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AN INVESTIGATION OF HOW DIGITAL BIM-OBJECTS CAN BE A COMPETITIVE STRATEGY FOR MATERIAL SUPPLIERS IN THE CONSTRUCTION INDUSTRY.

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Abstract

The construction industry has in general been rather slow in its implementation of new digital solutions compared to other industries. To date, only a handful of material suppliers are offering a service of so-called digital BIM-objects of their products. These 'digital product copies' can be utilized in projects' BIM-models for several purposes, being favorable to the design team and contractors. The advantages related to digitalization in connection to material suppliers have not been studied to a greater degree; hence this fact forms a ground for this study. The purpose of this study is to challenge the analog methods and processes that traditionally have been, and are still practiced widely. In a broader perspective, this study aims to encourage more material suppliers to create digital BIM-objects by answering how this could be a competitive strategy.

This study is designed as a collective case study, including four different material suppliers on the Swedish market being at the forefront of digitalization. Their digital journey and experiences constitute a great resource to share within the construction industry. Each case in this collective case study represents a type of building component, namely; windows (1), profile and ventilation sheets (2), facade systems (3), and doors (4). Empirical data was collected through semi-structured interviews. Except from the material suppliers in the collective cases, also a selection of their partners participated. A total of nine interviews were performed, resulting in a total of 12 interviewees. The interviews' raw data was used to generate a thematic structure. This structure organized the empirics to simplify the after-coming interpretation and analysis.

This study shows that users to the digital BIM-objects, such as digitalized designers and contractors, tend to work toward those material suppliers who can offer continuously developed and well-supported digital BIM-object. Also, combining digital BIM-objects with close relations could potentially generate invitations to an early phase of projects where the material supplier in question is later being procured in a somewhat streamlined and digital process. This manner still relies on innovative pilot-projects since analog methods are in the majority. However, efforts today could ensure the material suppliers not be out-of-competition for future projects as arising new digital and open mindsets pave the way.

Keywords: BIM, Building Information Modelling, Digital BIM-objects, Material Supplier, Merchandiser, Digitalization, Competitive Strategy, Procurement

Sammanfattning

Jämfört med många andra industrier så har byggnadsindustrin halkat efter med att implementera digitala lösningar. I dagsläget är det enbart ett fåtal materialleverantörer och tillverkare som erbjuder en tjänst av så kallade digitala BIM-objekt till sina produkter. Dessa digitala produkt kopior kan nyttjas för flera syften i projektmodeller vilket exempelvis gynnar desing-team och entreprenörer. De fördelar som finns relaterat mellan digitalisering och materialleverantörer har inte studerats i någon större utsträckning. Det faktum utgör därmed grunden till den här studien. Studiens syftar till att utmana de analoga processer och metoder som traditionellt har tillämpats under lång tid och som fortfarande utgör majortiteten i dagens läge. Genom att besvara hur digitala BIM-objekt kan vara en konkurrenskraftig strategi så syftar studien i ett längre perspektiv till att fler materialleverantörer ska uppmuntras att skapa digitala BIM-objekt till sina produkter.

Studien är designad som en samlad fallstudie, vilken inkluderar fyra olika materialleverantörer på den svenska marknaden som alla har en ledande position inom digitalisering. Deras erfarenheter inom digitalisering utgör goda exempel att dela med andra aktörer inom byggnadsindustrin. Respektive fall i studien utgör en typ av byggvaror vilka är; fönster (1), profil- och ventilationsplåt (2), fasadsystem (3) och dörrar (4). Semi-strukturerad intervjuer tillämpades för datainsamling. Förutom de materialleverantörer som ingår i de samlade fallstudien så deltog även ett urval av deras partners. Totalt genomfördes nio intervjuer med totalt 12 medverkande respondenter. Utifrån intervjuernas mjuka data så utvecklades en tematisk struktur. Strukturen organiserade empirin för att underlätta efterkommande tolkning och analys.

Av studien framgick det att användare av de digitala BIM-objekten så som vissa digitaliserade designers och entreprenörer tenderar att arbeta med de materialleverantörer som kan erbjuda välutvecklade och användarstödda digitala BIM-objekt. Studien visade dessutom på att en kombination av digitala BIM-objekt och nära relationer potentiellt kan generera inbjudningar till projekts tidiga faser där materialleverantören senare upphandlas i en mer effektiviserad och digital process. Den här typen av förfarande förlitar sig ännu på innovativa pilot-projekt eftersom de analoga metoderna fortfarande dominerar. Satsningar som görs redan nu kan innebära en säkring av materialleverantörens konkurrensposition till framtida projekt i och med nya digitala och öppna 'mindsets' som formar vägen frammåt.

Nyckelord: BIM, Building Information Modelling, Digitala BIM-objekt, Material leverantör, Tillverkare, Digitalisering, Konkurrenskraftig strategi, Upphandling

Foreword

This thesis marks the end of my time as a Bachelor's student in engineering at Lund University. This spring semester will be remembered as a challenging time due to the spread of the COVID-19 disease, causing noteworthy consequences. Unfortunately, I was hindered from using my scholarship, disbursed by Helsingborg city's "Vänorts-" committee, to visit Pärnu, Estonia to broaden the perspective of my thesis.

Nonetheless, I would like to express my gratitude for everyone making it possible for me to perform and finish my thesis. Firstly, thanks to my supervisor Stefan Olander. Your advice and expertise have been a great resource. Secondly, thanks to my, at the time, co-supervisors at BIMobject for inviting me to your office to share ideas. Good luck with new challenges in the future Viktor Davidov, Åsa Olsson, and Kristoffer Lagerström. Also, thank you Henrik Strand for coming on board as co-supervisor half-way through my thesis and keeping up my collaboration with BIMobject. It has been a pleasure working next to everyone at BIMobject. Last but not least, I would like to express my gratitude to all interviewees for their cooperation and openness. Without you, this thesis would not have been be possible to follow through. Keep up your good and inspiring work.

Lund, May 2020
Charlotte Bredberg

Abbreviations

BIM Building Information Modelling

CAD Computer Aided Design

CEO Chief Executive Officer

COO Chief Operating Officer

CTO Chief Technology Officer

EPD Environmental Product Declaration

ICT Information and Communication Technology

IFC Industry Foundation Classes

ISO International Organization for Standardization

LCA Life Cycle Analysis

LOU Lagen om offentlig upphandling

PO Purchase Order

Terms

digitalization digitalization is defined as the process of leveraging digitization to improve business processes

digitization digitization is defined as converting physical information into a digital one.

framework agreement A certain type of agreement to set down rules in a contact assigned for a fixed period. This can be used for procuring products and services

procurement A strategic process for negotiating to terms and acquiring necessarily material or services into the company's activities from an external source

purchase How material or services are ordered in a technical or practical sense

Contents

1 Introduction

1.1 Background

Compared to other industries, digitization and digitalization of the construction industry have been low (SvenskByggtjänst 2017). Commonly, suppliers in the construction industry seems to have disinclined to abandon their old ways of operating. For example, analog procurement is still the most commonly used procurement strategy despite access to new digital tools and changing market conditions. Possible reasons could be the tradition of the industry and the lack of new perspectives. However, in the next few years, the digitization of the construction industry is expected to accelerate rapidly (ibid.).

Contractors and designers, who are essential partners to the material suppliers, have already adapted to new digital methods to a large extent. For example, initiatives to utilize BIM-models for several purposes in building projects are ongoing in Sweden (Nilsson 2019). BIM-solutions could potentially replace analog documents throughout the design-procurement phases (ibid.). For example, in-model meetings, automated calculations, and digital exports as a legal base for procurement could reduce the need for analog documents. The numerous purposes make digital BIM-objects a subject for many users and projects. Thus, this fact, together with the lack of standardization, implies various solutions for how these digital BIM-objects are managed.

Parallel with the digitization; projects specifically demand higher sustainability and environmental product declarations (EPD). To meet these upcoming demands seem challenging if using analog methods. Another factor to consider is the last years building boom that has lead to increased prices for building materials and role-playing actors to turn to suppliers in other countries (The Government of Sweden 2020). As conditions on the market are changing, material suppliers need to apply competitive strategies to stay in the forefront of their business.

1.2 Problem Statement

Digitization or digitalization are frequently discussed terms in many industries. In the construction industry, digitalization might be best known for its advantages of doing visualizations applied in the design and engineering phase. However, material suppliers working at the forefront of digitalization in their business have not been studied to a high degree. This fact forms the basis for the problem statement. Today only a handful of material suppliers are offering so-called digital BIM-objects of their products. Their digital journey and experiences constitute a great resource to be shared within the construction industry. Whether or not the benefits of digitalization outweigh its efforts could preferably be answered by the handful of material suppliers driving digital efforts. Even better, along with feedback from their partners in the industry using both their products and digital BIM-objects.

At this point, many material suppliers lack incentives for digital efforts. The lack of knowledge in the field and the currently low maturity level form an underlying problem regarding digitalization (SvenskByggtjänst 2017). To many, it could seem very complicated and technical. To not lose out competitively, companies need to adapt to new processes and attitudes as the gap between digital leaders and others is widening (Castagnino, Rothballer, and Gerbert 2016). Digitalization will not happen automatically without active decisions; it is a drive that requires resources to happen. Thus, clear incentives are required for material suppliers to consider these efforts.

1.3 Research Questions

This thesis aims to answer the following formulated main question:

- *How can digital BIM-objects be a competitive strategy for material suppliers in the construction industry?*

The main question will be answered with the help of subqueries:

- *What emerges as crucial factors for whether or not a digital BIM-object is used in a project?*
- *In what way can digital BIM-objects challenge analog methods and processes such as analog procurement?*
- *In what way can digital BIM-objects help material suppliers to be involved early into building projects and thereby increase the chance of being procured?*

1.4 Purpose

This thesis aims to challenge the traditional analog methods and processes that material suppliers in the construction industry have practiced for a long time. In order to fulfill the purpose, material suppliers offering digital BIM-objects of their products will be studied. From a broader perspective, this study aims to drive more material suppliers to produce digital BIM-objects of their products and thereby implementing digital strategies such as digital procurement to a higher degree.

1.5 Scope and Limitations

Firstly, this thesis includes in its scope those actors who are exclusively functioning in the private sector, hence not the public sector. The public sector is excluded due to the additional regulations of the law (LOU), 'Lagen om offentlig upphandling', translated directly to "The law of public procurement", that applies to public procurement in Sweden (Upphandlingsmyndigheten 2018). LOU's fundamental principles, based on objectivity and openness in the procurement process, make it too extensive to be covered in this report (ibid.). The interviewees in this thesis all operate in the private sector.

Secondly, this thesis focuses on material suppliers and merchandisers in the construction industry. The material suppliers produces and delivers building components for constructional purpose on the Swedish market. Hence, material suppliers whose primary business is interior components and designs are excluded.

Thirdly, building projects usually have a long time-span and are commonly divided into several phases. The scope of this thesis focuses on the early stages of a project's life cycle. More specifically, to the design-, procurement- and purchasing phase. The effects and consequences in the production and maintenance phase are not studied.

1.6 Disposition

This thesis is divided into seven chapters, and the outline is described in the text below:

Chapter 1: Introduction
This thesis initiates by introducing the background, problem statement, research question, purpose, scope, and limitations considering the research topic under study.

Chapter 2: Previous Works and Relevant Results for this Report
The theoretical framework along with an analysis model, supporting the analysis and interpretation of the empirical result, is presented in this chapter.

Chapter 3: Method
This chapter presents and argues for the utilized method in this thesis. It includes the adopted research approach, methods for collecting data and assimilating theory, a discussion of validity and reliability, and finishes with ethical considerations.

Chapter 4: Empirical Findings
This chapter is dedicated to present the empirics, extracted from the semi-structured interviews, to the collective cases and participating interviewees in this study. Also, this chapter presents the developed thematic structure based on the interviews' soft data.

Chapter 5: Analysis and Discussion
The analysis is divided into two steps. Firstly, the empirical analysis and discussion presents comparisons and similarities between the interviewees' responses. Secondly, the theoretical analysis and discussion compares the theoretical reference with the interviewees' responses.

Chapter 6: Conclusion and Further Research
This chapter reconnects to the research question and the purpose of this study by presenting conclusions to this study, and finalizes with suggestions for further research.

2 Previous Works and Relevant Results for this Report

This chapter presents the theoretical reference frame used to form a base for the empirical study and supports the after-coming analysis and interpretation of the empirics. The chapter initiates with a presentation of previous works related to interesting topics for the research question. The chapter finishes with a model to present an overview of these topics, see section 2.2 'Theoretical Framework Model'.

2.1 Digital BIM-objects & Information Management

To begin with, the term (BIM) Building Information Modeling is a buzzword in the construction industry. BIM can be defined as a process, using digital models called building information models that apply to construction projects (BIMalliance 2020). One cornerstone for a successful implementation of BIM throughout a building project is to enable data flow between different role-playing actors and soft wares (Aguiar Costa and Grilo 2015). This challenge has been addressed to a standardized solution, namely Industry Foundation Classes (IFC), which is a neutral, open file format that allows information transfer between different soft wares such as CAD-programs (ISO 2018). The International Organization for Standardization (ISO) establishes internationally agreed design and manufacturing processes for the construction industry (ISO 2017). The IFC has been ISO-certified since 2013 and was reviewed in 2018 (ISO 16739-1:2018) (BuildingSMART 2020). IFC format is widely used for representing building product model data (Aguiar Costa and Grilo 2015). The digital models used in a BIM process are based upon so-called digital BIM-objects representing real building components such as walls, windows, and beams (BIMalliance 2020). The objects themselves are enriched by geometric data, forming the object in 3D, and other parameters defining real properties and data accurate to the physical component itself. The numerous possibilities make digital BIM-objects suitable for many applications and role players in construction projects (ibid.). Yet, there exists no standardization or frame considering information management directed to digital BIM-objects. The lack of standardization and numerous users causes various solutions for the existing digital BIM-objects on the market today.

Two main advantageous purposes for using digital BIM-objects can be described as (Nilsson 2015):

- Visualization
- Integration

Firstly, the objects' 3d shapes make them applicable for visualization and to produce drawings, something designers and engineers have utilized to a high degree (Castagnino 2016). Visualization allows the user to see how the product could look mounted into place quite realistically. Secondly, digital products simplify and speed up analysis, such as various calculations and simulations by integrating soft wares (Nilsson 2015). For all of this to work, the digital products and their properties need to be well defined (ibid.). One disadvantage is the extent of work that goes into defining and describing the digital

objects and their properties in an accurate manner (Nilsson 2011).

Digital BIM-objects can both be generic objects or product/supplier-specific. Figure 1 below shows a demo example for how a product-specific object could look like when distributed by a supplier.

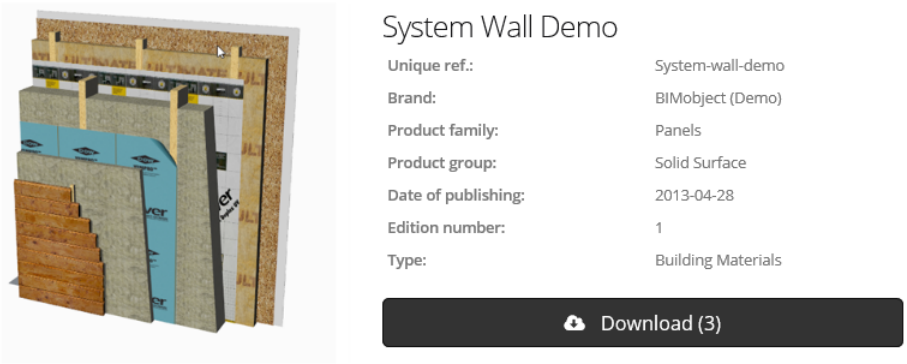

Figure 1: Example of a product-specific digital BIM-object. In this case a system-wall demo. Copyright: BIMobject.com.

2.2 EPD and Sustainability

To date, the building industry is responsible for high carbon dioxide (CO_2) emissions and much waste being unfavorable for the climate crisis and bringing a negative impact on projects' economies (Kellner 2017). Results from life cycle analyses (LCA) show that waste and leftover materials can stand for as much as 25 - 30 percent of the materials' total climate footprint, making it non-negligible (ibid.). To initiate a positive change, the industry must act at a significant scale and more rapidly, for example, by improving the building process to be more climate-smart (ibid.). One action to minimize the waste could be to implement a more accurate procurement of materials when possible (ibid.). Another example of how contractors can consider a climate perspective into the production phase is to demand the so-called Environmental Product Declaration (EPD)- data, a format used internationally containing third part reviewed information (IVL 2019). An additional incentive will soon be the reality for the construction industry as the Swedish government aims to introduce demands from January 2022 of obligated environmental declarations for all new building projects (ibid.). In a practical context, all material suppliers must be able to present LCA-data about their products so the contractor can put together the environmental declaration for the building. The result of LCA-calculations is presented with an EPD.

There exist no conventional standard system considering environmental classification. However, different classification systems like BREEAM (UK), Sweden Green Building Council (SWE), and The Nordic Swan Ecolabel (SWE) are widely applied both in Sweden and internationally and depend on the client's ambitions (Kellner 2017). These classification systems are based on LCA-calculations. The environmental classification systems are an essential instrument to enhance the building process in the construction industry. Therefore, material suppliers have to adapt to international and national stan-

dards considering labeling and certificates. However, demands for labeling and certificates can hinder the competition since that can limit the selection of material suppliers (The Government of Sweden 2020). With a prospect of simplifying material suppliers' communication of product information to the market, a project ran by the Swedish Environmental Research Institute (IVL) aims to describe how all kinds of environmental-related information can be located in one place. Also, this project investigates how this information can be compatible with BIM (IVL 2019). This project drives the development of a digital EPD-tool, making it affordable for also smaller suppliers and merchandisers to produce LCA-data for their products. Thus, they can compete on the same terms as larger companies. The time spent on analog documentation could then instead be used for developing smart and innovative solutions. At the same time, the Swedish Competition Authority is, on behalf of the Government of Sweden, about to investigate how other competition authorities within the EU are dealing with issues concerning a healthy competition in the market for building materials (The Government of Sweden 2020). The significance of the competition caused by implementing demands, such as standards and certificates, will be evaluated within this scope.

2.3 Procurement Process

For a start, it could be helpful to clarify the difference between the terms 'procurement' and 'purchase'. Procurement can be described as a strategic process for negotiating to terms and acquiring necessarily material, work, or expertise into the company's activities from an external actor. Commonly, a competitive bidding- or tendering process lays the ground for this. The term purchasing has a rather practical or technical character as it deals with how material or services are ordered. Figure 2 below illustrates how a general procurement process typically could look like:

Figure 2: Illustration of a general procurement process divided into six steps. Inspiration from (Van Weele 2018).

Determining specifications:
The procurement process initiates with an identification of needs and external demands based on the client. Both technical and functional specifications of the products are set in coordination with the targeted price level, quality, and quantity. These specifications follows by a tendering process. Tender documents can include an invitation letter to tender, design-drawings, a BIM-model, and other specifications needed.

Selecting supplier:
After the specifications are set, a selection process begins. The market is scanned for prospective suppliers who can fulfill basic requirements. Naturally, the organization considers suppliers based on their experiences on the supplier's performance in previous

orders (Van Weele 2014). To yield a more streamlined and well-planned purchasing process, the suppliers could be provided with a forecast (ibid.). The suppliers are evaluated based on their quality, delivery capacity, competitiveness, and innovation (ibid.).

Contract agreement:
In this phase, a contract dealing with prices, warranty, delivery terms, and payment terms forms between the two parties. As the terms and conditions are agreed to, the contract is being signed.

Ordering:
A purchase order (PO) specifying types, quantities, and prices for the product or service is sent to the supplier, e.g., the seller. This document does also specifies accountability, along with business- and legal terms (ibid.). From the point the supplier agrees to the PO, orders can take place. Preferably, all of the required information should be as precise as possible, such as a description of the product, order-volumes, and delivery-times (ibid.). This information can link to the actual bill to guarantee that what is being purchased is in accordance with the agreement.

Expediting and evaluation:
The purpose of this process is to secure the quality and delivery of the ordered units. For example, that the products are delivered in-time and at the correct location. Thus, an expediting process monitors the purchases and deliveries.

Follow-up and evaluation:
The process finishes with a follow-up to evaluate the collaboration. For each relationship with a supplier, it is important to enhance the purchase process by implementing well-formulated strategies (ibid.).

Moreover, one major difference between an analog procurement and a digital procurement is the tendering documents' format. Considering analog procurement, the tendering documents, such as the design-drawings, could typically be PDF:s or printouts, e.g., 2D formats. A digital procurement would instead send tendering documents, including an existing BIM-model, to the supplier. The meaning of a digital procurement process is to reduce administrative burdens and tedious tasks and give more time to think strategically (Aguiar Costa and Grilo 2015). Compared to other areas such as marketing, the procurement process has not followed the same implementation-phase when it comes to digitalization (Accenture 2017). Today, companies have invested in so-called eProcurement systems and cloud-based procurement tools but this could result in the same task but within new soft wares (ibid.). New information and communication technologies (ICT) are being introduced into construction processes to apply BIM for e-procurement (Aguiar Costa and Grilo 2015). As BIM-technology enables the construction of a centralized data-enriched model of building projects, it is helpful for the procurement process as it supports more accurate decisions (ibid.). This area is still widely unexplored and innovative solutions based on open formats such as IFC might arise in the future (ibid.).

2.4 Early Involvement

There are still many products on the market that are not represented by a digital BIM-object (Nilsson 2015). At the same time, more product-specific digital objects are put into architectural and constructional models at an early stage of projects (ibid.). Material suppliers offering digital BIM-objects could hope for the design team to download their objects and put them into the project's BIM-model. By offering their specific products in a digital format, they could hope to simplify the virtual product design process at an early stage and increase their chance of being procured (ibid.). Products can still be exchanged as the project proceeds, and it is not a technical problem to take in another object if they are built correctly.

The reason to involve strategically important suppliers early into projects could be to utilize their expertise to improve the quality and solutions in the finished building (Fernström 2012). For example, the material suppliers can contribute with technical support, calculations, product optimization, and correct layouts during the design phase to yield better-tendering documents (Nilsson 2015). Doing right from the start can shorten the production phase and reduce errors and could thereby be worth the extra time spent in the design. In addition, early involvement could imply the material supplier to care for the project's success at a higher level (Fernström 2012).

2.5 New Mindset and Close Collaborations

A shift in mindset in a conservative industry might be a slow process but is required for BIM innovations to reach its full potential (ibid.). Traditionally, the design and engineering phase has been the most receptive to BIM (Castagnino 2016). An investigation carried out by an information company within the building and real estate sector namely, 'Svensk Byggtjänst' found that mainly the larger companies within the building industry, such as contractors, can see an economic advantage along with digitalization (SvenskByggtjänst 2017). The study also showed that a substantial part of the companies considered increased digitalization to be rather a competitive advantage and a cost-saving strategy than a source of income (ibid.). It has become more important for material suppliers and merchandisers to offer digital formats, such as BIM-objects, to their products as their partners have adapted to a digital mindset (Nilsson 2015).

A high-dependency of suppliers characterizes the construction industry since a substantial part of the contractors' cost is due to purchased supply and services. Hence, these large volumes make the contractors one essential customer group for the material suppliers. During a couple of years, the home-building boom has caused a high demand for building materials, making Swedish contractors turn to merchandisers and material suppliers in other countries (The Government of Sweden 2020). The reason for this is that building costs have accelerated at a high level (ibid.). In fact, building materials stands for almost half of the increase (ibid.). Further knowledge about the market conditions when deciding between different building materials is needed (ibid.). Outsourcing, globalization, and digitalization, along with more recognition of the advantages of a high involvement with suppliers, have affected the supply purchasing management to be broader and more complex (Gadde and Snehota 2019).

Building projects involve many different actors, and lacking communication within the building process can be costly for the construction industry (SvenskByggtjänst 2017). Studies showed that increased digitalization encourages collaborations both at an internal and external level (ibid.). Accessing digital solutions is therefore a key to enhanced dialogues and co-operations. There is a risk that partners who are solely being procured based on the lowest price will not wholeheartedly go into the project and not offer their best solutions (Fernström 2012). Good relations and a shared goal are essential features to increase the success of a project (ibid.). To make the most out of a supplier relationship is a matter of organization (Gadde and Snehota 2019). Organization provides an insight into the supply side of companies as it creates new conditions for individuals' skill development and drives smooth interactions with suppliers through established inter-organizational interfaces (ibid.). Also, a strive for having simultaneous transactions with suppliers over time is preferred; rather than having a single purchasing transaction with a supplier (ibid.).

2.6 Theoretical Model

Figure 3 below provides a theoretical overview by using an illustrative model regarding relevant topics presented in this chapter. Each theme in the model contains several aspects, and the model as a total aims to explain the connection between theories with the research questions.

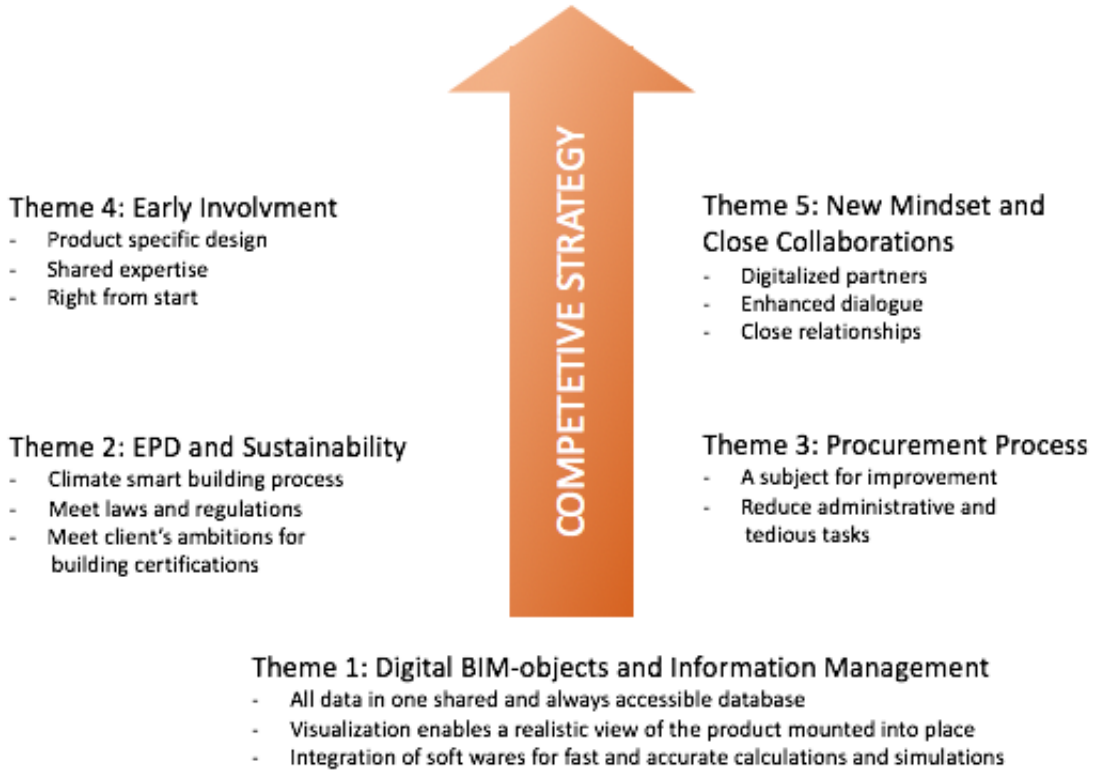

Figure 3: Illustration of a theoretical model applied in this study.

3 Method

This chapter considers the methodology of this thesis. It provides oversight for the strategies that have applied when selecting the method through motivations and discussions. Initially, this chapter explains how previous research has assimilated through the 'Research Approach' and 'Literature Study' and finishes with an insight into this study's research design and research method through 'Empirical Study', 'Validity Reliability' and 'Ethical Considerations'.

3.1 Research Approach

This thesis practice an inductive research approach meaning it emanate from reality. Empirics are collected in a way to reach a more profound interpretation and understanding of individuals' reality and perceptions regarding the research question (Söderbom and Ulvenblad 2016). This study does not ground in a hypothesis based on underlying theories, which is a significant feature of a deductive approach. Instead, a base of knowledge and theory around the subject is continuously growing as the research proceeds. Interpretation of empirics becomes an essential part of the research as it leads to a more general type of understandings and theories (ibid.). This study uses a subjective approach meaning that the viewpoints in the field are different as a cause of different subjective perspectives related to both the researcher and the interviewees (Flick 2014).

3.2 Literature Study

To build a base of knowledge around the research question, previous works, and relevant results were collected. Statistics and soft data brought insight into digitalization-related-topics and the current state of the construction industry. Digitization and digitalization emerged as frequently discussed topics on various platforms in the construction industry. Hence, it was not as common to find information focusing specifically on material suppliers compared to designers, contractors, or the industry in general. Digital procurement found to be a concept widely discussed for many industries but not to a substantial degree in the construction industry specifically.

In order to collect relevant literature and articles, (LUBcat) Lund University Libraries' catalog along with (LUP-SP) Lund University Publications Student Papers, and Google Scholar were used as primary sources. Also, information was extracted from relevant authorities'- organizations'- and companies' web pages. The search function's time range, considering the primary sources, was set from 2010 to 2020 to ensure the relevancy of the collected material. Note that older material, regarding methodology and single exceptions, might occur. Commonly, the search function used keywords such as;
Material supplier, merchandiser, BIM, Building Information Modeling, EPD, environmental product declaration, sustainability, competitive strategy, digitalization, digitization, construction industry, procurement, and qualitative research methodology.

3.3 Empirical Study

This thesis uses qualitative methods to systemize, compress, and elaborate data. The terms 'research design' and 'research method' should not be used equivalently. For this reason, it can be helpful to clarify their meaning. The research design constitutes the frame for data collection and analysis. In contrast, the research method refers to the technique for data collection. This thesis' research design and research method are presented in the text below:

Research Design:
The chosen research design used to plan this study is a so-called collective case study. Case studies aim to reconstruct and describe cases in-depth (Flick 2015). The subject for a case can vary, and in this study, the term 'case' refers to four participating material suppliers. Importantly, the cases must have a common link in order to be studied as a collective. For example, the link could be a shared issue or similarities of some kind.

Research Method:
This study's technique for empirical data collection was so-called semi-structured interviews. Semi-structured interviews are a suitable method, typically used in qualitative research, for understanding the interviewees' realities and viewpoints.

3.3.1 Collective Case Study Selection

As mentioned in the research design, this thesis studies four different material suppliers constituting the cases for this collective case study. These material suppliers are active in the Swedish market and share similar features that link them. More specifically, the material suppliers share similar digitalization strategies as they are offering digital BIM-objects of their products and drive digital solutions. Another similar feature amongst the cases is to manage and develop their digital BIM-objects and support their users in-house, in contrast, to use external resources for this service. Within their respective business category, they have a forefront-position regarding digitalization. To yield a specter of building components, the participating material suppliers each constitutes a category according to the list below:

- Category 1: Windows
- Category 2: Profile- and ventilation sheets
- Category 3: Facade systems
- Category 4: Doors

Short descriptions of the collective cases can be found in section 4.2 'Thematic Coding'.

Furthermore, the digital BIM-objects are freely distributed for building and construction purposes and is mainly a service toward designers and contractors. Hence, this study also integrates perspectives from the users of this service to yield a better understanding of the research question. These additional perspectives are further presented in section

4.1 'Presentation of Interviewees'. As a total, this selection aims to support and yield an understanding of the connection between digital BIM-objects and competitiveness.

3.3.2 Interviewee Selection

In qualitative research, it is common to apply substantial criteria for data collection (Flick 2014). In contrast to formal criteria using a randomized selection technique e.g., statistical sampling, substantial criteria use sampling strategies based on whether an individual's features are relevant for the study when deciding to include the individual or not (ibid.). An example of such a strategy is a purposive sampling, also known as selective sampling (ibid.). There exist numerous variants. A more systematic sampling strategy is preferred over convenience sampling, meaning the selection is limited to readily accessible participants (Flick 2015). Hence, this study applied a criterion oriented strategy for sampling. The strategy was suitable since expertise and experience within the digitalization field was required. The main criteria were to provide with or to use digital BIM-objects. Moreover, the interviewees' relevancy for the study was evaluated from their involvement in innovative projects and solutions. With the help of co-supervisors' consultation and contacts, relevant and potential interviewees belonging to businesses at the forefront of digitalization could be found. A full presentation of the interviewees can be found under section 4.1 'Presentation of interviewees'.

3.3.3 Data Collection

Activities before the empirical study:
This thesis uses semi-structured interviews for data collection. A semi-structured interview is characterized by open-ended questions and a non-strict interview form, e.g., an interview guide (ibid.). A total of three different interview guides were produced for this thesis, and these can be found in appendix 1,2, and 3. Initially, the interview guide addressed to the material suppliers themselves was produced. The following interview guides addressed to the contractors and the designers, were formed with counter-questions to the initial interview guide. This method was applied to ensure the questions' focus back to the material supplier. Moreover, each interview started with a short presentation of the interviewee and their business to collect background information. The questions to be covered in the interview do not necessarily follow a specific order but were sorted under their associated theme. The themes' purpose was to reflect key features, with the research question as a common denominator, to be studied. The themes forming the interview guides are presented below and can be recognized from section 2 'Previous works and relevant results for this report':

- Theme 1: Digital BIM-objects and Information Management
- Theme 2: EPD and Sustainability
- Theme 3: Procurement Processes
- Theme 4: Early Involvement
- Theme 5: New Mindset and Close Collaborations

The themes are sorted in a way to aim for natural transitions in the interview. Nevertheless, the interviewees' flexibility is likely to cause deviation from the predetermined order. A semi-structured interview allows such deviations within the interview guide as it encourage the interviewees to speak more freely and in-depth (Flick 2015). Still, empirical data can be collected around the themes in a structured way to simplify the analysis. In most cases, the predetermined order of the interview guide was well-followed. Applying this method also enables a simplified comparison between the respondents' answers.

Before the first interview session, it can be helpful to practice and go through the interview guide to improve the interviewer's skills and ensure proper data collection (ibid.). An online session with one co-supervisor coaching took place for this purpose. Note that performing the interviews was an iterative learning process, and the spontaneity and flow may have varied between interviews, which might have affected their quality.

Activities during the empirical study:
Data from an interview session can either be collected through actively taking notes during the interview or by recordings. Usually, taking notes requires a minimum of two interviewers and implies a risk to miss out on some data. Also, a semi-structured interview does not follow a strict interview form, so the interviewer was expected to stay sharp and follow up on the interviewees' answers. The content of the interview, as well as how the interviewees responded, such as their tone, were relevant to capture. For these reasons mentioned above, all interviews were audio-recorded. The recordings simplified the focus of the interviews' flow, memorization, and the after-coming analysis. The interviews lasted for about an hour and were taking place in an undisturbed environment to ensure a better quality of the recordings.

Practical issues caused the majority of the interviews to be online instead of face-to-face. The main argument for online-interviews derives from new strict regulations to avoid all unnecessary in-person meetings due to the spread of the COVID-19 disease. However, as an online solution had to be practiced, this thesis did not result in a local data sample. Interviewees spread across Sweden could participate as the factor of organizing and financing travels were excluded.

Activities after the empirical study:
As the interviews one by one were finished, the work of analysis and interpretation of data began. The interpretation of data is a continuous process during the data collection but may not be fully aware (Söderbom and Ulvenblad 2016). Still, it is important to plan activities before the data collection starts since they will help to identify relevant parts regarding the data collection (ibid.).

Interviews can be transcribed in order to simplify a more accurate analysis. This method is time-consuming and generates stacks of papers. Even so, each interview was listened through and transcribed after considering the pros and cons. It is possible to reduce the irrelevant data, such as if the interviewee gets off-topic, by only transcribing relevant data and restructure the data to fit into the pre-determined order of the interview guide (Trost 2014). This material constitutes the raw data to be interpreted and analyzed.

The aftercoming analysis is further described in the following subsection 3.3.4 'Thematic Analysis'.

3.3.4 Thematic Analysis

Collecting data through interviews makes it unsuitable for computer analysis (Söderbom and Ulvenblad 2016). Therefore, this thesis used a manual type of analysis. This study applied a so-called thematic analysis, which can be considered as a foundational method for qualitative analysis (Braun and Clarke 2006). Also, thematic analysis can be used within different theoretical frameworks (ibid.). The method aims to interpret and to find patterns in the data resulting in themes (ibid.). The themes say something about the research question and give meaning to the data (ibid.). The steps below describe this thesis' analysis procedure:

1. The procedure starts with analyzing the collective cases. Initially, a short description was assigned of each case.

2. The transcribed material from all interviews was used to go through the collected data. Relevant reflections were noted in its margins, and interesting statements were highlighted.

3. In this step, code was assigned to the data. The codes are simply short descriptions of what is being stated in the interviews. For example, this could be frequently-repeated topics.

4. The codes were sorted into themes that have a broader character than the codes.

5. The themes were reviewed in this step. This is an iterative process that eventually results in a coherent set of themes.

6. The themes were given descriptive names, and their connection to each other as well as to the research question were described.

Data was collected in a theme-structured manner according to the interview form. Since the relevant topics were quite known at the beginning of the study, the themes were rather pre-defined. Nonetheless, the thematic analysis generated an improved structure for presenting and analyzing the data.

3.4 Validity and Reliability

Validity:
Systemizing the research approach is an important feature to increase the understanding of the utilized method, hence yield a better validity (Söderbom and Ulvenblad 2016). However, the inductive approach applied in this thesis does not imply generalization to a noteworthy number of other similar cases. An underlying reason for this is that interviewees in this study do not represent a specific or targeted larger sample to be generalized. Therefore, it is not possible to draw conclusions or generalize the result to a large extent.

Moreover, there exist disagreements considering an ideal or sufficient number of interviewees in qualitative research. A suffice number depends on the research question and the scope of each interview (Flick 2015). The outcome of nine interviews in this thesis is motivated by their in-depth character. The interview guides were custom to the collective cases and their partners, and the questions were based on the theoretical framework. Thereby, the interview guides were suitable for their purpose. Also, the number of interviewees is in line with a qualitative study that does not strive to generalize the result statistically.

Reliability:
On the first hand, the reliability is relatively low since it would be difficult to reproduce the study with an identical outcome. The interviewees expressed that digitalization is a frequently discussed topic in the construction industry today. Consequently, if this study where performed another time, the outcome could vary due to ongoing research and innovations in the discussed field.

On the other hand, the interviewees' relevancy for the study were carefully considered as a criterion oriented strategy for sampling was applied. Also, recording and transcribing the interviews generated a more precise data collection.

3.5 Ethical Considerations

Research ethics is an important factor when planning and conducting research (Flick 2014). All interviewees in this study participated voluntarily. Their approval to audio-record the interview was always confirmed before the planned interview-session. Recordings and transcripts were stored safe and inaccessible for whom it was not intended. Naturally, judgments and comparisons of the empirics were made by the researcher of this thesis. The statement "doing justice to participants in analyzing data" means that interpretations are grounded in the data e.g., interview statements (ibid.). This approach was considered to avoid discrepancies and poor interpretation in the analysis process.

3.6 Method Critic

A thematic analysis is a quite straight-forward method (Braun and Clarke 2006). Even so, there exist several pitfalls that can cause a lacking analysis (ibid.). These pitfalls could, for example, mean an inconsistency between analytic points and extracted empirics, or themes unsupported by compelling examples (ibid.). In this thesis, the data has solely been interpreted and analyzed by the writer of this report. An additional pair of eyes, to review the researchers found codes and themes resulting in the same outcome, could strengthen the method.

4 Empirical Findings

This chapter is dedicated to the empirical result of this study. It presents and reports empirical findings through interviewees' answers and selected quotes. Initially, the chapter starts with an anonymous presentation of participating interviewees and their business in section 4.1 'Presentation of Interviewees'. It describes how the interviewees are referred to throughout this thesis. This chapter continues with short descriptions, based on empirical data, to the collective cases in section 2.4 'Thematic Coding'. A thematic structure was developed from the collective cases, which finalizes this chapter in section 4.3 'Thematic Structure'.

4.1 Presentation of Interviewees

Readers of this thesis should not be able to identify the participating companies or individuals in this thesis, whereas details such as names and companies' names have been encrypted. The interviewees were given a code constituted by a letter and a number for identification to secure their anonymity. The letters **(M)**, **(C)**, **(D)** and **(DC)** indicates Material supplier/merchandiser, Contractor, Designer/architect, and Design/contractor, respectively. A total of nine interviews were performed in this thesis. Table 1 below presents the nine interviewees, with their associated code, sorted into suitable business categories.

Table 1: Categorization of participating interviewees.

Interviewees' Code	**Category**
M1, M2, M3, M4	Material supplier/Merchandiser
C1,C2	Contractor
D1, D2	Designer/Architect
DC	Design and/or Contractor

In some cases, more than one interviewee participated in the interview to represent their company. Table 2 below provides a more extensive overview of all 12 participating interviewees along with the business they represent.

Table 2: An overview describing each interviewee shortly.

Interviewees' Codes	**Main Supply/Business**	**Nr of Interviewees**	**Interviewees' Roles**
M1	Windows and front doors (category 1)	3	M1:1 CEO, Marketing Director and COO M1:2 Head of Product Development and CTO M1:3 Digitalization Team Leader
M2	Profile- and ventilation sheets (category 2)	1	Digital Business Development Manager
M3	Facade systems, concrete repair, paint and floors (category 3)	1	Head of Business Development and Innovations
M4	Doors of all types for private and public environments (category 4)	1	BIM - Business Development Manager Europe
C1	Contractor	1	Project Manager
C2	Contractor	1	Head of a Department (Former Chief Buyer)
D1	Technical Consulting Company in Infrastructure	1	Architect and Technical Area Manager
D2	Design and visualization platform/tool*	1	CEO and Founder
DC	Design and/or contractor**	2	DC:1 BIM Coordinator DC:2 Project Manager

* This company provides clients with a digital BIM-based platform to simplify design and optional choices.
** This company has various roles in projects. For example, their role could be to only design for the project, or to run both the design and execution —their business drive integration between projects' phases by using digital solutions.

4.2 Thematic Coding

This study applies so-called thematic coding. The procedure starts with a short description of each case included in the collective case study (Flick 2015). As a result, four descriptions were developed for each material supplier, namely M1, M2, M3, and M4. The descriptions start with a statement being typical for the interview. The statements followed with a brief characterization of the interviewees, for example, including the interviewees' professions. At last, the main topics related to the research question, being discussed in the interview, were shortly described. These short developed descriptions are helpful for the following analysis.

4.2.1 Short Description; Interviewee M1

Interviewee M1:1:
'We have a sharp profile when it comes to digitalization and sustainability which we have received very positive feedback for.'

The interviewee M1 consists of interviewees M1:1 who is the CEO, Marketing Director and COO, M1:2, who is Head of Product Development, and CTO, and M1:3 who works as Digitalization Team Leader. The company's main business consists of windows and front doors executed in wood or wood-alumina, which are sold on several markets, including Sweden. The numerous possible configurations of their products are categorized in so-called object families with about 80% representation of the family. Mainly, the standard assortment is represented with digital BIM-objects. As a result, hundreds of objects are distributed on the market. The objects are mostly based on the larger projects' needs for light files. Their idea of digital BIM-objects is to enrich and develop them during the project. Eventually, the product is set and the digital BIM-object gets an ID. Moreover, the company has a specific department to manage the digital BIM-objects, digital procurement, and to reconnect user feedback. Also, they have developed a digitalization and sustainability strategy and named it. The strategy means having all environmental-related data ready; hence the selling-organization can always quickly provide documentation if a customer demands it. Considering digital procurement, they have participated in a pilot-project where an IFC was used as a legal document. In contrast to using a traditional analog document. In pilot projects requiring digital solutions, the company is involved earlier in projects; a contact establishes in the design phase instead of in the already operating building site. In general, their customers ask more and more for digital services and tools.

4.2.2 Short Description; Interviewee M2

'Many companies struggle to check how much you can profit in terms of money from digital implementation but still agrees that the drive and work needs to continue as it will eventually pay off, I reckon this is how us material suppliers should reason as well.'

The interviewee is the Digital Business Marketing Manager. The company's main business consists of profile- and ventilation sheets being sold on several markets, including Sweden. The company offers digital BIM-objects of the products they sell in large volumes, which results in about 75% coverage of products shipped out from the factory. More specialized products are not covered. Each digital BIM-object can be identified to a specific product, and if more information is required, it is always possible to take it further. The company is unique within its business category by having in-house staff for managing and developing the digital BIM-objects. A reason connected to this is their in-house design activities. The digital BIM-objects and associated digital solutions are a centralized part of the organization's operations, both internally and externally. The interviewee states that they would continue to develop digital solutions even if it would have been limited to internal utilization. Furthermore, EPD-data links to a few of their digital BIM-objects. Yet, the optimal way to handle this information is not clear. The efforts to collect all environmental-related data to all kinds of digital media is still ongoing.

In a few projects, with close-collaboration, their digital BIM-objects are used early in the project's model, which results in their products being purchased later. The company experiences a high demand for digital solutions going out. For example, they are asked to upload digital solutions to customers' clouds. However, the majority type of format received is still various 2D documents, not product specified.

4.2.3 Short Description; Interviewee M3

'It is most importantly about servitization and adding services to your products rather than to differentiate.'

The interviewee is the Head of Business Development and Innovations and works at a company whose primary business consists of facade systems but also concrete repairs, paint, and floors. Their products are being sold on several markets, including Sweden. Today, they distribute about 50 objects to their facade products. Recently, they have expanded with digital BIM-objects within the other categories as well. As a result, they offer quite a complete set of their standard assortment. The company has one resource to manage their digital BIM-objects and support the users. Moreover, the interviewee considers the digital BIM-objects as a potential carrier of environmental-related information. At this point, a few digital BIM-objects links to EPD-data, and the efforts are ongoing. Linking information in BIM-objects is considered a suitable option, but the optimal solution for managing environmental-related information is not wholly figured. Furthermore, they have delivered digital BIM-objects on their initiative for a project, but it has not been a requirement for the procurement. Typically, they still receive a majority of 2D documents, especially from small-, medium-sized, or specialized firms. An essential feature of their success have been physical visits, which have generated close contacts and an early involvement in projects. A combination of physical and virtual meetings, using BIM-platforms or similar, is suggested in the future to maintain such rewarding collaborations. At this point, the interviewee cannot conclude that the digital BIM-objects have generated more projects. The interviewee suggests that further demands of digital BIM-objects and models in projects could imply a change to this.

4.2.4 Short Description; Interviewee M4

'We might have another perspective compared to other material suppliers in this industry; we can see the opportunities coming; the most significant potential with BIM derives from the numerous actors that can benefit from it.'

The interviewee is the BIM - Business Development Manager for Europe. The interviewee's role has included the responsibility to implement BIM processes along with their brands in Scandinavia as well as other parts of Europe. All types of doors, for public and private environments, constitute the company's primary business. Their products are sold in several markets, including Sweden. The company distributes a broad representation of their standard assortment as digital BIM-objects. Initially, an external partner created their BIM-objects, but now they have a couple of resources in-house to manage their digital BIM-object. Moreover, environmental-related information is linked to

their digital BIM-objects today. Introducing environmental-data within the digital BIM-objects, for fast calculation purposes, is an arising request from users. At this point, it is still unclear exactly how to manage these requests. Moreover, aside from just a service toward architects, they do consider it to enhance communication at several levels, which will have significant benefits for them. Their long-term goal is to reach a more streamlined purchasing process, utilizing their digital BIM-objects, with a prospect to reduce misinformation along with cost- and time optimization. A few projects in recent times have demanded digital BIM-objects already in the procurement process. Except from strict demands, they have also experienced an increased interest in how they work with BIM-solutions.

4.3 Thematic Structure

A thematic structure was initially developed from the collective cases. As new data emerge during the data-collection process, the structure was modified and improved to assess for all interviews finally. Thus, all interviewees influence the structure since they, as a whole, constitute the ground for interpretation and bring understanding to the research question. The final thematic structure resembles the theoretical model. Slight modifications have developed the structure to give the data a more profound meaning. The thematic structure is presented in table 3 below.

Table 3: A thematic Structure developed from all interviews that are a part of the interpretation.

Codes	**Themes Names**
Need for standardization Reconnect and continuously improve In-house competence Basis for communication Next level of digital BIM-objects	Digital BIM-Objects; Game-Changing but with Challenges to Overcome
Discrepancies High demands for environmental data Product-specific data over generic data Data driven decisions	EPD and Sustainability; Already a Reality Today
Still mostly printouts Misinformation Time consuming looping Digital procurement left behind	Streamline the Procurement Process
The sooner the better Shared goal imply care Material suppliers; a great resource Forecast for production and delivery Framework agreements	Early Involvement for Better Projects
Customers' need for digital solutions Shared vision Being at the forefront of digitalization Transparency	New Mindset to Change the Construction Industry

The found themes are all related and are as a total helpful to understand the empirics and issues around the research question. 'Digital BIM-Objects; Game-Changing but with Challenges to Overcome' refers to the potential but also challenges that the digital BIM-objects are associated with for various role-playing actors in the construction industry. For example, the digital BIM-objects can support environmental-related issues and could potentially enhance the procurement process by streamlining operations. These aspects are brought up under the themes 'EPD and Sustainability; Already a Reality Today' and 'Streamline the Procurement Process'. Also, the material suppliers' expertise, along with their digital BIM-objects, could be utilized early in projects and potentially imply better decisions from the start. Hence, this relates to making smarter decisions in favor of environmental-related topics and optimizing the procurement process. The theme 'Early Involvement for Better Projects' relates to these aspects. The theme 'New Mindset to Change the Construction Industry' relates to how role-playing actors in the industry want to run projects in the future. For example, what measures material suppliers could consider to secure a competitive strategy, as their customers demand digital solutions to a higher degree. In the following subsections finalizing this chapter, a more detailed presentation of the empirics is presented assorted into the found themes.

4.3.1 Digital BIM-objects; Game-Changing but with Challenges to Overcome

The study showed that the satisfaction of the digital BIM-objects distributed on the market today varies by the material supplier in question. Interviewee M3 explains that the information that should be in the digital BIM-objects is not so straight forward as they have numerous different types of users. A recurrent idea amongst the interviewees is to avoid large files, e.g., too many polygons or too much soft data. As an option, interviewee DC:2 suggests a light-file version, intended for visualization purposes, and a complete version if the user wants to take it further. The interviewee explains that they are no longer running empty 3D models just for fancy visualization purposes. The next level of digital BIM-objects would be to utilize the information in the objects, to simplify various calculations and decisions. Also, the interviews showed a lack of harmony between existing digital BIM-objects. An oft-repeated topic in the interviews was the need for a standardization to improve the digital BIM-objects. Interviewee DC:2 states that the construction industry is based upon standards, and that is the way it operates best.

Besides offering digital BIM-objects of their products, the material suppliers in this collective case study shared another feature, namely in-house staff, to develop their objects. The importance to continuously develop the digital BIM-objects was highlighted in the interviews. The users' demands and wishes seemed to be changeable variables. In the best-case scenario, the material supplier can reconnect the users feedback to improve their objects.

Interviewee D1:
'... if the answer to all of this is no, the digital BIM-object is taken out of the project. It is not worth spending more time trying to fix something.'

The statement above refers to a situation when a digital BIM-object is used in the design phase of a project but eventually removed from the project. This removal and dissatisfaction could be due to discrepancies, broken-files, too large files, missing tracking-parameters, and, importantly, a lack of support from the material supplier side. The interviewee explains that even one resource in-house at the material supplier's organization who could manage these types of situations could make a massive difference in whether the digital BIM-object is used.

Interviewee DC:1:
'We did not choose them due to the price but because they wanted to develop. Thus, we could start a dialogue and develop their objects so they become more usable for the specific project.'

In this situation, the material supplier was procured in an early phase due to their openness and engagement to improve their digital BIM-objects to suit the specific project. For example, interviewee DC:1 explained what information the craftsman and women should be able to see in the model.

4.3.2 EPD and Sustainability; Already a Reality Today

Environmental aspects in building projects seemed to be, based upon the interviews, an issue that requires further measures. The interviewees were positive to investigate how digital BIM-objects could improve the industry's environmental footprint.

Interviewee C2:
Honestly, faulty orders have happened, and when the products are delivered to the building site to be built-in, we realize that we ended up with something that does not meet the standards. In the worst-case scenario, the products are scrapped, and a new order has to take place.'

The interviewee explains the importance of ensuring that product-orders are correct and delivered in-time to avoid waste and left-over materials, which is a part of today's reality. Moreover, the interviewee explains that the digital BIM-objects can provide a clear overview of the products' performance, hence, imply correct decisions and orders. In addition, interviewee M3 argues that product-specific data should be preferred over generic data to make data-driven decisions. The interviewee continues to explains that its a prerequisite to work with accurate data to make the right decisions. For example, to ensure that the orders' exactness in terms of numbers and volumes needed for the project. Interviewee D2 describes the urge to automate LCA-analysis. Automation would require a complete data-enriched model. The interviewee tells that the design in projects is expensive enough. Hence, to involve more consultants doing manual LCA-calculations would be not the optimal way to go. Also, interviewee D1 explains the advantages of using real data as fast and accurate calculations can be performed directly in the model. Hence, the real data can save time in the design phase. The below statement refers to the interviewee's main advantage as an architect if more material suppliers would offer digital BIM-objects.

Interviewee D1:
'The main advantage for me would be in terms of calculation, both cost and sustainability. Because then you have real data, whereas when you are using generic objects, you do not have real data.'

Interviewee D1 also describes discrepancies in naming between large environmental databases such as 'Svensk Miljöbyggnad' and the building industry. For example, if a manufacturer uses the name 'aluminum' for a material, the program will not automatically take it as 'alumina'. Thus, the user has to go in and check manually. Also, the interviewee continues to describe that language can be a factor if the manufacturer is selling in different countries. Interviewee DC:2 suggests a standard to simplify the data-management in digital BIM-objects. The data refers also to environmental-related information that is required for various calculations.

Moreover, the study showed that there exist several ideas for how the environmental information could be managed. Interviewee M1:3 explains that the environmental-related tasks are simplified if the information is accessible in the project's model. Linking the environmental-related information to the digital BIM-objects seemed to be an applied

solution at the moment in the collective cases. Interviewee M3 find linking as an option as they can easily manage updates and ensure that the newest document is in place. At the same time, linking might not be the best option, according to some interviewees. For example, interviewee DC:1 explains that a link is not very helpful in a calculation. The tasks are still manual as they have to create an excel sheet and fill in data by hand. The interviewee continues to explain that a solution meaning that data could be extracted directly from the digital BIM-objects should be possible and preferred.

4.3.3 Streamline the Procurement Process

To start with, all of the collective cases explained that printouts, PDF:s or even just phone calls or e-mails are the main type of document formats they receive from customers. They have experienced this analog manner for years, and it has not changed much. Also, interviewee D2 explains that PDF:s and printout sometimes imply tedious administrative tasks. For example, in larger housing-projects, the buyer of a new apartment cannot always select materials such as floors and doors since the administration of such selections are too extensive. Moreover, a majority of the interviewees argue that product-specific data is advantageous for the design team since they can verify that the products actually can be executed in that exact way early on in the process. At the same time, interviewee D1 argues that it is a part of the job as an architect to do this investigation about suppliers and their products extensively.

Interviewee M1:2 describes an analog process to normally take six to eight weeks of looping information before all specifications are set. In general, the interviewee estimates that they can often directly fulfill about 80% of the specifications that are set in the tendering documents. So the last 20% is still enough for causing waste and risks, according to the interviewee. A similar case was described by interviewee C2, having a former role as Chief Buyer. The interviewee describes a typical procurement procedure. The material suppliers' answers could typically be that they could meet 70% of the specifications set in the documents, but the last 30% was not doable. Interviewee M4 suggests that to streamline this process could save much money. In detail, interviewee C2 describes two projects during his time as Chief buyer. In the first project, the design team produced the documents rather freely, which caused the material suppliers not to meet the specifications in these documents very well. Hence, a dialogue started to re-do several parts. In the following similar project, the interviewee did not want to repeat the same mistakes. In this project, a certain material supplier was invited at the start. Their digital BIM-objects were used in the model initially, which resulted in products and solutions without any remarks when it was time for ordering.

Interviewee M1:1:
'Digital procurement has a huge potential in the construction industry, perhaps the most important potential.'

In the statement above, the interviewee explains that using digital solutions such as IFC yields a better overview and control in the procurement- and purchasing process. The interviewee experiences the processes as they look today unpleasantly due to many un-

certainties and risks. However, the interviewee estimates the digital purchases of building material to be only 2-3% of the total volume today. Furthermore, interviewee C2 explains that contractors must look to their clients best and ensure a healthy competition between material suppliers in the procurement process. Thus, if the number of material suppliers in a particular business category who offers digital BIM-objects increases from 50% to 80%, this could drive their procurement process to be more digital.

Interviewee M4:
'... the material suppliers who do not follow the digital development will probably be out-of-competition and excluded for procurement, and we can already see this happening.'

The statement above refers to interviewee M4's experience of procurement processes where the material supplier are required to deliver digital BIM-objects of their products. The interviewee continues to argue that the material suppliers who rely on the building boom and ignores the digital development might miss out on upcoming projects.

4.3.4 Early Involvement for Better Projects

All of the material suppliers included in the collective cases expressed that they can see clear advantages with being involved early in projects, e.g., in the design phase. For example, interviewee M3 means that there exists a philosophy to establish close-contacts, inviting them early in projects. Also, interviewee M2 expresses that this is the best way to run projects. The interviewee motivates this statement by the shared goal to finalize the project with the best value of money that implies to early involvement. Contrarily, a manner to subject several material suppliers to compete at a later stage of a project could result in immense efforts, faults, and expensive buildings. Interviewee M1:1 explains that when analog methods are used in the purchases of building material, it often happens from the building-site without an established contact earlier during the design phase. In the below statement, the interviewee describes a change they have experienced since they implemented digital solutions such as digital BIM-objects. The interviewee's experience with this type of project is positive.

Interviewee M1:1:
'A major advantage by us working digitally is us being involved in an earlier phase in projects, in contrast to a phase when the construction site is operating already.'

Considering the correlation between being involved early and having a service of digital BIM-objects, the interviewees disagree. Interviewees C1, C2, and DC explain that if the material supplier has nice BIM-objects this simplifies the construction of the model. They mean that this service can involve them in projects earlier. Also, this was the case when interviewee DC initiated a collaboration between them and a particular material supplier. Also, interviewee C1 and C2, who belongs to the same contractor have a framework agreement with a particular material supplier. Initially, this agreement was not dependent on the material suppliers service of digital BIM-objects. Interviewee C2 now argues that this will affect the material supplier's future agreements and will be a competitive advantage. Even so, early involvement is still possible without a service of

digital BIM-objects, but this was formulated as a less favorable option. Furthermore, interviewee D1 does not consider the BIM-object to have changed that part of the process yet. The interviewee can quite quickly build an object or has someone in the team to do it. Also, it was mainly interviewee M1:1 from the collective cases that clearly expressed a connection with their digital BIM-objects and an early involvement.

The interviewees' general perception was that it is better to decide product-specific or supplier-specific design early in projects. The majority of interviewees were positive to utilize the material supplier as a resource in the design. However, interviewee D2 argues that it might not be optimal to involve the material in such an early phase. The interviewee explains that building projects usually involve numerous actors, and they are instead aiming to minimize the number. At the same time, interviewee D1 considers material suppliers as a useful resource in the design for advice and recommendations about their products. Also, the interviewee M3 explains that a form of dialogue around their digital BIM-objects is a way to establish close contacts and push information about their products. In this statement below, the interviewee explains that they can be a needed resource in the design phase since they are the expert on their products. This argumentation goes for all of the material suppliers included in the collective cases.

Interviewee M3:
'We are the best experts on our systems; a designer or an architect could never be that.'

Another aspect to consider is how the material suppliers' planning, production, and storage can be affected if they are contacted early. The level of acknowledged advantages varies slightly among the collective cases. The main positive aspect of it is in terms of a forecast, but not much more. Interviewee M1:1 explains that they do not wish to begin the production earlier since the customers still want in-time orders, and an alternative to storage products means a risk to bind capital. Also, interviewee C2 considers the early involvement in implying material suppliers to optimize their capacity.

4.3.5 New Mindset to Change the Construction Industry

The material suppliers in this collective case study have noticed that their customers ask for more digital solutions. In the statement below, interviewee C1 explains that they need to collaborate with material suppliers who can meet them with digital solutions.

Interviewee C1:
'If there is a material supplier who can fulfill this or help us, it is to their advantage. We tend to work more towards those material suppliers.'

The interviewee describes that they are working in a more and more digital manner and with complete digital models. Thus, digitalized suppliers are encouraged. For example, the interviewee presents a framework agreement they have with a particular material supplier. In this case, the material supplier offers very nice supported digital BIM-objects suitable for their models. Moreover, interviewee DC:1 describes the building process as more transparent if a complete shared model, containing accurate price and time data, is

constructed for the project. The interviewee has the perception that many actors might want some extra profit and are therefore not transparent with information.

The interviewees in the collective cases mentioned that digitalization strategies is not shared with direct competitive businesses. Instead, collaborations across businesses are suggested. Nevertheless, interviewee M2 reasoned about an open attitude when sharing their digital journey in the statement below.

Interviewee M2:
'In general, people are a bit more collaborative when it comes to digitalization, and everyone's efforts are needed to change the construction industry. It is only positive, and things do get more open.'

The interviewee mentions several examples of contacts, study visits, and exchange of experience with other companies. In general, the material suppliers in this collective case study is positive about more material suppliers also to offer digital BIM-objects. For example, interviewee M3 considers it positive for the industry and believes it could lead to smarter solutions. Being at the forefront of digitalization is considered with strategic relevancy according to the collective cases. Interviewee M4 considers their digital forefront position today as an advantage over other competitive businesses. Thus, the interviewee explains that their advantageous position would be affected if the digitalization gap between them and competitive businesses decreases.

5 Analysis and Discussion

This chapter dedicates to interpretations, comparisons, and discussions through an analysis of the found empirics. The analysis initiates with finding patterns, differences, or similarities between the interviewees' answers in section 5.1 'Empirical Analysis'. Similarly, section 5.2 'Theoretical Analysis' re-connects the empirics to the theoretical framework which finalizes this chapter.

5.1 Empirical Analysis and Discussion

The interviewees' answers are analyzed within the thematic structure presented in chapter 4 'Empirical Findings'.

5.1.1 Digital BIM-objects; Game-Changing but with Challenges to Overcome

A recurrent item in the interviews was the need for standardization. This is repeatedly suggested in order for BIM processes to reach its full potential. The interviews indicate that there are still many challenges to overcome before this would be the reality. As interviewee M3 explains, it is unclear how to customize the digital BIM-objects to satisfy all the users' needs. This confusion is due to the numerous users and purposes the digital BIM-objects can target. At the same time, the numerous users and purposes is the significant potential with BIM, as interviewee M4 explains.

The existing digital BIM-objects seem to vary dramatically depending on the material supplier. The successful digital BIM-objects that receive positive feedback seem to rely on continuous updates, developments, and dialogues with the users. This makes the digital BIM-objects more user-friendly and suitable for specific projects. For example, this is the case when interviewee DC initiated a project with a particular material supplier, utilizing their expertise and digital BIM-objects. Thus, this generates business for the material supplier.

Contrarily, if the digital BIM-objects are executed poorly in some sense, along with a lack of support to fix the problem, it is probable to discard it from the project instead. For example, in the case where interviewee D1 explains that it is not always worth the time trying to fix the problem. In conclusion, the optimal way to practice this service of digital BIM-objects, seem to be as a living library to support and develop; instead of a single static download service.

5.1.2 EPD and Sustainability; Already a Reality Today

According to the interviewees, the digital BIM-objects do have the potential to fasten manual tasks, solve problems with waste, and to optimize product choices for building

projects. The interviewees in this study share an attitude about environmental-efforts in the construction industry. Further incentives and measures are needed since it is not a sustainable process today. Interviewee, C2 describes today's procurement process to be lacking. For example, due to faulty-orders. Enabling fast calculations and a more accurate procurement process requires real data, as interviewee M3 argues. The need for real data is also in line with interviewees D1's, and DC's wishes to have a correct information in the digital BIM-objects, which can easily be extracted to various soft wares.

However, the various practiced solutions for environmental-data management speaks for an uncertainty of how this could be best managed. This fact causes digital BIM-objects to miss on their full potential in some cases. Even so, the interviewees describe promising prospects by using digital BIM-objects to be a part of a solution to improve the construction industry in environmental terms. As oft-discussed in the interviews, a standard or a frame could improve and simplify also environmental-related tasks.

5.1.3 Streamline the Procurement Process

The current state of the procurement process appears to be still mostly analog as mainly 2D documents circles between material suppliers and their customers. The procurement process today is described as a back and forth information-looping between material suppliers and their customers. For example, interviewees M1:2 and C2 describe this manner. The reasons for the looping seem to be due to miscommunication, lack of knowledge in existing products, and risky manual methods. Also, this looping is described to be time-consuming, causing unnecessary costs.

Specifically, the procurement and purchasing processes seem to be a bit left behind in digitalization. For example, interviewee M1:1 mentions a small number of the total volume of material is being purchased in a digital manner. Cases in this study show examples of innovative actors and pilot-projects when this is done successfully. For example, how interviewee M1 managed to produce an IFC file to be a legal document and interviewee C2 who implied digital measures and close-collaboration to streamline the procurement process. This study shows that digital procurement is still widely unexplored, and different solutions are tested to pave the way. The material suppliers in this collective case study share features of operating in both analog and digital manners. Hence, this manner could mean competitiveness on several fronts.

5.1.4 Early Involvement for Better Projects

Most of the interviewees were positive about involving material suppliers early in projects, for example, by hearing their recommendations to the design. However, interviewee D2 mentioned that projects do often involve very many different actors and they aim to minimize the number instead. This disagreement could depend on the type of project and business in question. If the design team is well-known about existing products, the material suppliers are not necessarily a needed resource. A conclusion from this could be that only actors with a strategical relevance for the project's success should be invited.

The material suppliers philosophy to be involved early in projects did not seem to be

mainly motivated by wishes to pre-manufacturing and planning production. Of course, an early involvement can provide a helpful forecast. Their main advantages with an early involvement seem to relate to correct decisions from the start, hence being time- and cost-saving, and resulting in a more successful project. Successful meaning that all involved actors are satisfied with the outcome and long-term relationships are flourished.

A service of digital BIM-object did not appear to be a stand-alone factor, generating early invitations. A substantial part appears to rely on close relations and trust within the industry. However, the digital BIM-objects could still increase the chance of an early involvement as they are often used and helpful in models. Interviewee C2 suggests that they even might open for further framework agreements. Also, they can constitute a way to uphold a good relation and push information to customers as they become another channel to communicate through.

5.1.5 New Mindset to Change the Construction Industry

Digitalization seems in many ways to relate to a transparent and open environment in projects. Naturally, a reason is accessible data in a shared model, and freely distributed digital BIM-objects. The interviewees seem positive about transparency in the construction industry. For example, as interviewee DC:1 explains that projects risk to imply misunderstandings and hidden margins if there is a lack of transparency. Moreover, the material suppliers in this collective case study have noticed an increased interest in how they work with digital solutions. In projects utilizing digital BIM-objects they could have an advantage since other material suppliers are a bit behind in their digital journey. From a broader perspective, the interviewees in this study are positive about new digital solutions to change the construction industry. The traditional way to run projects seem to be challenged by these interviewees even more in the future.

5.2 Theoretical Analysis and Discussion

The empirics are analyzed to the theoretical framework presented in section 2 'Previous Works and Relevant Results for this Study' but uses the themes found in the empirics, instead of the theoretical model's topics, to organize this analysis.

5.2.1 Digital BIM-objects; Game-Changing but with Challenges to Overcome

Aspects brought up in theme 1 in the theoretical model, found in figure 3, are:
-All data in one shared and always accessible database
-Visualization enables a realistic view of the product mounted into place
-Integration of soft wares for fast an accurate calculations and simulations

Nilsson (2015) argues for visualization and integration as advantageous purposes when using digital BIM-objects. Firstly, visualization is naturally a nice feature to the digital BIM-objects since they provide a 3D view. However, interviewee DC:2 explains that they are no longer using the digital BIM-objects for this single purpose. Instead, the interviewee explains that the information contained within the objects should be utilized

to a higher degree, which again leads back to Nilsson (2015) suggestions of integration. Integration was also a purpose highlighted by interviewee D1 as the interviewee explains that the main advantage with digital BIM-objects is their real data that can be used for analysis, such as various calculations and simulations by integrating soft wares. This type of fast and accurate analysis is being mentioned by many interviewees to be beneficial. Moreover, interviewee M4 explains that the success of digital BIM-objects depends mainly on the fact that numerous role-playing actors can benefit from them. The numerous possibilities for various role-playing actors are also mentioned by BIMalliance (2020).

5.2.2 EPD and Sustainability; Already a Reality Today

Aspects brought up in theme 2 in the theoretical model, found in figure 3, are:
-Climate smart building process
-Meet laws and regulations
-Meet client's ambitions for building certifications

The high numbers of waste and leftover materials at building sites are mentioned by Kellner (2017). Interviewee C2 verifies this problem as the interviewee describes situations with faulty orders and scrapped building materials. One measure suggested by Kellner (ibid.) would be to implement more accurate orders to reduce this negative environmental impact. Also, Aguiar Costa and Grilo (2015) argue that BIM-technology is helpful for the procurement process as an informative constructed model simplifies decisions. This reasoning is explained similarly by interviewee C2, who could see that digital BIM-objects can be helpful for decisions. In a pilot-project, the interviewee also managed to imply correct products from the start. A close dialogue was initiated with the material supplier early in the design, and their digital BIM-objects were used as a basis. Perhaps could measures like this also reduce the risk of faulty orders and thereby minimize the waste and leftover materials. Another measure that Kellner (2017) argues for is demands for EPD-data. This study showed that the material suppliers in this collective case study are positive about this and are already preparing for how to manage this information in various media. The Government of Sweden (2020) can see a potential risk for hindered competition with increased demands for certificates and labeling. The material suppliers in this collective case study seemed to value the importance of having this type of environmental-related information ready if the customers demand it. This study found that the participating material suppliers are often asked to provide this information about their products, and it cannot be missing. For example, interviewee M1 has developed a strategy related to digitalization and environmental issues to prepare for these requirements.

5.2.3 Streamline the Procurement Process

Aspects brought up in theme 3 in the theoretical model, found in figure 3, are:
-A subject for improvement
-Reduce administrative and tedious tasks

In the general model for a procurement process described by Van Weele (2018), found

in figure 2, the suppliers are contacted in the tendering process. If the suppliers are not contacted earlier to support the product design, there is a risk that the supplier can not meet the set specification exactly, and a discussion-loop is initiated to find a compromise. These situations are described both by interviewees M1:2 and C2. The interviewees describe the most commonly used document format to be printouts or PDF:s and Aguiar Costa and Grilo (2015) means that digital procurement can reduce administrative tasks connected to that type of traditional documents. At the same time, Accenture (2017) has noticed that procurement processes are a bit behind when it comes to digitalization compared to other fields. A substantial part of the interviewees confirms this. For example, interviewee M1:1 explains that digital purchases of building material are not more than 2-3% of the total volume today. Moreover, Van Weele (2014) explains that suppliers are evaluated from criteria such as quality, capacity, competitiveness, and innovation. These aspects seem to have been evaluated in the case where interviewee DC procured a material supplier based on their cooperation and open-mind to improve their digital BIM-objects to suit the specific project. Van Weele (ibid.) means that it is important to develop a strategy for each relationship's purchasing process with a supplier. Moreover, interviewees C1 and C2 have signed a framework agreement with a particular material supplier. Hence, their collaboration could lead to a simplified purchasing process on both sides. Gadde and Snehota (2019) do also argue for having simultaneous transactions with suppliers over time rather than just single purchases.

5.2.4 Early Involvement for Better Projects

Aspects brought up in theme 4 in the theoretical model, found in figure 3, are:
-Product-specific design
-Shared expertise
-Right from start

Fernström (2012) explains that one reason to involve material suppliers at an early stage would be to utilize their expertise to order to improve the result of the finished building. The material suppliers are repeatedly described as resourceful, possessing desirable knowledge about their products. For example, when interviewee C2 invited a material supplier to an early phase of a pilot-project, the goal was to avoid common mistakes by using the material supplier's digital BIM-objects and their knowledge about their products and solutions. In this case, the material supplier cared to share their best support and recommendations to suit the project. Also, Fernström (ibid.) argues that an early involvement could imply additional care for the projects best. Thus, such a collaboration can be a successful way to run projects. Another aspect to investigate with the digital BIM-objects is how they could generate more business for the material supplier if used in project models. Nilsson (2015) explains that more and more digital BIM-objects are being used in BIM-models at the early stages of projects. Even so, there is still no guarantee that a specific product will be purchased later, even if it is used in the model. However, this study shows with some examples that a combination of good relations and well-developed digital BIM-objects can be a way into projects' models at an early phase with a high chance of later being procured.

5.2.5 New Mindset to Change the Construction Industry

Aspects brought up in theme 5 in the theoretical model, found in figure 3, are:
-Digitalized partners
-Enhanced dialogue
-Close relationships.

Nilsson (2015) explains that it has become more critical for material suppliers to offer digital BIM-objects since their partners ask for digital solutions. The material suppliers included in the collective cases expressed that they have seen an increased demand for digital tools and solutions; in general, their customers are a bit more interested in their digital efforts. However, interviewee M2 explains that it is not easy to translate digitalization in terms of money, which also interviewee M3 agrees with as they have not clearly seen it generating projects so far. Also, SvenskByggtjänst (2017) showed in their study that contractors associate digitalization with cost savings rather than a source of income. Similarly, the material suppliers in the collective cases do not express a direct relation between extra profits and digitalization. Eventually, the material suppliers in the collective cases believe that their efforts will pay off, hence their digital forefront positions. Furthermore, The Government of Sweden (2020) explains that the building boom has caused actors to turn to material suppliers in other countries due to expensive materials. At the same time, a substantial part of material suppliers ignores digital efforts and seem to rely on the building boom according to interviewee M4. As a conclusion, the market conditions today might still be favourable to material suppliers, generating business. Of course, this suggestion is no guaranty for the future.

6 Conclusion and Further Research

This chapter presents the conclusion drawn from this empirical study by reconnecting to the research question and purpose of this thesis. Since the research question is divided into subqueries, they are answered one by one and then summarized in section 6.1 'Conclusion'. Suggestions for what further research could focus on, and how this could be carried out, finalize this chapter in section 6.2 'Further Research'.

6.1 Conclusion

What emerges as crucial factors for whether or not a digital BIM-object is used in a project?

This study found that the existing digital BIM-objects today are a subject for improvement. The digital BIM-objects are described as game-changing, but several challenges hinder their full potential at the moment. An oft-repeated factor that could bring a substantial change to this is to find a standardization. This would unify the digital BIM-objects, hence making them more user-friendly. Nevertheless, this study presents a selection of outstanding and innovative material suppliers who receive positive feedback from the users of their digital BIM-objects. In fact, the collective cases show that material suppliers who continuously develops and supports their company's service to distribute digital BIM-objects implies digitalized partners to want their specific objects in the projects' models. It emerges as favorable for the material supplier if they reconnect feedback, and open for a dialogue about their digital BIM-objects. Contrarily, poorly made, static, and unsupported digital BIM-objects could imply the users to remove the objects from their projects and look for other options such as alternative suppliers or to build the objects themselves.

In what way can digital BIM-objects challenge analog methods and processes such as analog procurement?

This study shows that the analog procurement processes are associated with risks, faulty orders, time-consuming communications, waste, and leftover materials. The fact that the analog processes are lacking in several aspects open for other solutions. A promising prospect arising with digital procurement is to streamline the procurement process. So far, digital procurement has been limited to pilot-projects, but positive feedback supports its further practice. This study also found that if more material suppliers would offer digital BIM-objects, this could encourage their customers to apply digital procurement to a higher degree as a healthy competition could be ensured. As a result, the material suppliers who cannot offer digital solutions could risk being out-of-competition regarding these projects.

In what way can digital BIM-objects help material suppliers to be involved early into

building projects and thereby increase the chance of being procured?

Firstly, an early involvement of material suppliers emerges as being most beneficial for projects. This is motivated by shared expertise and closer collaborations that imply optimization and care for projects' goals. Thus, this manner seems as a favorable way to run projects. Secondly, the study indicates that a combination of close contacts and digital BIM-objects could increase the chance of early involvement, followed by procurement.

Finally, the answer to this thesis' main research question *'How can digital BIM-objects be a competitive strategy for material suppliers in the construction industry?'* can be summarized as:

The users to digital BIM-objects, such as digitalized designers and contractors, tend to work with material suppliers who are willing to develop and support this service through close collaborations and reconnecting dialogues. This combination could potentially mean an invitation to an early phase of a project where the material supplier in question is later being procured in a rather streamlined and digital process. The drive for digital solutions in the construction industry speaks in favor to practice these types of projects in the future. Of course, the analog methods are still in the majority today and cannot be ignored. Nevertheless, material suppliers who have already now made efforts to be at the forefront of digitalization minimize the risk of missing out on future projects. To sum up, these above-presented conclusions could possibly provide an incentive for more material suppliers to challenge analog processes and invest in digital BIM-objects.

6.2 Further Research

The point where this project ended could be a promising subject for further investigations. For example, a case study could be carried out that in-detail focuses on the production phase. Possibly, one could find effects at the building site if the material suppliers are invited early to participate in the project's BIM-model to share their expertise and digital BIM-objects. For example, these effects could relate to the planning of deliveries, the reduction of common errors and waste, the preciseness of in-time deliveries, and the quality of the finished product. Furthermore, since there exists no standard or frame for digital BIM-object, it can cause discrepancies between countries. First of all, the language can be problematic. The exchange and delivery of building products within the EU is extensive and constitutes an important market for many material suppliers. Therefore, it could be useful to investigate how standardization efforts could simplify collaborations within the EU to ensure healthy competition between countries.

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Appendices

Appendix 1

INTERVJUGUIDE:
Riktat mot materialleverantör.

Skapad av: Charlotte Bredberg
Ver. 3, senast uppdaterad: 2020-04-07

Introduktion

- Hur länge har ni arbetat på företaget eller i branschen och vad är er roll idag? Presentera er gärna kort.

- Kan ni berätta kort om er affärsidé, vad är det ni producerar och levererar?

TEMA 1: Digitala BIM-objekt och informationshantering

T1_F1: Själva idén med digitala BIM-objekt är att samla all information, som är uppdaterad och alltid tillgänglig, på en databas. Till och börja med så undrar jag till hur stor del ni arbetar med att digitalisera era produkter och processer. T.ex. hur stor del av ert produktsortiment finns som digitala BIM-objekt?

T1_F2: Till hur stor del innehåller era digitala BIM-objekt lika mycket information om produkten som man skulle kunna få på exempelvis er hemsida? Hur återkopplar ni vilken information som ska finnas i objekten?

T1_F3: Vilka risker kan förekomma med att kvalitetssäkra informationen vad gäller de digitala BIM-objekten?

T1_F4: Hur ser ni på de digitala BIM-objekten i dagens läge? (Skulle ni säga att dess roll snarare är kompletterande till andra metoder eller tänker ni att de i framtiden till och med kan ersätta?)

TEMA 2: Miljö och hållbarhet

T2_F1: Regeringen avser att införa krav fr.o.m. 2022 om redovisning av miljödeklarationer vid uppförande av byggnader. För att lyckas redovisa det krävs givetvis mycket data som gäller t.ex. de produkter som levereras. Datan som krävs kan även variera från projekt

till projekt. Hur förväntar ni er att en sådan ny lag kan påverka era kunders krav på er? (Vidtar ni några speciella strategier för att vara redo för det?)

T2_F2: Vilka skillnader kan förekomma när det gäller att göra en produkt redo för miljödeklaration om man arbetar med digitala BIM-objekt eller analoga metoder?

T2_F3: Hållbarhet är en trend som växer sig starkare, speciellt i byggbranschen som står för t.ex. höga CO2-utsläpp och mycket avfall. Hur tror ni att digitala BIM-objekt kan bidra till att man tar smartare val som gynnar hållbarhetstänket?

TEMA 3: Upphandlingsförfarande

T3_F1: Vilka är era främsta kundgrupper?

T3_F2: När era kunder upphandlar materialleverantörer, vad är det för underlag de skickar till er så ni kan lämna anbud? (T.ex. är det oftast 2D bygghandlingar som gäller i analog upphandlingsprocess?)

T3_F3: När handlingar projekteras fram, på vilket sätt kontrolleras det att de krav och specifikationer som sätts på produkter faktiskt finns tillgängligt och går att producera?

T3_F4: Till hur stor del kan ni direkt uppfylla de krav och önskemål som angetts i de underlag ni fått så ni kan lämna ett anbud utan anmärkningar?

T3_F5: Kan du berätta om något exempel på ett krav eller önskemål ni fått som t.ex. är motsägelsefullt eller inte går att uppfylla?

T3_F6: I ett sådant läge, hur lång tid och hurpass enkelt är det att mötas kring en lösning?

T3_F7: Vem är det som kontrollerar att det som har projekterats stämmer överens med det som upphandlas? Hur mycket arbete innebär den processen?

T3_F8: Vem är det som sätter villkoren för upphandlingen och således påverkar de som kan konkurera? Hur stor del har projektören/arkitekten när det kommer till val av materiallevarantör?

T3_F9: Kan du berätta om något exempel om när det vart en fördel eller till och med ett villkor i upphandlingen att kunna leverera digitala BIM-objekt av produkter?

T3_F10: Vid upphandling av materialleverantörer, hur vanligt är det att tillämpa digital upphandling jämfört med analog upphandling i branschen?

TEMA 4: Involveras i ett tidigt skede

T4_F1: Förr eller senare måste materialleverantör bestämmas men på vilket sätt tror ni

att det spelar någon roll för de som projekterar om när det blir?

T4_F2: På vilket sätt hade ni värdesatt att delta projekteringsmöten under modellens utveckling för att redan då kunna delta i beslut och ge rekomendationer om produktval?

T4_F3: När är det vanligtvis som en materialleverantör får chansen att sälja in nya produkter eller ge rekommendationer om produktval i ett projekt?

T4_F4: På vilket sätt kan era digitala BIM-objekt påverka hur tidigt det är möjligt för er att involveras i ett projekt?

T4_F5: Hur kan det påverka er planering av tillverkning, leverans och därmed risken kring att ha ett stort lager, om ni får involveras tidigare i ett projekt?

TEMA 5: Nytt mindset och nära sammarbeten

T5_F1: Hur viktigt tycker ni relationen till projekteringen är om man jämför med relationen till era främsta kundergrupper?

T5_F2: På vilket sätt kan de digitala BIM-objekten påverka kommunikationen och hur nära sammarbete ni har med era kunder?

T5_F3: Vilken respons av kunder och branschen har ni fått för de digitala BIM-objekt ni skapat?

T5_F4: På vilket sätt märker ni av att er kundkrets arbetar med digitala BIM-objekt/lösningar?

T5_F5: Digital mognad är ett mått på hur väl en organisation kan tillgodogöra sig nyttorna av digitalisering. På vilket sätt skiljer sig den digitala mognaden mellan er som materialleverantör och andra aktörer i branschen?

T5_F6: Vilken nytta ser ni i att uppmuntra materialleverantörer att ta hjälp av varandra med digitalisering och kanske följa ert exempel?

T5_F7: På vilket sätt kan det påverka er konkurrens om andra materialleverantörer tillämpade samma digitaliseringsstrategi som ni?

Avslutning

-Slutligen, är det något ni vill tillägga?

-Tack för er medverkan!

Appendix 2

INTERVJUFORMULÄR:
Riktat mot entreprenör.

Skapad av: Charlotte Bredberg
Ver. 2, senast uppdaterad: 2020-04-07

Introduktion

- Hur länge har ni arbetat på företaget eller i branschen och vad är er roll idag? Presentera er gärna kort.

- Kan ni berätta kort om er affärsidé på företag X?

TEMA 1: Digitala BIM-objekt och digital informationshantering

T1_F1: Själva idén med digitala BIM-objekt är att samla all information, som är uppdaterad och alltid tillgänglig, på en databas. Vilken erfarenhet ni har av att arbeta med digitala BIM-objekt?

T1_F2: Upplever ni att digitala BIM-objekt av en materialleverantörs produkter innehåller lika mycket information om produkten som man skulle kunna få på exempelvis materialleverantörens hemsida? Hur väl anser ni att materialleverantörer vet vilken informationen som ska ingå i objekten och hur den ska ligga där?

T1_F3: Vilka risker kan förekomma med att kvalitetssäkra informationen vad gäller de digitala BIM-objekten?

T1_F4: Hur ser ni på de digitala BIM-objekten roll i dagens läge? (Skulle ni säga att dess roll snarare är kompletterande till andra metoder eller tänker ni att de i framtiden till och med kan ersätta?)

TEMA 2: Miljö och hållbarhet

T2_F1: Regeringen avser att införa krav fr.o.m. 2022 om redovisning av miljödeklarationer vid uppförande av byggnader. För att lyckas redovisa det krävs givetvis mycket data som gäller t.ex. de produkter som levereras. Datan som krävs kan även variera från projekt till projekt. Hur förväntar ni er att en sådan ny lag kan påverka era krav på materialleverantörerna?

T2_F2: Hur och var skulle ni föredra att miljödokumentation om leverantörernas produkter finns, i digitala BIM-objekt eller något annat?

T2_F3: Hållbarhet är en trend som växer sig starkare, speciellt i byggbranschen som står för t.ex. höga CO2-utsläpp och mycket avfall. Hur tror ni att digitala BIM-objekt kan bidra till att man tar smartare val som gynnar hållbarhetstänket?

TEMA 3: Upphandlingsförfarande

T3_F1: När ni upphandlar materialleverantörer, vad är det för underlag ni skickar till dem så de kan lämna anbud? (T.ex. är det oftast 2D bygghandlingar som gäller i analog upphandlingsprocess?)

T3_F2: När handlingar projekteras fram, på vilket sätt kontrolleras att de krav och specifikationer som sätts på produkter faktiskt finns tillgängligt och går att producera?

T3_F3: Till hur stor del kan materialleverantören direkt uppfylla de krav och önskemål som angetts i underlagen så de kan lämna ett anbud utan anmärkningar?

T3_F4: Kan du berätta om något exempel på ett krav eller önskemål som ställts i upphandlingen men som materialleverantören ej kan uppfylla direkt och behöver kompromisas på något vis?

T3_F5: I ett sådant läge, hur lång tid och hurpass enkelt är det att mötas kring en lösning?

T3_F6: Vem är det som kontrollerar att det som har projekterats stämmer överens med det som upphandlas? Hur mycket arbete innebär den processen?

T3_F7: Vem är det som sätter villkoren för upphandlingen och således påverkar de som kan konkurera? Hur stor del har projektören/arkitekten när det kommer till val av materiallevarantör?

T3_F8: Kan ni berätta om något exempel ni vart med om när det vart en fördel eller till och med ett villkor i upphandlingen att materialleverantören ska kunna leverera digitala BIM-objekt av produkter?

T3_F9: Vid upphandling av materiallevernatörer, hur vanligt förekommande är digital upphandling jämfört med analog upphandling i branschen?

TEMA 4: Involveras i ett tidigt skede

T4_F1: Förr eller senare måste materialleverantör bestämmas men på vilket sätt spelar det någon roll för er som entreprenör om när det blir?

T4_F2: På vilket sätt hade ni värdesatt att materialleverantören deltar projekteringsmöten under modellens utveckling för att redan då kunna delta i beslut och ge rekomendationer om produktval?

T4_F3: När är det vanligtvis som en materialleverantör får chansen att sälja in nya produkter eller ge rekommendationer om produktval i ett projekt?

T4_F4: På vilket sätt kan digitala BIM-objekt påverka hur tidigt det är möjligt för en materialleverantör att involveras i ett projekt?

T4_F5: På vilket sätt skulle det kunna påverka planering av tider och leverans av produkter om materialleverantören involveras tidigare i ett projekt?

TEMA 5: Nytt mindset och nära sammarbeten

T5_F1: Hur värdesätter ni relationen till materialleverantören?

T5_F2: På vilket sätt kan digitala BIM-objekt av produkter påverka kommunikationen och hur nära sammarbete ni har med materialleverantören?

T5_F3: Vilken feedback skulle ni vilja ge till de materialleverantörer som erbjuder digitala BIM-objekt och som ni har erfarenhet av?

T5_F4: På vilket sätt tror du att materialleverantörer märker av att ni arbetar med digitala lösningar?

T5_F5: Digital mognad är ett mått på hur väl en organisation kan tillgodogöra sig nyttorna av digitalisering. På vilket sätt skiljer sig den digitala mognaden mellan er som enterprenör och materialleverantörer?

T5_F6: Vilka skulle era främsta vinster vara om fler materialleverantörer väljer att skapa digitala BIM-objekt av sina produkter?

T5_F7: På vilket sätt hade det förändrat konkurrensen emellan materialleverantörer om fler och fler kan erbjuda digitala BIM-objekt av sina produkter?

Avslutning

-Slutligen, är det något ni vill tillägga?

-Tack för er medverkan!

Appendix 3

INTERVJUFORMULÄR:
Riktat mot projekteringen/arkitekt.

Skapad av: Charlotte Bredberg
Ver. 2, senast uppdaterad: 2020-04-07

Introduktion

- Hur länge har ni arbetat på företaget eller i branschen och vad är er roll idag? Presentera er gärna kort.

- Kan ni berätta kort om er affärsidé på företag X?

TEMA 1: Digitala objekt och informationshantering

T1_F1: Själva idén med digitala BIM-objekt är att samla all information, som är uppdaterad och alltid tillgänglig, på en databas. Till hur stor del arbetar ni med digitala BIM-objekt?

T1_F2: Hur upplever ni att digitala BIM-objekt innehåller lika mycket information om produkten som man skulle kunna få på exempelvis materialleverantörens hemsida? Hur väl anser ni att materialleverantörer vet vilken information som ska ingå i objekten och hur den ska ligga där?

T1_F3: Vilka risker kan förekomma med att kvalitetssäkra informationen vad gäller de digitala BIM-objekten?

T1_F4: Hur ser ni på de digitala BIM-objektens roll i dagens läge? (Skulle ni säga att dess roll är snarare att komplettera andra metoder eller tänker ni att de i framtiden till och med kan ersätta?)

TEMA 2: Miljö och hållbarhet

T2_F1: Regeringen avser att införa krav fr.o.m. 2022 om redovisning av miljödeklarationer vid uppförande av byggnader. För att lyckas redovisa det krävs givetvis mycket data som gäller t.ex. de produkter som levereras. Datan som krävs kan även variera från projekt till projekt. Hur förväntar ni er att en sådan ny lag kan påverka era krav på materialleverantörerna?

T2_F2: Hur och var skulle ni föredra att miljödokumentation om materialleverantörernas produkter finns, i digitala BIM-objekt eller något annat?

T2_F3: Hållbarhet är en trend som växer sig starkare, speciellt i byggbranschen som står för t.ex. höga CO2-utsläpp och mycket avfall. Hur tror ni att digitala BIM-objekt kan bidra till att man tar smartare val som gynnar hållbarhetstänket?

TEMA 3: Upphandlingsförfarande

T3_F1: När en materialleverantör upphandlas, vad är det för underlag som skickas till dem så de kan lämna anbud? (T.ex. är det oftast 2D bygghandlingar som gäller i analog upphandlingsprocess?)

T3_F2: När ni projekterar fram handlingar, på vilket sätt kontrollerar ni att de krav och specifikationer som ni sätter på produkter faktiskt finns tillgängligt och går att producera?

T3_F3: Till hur stor del uppfattar du att materialleverantören direkt kan uppfylla de krav och önskemål som angetts i underlagen så de kan lämna ett anbud utan anmärkningar?

T3_F4: Kan du berätta om något exempel på ett krav eller önskemål som ställts i upphandlingen men som materialleverantören ej kan uppfylla direkt och behöver kompromisas på något vis?

T3_F5: I ett sådant läge, hur lång tid och hurpass enkelt är det att mötas kring en lösning?

T3_F6: Vem är det som kontrollerar att det som har projekterats stämmer överens med det som upphandlas? Hur mycket arbete innebär den processen?

T3_F7: Vem är det som sätter villkoren för upphandlingen och således påverkar de som kan konkurera? Hur stor del har du som projektör/arkitekt när det kommer till val av materiallevarantör?

T3_F8: Kan ni berätta om något exempel där det vart en fördel eller till och med ett krav i upphandlingen att materialleverantören ska kunna leverera digitala BIM-objekt?

T3_F9: När materialleverantörer ska upphandlas, hur vanligt förekommande är digital upphandling jämfört med analog upphandling (sett i stort i branschen)?

TEMA 4: Involveras i ett tidigt skede

T4_F1: Förr eller senare måste materialleverantör bestämmas men på vilket sätt spelar det någon roll dig som arkitekt/projektör om när det blir?

T4_F2: På vilket sätt hade ni värdesatt att materialleverantören deltar i projekteringsmöten under modellens utveckling för att redan då kunna delta i beslut och ge rekomendationer om produktval?

T4_F3: När är det vanligtvis som en materialleverantör får chansen att sälja in nya produkter eller ge rekommendationer om produktval i ett projekt?

T4_F4: På vilket sätt kan digitala BIM-objekt påverka hur tidigt det är möjligt att involvera en materialleverantör i ett projekt?

TEMA 5: Nytt mindset och nära sammarbeten

T5_F1: Hur värdesätter ni relationen till materialleverantören?

T5_F2: På vilket sätt kan digitala BIM-objekt av produkter påverka kommunikationen och hur nära sammarbete ni har med materialleverantören?

T5_F3: Vilken feedback skulle ni vilja ge de materialleverantörer som erbjuder digitala BIM-objekt och som ni har erfarenhet av?

T5_F4: På vilket sätt tror du att materialleverantörer märker av att ni arbetar med digitala lösningar?

T5_F5: Digital mognad är ett mått på hur väl en organisation kan tillgodogöra sig nyttorna av digitalisering. På vilket sätt skiljer sig den digitala mognaden mellan er som arkitekt/projektör och materialleverantörer?

T5_F6: Vilka skulle era främsta vinster vara om fler materialleverantörer väljer att skapa digitala BIM-objekt av sina produkter?

T5_F7: På vilket sätt hade det förändrat konkurrensen emellan materialleverantörer om fler och fler kan erbjuda digitala BIM-objekt av sina produkter?

Avslutning

-Slutligen, är det något ni vill tillägga?

-Tack för er medverkan!