in housing projects.

The findings could be further developed by exploring how tools such as EquipmentLoop can be used to work more efficiently. One of the initial aims with this thesis was to investigate the use of EquipmentLoop, but as the process developed the authors felt it was more necessary to focus on early AK processes. EquipmentLoop is an app that is in the early adoption phase by Skanska. The primary function is to track equipment in a database whilst presenting an accessible interface to the end user. It would be worthwhile to study cost savings, the ability to compare equipment between projects, how AK categorization can occur within the app and other efficiency improvements provided by EquipmentLoop.

As mentioned in the analysis ABC is perhaps part of the solution. Using ABC would help explain why certain AK are important to consider. Costs are allocated based on activities rather than arbitrary constraints such as square meters, which makes it easier for managers to interpret. ABC in construction exists today but to implement it requires a lot of reorganizational work. Costs need to be categorized by activity and then incorporated into these activity costs. Future research could analyze how to do this or implement it for some elements and analyze the effect.

8 References

AL-HAJJ, A. & ZAHER, T. Effectiveness of implementing Activity Based Costing technique on cost control function and performance of construction project. 7th International Conference on Innovation in Architecture, Engineering & Construction, 2012.

ASSAF, S. A., BUBSHAIT, A. A., ATIYAH, S. & AL-SHAHRI, M. 2001. The management of construction company overhead costs. *International Journal of Project Management,* 19**,** 295-303.

BOVERKET 2014. Svenska byggkostnader i en internationell jämförelse [An international comparison of Swedish construction costs]. *2014:14,* 1.

BOVERKET 2016. Reviderad prognos över behovet av nya bostäder till 2025 [Revised forcast of the need for new housing until 2025]. Stockholm.

BOWEN, P., HALL, K. & EDWARDS, P. The pricing of contract preliminaries: quantity surveyors and contractors compared. Conference proceedings of CIB-W65 international symposium on organization and management of construction, Glasgow, 1996.

BRINKMANN, S. 2013. *Qualitative Interviewing* Oxford University Press.

BRYMAN, A. 2006. Integrating quantitative and qualitative research: how is it done? *Qualitative Research,* 6**,** 97.

BRYMAN, A. & BELL, E. 2015. *Business research methods,* Oxford University Press.

BUSINESS REGION GOTHENBURG 2019. Economic Outlook 2019 #4.

BYGGANDETS KONTRAKTSKOMMITTÉ 2011. Entreprenadindex husbyggnads- och anläggningsverksamhet: tillämpningsföreskrifter för indexberäkning av kostnadsändrinar [Construction index for housing and infrastracture works: application rules for index calculation of cost changes].

BYGGFÖRETAGEN. 2020a. *Entreprenadindex [Construction index]* [Online]. Available: http://www.entreprenadindex.se/ [Accessed May 2020].

BYGGFÖRETAGEN. 2020b. *Construction index in english* [Online]. Available: https://byggforetagen.se/in-english/ [Accessed May 2020].

BYGGFÖRETAGEN. 2020c. *Regionala byggprognoser [Regional construction prognoses]* [Online]. Available: https://prognos.byggforetagen.se/stockholm/totalt [Accessed May 2020].

CHAN, C. & PASQUIRE, C. 2006. A decision-making matrix model for construction project overhead estimation.

CHAO, L.-C. & LIAW, S.-J. 2017. Bidding Model Incorporating Bid Position for Determining Overhead-cum-markup Rate. *Procedia Engineering,* 196**,** 302-308.

CILENSEK, R. 1991. Understanding contractor overhead. *Cost Engineering,* 33**,** 21.

DUBOIS, A. & GADDE, L.-E. 2002. Systematic combining: an abductive approach to case research. *Journal of Business Research,* 55**,** 553-560.

EUROSTAT. 2020a. *Construction cost of residental buildings* [Online]. Available: https://ec.europa.eu/eurostat/databrowser/view/teiis510/default/bar?lang=en [Accessed May 2020].

EUROSTAT. 2020b. *Construction cost of new residential buildings* [Online]. Available: https://ec.europa.eu/eurostat/databrowser/view/teiis510/default/bar?lang=en [Accessed May 2020].

EUROSTAT OECD. 2012. *Methodological Manual on Purchasing Power Parities (2012 Edition)* [Online]. Available: https://play.google.com/books/reader?id=SbhFEsSgRC8C&hl=sv&pg=GBS.PA30 [Accessed May 2020].

EVIDENS 2018. Effekter av kreditbegränsningar för unga förstagångsköpare [Effect of credit limitations for young first time buyers]. 44.

EVIDENS 2019. Analys och utvärdering av statligt stöd till kommunerna för bostadsbyggande och planering [Analysis and evaluation of state aid to municipalities for housing construction and planning]. 41.

FLICK, U. 2014. *An introduction to qualitative research*, SAGE.

GAO, S. & LOW, S. P. 2014a. Lean Construction Management. [electronic resource] : The Toyota Way. 1st ed. 2014. ed.: Springer Singapore.

GAO, S. & LOW, S. P. 2014b. The Toyota Way model: an alternative framework for lean construction. *Total Quality Management & Business Excellence,* 25**,** 664-682.

GARDINER & THEOBALD. 2012. *International Construction Cost Survey* [Online]. Available: http://www.willsrealtors.com/ICCS%20Construction%20Cost%20US$%20Version_Dec%202012.pdf [Accessed May 2020].

HOLLAND, N. L. & JR, D. H. 1999. Indirect cost categorization and allocation by construction contractors. *Journal of architectural engineering,* 5**,** 49-56.

INYANG-UDOH, U. Investigation into the Costs of Preliminaries and Relationship between These Costs and Total Cost of Building Projects. West Africa built environment research (waber) conference, 2013. 1207.

JORDAN DENTZ., I. N., AND MICHAEL MULLENS 2009. Applying Lean Production in Factory Homebuilding. *Cityscape: A Journal of Policy Development & Research,* 11**,** 81.

JOSEPHSON, P.-E. & BJÖRKMAN, L. 2010. *31 recommendations for increased profit-reducing waste,* Chalmers University of Technology.

JOSEPHSON, P.-E. & BJÖRKMAN, L. 2013. Why do work sampling studies in construction? The case of plumbing work in Scandinavia. *Engineering Construction & Architectural Management (09699988),* 20**,** 589-603.

JOSEPHSON, P.-E. & SAUKKORIIPI, L. 2007. Waste in construction projects: Call for a new approach. Chalmers University of Technology.

KIM, Y.-W. 2017. *Activity Based Costing for Construction Companies,* John Wiley & Sons, Incorporated.

KIM, Y.-W. & BALLARD, G. Activity-based costing and its application to lean construction. Proceedings of the 9th Annual Conference of the International Group for Lean Construction, Singapore, 2001. 6-8.

KOSKELA, L. 2000. An exploration towards a production theory and its application to costruction. *Technical research centre of Finland. Espoo.*

LIKER, J. K. & FRANZ, J. K. 2011. The Toyota way to continuous improvement. [electronic resource] : linking strategy and operational excellence to achieve superior performance. McGraw-Hill Professional.

LODICO, M. G., SPAULDING, D. T. & VOEGTLE, K. H. 2006. *Methods in educational research: From theory to practice*.

NABIL, I. & EL-RIYATI, A. 2015. An overhead costs assessment for construction projects at Gaza Strip. *American Journal of Civil Engineering,* 3**,** 95-101.

NDIHOKUBWAYO, R. & HAUPT, T. 2009. Vatiation orders on construction projects: value adding or waste. 1.

NORDSTRAND, U. 2008. *Byggprocessen [The construction process]*, Liber.

PEURIFOY, R. L. 1975. *Estimating construction costs*.

PLEBANKIEWICZ, E. & LEŚNIAK, A. 2013. Overhead costs and profit calculation by Polish contractors. *Technological and Economic Development of Economy,* 19**,** 141-161.

REGERINGSKANSLIET 2019. Regeringen inför ett effektivare investeringsstöd för hyresbostäder [The government impose more efficient investment aids for rental housing].

RÉVAI, E. 2012. *Byggstyrning [Construction management]*, Liber.

RICS 2015. *NRM 2: Detailed measurement for building works,* Coventry, Royal Institution of Chartered Surveyors (RICS).

RICS 2018. *New Code of Estimating Practice: The Chartered Institute of Building*, John Wiley & Sons Ltd.

SCB. 2017. *Entreprenadindex är mitt i prick [The construction index is in the middle]* [Online]. Available: www.entreprenadindex.se/UserFiles/Entreprenadindex_dokument/Nytta_med_index.pdf [Accessed May 2020].

SCB. 2019a. *Befolkning i Stockholms län 31 mars 2019 [Population in Stockholm county]* [Online]. Available: https://www.sll.se/globalassets/4.-regional-utveckling/publicerade-dokument/statistik-befolkning-stockhoms-lan-q1-2019.pdf [Accessed May 2020].

SCB. 2019b. *Folkmängd i riket, län och kommuner 31 december 2019 och befolkningsförändringar 1 oktober - 31 december 2019 totalt [Population in the state, counties and munipalitices 31st December 2019 and population changes 1st October - 31st December 2019]* [Online]. Available: https://www.scb.se/hitta-statistik/statistik-efter-amne/befolkning/befolkningens-sammansattning/befolkningsstatistik/pong/tabell-och-diagram/kvartals--och-halvarsstatistik--kommun-lan-och-riket/kvartal-4-2019/ [Accessed May 2020].

SISKINA, A. & APANAVICIENE, R. Construction company overhead costs optimization strategies. CIB Joint International Symposium 2009 - construction facing worldwide challenges, 2009 Rotterdam (Netherlands). in-house publishing, 662-671.

SKANSKA. 2019. *Skanska in Sweden* [Online]. Available: https://www.skanska.se/en-us/about-skanska/skanska-in-sweden/ [Accessed May 2020].

SKANSKA. 2020a. *Key figures* [Online]. Available: https://group.skanska.com/investors/financial-information/key-figures/ [Accessed May 2020].

SKANSKA. 2020b. *Our values* [Online]. Available: https://www.skanska.se/en-us/about-skanska/skanska-in-sweden/vara-varderingar/ [Accessed May 2020].

SKANSKA RENTAL. 2020. *Skanska Rental - Mer än bara uthyrning [More than just rental]* [Online]. Available: https://rental.skanska.se/om-skanska-rental [Accessed May 2020].

STAŠOVÁ, L. H. 2019. Evaluating the Use of the Activity Based Costing Method in the Construction Industry in the V4 Countries. *International Journal of Industrial Engineering and Management***,** 257.

SVERIGES BYGGINDUSTRIER 2015. Fakta om Byggandet [Facts about construction].

SVERIGES BYGGINDUSTRIER 2018. Byggkonjunkturen [Construction activity]. *Konjunkturrapport från Sveriges Byggindustrier,* 2**,** 8.

SVERIGES BYGGINDUSTRIER 2019a. Byggkonjunkturen [Construction activity]. *Konjunkturrapport från Sveriges Byggindustrier***,** 10.

SVERIGES BYGGINDUSTRIER 2019b. Vad det värt det? Kreditrestriktionernas effekter på ekonomisk tillväxt [What its worth it? Credit restriction's effects on economic growth]. 35.

SVERIGES BYGGINDUSTRIER 2020. Nordisk Byggkonjuktur 2019-2020 [Nordic construction activity 2019-2020].

TAH, J. H. M., THORPE, A. & MCCAFFER, R. 1994. A survey of indirect cost estimating in practice. *Construction Management & Economics,* 12**,** 31 www.tandfonline.com.

TAYLOR, S. J., BOGDAN, R. AND DEVAULT, M. 2016. *Introduction to Qualitative Research Methods : A Guidebook and Resource,* Hoboken, New Jersey, Wiley.

TIMMER, S. 2015. *Hermeneutics for Designers* [Online]. Available: https://www.uxbooth.com/articles/hermeneutics-for-designers/ [Accessed May 2020].

WILMOT-SMITH, R. 2006. *Construction Contracts: Law and Practice,* Oxford University Press.

WOMACK, J. P. & JONES, D. T. 2003. *Lean thinking : banish waste and create wealth in your corporation,* Free Press Business.

9 Appendix

9.1 Interview questions

The interviews were based on the questions below. However, they were adapted depending on the interviewee's role and the interviews were only semi-structured. Therefore, spontaneous discussions were also held. Some questions were excluded from certain interviews if they were deemed irrelevant.

1. What is your name?
2. What is your background?
3. What is your role within the company?
4. How much experience do you have in your current role?
5. What are your experiences of working with AK?
6. How do you define AK?
    a. Is that your own definition?
7. Do you think other departments within Skanska have experience with AK? Explain
    a. Do you think there are differences between estimators, design and production, concerning AK?
8. Are there elements of AK that are more important than others? Which?
9. How would you describe your experience of AK with Skanska until now?
10. Do you receive (or give) directions from management about how you (or others) should manage AK?
11. Describe how you manage AK.
12. Do you think other people view AK the same way you do?
13. What problems do you see with AK today?
14. Which areas have the most room for improvement?
15. Which elements of AK are increasing or decreasing in efficiency?
16. Which elements of AK are increasing or decreasing in cost?
17. After a project is complete are there any follow up processes concerning AK?
18. What are the biggest obstacles for improving managing AK?
19. Do you know what EquipmentLoop is?
20. What are the pros and cons of using EquipmentLoop?
21. How has EquipmentLoop affected the management of AK?
    a. How has it helped to lower AK in projects?

9.2 Questionnaire

The following questions were sent to Skanska employees working at the housing departments 1 and 2 in Gothenburg. The questionnaire was created as a Google form and sent by e-mail.

Question	Answer format
What is your name?	
What is your role at Skanska?	• Site Manager • Project Manager • Site Supervisor • Estimation Engineer • Estimating Manager • Design Manager • Regional Manager • Logistics Manager • Project Engineer • Other
How well do you think you can define AK?	• 1-5 (5 = very well)
Which definitions of AK do you most agree with? Choose the alternatives you agree with. "AK are costs that..."	• cannot be attributed to a specific work • arises because of a chosen point in time for the project's implementation • are common to the implementation of the whole project • cannot be attributed to anything directly value creating • things that are not built in • costs for running the construction site that cannot be attributed to a specific work task
Do you think your colleagues have a good understanding of AK?	• No • Somewhat • Yes • More or less
Is it important to lower AK?	• No • Do not know • Yes • Other aspects are more important
Is it important when defining AK to group resources as AK or is it enough to focus on each individual resource?	• Important to define resources as AK • It is enough to focus on each individual resource • Do not know • Other
Where does your definition of AK come from?	• Estimators • My own • My bosses • Colleagues

	• Other • Do not have a definition for AK
Which are the most expensive in your projects? ❖ Site management ❖ Scaffolding ❖ Site establishment ❖ Mechanical plant (large) ❖ Temporary services	• 1-5 (5 = most)
Which resources have the greatest potential to reduce costs? ❖ Site management ❖ Scaffolding ❖ Site establishment ❖ Mechanical plant (large) ❖ Temporary services	• 1-5 (5 = greatest)
During the last 10 years, which costs have increased most? ❖ Site management ❖ Scaffolding ❖ Site establishment ❖ Mechanical plant (large) ❖ Temporary services	• 1-5 (5 = most)
AK can be improved on in which of the following areas? ❖ Leadership directives ❖ Purchasing options ❖ Work methods ❖ Communication ❖ Planning ❖ Awareness of contractors	• No • Maybe • Yes
Do you feel you have enough knowledge, tools and methods to make informed decisions about AK?	• 1-5 (5 = definitely)
Do you feel closer collaboration between production, estimation and design would lower AK?	• No • Maybe • Yes
Would it help to have a quantity surveyor out in production?	• Do not agree • Agree • No opinion
What is the biggest obstacle to lowering AK?	• Skanska rental • Unengaged contractors • Culture / attitudes • Communication • Lack of digital tools • No obstacles • Other

Which percent of AK are you comfortable with in projects?	• <10% • 11-12% • 13-14% • 15-16% • 17-18% • 19-20% • >20%
Additional comments	

DEPARTMENT OF ARCHITECTURE AND
CIVIL ENGINEERING
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden
www.chalmers.se

CHALMERS
UNIVERSITY OF TECHNOLOGY