YRKESHÖGSKOLAN
NOVIA

Research on Improving Commmunication and Visual Communication in an Organization

Viktor Sundkvist

Master's Thesis

Thesis for a Master of Engineering (UAS) – degree

Industrial Management and Engineering

Vaasa 2022

DEGREE THESIS

Author:	Viktor Sundkvist
Degree Programme and place of study:	Industrial Management and Engineering, Vaasa
Supervisor(s):	Roger Nylund

Title: Research on Improving Communication and Visual Communication in an Organization

---

Date: 29.05.2022 Number of pages: 89 Appendices: 2

Abstract

The thesis is about how internal communication and visual communication works within an organization and specifically between the engineering- and the production department. The purpose of this thesis was to investigate the possibilities of improving the internal communication and if this can be achieved through using more visual communication tools in the communication processes. The purpose of this thesis was also to investigate the possibilities of implementing a BIM model in work processes. The aim with this thesis was to investigate possible issues in the current communication processes and analyse what these issues depends on as well as investigate the challenges and possibilities with using a BIM methodology. The thesis also provides proposals on how to achieve an improved quality on the internal communication.

The methods used in the thesis was literature studies as a base for the theoretical framework for the later studies. The literature studies were based on earlier research on communication, management, organization change processes and organizational culture. The literature studies were also based on earlier research on BIM methodology, BIM implementation and BIM technology. Thereafter there were qualitative interviews with nine individuals, these individuals were both from inside the organization as well as from outside.

Some issues in the internal communication in the organization were identified. The employees are experiencing issues with communicating between each other and between departments, aspects of the communication process are left out or not being handled properly. It also turns out that the employee's see visual communication as a highly beneficial tool in the communication process and by using this it is easier to grasp what is being communicated between each other. The analysis also points out that there are possibilities of implementing BIM in work processes and that this can possibly be done either through the current tool that the organization has in use or through implementing a completely new tool.

Language: English
Key Words: Organization, Communication, Visual Communication, BIM

EXAMENSARBETE

Författare:	Viktor Sundkvist
Utbildning och ort:	Industrial Management and Engineering, Vasa
Handledare:	Roger Nylund

Titel: Förbättrande av intern kommunikation och visuell kommunikation i en organisation

---

Datum: 29.05.2022 Sidantal: 89 Bilagor: 2

Abstrakt

Detta examensarbete handlar om hur intern kommunikation och visuell kommunikation fungerar inom en organisation och specifikt mellan ingenjörs- och produktionsavdelningen. Syftet med detta examensarbete är att undersöka möjligheterna med att förbättra den interna kommunikationen och om detta kan uppnås genom att använda mer visuella kommunikationsverktyg i kommunikationsprocesserna. Syftet med detta examensarbete är också att undersöka möjligheterna med att implementera en BIM-modell i arbetsprocesser. Syftet med detta examensarbete är att undersöka möjliga frågeställningar i nuvarande kommunikationsprocesser och analysera vad dessa frågor beror på samt att undersöka utmaningarna och möjligheterna med att använda en BIM-metodik. Avhandlingen ger också förslag på hur man kan uppnå en förbättrad kvalitet på den interna kommunikationen.

De metoder som användes i avhandlingen var litteraturstudier som bas för det teoretiska ramverket för de senare studierna. Litteraturstudierna bygger på tidigare forskning om kommunikation, ledning, organisationsförändringsprocesser och organisationskultur. Litteraturstudierna baserades också på tidigare forskning om BIM-metodik, BIM-implementering och BIM-teknik. Därefter gjordes kvalitativa intervjuer med nio personer, dessa personer kom både inifrån organisationen och utifrån.

I avhandlingsanalysen visar det sig att den interna kommunikationen i organisationen har vissa problem. Medarbetarna upplever problem med att kommunicera mellan varandra och mellan avdelningar, aspekter av kommunikationsprocessen utelämnas eller hanteras inte korrekt. Det visar sig också att medarbetaren ser visuell kommunikation som ett mycket användbart verktyg i kommunikationsprocessen och genom att använda detta är det lättare att förstå vad som kommuniceras mellan varandra. Analysen pekar också på att det finns möjligheter att implementera BIM i arbetsprocesser och att detta möjligen kan göras antingen genom det nuvarande verktyg som organisationen har i bruk eller genom att implementera ett helt nytt verktyg.

Språk: Engelska
Nyckelord: Organisation, Kommunikation, Visuell kommunikation, BIM

OPINNÄYTETYÖ

Tekijä:	Viktor Sundkvist
Koulutus ja paikkakunta:	Industrial Management and Engineering, Vaasa
Ohjaaja(t):	Roger Nylund

Nimike: Viestinnän ja visuaalisen viestinnän parantaminen organisaatiossa

---

Päivämäärä: 29.05.2022 Sivumäärä: 89 Liitteet: 2

Tiivistelmä

Opinnäytetyössä kerrotaan, miten sisäinen viestintä ja visuaalinen viestintä toimivat kohdeorganisaation sisällä ja erityisesti suunnittelu- ja tuotanto-osastojen välillä. Tämän opinnäytetyön tarkoituksena on tutkia mahdollisuuksia parantaa sisäistä viestintää ja voidaanko tätä saavuttaa käyttämällä enemmän visuaalisia viestintävälineitä viestintäprosesseissa. Tämän opinnäytetyön tarkoituksena on myös tutkia mahdollisuuksia tietomallin toteuttamiseen työprosesseissa. Tämän opinnäytetyön tarkoituksena on tutkia mahdollisia ongelmia ajankohtaisissa viestintäprosesseissa ja analysoida, mistä nämä ongelmat johtuvat, sekä tutkia tietomallien käytön haasteita ja mahdollisuuksia. Opinnäytetyö tarjoaa myös ehdotuksia sisäisen viestinnän laadun parantamiseksi.

Opinnäytetyössä käytetyt menetelmät olivat kirjallisuustutkimuksia pohjana myöhempien tutkimusten teoreettiselle viitekehykselle. Kirjallisuustutkimukset perustuvat aikaisempaan viestintää, johtamista, organisaatiomuutosprosesseja ja organisaatiokulttuuria koskeviin tutkimuksiin. Kirjallisuustutkimukset perustuivat myös aikaisempiin tutkimuksiin BIM-metodologiasta, BIM-toteutuksesta ja BIM-teknologiasta. Myöhemmin laadullisia haastatteluja tehtiin yhdeksän henkilön kanssa, jotka tulivat sekä organisaation sisältä että ulkopuolelta.

Analyysi osoittaa, että organisaation sisäisessä viestinnässä on tiettyjä ongelmia. Työntekijöillä on ongelmia keskenään ja osastojen välisessä kommunikaatiossa, viestintäprosessin näkökohtia ei jätetä huomiotta tai käsitellä oikein. Osoittautuu myös, että työntekijä näkee visuaalisen viestinnän erittäin hyödyllisenä työkaluna viestintäprosessissa ja sitä käyttämällä olisi helpompi ymmärtää, mitä keskenään viestitään. Analyysi osoittaa myös, että tietomallin käyttöönottoon työprosesseissa on mahdollisuuksia ja se voidaan mahdollisesti tehdä joko organisaation nykyisen työkalun kautta tai ottamalla käyttöön kokonaan uusi työkalu.

Kieli: Englanti
Avainsanat: Organisaatio, Kommunikaatio, Visuaalinen kommunikaatio, BIM

Table of Contents

1 Introduction

This thesis focuses on the communication within an organization and the communication within departments using several types of communication methods. The thesis also focuses on providing knowledge to the client regarding Building Information Modelling.

The thesis is constructed by first conducting a literature study, which is presented in Chapter 2 and 3 and based on this literature study the research methodology is approached. The research method chosen for this thesis is a qualitative research method and is presented in Chapter 4. The qualitative research is performed through interviews, both internal interviews with members of the organization and external interviews with BIM experts. The research results are presented in Chapter 5 and in Chapter 6 the research results are analysed and discussed to present key findings. In Chapter 7 the researcher presents recommendations and suggestions for future research based on the results of the thesis.

1.1 Client

The client for this thesis is a world leader in advanced composite yacht building. The company is a Finnish founded organization that have their headquarters based in Luoto, Finland. They also have facilities located in Pietarsaari, Finland and in Palma de Mallorca, Mallorca. The company combines leading edge design and engineering with innovation and traditional craftmanship to provide clients with the ultimate experience in performance and comfort afloat.

1.2 Background and problem statement

In today's manufacturing industries, the methods and materials that are used are changing in the same rate as technology progresses. The further advanced the technology becomes, the more detailed and more complex the design phase and manufacturing phase becomes. The reason for the materials to change or to be modified in today's manufacturing industries, is to either improve the materials properties or to achieve new types of materials with a distinct set of properties. As the manufacturing materials change, it provides the industries with opportunities to develop new manufacturing methods or new products due to the improvements or different properties of the new material. This in turn creates challenges both for the designing- and the manufacturing phase. (Vasiliev & Morozov, 2013) When the materials, the design methods or the manufacturing methods change it creates a different demand and sometimes a higher demand on the practitioners' communication. If the communication between departments and between disciplines misaligns, the achieved result might not be satisfactory. There can be vast amounts of information that is transmitted between the persons responsible for planning and the ones responsible for manufacturing and this in turn can create challenges. (Trenholm, 2020, Chapter 2, para 15)

One of the technological advancements to this day for design and manufacturing is the use of BIM. BIM stands for Building Information Modelling and is a way of managing data in one place instead of several places, meaning that all information that is needed for a construction project can be collected from a single three-dimensional model. BIM can be used from start to finish in a project. BIM can contain the project's design phase, the parts for purchasing or invoicing, the construction sequence for the manufacturing and so on. (Ingram, 2020)

The organization, for which this thesis is performed, has planned actions for improving communication processes and one of these actions is to introduce a further use of video- and image material in their guidelines. Another planned action that is also in progress is to introduce a BIM tool to the work processes, this also for improving the internal communication within the organization as well as the visual communication. The goal is that the BIM tool could benefit e.g., the build progress tracking for projects by using a more automated process for planning as well as being done virtually in a three-dimensional space.

This is where my interest enters the picture. My interest with this thesis is to investigate what types of misalignments in the communication process that can occur in an organization and how you could deal with these issues. A common issue regarding internal communication in an organization is that it does not reach everyone or that you do not get the feedback you need. I have chosen to investigate the internal communication in an organization and the visual communication for this work. I have also chosen to investigate the fundamental principles of BIM as well as the possibilities and challenges with using BIM.

1.3 Research questions and purpose

The aim of this thesis is to research on communication within an organization and the communication within the departments, using several types of communication methods. The aim with this thesis is also to provide the organization with an insight in what Building Information Modelling is and to provide sufficient knowledge on the subject for future decisions on implementation of BIM into a work process.

By later combining the findings from the theoretical research with the conducted research methodology in form of literature studies and interviews, it will form the base for the resulting conclusions and answers to the research questions.

The research questions that have been defined for this thesis are the following:

- How to communicate in the most efficient way?
- Is it possible to achieve a higher sense of meaning and context through visual communication?
- What are the challenges and opportunities with implementing BIM into work processes?

The purpose of this thesis is to research in communication, visual communication as well as building information modelling and provide the organization with more in-depth knowledge in building information modelling. The research's aim is to address the status of the internal communication, what issues there are and if there are possibilities to deal with these issues. The research is also going to include what challenges and opportunities there are with Building Information Modelling and the possibilities of incorporating this into a work process. The thesis is also going to investigate the possibilities of improving the internal communication with a further use of visual communication. After the research is performed, and if there are possibilities of improving the internal communication, suitable tools, or models to support this improvement would be presented as proposals for the organization to consider.

1.4 Research limitations

This thesis is limited to the research on building information modelling and to the research on internal communication in the organization. The study also includes research on visual communication, but that research does not include the use of video-material due to the planned time schedule. The research focus is on interactions between the organizations engineering- and production departments.

For the building information modelling part of this study, the research looks at the process from a visual communication point of view based on the BIM model and not from the point of view on the data and information sourcing to and from the BIM model.

2 Previous research on communication

In this chapter, as a part of the thesis theoretical framework, communication and communication processes are presented. Communication is an interaction process that is encountered every day, both consciously and unconsciously by all personnel in an organization and their several types of communication processes which are presented further on in this chapter.

2.1 Communication and information

One of many definitions for communication is: a process of transacting or exchanging information, and the word communication is descendant from the Latin word *communicatio,* which translates to sharing. (communicatio, 2019)

Another point of view on communicating is that communication indeed is sharing but also that other key fundamentals define the process. In Berglund's and Sewerin's book (2019) about leadership and organizations they mention that communication is a way of gaining and sharing both information and feelings between people. They also mention that people want to force other people to action through communication. Through communication you build trust and respect and show that you belong together, and that you have a functioning relationship through communication. (Berglund & Sewerin, 2019, Chapter 5, para 2)

As mentioned, there are several definitions of what communication is and what is meant with the term communication. Each definition differs on different dimensions e.g., breadth, role of senders and receivers, intentionality, the importance of symbols etc. (Trenholm, 2020, Chapter 2, para 3)

In Trenholm's book, different communication definitions are presented, and the following are some of these definitions, see *Table 1.*

- Definition 1: Communication is a process of acting on information. (Trenholm, 2020, Chapter 2, para 3)

- Definition 2: Communication is "the transmission of information, ideas, skills, etc.by the use of symbols – words, pictures, figures, graphs etc." (Trenholm, 2020, Chapter 2, para 3)

- Definiton 3: Spoken symbolic interaction is the process by which people use words and other symbols to create meaning and affect one another. (Trenholm, 2020, Chapter 2, para 3)

Table 1. Communication definitions. (Trenholm, 2020, Chapter 2, para 3)

When defining communication, different dimensions such as breadth of the communication is a key aspect i.e., how broad definition is wanted of the communication process. Definition 1 in *Table 1* is one example of a broad definition of communication. (Trenholm, 2020, Chapter 2, para 4)

An approach to communication is to view it as a sender-receiver based communication process where information is either sent from a sender or received by a receiver. Definition 2 in *Table 1* is an example of a sender-based communication, whereas Definition 3 is more of a receiver-based communication. Definition 3 is also in the same time viewed as a spoken symbolic communication, meaning that symbols are used in the communication e.g., words. (Trenholm, 2020, Chapter 2, para 6-8) In today's world, the need of transmitting information has increased and is continuosly increasing. There are vast amounts of different types of information that is being transferred between communicators and through numerous channels. (Berglund & Sewerin, 2019, Chapter 5, para 5)

According to Berglund and Sewerin (2019) this has lead to an increased demand of documenting, developing and compiling information internally in organizations and this in turn increases the administrative burden on organizations. This issue requires organizations to be able to allocate their human resources and their time on dealing with information and documentation and also to be able to set priorities on different information. (Berglund & Sewerin, 2019, Chapter 5, para 5)

2.2 Communication methods

As previously mentioned, there are different forms of communication as well as there are different communication processes. These forms of communication are:

- Verbal communication
- Non-verbal communication
- Written communication
- Visual communication

Verbal communication refers to a spoken interaction between persons, whereas non-verbal communication refers to an interaction between persons using e.g., their body language, body posture, the space between the persons interacting, eye contact. Non-verbal communication can occur both intentionally as well as unintentionally during communication. (Carpenter, Bauer, & Erdogan, 2012; Trenholm, 2020)

2.2.1 Verbal communication

Verbal communication can occur either in person or through modern day electronic devices e.g., mobile phones or calls through computer programs. Verbal communication can be split into two sub-types of verbal communication: storytelling and crucial conversations. Storytelling is a way of constructing common meanings e.g., for individuals in an organization, it helps to clarify key values and is used to present the way of working in an organization. Crucial conversation is a similar process but requires more preparation, planning and reflection before performing the communication. Often during this type of crucial conversation, the emotional response and opinions of the individuals

communicating can vary e.g., if a person is asking for a raise at work, conducting an interview etc. (Carpenter, Bauer, & Erdogan, 2012)

Verbal communication, as well as non-verbal communication can occur in different forms. One form is face-to-face communication. Face-to-face communication can occur between one or more persons. According to Trenholm (2020) face-to-face communication is the richest method of communicating since it contains the most verbal and nonverbal cues. Trenholm (2020) also mentions that if the message material is sensitive, face-to-face communication is the right choice. (Trenholm, 2020, Chapter 9, para 32)

2.2.2 Written communication

Written communication is a type of communication method that is performed using written tools to create, exchange and receive information. This can be done through e-mails, training manuals or guidelines, forms, notes etc. The written communication process is often asynchronous, in contrary to verbal communication where the process happens in real time. (Carpenter, Bauer, & Erdogan, 2012) According to Trenholm (2020) using e-mail as a form communication method can be done if the message must be sent straight away, if a reply is not immediately needed, the content is not personal and if it must go out to several people (Trenholm, 2020, Chapter 9, para 32).

2.2.3 Visual communication

Visual communication is a communication process between persons with the help of visual aid or entirely through visual aid. The use of visual aids in communication can help increase the understanding of difficult and complex ideas and meanings e.g., concepts that could be hard to verbally describe can be better comprehended by visualizing them through a diagram or a graph. (Trenholm, 2020, Appendix A, para 17) It is important that the user is cautious when using visual aids to improve the communication, overloading a person with visual aids or presenting e.g., complex graphs can lead to the opposite reaction with less understanding and comprehension of what is trying to be communicated. (Trenholm, 2020, Appendix A, para 17)

In visual communication, the process of communication is intricately linked to that of a thinking process, perception and how people react and interpret differently is a part of the visual communications process. (Sless, 2019, Chapter 1, para 4) In the figure below there is an illustration of an object and depending on how people has learned to read patterns the illustration is perceived in a variety of ways. A question that follows this illustration is that what does the illustration represent, see *Figure XXX.* (Sless, 2019, Chapter 1, para 4)

Figure 1. Hidden figure. (Sless, 2019, Chapter 1, para 4)

The human eye is trained throughout one's life to read patterns in separate ways and by looking at *Figure 1,* the mind is trying to comprehend what the illustration represents piece by piece. For some, the illustration already represents an item and for others the illustration remains unknown. If then further details on the illustration is given as in *Figure 2* or the information is given that the illustration represents a cow, the key details stand out and the unnecessary details are ignored. (Sless, 2019, Chapter 1, para 4)

What has happened is that the visual thinking has changed and not the illustration itself, while it is common that people strongly believe that the change has happened outside of themselves and according to Sless this is a central issue in visual communication. People don't recognize that their visual thinking is causing them to see or not to see what is being illustrated or shown. (Sless, 2019, Chapter 1, para 4)

Figure 2. Hidden figure, shown in detail. (Sless, 2019, Chapter 1, para 5)

In visual communication, not only is the content of the visual aid important but also how it is presented and perceived. According to Fletcher (2021) the communication process is much more complex than it appears. The author mentions that the way that the information is delivered is an aspect that can be design and controlled by the sender, whereas the reception of the information is not in the sender's control. The sender cannot control how the receiver interprets the information, but the sender can manage the information to promote that the receiver interprets it according to the sender's intention. Fletcher (2021) mentions that there are a few basic principles for visual communication and for visual communication design that can promote the management of communication reception. (Fletcher, 2021, Chapter 1, para 2)

The principles for a successful communication design is:

- Know your audience
- Everything communicates something
- Delivery matters: clarity is key
- Complex information is better communicated visually
- A system and process for feedback is necessary

(Fletcher, 2021, Chapter 1, para 2)

2.3 Communication models

As well as defining communication, abstract representations of the process exists in form of models. These models are used to describe the communication process structure and visually help to understand how the process works. An important fact with these models is that they are merely representations and that they do not capture the entire process, only certain aspects of the total process. (Trenholm, 2020, Chapter 2, para 9)

2.3.1 Psychological model of communication

An example of a communication model is the psychological model of communication, see *Figure 3.* This psychological model is a modified version of the Shannon-Weaver model that was one of the earliest models of describing the communication process as a message transmission. (Trenholm, 2020, Chapter 2, para 13)

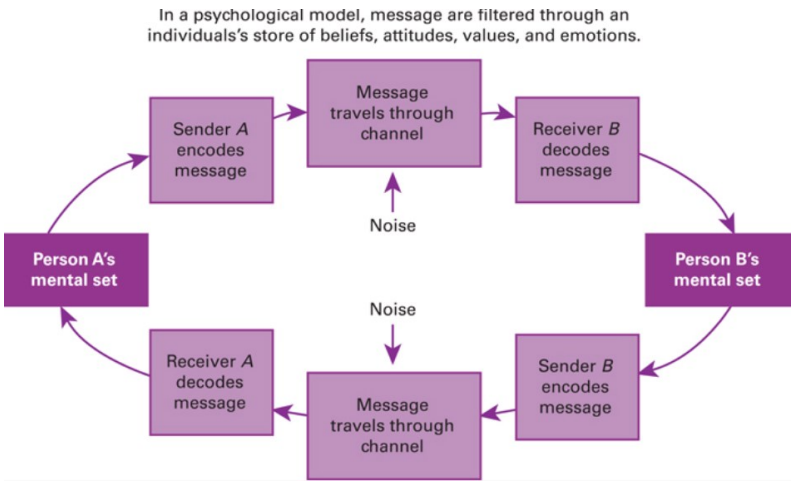

Figure 3. A psychological model of communication. (Trenholm, 2020, Chapter 2, para 13)

As previously mentioned in the definitons paragraph, this model is an example of a sender-receiver based communication, see *Chapter 2 paragraph 1*. The difference between the original psychological model and the modified Shannon-Weaver model is that the modified model has an additional feedback loop between Person A and Person B, see *Figure 3*. (Trenholm, 2020, Chapter 2, para 14)

According to the Shannon-Weaver model the individual either encodes or decodes the communication meanings. Initially a person, Person A, has information that he or she wants to transmit to another person, Person B. Person B can be a single person or several persons.

Person A starts the process by encoding the information into a message that Person A believes that Person B is capable to comprehend. Person A transmits the message through a channel, that is the medium of the transmission, until it reaches its destination at Person B. During the receival of the message, Person B decodes the message and determines the reply for Person A. In the reply to Person A, Person B gives feedback on the received message from Person A. After the reply has arrived from Person B to Person A on the initial message, Person A evaluates whether or not the communication was successful. (Trenholm, 2020, Chapter 2, para 14) In Trenholm's book it is said that communication is most successful when individuals are "of the same mind" - when the meanings they assign to messages are similar or identical. (Trenholm, 2020, Chapter 2, para 14)

What happens during the encoding and decoding is that both of the persons are filtering the messages through their mental sets. The mental set is a joint notion of a person's feelings, values, beliefs, attitudes etc. and therefore the result of each encoding or decoding is unique due to each persons different mental sets and experiences. This may lead to the persons giving different meanings to the messages and in that case they might misalign on the communication. The communicaton can also misalign if noise enters into the transmission channel. Noise is any form of distraction that interferes with or changes the message in the communication channel. (Trenholm, 2020, Chapter 2, para 14)

As mentioned, the process of communication is viewed as unsuccessful if the intended meanings from the sender differ from the meaninings interpreted by the receiver. The problem appears if the mental sets of the sender and receiver are so far apart from each other that they share no mutual experience, if the senders message is coded in a way that is unfamiliar to the receiver, if the transmission channel is overloaded or interfered by noise, if there is little or no opportunity for feedback, or if the receiver is distracted by internally competing stimuli. (Trenholm, 2020, Chapter 2, para 15)

The way to solve these problems is for the sender to learn to see the communication process from the receiver point of view and to encode the message in a clear way for the receiver. The sender can also utilize multiple transmission channels to get the message across and try to create an enivronment without noise in the channel. Another way of improving the process is to create opportunities for feedback and learn how to read the receivers non-verbal communication. This is ways for the sender to improve on the

communication process and there is also ways for the receiver side of the communication to improve. (Trenholm, 2020, Chapter 2, para 15)

Trenholm (2020) states that the receiver can thoroughly prepare for the senders message and prepare for that it might be difficult to decode. The receiver can also learn to see the communication process from the senders point of view and try to understand where the senders meanings comes from. The receiver can improve its listening skills and also ask questions to check whether the understanding is correct or not (Trenholm, 2020, Chapter 2, para 15).

2.3.2 Barnlund's transactional model of communication

A similar model to the Shannon-Weaver model is the Barnlund transactional model of communication. They are both transactional models of communication but in Barnlund's model the communicators fields of experiences has a significant effect on the communication process, see *Figure 4.* According to Barnlund (2021) the communication process is not linear, where the interaction goes from A to B and vice versa, but reciprocal. Both parties in the communication process is each equally responsible for the communications effectiveness and the process of communicating is not merely sending messages to each other back and fourth (BizNews, 2022).

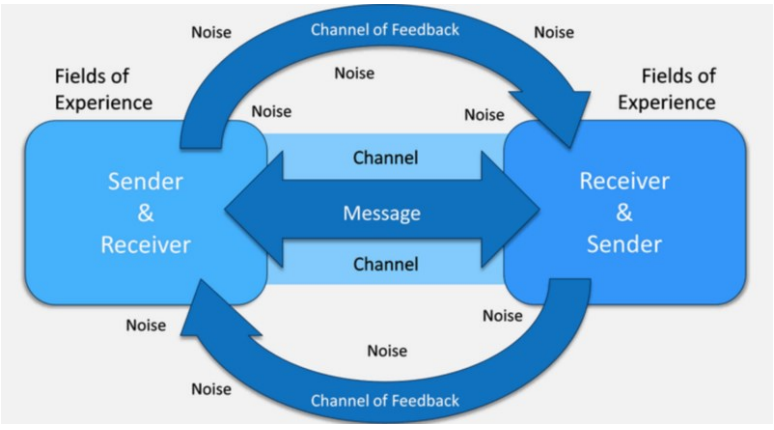

Figure 4. Barnlund's Transactional Model. (Lack of communication in project management, 2021)

On creating the transactional model of communication, Barnlund also listed five principles that adhere to the model and to the process of communication, see *Figure 5.*

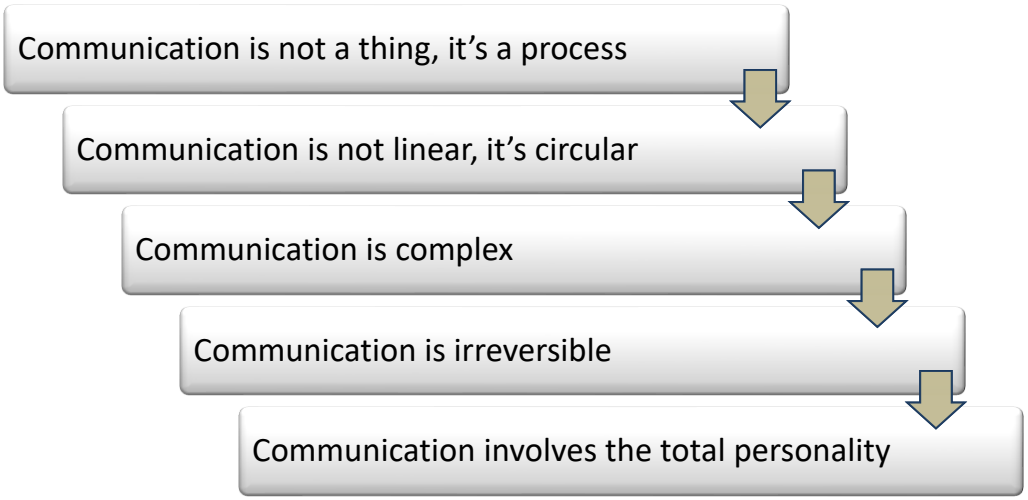

Figure 5. Barnlund's five principles. (Lack of communication in project management, 2021)

What Barnlund meant with these five principles is that communication is not a simple thing that one do, it's a complex process between individuals that occurs interactively. During this interaction, the way that the individual thinks, looks, behaves and acts is going to affect the communication process and the communicated matters is going to be irreversible. (Lack of communication in project management, 2021) (BizNews, 2022)

2.4 Organizational change and communication

In terms of communication within an organization there are a number of factors that play a part and one of these is the organizational culture. The organizational culture is often described as "the way we do things around here" and is a quote directly taken from the book by Kaufmann and Kaufmann (2015). This is a way of describing the fundamental values and assumptions that a company's personnel have in terms of e.g., working processes, working methods and communication. (Kaufmann & Kaufmann, 2015, Chapter 11, para 10)

The organizational culture can have long term consequences as well as long term functions and it can contribute to increasing the personnel's sense of identity. The clearer the values are, the greater the sense of being a vital part of the business among the personnel will be

established. This leads to an increase in their organizational commitment to the company's goals and the culture defines, creates meaning and stability for the personnel which then enhances the guidelines for work behaviour. This can also lead to less insecurity among the personnel, especially among new employees. (Kaufmann & Kaufmann, 2015, Chapter 11, para 13)

An organizational culture is established and developed typically through two aspects and the first aspect is through a leader with a dynamic personality and that has strong values and an unclouded vision. This is only achieved if the values and visions are accepted and maintained by the company. If so, the co-workers will identify with the same values and visions. Second, through common shared understanding and experiences that are developed through constant commitment together at work. This leads to the creation of a collective understanding of the company's values, see *Figure 6.* (Kaufmann & Kaufmann, 2015, Chapter 11, para 14)

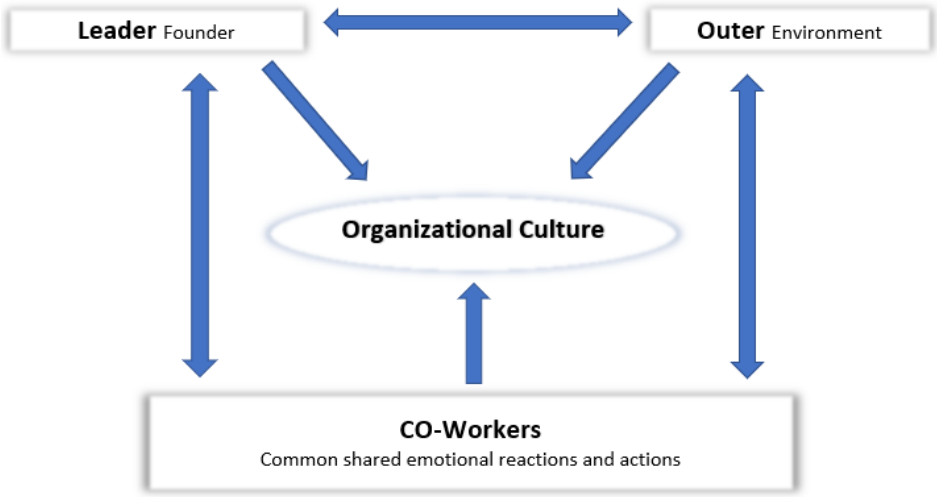

Figure 6. Organizational development. (Kaufmann & Kaufmann, 2015, Chapter 11, para 13)

2.4.1 Organizational change and change models

According to Fincham and Rhodes (1999), there are a number of uncertainties that change involves and these must be considered during a change process. The first thing to consider is how do we know that change is needed? Is there a measurable way of determining that change is needed and how do we measure it? Do we measure it through the company's profit, the sales or through customer level of satisfaction etc.? When can a satisfactory level

of performance be determined and who determines this level? Is it the employees' task, the shareholder's task, or the customer's task? (Fincham & Rhodes, 1999)

The second thing to consider is how to agree upon the change action, what necessary actions needs to be taken? What is the fundamental issue, and can this issue be agreed upon through a unified view? The question then is that who gets the last call or the dominant part of the agreement? This usually ends up on the top management's shoulders. (Fincham & Rhodes, 1999)

The third and last thing to consider is if the change can be recognized by the organization and to what extent will it be recognized? Who has followed the action plan of changing and who has not changed? According to Fincham and Rhodes (1999) this is something that needs to be followed up because the extent of the change needs to be known. (Fincham & Rhodes, 1999)

2.4.2 Kotter's eight steps model

In the book *Leading change* by author John P. Kotter (1996) the author presents how organizations transform to the better and why some fail at doing this. The author mentions that major changes has helped organizations to adapt to significant shifting conditions, it have improved their competitive stand in their market and the changes have helped them achieve a better future. (Kotter, 1996)

The author also mentions that to some degree, change has its downside and there will be pain linked to the shifting conditions of the change. The amount of pain depends on the number of errors that can occur, and many of these errors can be avoided if the process is done accurately. (Kotter, 1996) Rosabeth Moss Kanter argues (according to Fincham & Rhodes, 1999) that the complexity of the change process needs to be recognized and organizations must be prepared for initiate problems caused by the change process. The author states that it is a long-term process with trials end errors before performing the entire change and reaching the goal. (Fincham & Rhodes, 1999) Jim C. Collins argues (according to Kotter, 1999) that one of the biggest mistakes that can be made during the process of change is to dive into the process without having managers and employees informed on the urgency of the situation. The managers and employees need to be on the

same level of knowledge on how urgent the matter of change is, and they need to do their share of commitment to the cause without letting complacency get in the way, which it can most certainly do. (Kotter, 1996)

The problem with complacency is that it can be easily overestimated on how hard the change can be forced upon people and how hard it is to get people out of their comfort zones. Those leading change can easily confuse urgency with anxiety by pushing too hard, this can lead to people becoming more hesitant to changing and drive them further into their comfort zone. (Kotter, 1996) One mistake that can be made is to look at the change process as a single event where in fact this is polymorphous. The change process is not the same for all the people that are involved, everyone manages the change process in their own way with their own strategy thus the change is uncertain and varies throughout the organization. (Fincham & Rhodes, 1999)

Another big mistake that organizations can make in leading change is to not have a sufficiently diversely and large experienced team introducing the changes. The key point is that one person alone leading change cannot match the same amount of diversity in knowledge, formal title, reputation, and relationships as a large and diverse team would have. A resolute team with the urgency of change is necessary for guidance through the process but without a set vision for the future, they would fail. A vision of the future plays a key role in leading change by guiding large numbers of people towards the set goal and by inspiring actions towards the goal. Without a set goal the efforts of transformation can instead drift away into a list of confusing, incompatible, and time-consuming projects that go in the wrong direction or nowhere at all. As the author states: "*Real transformation takes time"* and complex efforts to change strategies or restructure business tend to lose momentum if there are no short-term goals to meet and celebrate. Most people will not go on and on for extended periods of time without seeing results, the period is about six to eighteen months. After this the devotion to the cause will suffer and decrease eventually. Without short-term wins, too many employees give up on the cause or start questioning the change. (Kotter, 1996)

To successfully introduce and establish the changes, the obstacles that stand in the way need to be removed. Obstacles could be in form of the wrong mindset in employees, that they see the change as a problem and that it is not possible to establish. The challenge here is to convince them that there is no problem and that it is possible to establish the change. Another obstacle can be in form of organizational structure or compensation/performance-appraisal systems. These systems can force people to choose between adapting to the new vision or their self-interests. (Kotter, 1996) In the book *Principles of Organizational Behaviour* by Fincham and Rhodes (1999), the author discusses the problematics of change management and that it is not a simple procedure. The author states that one cause for this can be cultural blocks, other causes can be fear of change and the uncertainty that is associated with it. (Fincham & Rhodes, 1999)

One of the last mistakes mentioned by the author is the importance of anchoring the changes into the organizations culture. The authors idea with this is that usually change sticks if it becomes recognized as something that goes under the statement: "*the way we do things around here."* To link the changes to the company culture, the company need to address two key factors to their employees regarding the changes. First, they need to show people how specific behaviours and attitudes have helped improve their performance. It happens easily that people tend to create inaccurate links themselves if not given a conscious explanation by the employer. Second, time needs to be taken to ensure that the succeeding generation of leaders and managers does personify the innovative approach of doing things. (Kotter, 1996)

John P. Kotter has compiled these common mistakes under the name "*The Eight Mistakes*" and these eight mistakes are also known as Kotter's eight steps model of change, see *Figure 7.* (Kotter, 1996) There are several different change management models, John P. Kotter's eight steps model is one of them and the Prosci ADKAR model is another.

Figure 7. Kotter's eight steps model (Kotter, 1996)

2.4.3 The Prosci ADKAR model

The Prosci ADKAR model is a change model for identifying the gaps within a change management process and the model is targeting change process at an individual level. According to Prosci (2022), in order to effect change in an organization one must first understand how to effect change on an individual level. The ADKAR model is a framework for understanding and managing individual change and ADKAR is an acronym for the five outcomes an individual must achieve in order to successfully achieve change, see *Figure 8.* Prosci (2022) also mentions that the model is sequential and cumulative, meaning that the outcomes must be achieved in the given order, starting with Awareness, for the change to be implemented and successful. (Prosci Inc., 2022, page 4-6)

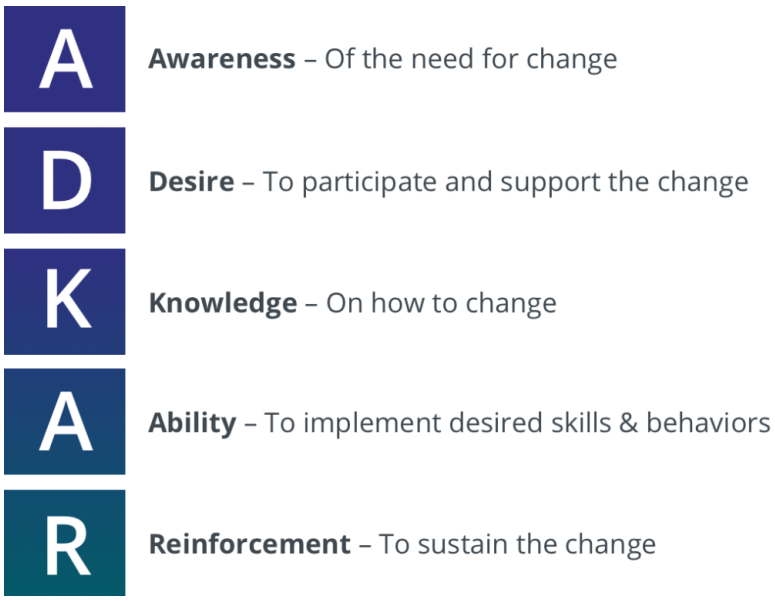

Figure 8. The Prosci ADKAR model. (PDI Vision, 2022)

In the ADKAR model, the initial step of the change management process is to raise awareness among the employees in an organization. According to Prosci (2022) the natural human response to change is resistance and a critical component to overcoming resistance is to raise awareness of the organizational need of change. (Prosci Inc., 2022, page 10)

After the individual is aware of the need of change, the desire to change is equally important to achieve. According Prosci (2022) the employee's personal motivators or barriers contribute to their level of desire to change and every employee can have their unique reason for engaging or resisting. It is also mentioned that the best person to help a resistant employee is their direct manager or supervisor, they are usually closest to the employee and are able to translate the change into the employee's personal context. The managers need to help connect the change to employee's personal motivators and to remove or minimize barriers. (Prosci Inc., 2022, page 11)

After reaching awareness of the change and the individual is motivated and has the desire to change, the following step is to provide the knowledge needed for the change to take place. Prosci (2022) mentions that the mistake that organizations usually does is that they immediately send their employee's for training, without the awareness of why they need training. This can lead to the employee's lacking interest and desire to engage in the training because they are not aware of why they need it. Prosci (2022) mentions that in

order to make the most out of employee training, the training must come after initial awareness and desire building. (Prosci Inc., 2022, page 11)

After the individual has the needed knowledge for the change there is still the possibility that the employee is not fully aware of how the knowledge should be used. This is when there is a gap between knowledge and ability, knowledge is knowing what to do and ability is being able to put that knowledge into work. In order to bridge the gap between knowledge and ability, Prosci (2022) mentions that there should be hands-on-coaching or practice for the employees. The employees must be given the opportunity to put their knowledge into action, make mistakes, ask for support and to learn from their mistakes. This often takes time and practice to adopt the change. (Prosci Inc., 2022, page 12)

The final outcome for the individual needed for successfully achieving the change is to reinforce it. If the change is not reinforced, there is the possibility of falling into old habits and doing workarounds. According to Prosci (2022) this is normal because the human brain is physiologically programmed to revert to old habits if reinforcement has not taken place. In order to reinforce the change, one must monitor whether the change is sustained or not. A first step for reinforcement is to recognize where the change has taken hold and to celebrate that. Prosci (2022) means that positive recognition is a great way to reward employees for working hard to implement changes and demonstrate to the organization that change participation is important. It is also mentioned that if there are employees that are reverting to old habits or old processes, the followup is needed to be able to understand their barriers to changing. Here it is needed to check whether the employees need more training or coaching or if they have missed out on any of the ADKAR elements. (Prosci Inc., 2022, page 12-13)

If compared to John P. Kotters change model, there are less steps or elements in the ADKAR model but they share common features. Both models initial steps are to raise awareness among those that the change process affects, they highlight that desire is needed in order to engage employees in the change process. The knowledge of initiating the change and how the change will be executed must exist in order to successfully achieve the change. Both models also put focus on the reinforcement, that the desired outcome of the change process needs reinforcment in order to succesfully take hold.

The main difference between Kotter's model of change and Prosci's ADKAR model of change is that the ADKAR model is an individual change model according to Prosci (2022). Prosci (2022) also mentions that it is crucial that there is awareness of initiating the change, that the change process must start from this and that the individual must progress through each of these steps in order to implement and sustain a change. (Prosci Inc., 2022, page 4)

2.4.4 Pettigrew's model of change

In the book *Principles of Organizational Behaviour* by Fincham & Rhodes (1999) there is a similar model showing the process of organizational change by A. Pettigrew, *The Awakening Giant* (1985). This model has similarities to the one made by John P. Kotter (1996) that has eight steps of the change process, Pettigrew's model has four steps less than Kotter's and these will be presented below. (Pettigrew, 1985) (Fincham & Rhodes, 1999)

Pettigrew's model consists of four stages and the two first stages function as a developer of awareness for the change process to the organization where the problem is made aware of and alternatives on the actions are made. The third stage focuses on the change action, the alternative views are acted upon, and the change process is initiated. The fourth and last stage involves the stabilization of the change process over a longer period, see *Figure 9.* (Fincham & Rhodes, 1999) (Pettigrew, 1985)

Figure 9. The process of organizational change. (Pettigrew, 1985) (Fincham & Rhodes, 1999)

During the development of concern, a group of people determines that the existing organizational structures and procedures are no longer compatible with the operating environment. Followed by acknowledgement and understanding of the problem that the organization faces, an analysis of its causes and alternative ways of action. Planning and acting upon the problem to create specific changes with the previously stated diagnose in mind and with objective-setting work. Finally stabilizing the change which includes how the organization's reward information and power systems reinforce the intended change direction. (Pettigrew, 1985) (Fincham & Rhodes, 1999)

Fincham & Rhodes (1999) states that the change implementation stage in the model here is compressed in contrary to many stereotypical models where this stage is exploded into several stages. This is similarly done in Kotter's eight steps where the latter stages of the model have been expanded into several smaller steps. (Kotter, 1996) (Fincham & Rhodes, 1999)

The initial stages are expanded into several stages whereas in stereotypical models they are compressed into a single stage. The reason for this is that Pettigrew wanted to maintain focus on how critical the problem definition is and that this must be thoroughly investigated and understood before continuing the change process. If this is then looked at in Kotter's model, the initial stages are kept as several smaller steps and not compressed into one single stage. (Pettigrew, 1985) (Fincham & Rhodes, 1999) (Kotter, 1996)

3 Previous research on BIM

In this chapter, as a part of the theoretical framework for the study, the theoretical field of Building Information Modelling is presented, also known as BIM. The purpose of this chapter is to give the reader a better understanding of the principles of BIM, what BIM stands for, for what purposes BIM is used for and how it is used. The chapter also addresses the process of implementation in organizations, the possibilities that the implementation produces and what challenges the implementation process might develop.

3.1 Definition of BIM

Building Information Modelling, also known as the abbreviation BIM, is the process of creating an intelligent model that is shared with all participants in the project during its entire life cycle. According to Ingram (2020) the intelligent model starts from the conceptualization of assets and further information is added to the model throughout the entire design process by different personnel involved in the project. The model is built up from intelligent parametric objects and these objects can be changed and manipulated numerous times during the project's life cycle and this without compromising consistency and correctness of the model. All information that has been created or put into the model can be extracted at any given time of the project life cycle. (Ingram, 2020, Chapter 2)

3.1.1 BIM maturity levels

The adoption of BIM is in general divided into four levels, so called BIM maturity levels. These maturity levels describe in which stage the user is with the BIM adoption and how far the project-data is integrated with computer-based graphics elements. This is shown in the Bew-Richards BIM maturity diagram below, see *Figure 10.* (Shepherd, 2019, Chapter 4, Section 2, para.2)

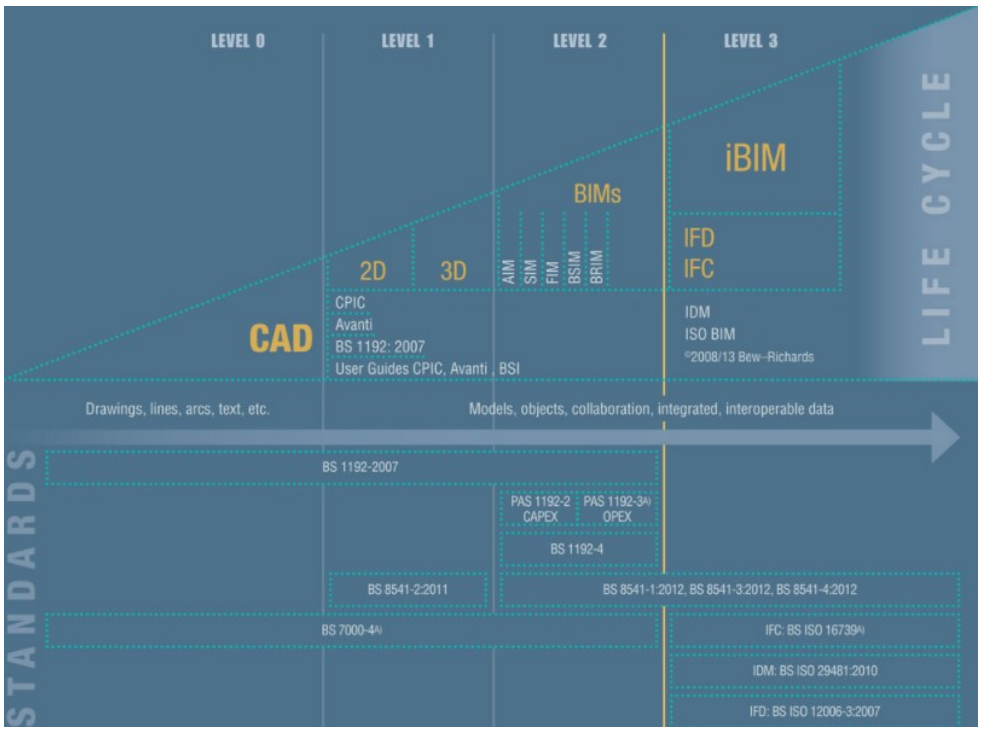

Figure 10. The Bew-Richards BIM maturity diagram.

(Shepherd, 2019, Chapter 4, para. 3)

The first level, Level 0, corresponds to a process where the drawings made are prepared in an editable CAD format but are shared and exchanged on a paper-based format. This includes the exchange of electronic paper formats such as PDF and even though these formats are readable, they are not reusable for drafting purposes. (Shepherd, 2019, Chapter 4, para. 3)

A key capability of CAD is that it allows users to organize drawings and drawing elements into different layers so that the user has control over the presentation and visibility of distinct groups of elements. There is a British Standard for coordinating project information in CAD and is shown in the figure, spanning from Level 0 to Level 2, see *Figure 10.* This standard, BS-1192:2007, provides detailed guidance on how layers should be arranged to manage the exchange of drawing information. If the CAD system is used to prepare the drawing files but are not exchanged with other project members according to a common layer naming convention, the process is still operating at Level 0. (Shepherd, 2019, Chapter 4, para. 3)

The second maturity level of BIM is Level 1 and at this level some of the challenges in the first level is addressed. This is done by applying a standardised process of sequentially naming, distributing and combining the 2D- and 3D CAD files for each project in an organized and efficient manner. At Level 1 the focus is more based upon the development of coordinated drawings and not using any information that might be linked to them.

The file based drawings and documents for BIM Level 1 are typically exchanged via an online file storage portal that is configured for each project. Once a file based drawing has been added through the online storage portal, an automatic notification would be sent to the other participants that has access to the online storage portal. A key capability of using this type of CAD information exchange is the possibility for participants to view other disciplines drawing files and use them as a background for their own drafting. This is in CAD terminology variously known as external references or as reference files. For Level 1 there is a common layer structure for organizing all drawings that is exchanged through CAD. The layer structure can be set so that one disciplines drawings have drawing names prefixed by “10” and another discipline has their drawings prefixed by “20”. Similarly done is the process of underlying elements in each layer by adding more numbers or letters to the drawing prefix. This process is supportive in means of searching, isolating and coordinating between various disciplines drawings in a project. (Shepherd, 2019, Chapter 4, para. 4)

The third BIM maturity level is Level 2 and this level builds upon Level 1 as it represents the next development in multi-level disciplinary design- and construction data integration. The process of BIM Level 2 can be described as a set of stages, from separate models to a combined federated BIM model that all participants has access to and can view. In the figure below, see *Figure 11,* the different stages can be seen and a typical process for the disciplines in the *Model Designers* branch is that they can use discipline specific BIM software for creating each model. It is usually done this way in order for the model designers to be able to produce and update their own model files with the tools that they use, which are best suited to their respective speciality. (Shepherd, 2019, Chapter 4, para. 5)

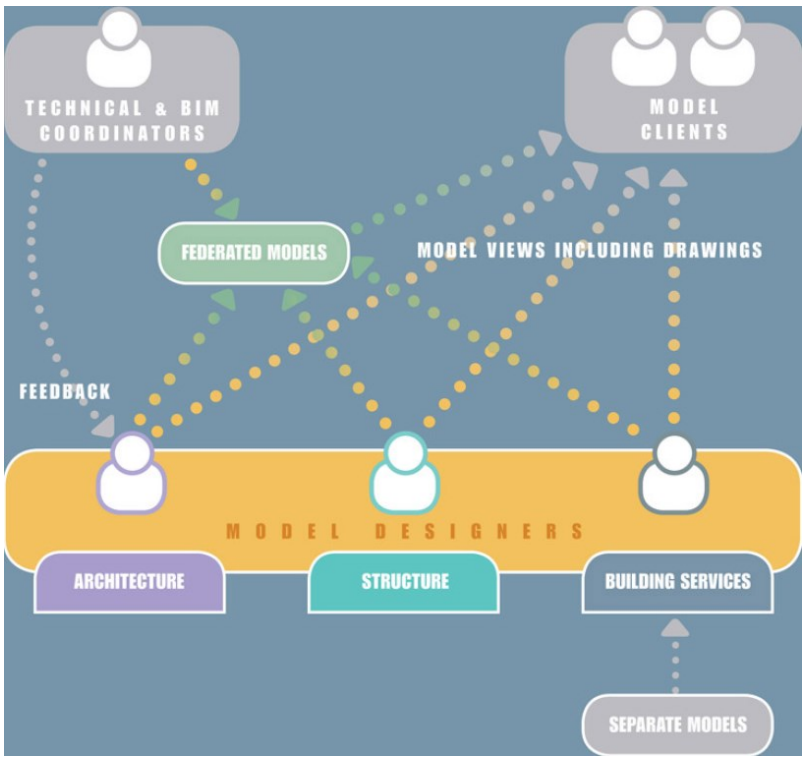

Figure 11. BIM Level 2: Collaboration using a federated model.
(Shepherd, 2019, Chapter 4, para. 5)

For all participants to access the models produced by the model designers, there is an additional software that acts as a bridge between these parties. This bridge is a software package that combines the models from the model designers, this process is known as a model federation. This means that the model designers are free to use any type of software for producing their models, but it must be possible to export all models into a generic format so that all models can be combined with the bridge software. Another key aspect when exporting the models into a federated model is that the exported models should be exported in a format that preserves both their original geometry as well as their location in 3D-space. With BIM Level 2 the data in the model can managed through a resource planning system, known also as an ERP system. Compared to CAD geometry, BIM models and elements can contain significantly more properties to which end-users can add data. When this data is stored in BIM it can be integrated and updated using an ERP system in which other departments can have access to it e.g., purchasing, sales, accounting, human resources etc. (Shepherd, 2019, Chapter 4, para. 5)

The fourth and final maturity level of BIM is Level 3 and contrary to Level 2, at Level 3 the construction of the shared model is not done by individual file sharing but through a database structure using a single shared model i.e., a schema, see *Figure 12*. This is done due to the tendency for individual file sizes to swell beyond practical limits as the model content becomes more refined and detailed. By implementing a database structure, the information sharing can be distributed and remain coherent across multiple devices without going beyond the practical limits of the file size. (Shepherd, 2019, Chapter 4, para. 6)

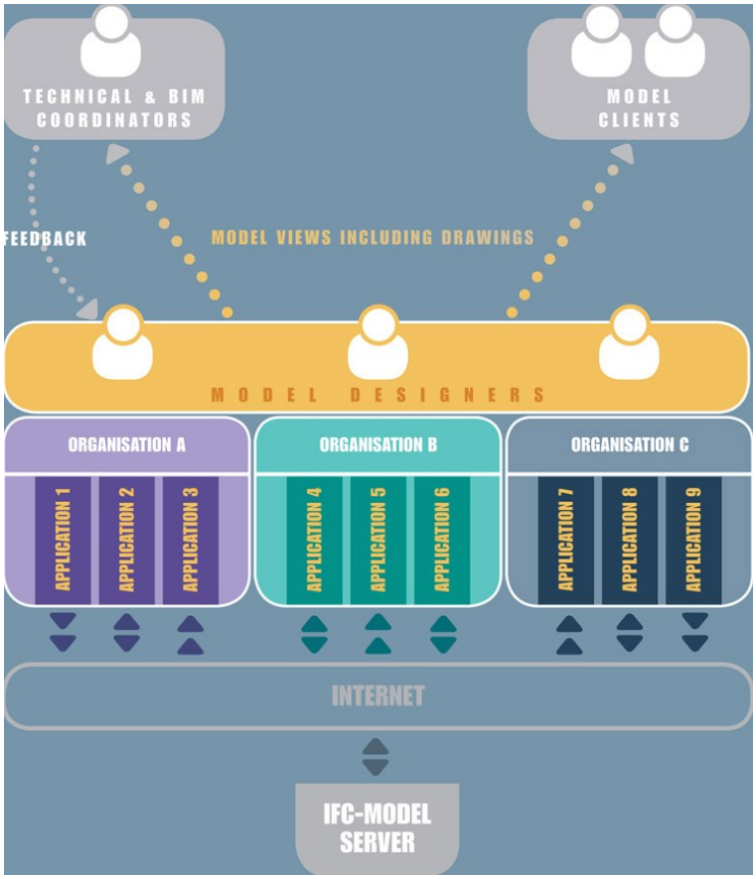

Figure 12. Collaboration via single shared building model.
(Shepherd, 2019, Chapter 4, para 7)

The shared project model for BIM Level 3 is directly and continuously updated by users and this is done by organizing all model information into a common non-proprietary industry-recognized data structure known as Industry Foundation Classes or IFC. In contradiction to BIM Level 2, as explained above, where the shared building model is organised using proprietary file formats that are periodically converted and uploaded as separate models into the shared project repository for integration into the federated model (Shepherd,

2019, Chapter 4, para 7). An overview of how the federated model is built up can be seen in the illustration from Castro Group, see *Figure 13.* Here the illustration represents the different disciplinal models of a building project and how they are merged into a federated model. (Castro Group, 2022)

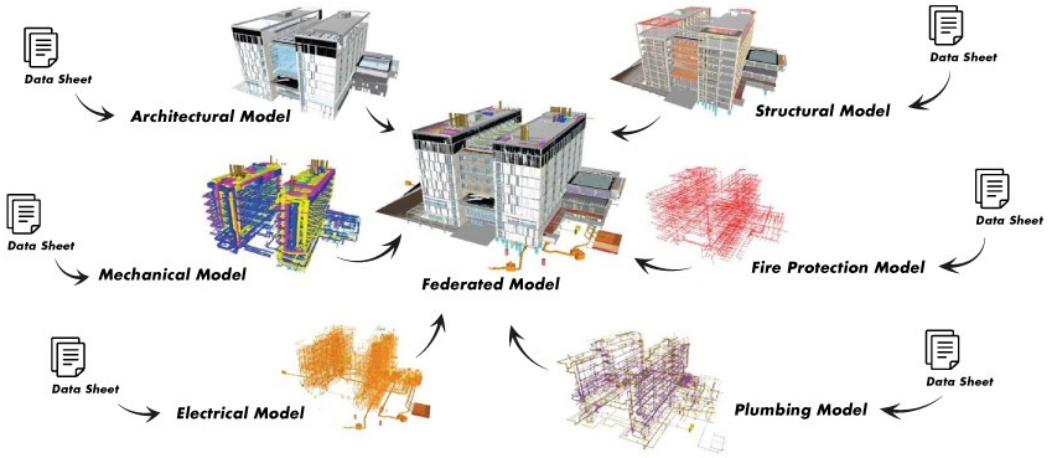

Figure 13. Federated model and disciplinal components. (Castro Group, 2022)

At Level 3 the entire project model remains accessible, and the users can extract and download partial models from the project model server. It is done in the sense that the segments of the stored model that has been selected and downloaded, also known as checked out, can be modified with a modelling tool, and be reloaded into the stored server model afterwards. When reloading the modified model to the stored server model, known as checked in, the modified model merges into the existing model in a way that updated objects replaces their existing counterpart and new objects are stored into the existing model while deleted objects are completely removed. (Shepherd, 2019, Chapter 4, para 7)

3.2 The Pros and Cons of BIM methodology

Building information modelling is a way of dealing with the issues that can be found using merely drawings and CAD drawings for building projects. The issue that occurs with drawings and CAD drawings is that no matter how detailed the drawing is made, the information that is meant to be represented with the drawing will usually only be partially understood by the person reading the drawing. The person responsible for creating the

drawing is relying on the person reading the drawing to interpret it correctly, to fully understand the content and to use it in the right manner for their situation. (Ingram, 2020, Chapter 1, para 1)

Ingram (2020) mentions that another issue that occurs with drawings is that they can never be fully synchronized with other persons related documentation. There will always be aspects in other persons related documentation that does not fully align with the separate drawing. Usually there is not simply one, but several drawings that need to align with the documentation, which makes the process impossible. As a result, when the created drawing is interpreted by the reader, the reader is guessing the correct intention of the drawing, checking whether or not the intented content is accurate, correcting faults in the drawings etc. With this process, a lot of time is spent on checking, correcting and trying to grasp the intention of the drawing when instead this valuable time could have been spent on other things that are more important (Ingram, 2020, Chapter 1, para 1).

Other related issues with drawings that Ingram (2020) mentions is the fact that there are usually a great amount of drawings that are produced for a project. When the draftsmen become overloaded with drawings, it can lead to them being overconfident at the time of reviewing drawings. Details are not thoroughly checked and left out and typically key details between different disciplines or elements can be missed. For a build project there are vast amounts of information that need to be stored, to be accessible and that needs to be kept updated. The flow of information is constant, the information amount only increases along with the progression of the project build. The information that needs to be stored for the build project is also diverse, there are several different disciplines that interacts with each other and needs to be coordinated to prevent collisions or incorrect installations. Coordinating this diverse information for storing and for comparison is problematic since each discipline professionals tends to store their information in data formats that are specific to them and not to other disciplines, making comparison problematic or almost impossible. (Ingram, 2020, Chapter 1, para 1) In the journal article by Jabłonka, Ornat and Żółkiewski (2018) the authors mention that due to the amount of information that is normally stored into a BIM model, the problem of its proper formatting and ordering still exists. Though this issue can seem to be relatively simple, this is based on the assumption that the entire project is implemented on one type of software within one

company and this is usually not the case, in fact it is extremely rare that this happens. (Jabłonka, Ornat, & Żółkiewski, 2018, page 25)

The proper management and ordering of the BIM model requires the person in charge to possess the right knowledge, to be systematic and have good organizational skills. This can be a more difficult issue with BIM according to Jabłonka, Ornat, & Żółkiewski (2018). The ability to create a model that is universally understandable and transparent, also to people that don't have a technical background, is a also vital part of the proper BIM model management. It is crucial to adopt this from the very beginning of the BIM model, as it will become difficult to correct in a later stage when the model has grown along the project timeline. The authors mentions that by not adopting this management methodology, the risks are high of creating “information noise”. To avoid this, prior to the BIM model creation, it should be pre-determined the appropriate procedures for individual data submission by participants into the BIM model. (Jabłonka, Ornat, & Żółkiewski, 2018, page 26)

Another key issue is elements being too detailed depicted in the BIM model. Having a perfectly constructed digital twin can be very attractive and opens the possibility for it to be used in e.g., marketing. The issue occurs when the model is incredibly detailed and this in turn leads to it taking up a lot of memory, this puts a heavy load on the workstation from which the model is opened and operated. This is usually not a problem for the designers that have capabilities to run significantly heavy models through their computers at their workstations. In other situations where the conditions are not as good, poor internet connections on the actual build site or poor computational power, it can become a difficulty to properly open and run the model. A way of dealing with this issue is to use common sense and keep moderate complexity of the models and on individual objects inside these models. (Jabłonka, Ornat, & Żółkiewski, 2018, page 26)

3.3 BIM methodology in the yacht building industry

In the journal article by Jabłonka, Ornat, & Żółkiewski (2018) the authors mentions that there can be doubts about whether or not the use of BIM could be applied within the ship- or yacht building industry. The authors mention that BIM is most commonly seen as a tool in the building construction industry and in order to understand that BIM is perhaps not bound to a single industry, one have to change his view on the BIM technology and not have the source in consideration. (Jabłonka, Ornat, & Żółkiewski, 2018, page 27)

The main purpose of BIM to this day, is to help with the implementation of complex project constructions, such as ships and luxury yachts. Jabłonka, Ornat, & Żółkiewski mentions (2018) that it should be the complexity of the project and the degree of assimilation to the building structure that determines the applicability of BIM. Comparing the yacht building industry with the building construction industry, there are common features and installations that can benefit in both project coordination, performance and maintenance elements by implementing a single consistent database with the help of a BIM tool. Some of these common features are ventilation, lighting, sanitary etc. (Jabłonka, Ornat, & Żółkiewski, 2018, page 27)

Liu, Chen and Wu (2017) concludes in their paper that a BIM-based integrative design and construction approach for a luxury yacht building project is feasible. In the article the authors have compared the luxury yacht industry with the building construction industry and observed that there is a strong resemblance between the industries IT infrastructure, project delivery process and design workflow in construction projects. This and that the luxury yacht industry has also demonstrated the capacity and readiness to embrace a BIM-based approach through its state-of-the-art software applications. (Liu, Chen, & Wu, 2017, page 46)

4 Research Methodology

In this chapter the different research methods are presented, the chosen research method for the study is further explained and an explanation on how the data was collected during the research with regards to the theoretical framework.

4.1 Research methods

For researching purposes, the commonly used forms of research methods are qualitative research methods and quantitative research methods. The use of each method depends mostly on the type of research that is being done, whether the data comes in forms of numbers and values or if it comes in forms of human thoughts, expressions, or conversations. In Tracy's book (2019) about qualitative research methods, the author mentions that the distinction between qualitative- and quantitative research lies in their key features. (Tracy, 2019, Chapter 1, para 6)

In quantitative research, the focus is on data in form of numbers and on transforming data into numbers. According to Tracy (2019) the transformation of data can be used on actions, conversations, physical activities etc. and in the quantitative methodology, measurements and statistics are employed to create mathematical models and predictions. Tracy (2019) also mentions that the quantitative research is often driven in terms of scale e.g., how much and how often (Tracy, 2019, Chapter 1, para 6).

Another important difference that Tracy (2019) mentions between the two methods is the research instrument. In quantitative research, the research instrument is separate from the researcher and distinctly different from the researcher controlling the instrument e.g., a social scientist using a survey to measure participant attitudes. In qualitative research, on the contrary, the researcher is the instrument. The observations that the researcher experiences during e.g., interviews, they are registered and processed by the researchers mind and body. Here, self-reflexivity is important for the researcher regarding the reasearchers own goals, biases, interests etc. Tracy (2019) states that "Qualitative research is about immersing oneself in a scene and trying to make sense of it" (Tracy, 2019, Chapter 1, para 6).

4.2 Qualitative research and collecting empirical data through interviews

In this study, the research was performed in a qualitative manner and the empirical data was collected through semi-structured interviews. In Tracy's book (2019) a semi-structured interview is defined as a more flexible and organic way of interviewing and the reason for this flexibility is simply to promote and stimulate discussion rather than dictate it. (Tracy, 2019, Chapter 7, para 4).

The data that was collected through the interviews was empirical data and by saying empirical data it is meant that the information that was collected through the interviews, the interviewees had acquired through experience and observations. (QuestionPro, 2022)

4.2.1 Interview areas and interview questions

The research interviews for this study included questions regarding BIM and communication. These different interview areas were held in separate interviews, meaning that there were interviews with discussions regarding BIM and interviews with focus on discussing communication. The BIM interviews were held with external field-experts and the communication interviews were held internally with employees in the organization. For some cases, the internal interviews would include both BIM- and communication discussion and these cases were with interviewees that had a bit more knowledge in BIM and that could possess valuable opinions and ideas. The interview questions that were used in the interviews were attached in this study as appendices, see Appendix 1 and Appendix 2.

4.2.2 Preparing and conducting the interviews

The preparation for the interviews began with determining the reason for the interviews and to determine the aim of the interviews. The aim of the interviews was to gather data to be able to answer the research questions that were presented in previous chapters, see Chapter 1.2. The research questions that were established for this study were:

- How to communicate in the most efficient way?
- Is it possible to achieve a higher sense of meaning and context through visual communication?
- What are the challenges and opportunities with implementing BIM into work processes?

In the interviews, these questions were presented in several different formulations. The reason for having several interview questions with the same core question is that in some cases the interviewee could be short on the answers, even though the interviewer was asking open questions and trying to push for a discussion. In this case, by having several related questions the probability of getting a discussion going was more likely to happen when the interviewee received several different formulations on the same core question. This is defined by Cassell (2015) as exploratory semi-structured interviews, were the interviewer devises several interview questions around a theme to gather different perspectives on it (Cassell, 2015, Chapter 2, para. 10) Another key aspect with the interview questions is in what order they would be presented and here it was up to the interviewer to determine the proper order individually for each interview. Cassell (2015) mentions that in semi-structured interviews the interviewer is going to deviate from the interview schedule with the set list of questions depending on the response from the interviewee (Cassell, 2015, Chapter 2, para. 4). There was always the possibility that by asking one question, the initiated discussion would answer to several interview questions at once and it was crucial to be aware of this and to be able to adjust accordingly.

The next step of the interview preparation was to establish which persons were going to take part in the interviews. A key thing with selecting individuals for the interviews was to diversify the candidates, trying to get as broad base of experience and knowledge from the

interviews as possible. By selecting candidates from different departments and different disciplines, the probability of receiving more diverse information on subjects was higher than only selecting individuals with similar backgrounds. This is called purposive sampling and according to Cassell (2015) purposive sampling is when “members of a sample are chosen with a purpose to illustrate or represent a particular type in relation to a key criterion” (Cassell, 2015, Chapter 3, para 19).

Once the candidates had been selected, it was needed to evaluate if the number of interviews was enough, if there were too many interview candidates or if there were too few. Caution had to be taken not to plan too many interviews, there would be more work to be done after conducting the interviews. The data had to be compiled, the data had to be interpreted and the data had to be analysed before being able to come to any conclusions and results. Knowing the proper number of interviews needed for the research is not always a simple task, usually the way of knowing according to Cassell (2015) when the right amount has been achieved is when the interviews do not bring anything new during the discussions. Cassell (2015) also notes that it is not always the number of interviewees that is important but the quality of the interviews. Another way of determining the appropriate number of interviews is to ask one’s supervisor for guidance, who is familiar with the dissertation demands and what is locally an acceptable number. (Cassell, 2015, Chapter 3, para 24)

An aspect that should be thought of prior to conducting interviews is how the interviews should be held, individually or in group format. The interviews in this research were held individually with one person at a time. The reason for selecting individual interviews over group interviews is that, in individual interviews it is easier to connect with a single person, it is in a way easier to get a discussion started and gather valuable information from the interviewee. In group discussions there are several people trying to discuss at the same time and it can happen that one person might not be as talkative in groups where they feel that they will not be heard and the fact that peer pressure might influence their answers according to the other participants values. Abrahamsson and Andersen (2005) mentions in their book that it is a fact that people behave differently in groups than they do when they are alone and the reason for this is the social impact (Abrahamsson & Andersen, 2005, Chapter 5.2, page 113).

The interviews were in majority held face-to-face in a separate room with the possibility to talk behind closed doors, this to make the interviewees feel comfortable and to eliminate disturbances during the interview. There were a small number of interviews that were held virtually through Microsoft Teams but nonetheless the procedure was the same as the rest. In Cassell's book (2015) about conducting research interviews, it is said that face-to-face interviews tend to be the most efficient way of interviewing. This because the interviewer has the possibility to read the interviewees reactions and facial expressions during the discussions and make minor adjustments if there is need to. (Cassell, 2015, Chapter 3, para 3) Prior to the interviews, all interviewees were asked for their permission for the interview to be recorded and they were made aware that the interview was strictly confidential. The interviews were held in Swedish and recorded through Microsoft Teams and the transcripts were later on translated to English. The recordings were decoded manually to further investigate and review the content of the discussions held in the interview. All of the interview transcripts were later on also manually corrected to fully correspond with the recorded discussions. Also, at the beginning of each interview, the interviewee were given a preamble on the purpose of the interview and according to Cassell (2015) the intention of an interview preamble is to provide the interviewee with information on the purpose of the research (Cassell, 2015, Chapter 3, para 9).

The interviews in this research are presented anonymously in the following chapters and each of the interviewees has been identified as Interviewee 1 to Interviewee 10. This structure promotes the presentation of all of the individual interviewees answers and opinons while keeping the anonymity. Later on these identitifications will be referred to as I1 to I10.

4.3 Secondary research

The second research method for this study was to collect already existing data in literature findings and to investigate previous research in the fields of interest. The literature findings had to be relevant with the research purpose and the findings had to provide material for answering the research questions. The secondary research was done in two different areas, the same as for the interviews, and those areas were: Building Information Modelling and communication. The literature findings for this research were presented in the previous chapters, see Chapter 2 and Chapter 3.

4.4 Qualitative data analysis and interpretation

According to McNabb (2017) the analysis and interpretation of qualitative data is divided into two parts, data management and data analysis (McNabb, 2017). The data management part was treated in the previous parts of the research methodology chapter and the data analysis part is treated in this part of the research methodology chapter.

The data analysis is divided into three stages: data reduction, data display and drawing conclusions from the data (McNabb, 2017, Chapter 31, para. 3). After the data was gathered in form of written transcripts of the interview's audio- and video recordings, the data was analysed using a content analysis approach. Presented below is a process chart of the qualitative content analysis method used for this research, see *Figure 14.* According to Columbia University (2019) content analysis is used to determine the presence of certain concepts or themes from qualitative data, and this is done through coding of the data. By using content analysis, the researcher can quantify and analyse the presence, meaning and relationships of these concepts or themes.

In content analysis there are a few decisions that must be made prior to conducting the analysis process. First is to determine if the data is going to be analysed with an inductive approach or with a deductive approach. The inductive approach is where the data is analysed without having predetermined notions or categories and the deductive approach is where the researcher has predetermined key words, categories or variables that are going to be tested to explain the data. (Columbia University, 2019) Second, is to determine whether the data is going to be analysed using a semantic approach or a latent approach.

Semantic approach is when analysing the obvious text content as it is and latent approach is when analysing the text for the hidden content and examining the deeper meaning of the words and sentences used in the text. (Caulfield, 2022)

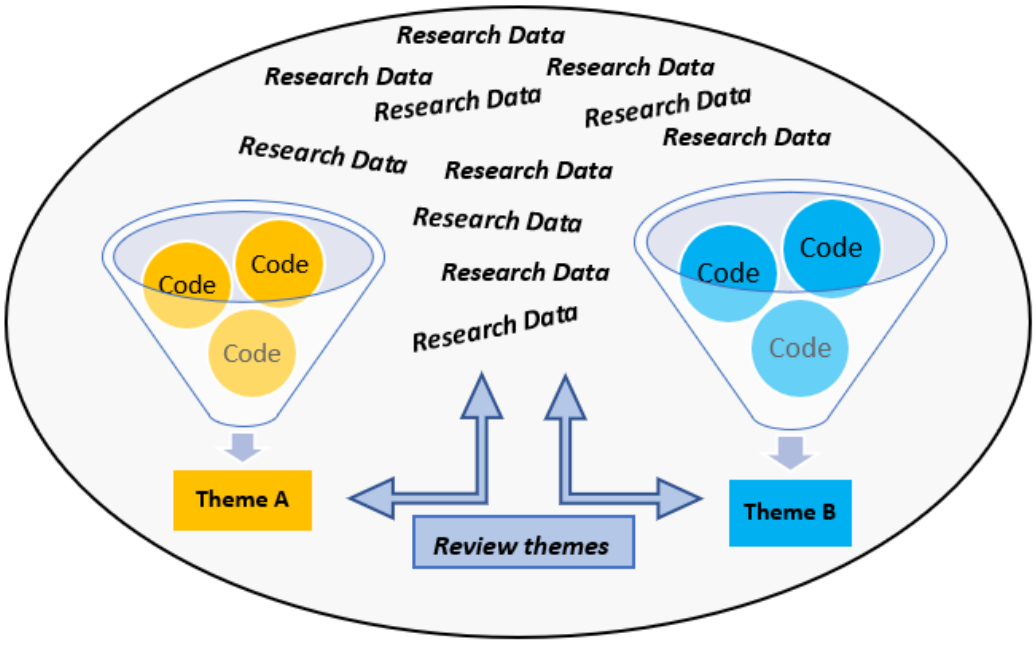

Figure 14. Content analysis process chart.

Conducting this research through content analysis, in a deductive manner and with a latent approach, a coded interview transcript would look like the one presented in *Figure 15.* The interesting and to the researcher obvious and important codes was first highlighted. By interpreting the transcript repeatedly to find the key codes, the deeper meaning of the codes could be extracted. It is mentioned by Cassell (2015) that there are possibilities of losing a sense of the individual interviewee with this type of analysis, when parts of their data is reduced and considered alongside that of other interviewees data and outside of the overall transcript context. (Cassell, 2015, Chapter 6, para. 9)

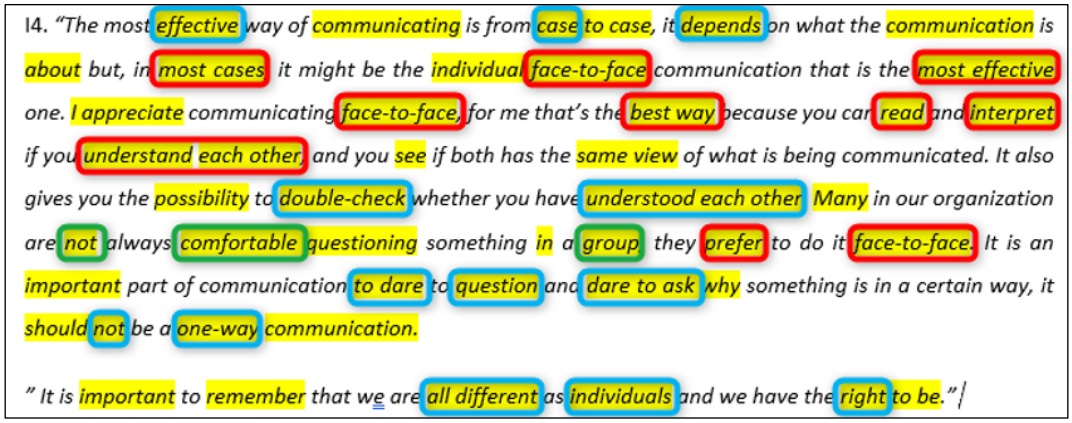

Figure 15. Example of coded interview transcript using content analysis.

Once the key codes were extracted, the researcher could generate themes from them and during the research progress these codes and themes could change or be completely discarded depending on the resulting data codes and themes, see *Figure 16.* In the results chapter of this thesis the generated themes will be presented, analysed, and further discussed.

Codes	Themes
Situation and people determine effectivity	Communication fundamentals
Everyone should be heard and seen	Communication methods
Rights for individual differences	Communication issues
Important to have courage	
Face-to-face communication is usually most effective	
Face-to-face communication promotes equal understanding	
Communicating face-to-face is preferred	
Non-verbal communication plays a key role	
Group communication isn't always suitable	

Figure 16. Codes and themes derived from content analysis process.

After the data was collected and analysed using a content analysis approach, conclusions were drawn and the researcher made interpretations on the research results. McNabb (2017) argue that no matter how organized, categorized and structured the data is presented, it is not enough to simply present the research data as it is. The researcher must interpret what meaning the data has in relation to the research design, the research objectives and the research's contribution to theory. (McNabb, 2017, Chapter 31, para. 3)

5 Results

In this chapter, the results from the research methods are presented from the interview areas. After the results have been presented, the discussion of the results and conclusions are presented in the following chapter.

5.1 BIM and Communication interviews

In this chapter the results from the interview areas are presented. The communication interviews that were held were done internally with the organization's employees, from both the engineering- and production department. Some of the interviewees took part in both interview areas because of their organizational role and experience. The external interviewee I1 was interviewed explicitly because of the BIM knowledge that this interviewee possessed. The intention with this research was to include an interview with the Assembly Manager for the organization, interviewee I3. Unfortunately, in time for the interview the interviewee was unavailable, and the interview could not be held.

The roles of the interviewees for the interviews were:

- Director, Business Development (External) (I1)
- Head of Production (I2)
- Assembly Manager (I3)
- Head of Engineering (I4)
- Team Leader, Mechanical (I5)
- Team Leader, Interior (I6)
- Technical Engineer, HVAC (I7)
- Production Foreman, Hull (I8)
- Production Foreman, Deck (I9)
- Production Foreman, Interior (I10)

5.1.1 Views on communication and effective communication

In communication there are several aspects that play a vital part in the process and that is affecting the effectivity of it. When the interviewees were asked what they consider to be communication and how to effectively communicate, there were different views on the subject but also recurring themes among the interviewees. Most of the interviewees thought of the communication process as something physical e.g., a meeting, a face-to-face conversation etc. and most of them mentioned that the communication process is the most effective when done physically face-to-face.

> *"Communication is fundamentally first to talk in person and second through writing such as e-mail and text messages."* (I10)

> *"Communication is everything that someone can see or hear. Every e-mail, every image that you create and show to someone else, all corridor talk, all telephone talk, all forms of talk. Even in form of presentations and similar one-way communications."* (I6)

> "*There are many different forms of communication. Talking to each other physically is one form and another is sending e-mails, text messages etc."* (I5)

There was also an interviewee that had a bit more in depth explanation of the communication process, mentioning that the fundamental in communication is to be transparent and honest with what you are saying and receiving. The interviewee also mentioned that it is important to understand what other people might need from you in terms of information.

> "*The fundamentals in communication are transparency and honesty, that you dare to speak out if you have issues, if you are missing information or if you need more information. To be able to listen is also an important aspect of communication. Also, that you have some understanding in other areas, what sort of information they might need from you. You maybe not have to always communicate in all places, but one must create oneself an understanding in what your colleagues need from you as well and vice versa. This I would say is the fundamentals in communication."* (I4)

The interviewees also agreed upon the effectivity of the communication to be depending on the situation, in some cases the individual form of communication would be best suited and in other cases the group communication would be better suited. Overall, the individual

face-to-face communication was the most dominant preferred form of communication but also the possibility to in writing follow up what has been communicated seemed to be equally important in some cases.

> *"The most effective way of communicating is from case to case, it depends on what the communication is about but, in most cases, it might be the individual face-to-face communication that is the most effective one."* (I4)

> *"I do believe that tasks that are important should be dealt with using face-to-face communication and afterwards write down the agreements on a memo. There are situations where group communication is good, especially whenever there are several people that are involved and here, I believe that should be done by conducting a physical meeting."* (I8)

> *"There are several forms of communicating and the communication methods success depends a lot on the message, what is the intention of the message. Many messages can be delivered through writing e.g., e-mail, mail etc. Some messages can be sent as text messages whereas sensitive messages containing details that can be misinterpreted and especially in a negative manner, it is important to deliver these messages to the receiver face-to-face. It allows the people communicating to see and be able to read each other's body languages during the communication. Depending on how the sender uses its body language, the receiver can interpret the message differently e.g., delivering the message with an aggressive approach, the receiver can interpret the message as threatening."* (I2)

The interviewees mentioned that the reason for the face-to-face communication to be the most effective one was because of the possibility to use the visual communication and non-verbal communication simultaneously as the verbal communication e.g., body language and drawing sketches. They said that conducting communication in this way gives both communicators improved chances to know if they understand each other and gives them the possibility to double-check whether they have understood each other or not.

> *"I appreciate communicating face-to-face, for me that is the best way because you can read and interpret if you understand each other, and you see if both has the same view of what is being communicated. It also gives you the possibility to double-check whether you have understood each other."* (I4)

> *"It depends on what is being communicated but in regards of the communication between production and engineering, if it is a task that you are discussing, it is best to discuss face-to-face. You then have the possibility sketch, draw, and think together. If you compare it to Microsoft Teams, even though you can share your screen and show what you are referring to, the face-to-face alternative is better. The advantage of e.g., e-mail communication is that you have records of what has been communicated."* (I5)

> *"The most effective way is to physically communicate face-to-face and to the extent that both parties have a complete understanding in what both are saying. Meeting each other face-to-face, you have more possibilities to read each other and see from body language if there is something that is not clear. There should not be the possibility for the communication to be forgotten e.g., a reply to an e-mail, after reading it, is something that is easily forgotten."* (I7)

A few the interviewees thought that the communication process could be best started, specifically for a new project, by arranging group meetings with more people. In these discussions they would receive information on the great whole and later this communication would develop into face-to-face individual communication.

> *"I think that initially it is best to discuss a given task in group discussions and later develop it into individual face-to-face communication and not through mail. At a later stage it is possible to once again arrange a group discussion to look through the progress on the given task."* (I9)

> *"In order for us to quickly receive a bigger picture of let us say in the beginning of a new project is that the project management presents the project to everyone so that everyone understands what has been sold and what is going to be manufactured. After this, the departments would receive in more detail their responsibilities and tasks. I prefer these type of group discussions at least at the beginning of new projects to get some form of start-up going and periodically during the project build timeline."* (I10)

5.1.2 Current communication in- and between departments

During the interviews, the interviewees were asked what their opinion is on how the communication works in the organization and specifically between the production- and the engineering department. The interviewees mentioned a variety of issues that they experience, one of these were the feedback between the departments. The interviewees experienced that feedback from the production- to the engineering department does not work as good as it should in some areas, but there were also areas that work well.

> *"I think that overall, the communication works quite ok but often when you visit the production floor, it can be overheard that they have done tasks in a different manner and have not notified the engineering department about this. The feedback is sometimes left out, I do not know the reason for this, but it does happen."* (I5)

> *"The systems department has made progress with the communication but have a lot to work on. I am not sure if there is some pride involved because it often becomes a bit tricky, they wait too long before they provide their feedback. Instead, they are frustrated and angry. Instead of communicating and try to solve the task together, they suck it up and it eventually becomes an issue where it could have been avoided in the first place."* (I4)

> *"There are areas that have a better working communication than others. I often take the Interior department in engineering as an example. They have a direct and well working communication with both the interior foremen and with all carpentry personnel. I have experienced that this is working well, you get great feedback from both the carpentry and the assembly, and it is usually quite objective."* (I4)

It was also mentioned that the production personnel can sometimes change a certain detail on a drawing or only pick certain elements from it that they would then manufacture. The problem would then appear afterwards, when the feedback of this change would not be provided to the engineering department.

> *"If we receive a drawing that we are not familiar with and we see issues from a manufacturing point of view, we can change details or only pick certain aspects from the drawings and manufacture as we please. The problem is then that the feedback does not reach the engineers and on the future projects we would repeat this process all over again. I believe that we could eliminate this issue by meeting each other face-to-face more often and giving each other feedback."* (I8)

Another issue that the interviewees mentioned was the threshold for communicating. The interviewees believed that there is a greater deal of threshold for initiating communication and feedback in some departments and that this is also individually different from person to person. Some people struggle to communicate with others, some people do not, and this usually depends on the individual itself.

> *"It varies depending on the individual, everyone does their job a bit differently. Some of the engineering does want to communicate face-to-face by going through tasks with certain production personnel and receive their input verbally. I would say that this works in most cases but there are also people that struggle with this and does this same communication through e-mails, this does not work equally well."* (I8)

> *"I have 20 years of experience in the carpentry and interior department, they have been seen as precursors in using 3D-drawings and somehow early on we established a low threshold to communicate with the engineering department in terms of interior. Nowadays, working with other disciplines and departments I have experienced that the communication threshold in other areas is a bit higher for some reason. Also, the use of paper drawings is more relied on in these areas and for much of the personnel this is all they know, they do not have any experience in using 3D-drawings. In these cases, it falls completely on the production foreman's shoulders to be in contact with the engineers."* (I10)

> *"It varies depending on discipline and people. Unfortunately, there are large variations between people on this subject. There are engineering disciplines with a lot of activity towards the production department and there are production disciplines with a lot of activity towards the engineering department. I would say it very much depends on the individual itself. If the individual by nature is proactive, active and want to make progress then you often have a better communication with the party you are dependent on. And the other type is more standby, waiting for information to come to them."* (I2)

Additionally, when asked how they see that improvements could be done to eliminate these issues and what benefits would be obtained by doing so, an interviewee mentioned that if we could improve our communication by communicating more verbally in a physical form it would improve the personal chemistry among the personnel.

> *"It would improve the personal chemistry; it creates a better sense of trust between those who communicate verbally rather than through e-mails. There is a lot of background to the work we do that does not always appear e.g., on drawings. By communicating face-to-face, you can receive this background feedback and develop an improved understanding at the same time."* (I8)

Another interviewee highlighted that one of the possible reasons for the communication issues between the departments could be the lack of motivation among personnel to communicate properly and for improving it. The interviewee mentioned that a possibility to promote this would be to increase the personnel's awareness of their actions; how does it affect themselves, how does it affect the project their working and how does it affect the organization.

> *"I believe that we have had issues with this, and I experience that it is especially difficult to involve the production personnel apart from the foremen. They lack the motivation to communicate properly, some people take their work very seriously and others are there simply to do their work and go home afterwards. A feasible way to stimulate the motivation could be to involve the production personnel more, increase their interest in improving the communication and make their daily work more interesting for them. I think that communicating to the personnel; how does this affect the entire organization and how does it affect themselves is vital to achieve improvements in the communication."* (I7)

The interviewees were also asked whether they experience specific phases or operations in a project build where the communication noticeably deteriorates. The views on this were for some on the initial stages of a project build, that the communication often is worse at the beginning and becomes better after a while, but there were also different views on this topic.

> *"There are issues in the initial stages of a project build, where departments are not fully aware of each other's work progress. The engineering is not fully aware of how far the production is in some operations and this is mostly up to us as individuals to follow the progress. It easily happens that we as engineers get stuck inside our own engineering bubble."* (I4)

> *"I would say that at the beginning of a project it is worse, when the production foremen are still bound by a previous ongoing project, they do not fully commit to the new project build. They have their hands full with the previously started project build."* (I5)

Some of the other views from the interviewees were that the communication deteriorates significantly in the end of a project build when it is getting closer to the delivery date. They mentioned that this is often caused by the increased time pressure that happens once the yacht has been launched into the water and these circumstances often require quick decisions.

> *"If we look at the systems side and specifically in the production, in the end of a project, tasks are done without the consent of the engineering or without giving feedback to them. This is because of the time pressure; things need to be done quickly at this stage. To prevent this, everything should be as far done as possible before reaching the critical points in the time-schedule e.g., launching and to meet in person, discuss and document how things are changed during the end of a project."* (I7)

> *"The closer we get to the finish line, the worse the communication becomes. In the beginning of each project the issue with the communication is manageable but the closer we get to the end of the project; the time pressure causes misalignments in the communication."* (I8)

Another point of view from one of the interviewees was that the communication starts to eventually deteriorate after the initial stage of the project build. The interviewee mentioned that the reason for this is when more people start to get involved in the project, there are more people to share information with and more people that are communicating or that should be communicating. The interviewee did also mention that one of the causes for the deterioration in the communication is the time pressure.

> *"I would say that in the initial stages of a project build, when there are not yet as many people involved, the communication is working quite well. Once we start the assembly stage of the project build, when there are more people involved from both the production and the engineering department, this is the point where the communication deteriorates. Even though we have meetings and weekly meetings, in the periods where the work is hectic and has a high tempo you can see that there are issues in production on providing feedback to the engineering department on changes that have been done during manufacturing. The*

time pressure causes the lack of feedback, the production must quickly take decisions on certain details and do not have time to discuss this change with the engineers, nor does the feedback reach the engineers afterwards which is vital that it does. The feedback must be provided to the engineering department so that they can update their drawings accordingly and so that the same issue does not appear on future projects." (I2)

5.1.3 Current organizational communication and information handling

In the internal interviews, the interviewees were asked what their opinion is on the current way of dealing with information in the organization; their reflections on the amount of information that everyone is dealing with, is this information shared with everyone that needs it, is the number of channels appropriate etc.

Some of the interviewees saw this as currently one of the biggest issues with the communication, that the information handling is not done properly within the organization. The interviewees mentioned that the current information amount is enormous and some questioned whether everyone should take part of this and if there should be some form of filtering to make this information handling more effective.

"The biggest issue we have is the information handling, we have improved our communication and we communicate much more but does everybody need to take part in every piece of information? The amount of information flow at present is enormous, everyone cannot manage all the information that we receive today. We should start filtering out those that do not need the information that we are transmitting." (I2)

"I experience that, the more requirements that the engineering receives from various involved parties in projects, the more likely it is that we are soon getting too much information to manage ourselves. Not in the form of information that we require to do our work, that I do not experience has changed a lot, but all the documentation that goes along with our work and the information that comes from external parties that we need to form an opinion about." (I4)

For some of the interviewees the amount of information that they must deal with is manageable, but they see the structure of dealing with the information as an issue. The interviewees believed that there was not enough logic for dealing with the information, if there was any logic at all, and that there should be logic to it. Some of the interviewees also thought that it could be beneficial to concentrate the information more to one place, that it is currently too spread out on several channels.

> *"The amount of information is manageable for the individual point of view and, it could be possible and beneficial to further concentrate the information to one platform. I also believe that for the information to be easily accessible there should be a logic for managing it, we currently do not have this logic."* (I7)

> *"The amount of information is manageable. I do believe that the number of channels is too many, we could concentrate all information preferably to one place. It is hard to locate all information when it is spread out on several channels."* (I5)

> *"It is a lot of information, and we do not have a proper way of dealing with it, so it gets messy easily. Then the fact that our projects are constantly changing details to some extent, to find the time to process all information is quite hard."* (I4)

One of the interviewees mentioned that it may be the case that it is not possible to modify the number of channels that are used because of the organizations unique way of manufacturing their products usually with a lot of participants both internal and external. Although the interviewee did mention here as well that it would be beneficial to establish a structure for information handling.

> *"I am not sure we can control the information channels any more than what we currently can. We might have a bit too many channels now from which to gather information. I think that most of us can manage this when we have an appropriate amount of workload. In a way it is hard to control this since our company profile tells that we are fully custom manufacturers, this means that the world is wide open, and we need to look for information where we can find resulting in the process becoming sprawling. To improve this, we should establish a structure for information handling, where do we place all information and how do we deal with the information internally etc."* (I4)

5.1.4 Using visual tools in communication

During the interviews, the interviewees were asked what their opinions were on visual communication, to utilize visual aids in a communication process. The interviewees were first asked if they believe that it is possible to achieve a higher sense of meaning and context in the daily work by utilizing more visual aids. All the interviewees agreed on this question, everyone believed by using visual aids it is possible to achieve a higher sense of meaning and context and especially in form of three-dimensional modelling tools.

> *"Yes, it's absolutely helpful, sometimes you aren't maybe as much involved in every project and by seeing a detail visually to get a better understanding it is easier to understand the context."* (I5)

> *"Yes, I do. I believe that if we were able to have our engineering more complete in an earlier stage it would benefit the production enormously. It would provide us with the possibility to visualize what we have engineered, and it would better explain our thinking. It would give the production a completely different understanding of the great whole, which I believe would speed up the production operations."* (I4)

> *"It works well! For instance, a 3D-model provides you with a lot of information once you know how to use it properly. You might need to start with the bigger picture and zoom in gradually on the object in which you are interested. It is key to first start by showing the great whole and then gradually remove surrounding elements and go more into detail. With this you see other connecting elements and how they might influence or be influenced by other elements in the assembly."* (I7)

As previously mentioned, most of the interviewees referred to visual communication and visual tools as the 3D-modelling tool that is currently used. Most of the interviewees believed that this tool is crucial and highly beneficial in their work, but also that many among the production personnel do not know of it or how to use it. They mentioned that it would be beneficial to have more people among the production personnel that can use this tool.

> *"We are working towards using 3D-models more in the production department, to develop our skills to use these models more. Once we have more people capable of opening the 3D-models and taking the required information from there, this would provide us in the production with a clearer view on what we are dealing with and for us to better understand how everything connects. Though, this in turn would require the engineering to produce models that are more precise."* (I8)

> *"Yes, I believe so, absolutely. It is mostly used for checking space requirements and that everything works together. It is a helpful tool that prevents a lot of trial and error in our work. Even though everything is not made entirely according to the drawings, it provides the production personnel with a good overview of how things should look and provides them with a good starting point."* (I7)

One of the interviewees gave further opinions and explanations on the current modelling tool, that this tool might not be appropriate for the work that is done inside the organization. The interviewee did agree with the rest saying that visual communication promotes a higher sense of meaning and context and that using 3D-models as visual aid is key in their work.

> *"I completely agree that it does promote that. In terms of both foremen, the production, and the specific projects that we work with I would like to point out that the tool that we are currently using is not appropriate. It is appropriate for the engineers working with the separate parts and that does not require them to have the great whole displayed, but for a foreman in the production that is working with one or more systems often needs the great whole displayed to see how everything connects and how a system moves through a project. The current modelling tool that we have is terribly slow in these terms and it also requires a lot of time and knowledge to use. It is exceedingly difficult to successfully assemble a complete model of a project in the tool if not even impossible."* (I2)

Further on the visual communication, the interviewees were asked what they think is important to keep in mind when using visual aids to communicate. The interviewees said that the key thing with visual communication is to only show that which is interesting and to keep it simple. Depending on the visual communication method if it is images, models, or videos it might differ. For 3D-models, it is important that it is easy to open and to use, videos on the other hand should be simple and short e.g., an instructional video.

> *"It should be kept as simple as possible. Especially in terms of instructions on specific operations for the personnel it is key to keep it as simple and as short as possible e.g., in terms of using video-and image material. In terms of 3D-models, the system for using this communication method with the use of models should be simple to use to open models or a complete model and it should not be very time consuming."* (I2)

They also said that the presentation is important, how different details are graphically presented, how they are colored, what details stands out among other parts and to present it in a good-looking way. One interviewee mentioned that it is not only the intention with the message that is important, but the presentation of it is also equally important.

> *"It is important that you have as little of topic material as possible in e.g., the 3D-model that you are showing. Only the things that are relevant to your discussion should be shown, everything else should be hidden or deleted. Color coding is particularly important. You can work with colors, transparency, lines etc. Your message should be presented as clearly as possible and to reserve some extra time for preparing the file you are about to show before you show it can be important and worth it."* (I4)

> *"Personally, I think that it must look good, that is the first thing. Regardless of what the medium of transmitting the message is, if it is a sketch, a drawing, or a 3D-model, they must look good. It is not only the intention with the message it is also how it is presented, and it is equally important. In the interior department's guideline for drawing approval the first point is: Does it look good?"* (I5)

Interviewee I5 gave a more in-depth explanation on certain key considerations regarding visual communication. The interviewee mentioned that upon color coding and selecting colors to use for elements in e.g., the 3D-models, there should be some logic to it. The interviewee also said that it is not only the type of colors that is important but also what shade of the color that is important, some colors might behave in a certain manner when viewed on a computer screen and sometimes they behave in an unpleasant way.

> *"The first thing that comes to mind, in our 3D-models, e.g., the pipe routings, components etc. their coloring is a complete mess. There is no logic in the color use for these parts, there should be some logic to it. When we first started having computers on the production floor, we started questioning how the production would determine, based on visually looking at the 3D-model, what has been manufactured and what has not. To solve this, red and green*

> *colors were chosen for each status in the manufacturing process and not only which color but also which shade of each color. The chosen colors, if put into the model as 100% green or red, they are quite difficult to look at because they are quite strong colors and when moving the model, the screen could start to flicker because of this. Therefore, the colors used were a bit shaded with another color."* (I6)

The interviewees also mentioned that in some cases, being able to see the great whole is necessary to fully understand the content of the visual communication. The process could be to first display the great whole and later zoom in on the detail that is being discussed, in other cases simply by overlaying other elements would be key to prevent future issues e.g., system collisions.

> *"In some cases, the bigger picture could be required to understand what is being visually shown and often the question is that where is this detail located. It usually only requires some further explanation since both the production and the engineering are using the same models in their work."* (I7)

> *"3D-models are an exceptionally effective way to quickly get an overview of what you are going to manufacture. But usually, for the interior side at least, other disciplines such as HVAC is not visible in the interior models and if the user does not know that these disciplines need to be separately brought in to check collisions, there is a risk that there might be collisions further on in the process."* (I10)

The interviewees were also asked whether they believe it would be beneficial to further use image- and/or video-material in the organization's guidelines and documents as a step of utilizing more visual communication. The interviewees thought that this would be beneficial and that this would increase their performance and minimize uncertainty in how some operations are performed.

> *"I firmly believe that by replacing long text documents with a relatively short instructional video, this replacement would easily deliver the content that is presented in a better manner and with a greater understanding."* (I2)

> *"I believe that the visual aid would indeed be helpful and especially for those that are relatively new in the organization or unfamiliar with said operation."* (I8)

One of the interviewees mentioned that the engineering department does not really have any appropriate guideline for their work, establishing this would be beneficial and it would be beneficial in more than one way.

> *"In engineering we currently do not have any written procedures or guidelines for how we work. You do as you please currently. It would be good to have guidelines e.g., for how a drawing is done and how you model in 3D, especially for new employees. It would also be good with documentation of tips and tricks, tacit knowledge that you only acquire from experience."* (I5)

The interviewees mentioned that there are also cases where it would not be possible to incorporate more image-material into the document, simply because the solutions are often custom made in projects. They also mentioned that adding images into guidelines could make them longer and harder to read.

> *"I do not think that this works in every case. Some guidelines that we use are quite specific and cannot be used universally on every project. I think that using images in the guidelines should not be required in every case and for some operations the user should be sufficiently familiar with the content and should not need additional images for explanatory purposes."* (I9)

> *"The problem could be that the document becomes quite long with adding e.g., images, leading to people not wanting to read them because of the length. So, this needs to be considered in that case."* (I8)

In terms of visual communication, the organization is utilizing this also in their build progress tracking document. In this document the build progress is followed by using snapshots from the 3D-model of the build, the components in the 3D-model are color coded depending on the component's status and in addition to the snapshot, the time schedule for the build project components is written down. The interviewees were asked about their opinion on this document and the way of tracking the build progress. They were also asked whether they see any issues with this method and if they have any thoughts of how this method could be improved.

"The weekly based planning is done using a text document containing descriptive images of the components and a timeline for the assembly of them. The challenge with this document is that it is static, meaning that the changes that are done are done manually and if a change is made to a component in the beginning of the time schedule the following components time schedule need to be manually changed accordingly. This requires the user to be significantly familiar with the document, this in turn makes it difficult for someone else to step in and do changes to the document because they are not as familiar with the document." (I2)

"I believe that the visual aid to follow the progress is a useful tool, when it's visually shown what has been done and when, what should be done and at what point in the time-schedule it should be done." (I5)

"This is a useful tool, being able to see the build sequence for all components, in what order everything should be installed. A function that I would like to add is the possibility to do the same process, but in a 3D environment instead of in a Word document with only snapshots of the 3D-model and explanatory text." (I9)

5.1.5 BIM interpretations and BIM methodology points of view

During the interview with the external interviewee, the interviewee was asked what a suitable description of BIM would be to someone that is not familiar with the term. The interviewee mentioned that BIM is a digital process of planning, constructing, and maintaining a construction and that the key value lies within the information management and not as much with the three-dimensional representation. It was also mentioned that the core of BIM lies also within gathering all information in one single place.

"BIM is the digital process of planning, constructing, and maintaining a construction. In BIM, the key value lies within the information management and not as much with the three-dimensional representation. The core methodology that the BIM concept adopts is that the information is gathered in one place. The reason for using this methodology is to simulate the constructions performance, the construction's properties and in some cases also the construction process itself. BIM also allows for the construction process to be sped up by improving the preparatory work for components used in the construction." (I1)

When the interviewees were asked what their opinions are on the implementation process, whether they believe this to be challenging and how it possibly could be challenging, the interviewees thought that the BIM implementation process is in overall as any other change management process and it would be wise to treat it as such, one of the interviewees took the Prosci ADKAR model as an example. ADKAR stands for: Awareness, Desire, Knowledge, Ability, Reinforcement. Also, one interviewee mentioned that initially there are several alternatives regarding how you implement BIM. The interviewee thought it would be wise to implement this kind of change by smaller steps and set limits on the expectations and what is wanted from the process.

> *"Challenges with this implementation would partly be because it is a new method of working and partly because there is a vast number of alternatives regarding how you implement a BIM process. It is important to initially set limits on what is wanted from this process and what you would benefit most from between different departments. I believe it would be wise to implement this type of substantial change in smaller steps to successfully establish them into our work processes."* (I2)

> *"I would say from my experience that from an organizational point of view, the BIM implementation process is in overall as any other change management process e.g., the Prosci ADKAR model. A few key points that promote becoming efficient using BIM: identifying roles and required knowledge needed for the implementation, encourage, and create meaning for people interested and with drive for the role, having trial-and-error acceptance, and having dedicated support available when encountering issues."* (I1)

Further, one of the interviewees mentioned that the BIM implementation does cause the organizations work methods to change and that the personnel's responsibilities change and what their roles are.

> *"With BIM, the work methods do change, and the responsibility roles changes i.e., who does what."* (I1)

With the implementation process and the required assets for introducing and advancing the use of BIM in the organizations work processes, the interviewees were asked if they believe that the current asset in the organization is enough for implementing the BIM system and to maintain a prominent level of BIM efficiency. They were also asked that if this is not the case, do they believe that this implementation requires further assets in the

organization. The interviewees thoughts were that this depends on the level of implementation and how much of it that is done internally. One of the interviewees mentioned that there should be a leading role or management in the organization for BIM, this to enable that the progress moves forward and when the capacity increases that the responsibilities is spread out on others in the organization.

> *"My recommendation is that there should be some form of leading role or management for BIM in the organization. Also, depending on the scale of the organization and how much of BIM is done internally, this affects how the organizational model in regards of BIM is structured. It is important that the leading role moves the progress forward and when the capacity increases also that the responsibility is spread out on others in the organization."* (I1)

> *"Depending on the level of implementation, it does demand some form of change in working methods and it also depends on what is possible to achieve using the alternatives that are available on the market. Let us say that the implementation level would involve adding data to track the build progress, this I do not believe would require any further assets. Initially it would produce a bit more work but keeping the model up to date later would not require any additional work other than what we already have at present. But to take this BIM process a step further by adding more product information and data into the model, I believe that this would significantly involve more asset requirements."* (I2)

In change management processes the term resistance against change is a term that is often discussed. In the interviews, the interviewees were asked if they believe that the implementation and further use of BIM could be faced with resistance in the organization or if they believe that it would be almost immediately accepted by the personnel. The interviewees thoughts on this were that there are always those that are reluctant to change and those that are not and that this highly depends on the desire and will to implement something new and to evolve.

> *"I would say that there are always those that are willing to try something new and those that would not want to change anything at all. I would say this depends on the desire and will to implement something new and in this case the organization should investigate the reason for this. In an organization it is possible to divide this into smaller parts, departments, and investigate why some departments are more willing than others to change and vice versa."* (I1)

> *"I would like to claim that most would accept if the system were easy to handle and they see this as a positive change because most of the personnel are keen to receive information and know where we are at in our project builds. Specifically, this would be seen as positive and interesting for those departments where the daily work does not involve much of the assembly work but rather to manufacture parts for the assembly work. It would give those who does not see the project builds daily, a better insight in how far we are with the build progress. Of course, all changes meet some form of resistance but in this case, I believe it would be positive feedback on the implementation."* (I2)

Some of the interviewees thought that most of the personnel would see this implementation and further use of BIM as positive. Even though most of the personnel would view this as positive, one of the interviewees pointed out that the biggest obstacle to overcome would be the implementation of the software itself, if a new one was required, and not the process. The interviewee mentioned that depending on how complicated the new software would be and how difficult it would be to learn, this would be the biggest obstacle.

> *"I believe that the majority would accept this and be thrilled about working with a new tool. I believe that the biggest obstacle would be if the implementation required a new software that you would need to learn and depending on how complicated this new software is to learn, this would be the threshold for accepting the implementation. You become comfortable with what you already have learned but at the same time, most of our employees are young, most are open to renewing the technology and have the will to learn and develop. I do not believe there would be any great deal of resistance against this."* (I4)

5.1.6 Considerations when implementing BIM in work processes

The research interviews were also treating the implementation of BIM in work processes and the interviewees were asked what their opinion was on this. The interviewees were asked if they could see any possibilities with this and what possibilities this could be, also they were asked if they see any immediate issues with this implementation.

The interviewees had some shared thoughts regarding the use of BIM, one of these thoughts were that this would create opportunities for the organization and that the ability to visually see more of the great whole as well as seeing building sequences would be beneficial. It was also pointed out that this implementation would be good, if the new system is easy to understand and to use.

> *"A new system that is easy to understand is always good, and additionally with all information from a single place. In terms of visually being able to see e.g., the build progress on parts this system would ease understanding the bigger picture."* (I8)

> *"I would say that with the ability to see the building sequence from a 3D-model and being able to see the time schedule simultaneously, you have better possibilities to plan for other components and other areas. You can better estimate what time schedule needs the production has for drawings and similar information."* (I9)

> *"This could be possible with a BIM system, where components are connected, and they are in relation to each other. If you e.g., change the assembly date for component A in the BIM model, it automatically changes the assembly date for the following component and further it is possible to see how it affects the entire project build and the lead time. This would also create the possibility to see if the effect would result in the need of adding additional work shifts, overtime etc. to cope with the changed time schedule."* (I2)

Another thought that the interviewees had was that this may not be as straight-forward as one might think. They thought that a possibility with this implementation could be that the organization would need to change the software used to create the models and to open them. They stated that the software used is not meant for this type of use and that because of this it would need to be replaced.

> *"We are working in this type of way with the software we use. Though, I think that currently we are a bit restricted by the software we are using and for us to develop our work method we would need to change the software."* (I6)

> *"I think this would create more opportunities. I am worried if we have enough computing power to establish a complete model of a project with our current software? I see huge benefits in being able to visually see all elements and all disciplines by opening a single model and not having to open and cross reference between several. I believe that if more people were familiar with using 3D-models, if all information were available in the 3D-model, they could open the model and extract the information they need on their own."* (I10)

The interviewees were then asked how they see that this would impact the internal communication between the departments, specifically between the production- and the engineering department. The interviewees presented several possibilities that they could imagine would develop from using this system, but they also mentioned that they did not see that this would change the importance of the face-to-face communication and that this would still be done. One of the interviewees stated that you cannot stop discussing and communicating, no matter how well the program performs.

> *"If we think in terms of documentation, it will ease a lot to have everything in one place. The information exchange would indeed improve if everything were in one place, but I do not see that it would change the face-to-face communication. To be able to see what has been manufactured and what has been installed would be great to be able to see without having to open separate documents and scroll through to see if it is marked as done or under progress and so on."* (I5)

> *"No matter how well the program works, you cannot stop discussing and communicating. There is always the possibility that someone is sick, there are time delays, or something goes completely sideways and the whole chain stops. The great whole, being able to view and sequentially go through the build sequence is great. When you start going into more details it becomes more difficult to e.g., estimate time requirements for a manufacturing specific component, this usually changes from project to project."* (I9)

Another of the interviewees thought that this would not only benefit the communication between the production- and engineering department but also the entire organization, from the top-level management to the production personnel. The interviewee mentioned that in this way, the awareness of where the build projects are at would increase among the personnel when they have the possibility to open a complete model of a project and based on e.g., the color coding's in the model see where the progress is.

> *"I believe it would benefit the internal communication within the entire organization, all the way from top level management to the production personnel. It would increase the awareness among the personnel regarding where we are at in terms of project build progress: what is done, what is in progress and what is missing based on color coding in a 3D-model. This would give the top-level management a snapshot of the current build progress for a project without having to further investigate it and it would also be possible to involve purchasing, sales and marketing. It would also benefit the communication between the production- and engineering department in the sense that you have the possibility to see the status of the build progress without having to visit the build site. It would save time in those instances where personnel must travel to see the build progress."* (I2)

6 Discussion

The main purpose of this thesis is to investigate the organizations internal communication and specifically the communication between the production- and engineering department. The purpose is also to investigate if visual communication could be beneficial to further use in work processes. Also, to investigate possibilities with using a BIM model, implement BIM methodology in work processes and later present more in-depth BIM knowledge to the organization.

The research methods were in form of semi-structured interviews, with both internal and external interviewees, and in form of a literature study. The interviewees were asked questions regarding communication as well as questions regarding BIM to obtain knowledge and opinions in these areas. The semi-structured interviews provided answers to the questions made and based on this knowledge and the knowledge obtained from the literature study, parallels were drawn between these and later present answers to the initial research questions.

6.1 Analysis of research results

In the following parts of the discussion chapter, the different themes of the research results are analysed and important findings are presented. The analysis is divided into separate sub-themes and in these sub-themes the findings are discussed and analysed in terms of the current communication in the organization, and possible issues that appeared during the interviews. The analysis will further on interpret the interviewees' views on visual communication and how they thought of this in terms of improving organizational communication. Finally, the implementation of BIM into work processes is analysed, what the interviewees thoughts were on this and how they experienced that this would affect the organization and their work methods.

6.2 Analysis of the current organizational communication

Organizational communication, specifically between the production- and engineering department is in most of the interviewee's opinions working quite well in some areas, but there are also areas with issues that need to be dealt with. After analysing the research results in accordance with the analysis procedure mentioned in chapter 4.4, the main themes for the organizational communication were:

- Feedback issues in the organization
- Inappropriate communication methods for vital information
- Inappropriate information handling procedures
- Variations between the communication efficiency of different disciplines and departments
- Lack of motivation and interest in proper communication
- Inappropriate visual communication tools

The research results indicates that there are issues with people not being motivated to effectively communicate. There is little or no awareness among some employees of why proper communication is important, both for the employees themselves, for the entire organization and how it affects both. By clearly explaining why this is important, thus increasing the awareness, the employees will have a better understanding of why it is important according to Prosci (Prosci Inc., 2022).

There was a split opinion in the results regarding the instances where the communication starts to deteriorate. Some believed that this happens at the beginning of a project build, others believed that it happens in the end and both sides based their assumptions on two main culprits: time pressure and lack of information. The indication here was that time pressure causes misalignments in the communication in form of missing feedback, it creates difficulties to put equal focus on all project builds and that the personnel do not possess the information of all the project participants roles and responsibilities.

6.2.1 Issues with feedback in the organization

According to the research results presented in chapter 5, there are issues with providing feedback to each other in the organization. The research results indicate that it is usually feedback from the production department to the engineering department that is lacking. The indication on the interviewees' responses was that they consider feedback to be highly valuable and that the value of it is constantly increasing because the organization is constantly developing their work methods. This because the project builds become more and more challenging in terms of technical advancements. Improving performance in manufacturing project's is a continuous process and according to Vasiliev and Morozov (2013) this requires the communication process to function properly, to achieve the increased performance. (Vasiliev & Morozov, 2013)

The research results indicate that a recurring phenomenon is that the production personnel sometimes make quick decisions on their own during hectic periods with time pressure without acquiring or providing feedback to the engineers. It is also common that production personnel don't provide feedback at all or too late to the engineering department but there are variations on this depending on the individual and their discipline. It indicates that some employees' struggle with providing and receiving feedback and it could potentially have something to do with their personality. According to Berglund and Sewerin (2019) feedback is a work method that is meant to improve the organizations performances, but it is also difficult as a human to deal with feedback. (Berglund & Sewerin, 2019, page 153-154) The research results also indicate that the production personnel often make these decisions on changes because they are unfamiliar with the details of the project and don't have the background information on it. The production personnel change certain details according to their assessments that the change would improve the whole, but since they do not know the background information it is possible that the opposite occur. Trenholm mentions (2020) that issues in communication processes occur if the sender's message is coded in a way that is unfamiliar to the receiver or if there is little to no room for feedback in the process. (Trenholm, 2020) It is also mentioned by Fletcher (2021) that a process for feedback is necessary for a successful communication design (Fletcher, 2021).

6.2.2 Issues with communication methods

The research results indicate that the personnel had different views on what defines communication. Some thought of it as a deep social interaction process, others as simply talking and sending e-mails to each other. According to Trenholm (2020) there is no single definition that tells us what communication is. Everyone has their shared opinion of what communication is and how it is done (Trenholm, 2020) A recurrent implication is that it is important to have an understanding of each other as different individuals when communicating. The research results also indicate that the personnel value verbal communication higher than written, specifically the verbal face-to-face method whenever there is vital information that needs to be communicated. This mostly because of the possibilities to use non-verbal as well as visual communication simultaneously but also because it provides the possibility to build trust and improve personal chemistry among the personnel. This coincides with Trenholm (2020) mentioning that the face-to-face communication is the richest medium because it contains the most verbal and non-verbal cues, and it is more suitable for building trust among the parties communicating and trust is extremely important for effective communication. Trenholm mentions (2020) that this is not the same when e.g., communicating virtually, that trust is more slowly developed using this method. It is also indicated that there are always interferences with the communication process, in one way or another, during work and according to Trenholm (2020) there is a possibility that the communication misaligns whenever noise interferes with the communication process, and this can be any form of distraction. (Trenholm, 2020) It is also mentioned by Barnlund (2021) that communication is not a simple thing, but a complex process that occurs interactively between individuals. Depending on how individuals think, use their body language and acts is going to affect the communication process (Lack of communication in project management, 2021).

6.2.3 Issues with information handling

The research results indicate that there is a split opinion among the personnel regarding information handling. The production personnel assessed that the current information amount is manageable, both for the production- and the engineering department, whereas the engineering personnel assessed that the amount is becoming unmanageable for the engineering department. The implication of why the production personnel considers the

information amount to be manageable for the engineering department was that they have better possibilities than the production department for dealing with all the information that they receive. This would not be the case with e.g., the production foremen because of their work nature. They have a team of personnel to lead and do not have the same possibilities of spending a lot of time in front of their computers, which the engineers have since their work is mostly done in front of a computer. This could potentially indicate that the departments aren't fully aware of each other's work scope and the actual amount of information that each department is dealing with. Although, there were a few contradictions to this were some of the engineering- and production personnel believed that both the information amount and channels is manageable.

The production and engineering departments did share an opinion and the opinion was that the structure or logic for handling information is lacking or completely missing. The issue could occur on an individual level of knowing who to share the information with, what should be shared, how and where should the information be stored. The information flow was implied to be enormous and constantly increasing. The information sharing should be filtered, not everyone should take part of the information. This coincides with Berglund and Sewerin mentioning (2019) that the need of transmitting information has increased and is continuously increasing in today's world and that there are vast amounts of information being transferred between communicators and through numerous channels, see chapter 2.1. Berglund and Sewerin (2019) also mentions that the increase in information transmission needs of today's world has led to an increased demand of documenting, developing and compiling information in organizations, which in turn has increased the administrative burden on organizations, see chapter 2.1. The personnel implied that it could be a potential benefit to further concentrate the information to a single place using a logic. There is currently no guideline for information handling in the organization. Employees' handle information according to their own assessments and experience. This results in scattered information which in turn creates difficulties of knowing where to extract the correct information. McKnight (2013) mentions that information management is vital in order to avoid unneeded redundancy and to not miss opportunities that information might provide. (McKnight, 2013, Chapter 1, para. 4) By concentrating information to a single place, it promotes the convenience of easily finding information as

well as not having to worry about acquiring the correct version of information since there are no other places where other versions could be stored.

6.3 Analysis of visual communication in work processes

Visual communication and visual tools were implied to be beneficial for communicating complex and unfamiliar information, which coincides with Fletcher saying (2021) that complex information is better communicated visually (Fletcher, 2021). The research results also indicate that the visual communication promotes understanding of the context by visually being able to display the great whole and gradually look into detail on systems and components in the 3D-models. According to Ingram (2020) some of the benefits with a virtual model is that it provides a better visualization of information as well as improved simulation of the construction. (Ingram, 2020, chapter 9, para. 2) This is also mentioned by Fletcher (2021) that to successfully raise awareness regarding the details you are communicating, it is good to start from a broader base and work your way down into smaller details. It is also helpful to repeat or relate information in what you are communicating, you can relate drawings and images to one another visually so the audience can make the intended connections. (Fletcher, 2021, chapter 1, para. 4)

The research results indicates that the use of visual communication promotes a higher sense of meaning and context and that it is a vital part of the organization's communication process. The research results indicates that visual communication is mostly associated with using 3D-models to aid work communication and that these models are highly valuable for the work performance. It is implied that the visual tool, specifically 3D-models, are a quick and helpful way to better visualize what should be manufactured and that it prevents a lot of trial and error in their work. This is mentioned by Ingram (2020) that some of the benefits with a virtual model is that reworks are reduced, and information is better visualized. (Ingram, 2020, chapter 9, para. 2) It was also indicated that not all production personnel possess the knowledge of handling these models or are aware of them at all, some would only know of basic 2D-drawings in paper format.

It is implied that the challenge is to not overload work processes with visual tools since that could promote less understanding and less use of the visual tools themselves. This coincides with Sless saying (2019) that overloading a person with visual aids can lead to the

opposite reaction with less understanding and comprehension of what is trying to be communicated (Sless, 2019).

The visual presentation of information e.g., coloring and information structuring is considered to be important in visual communication according to the research results. It implies that the visual tool not only presents the message and information in the message, but it also represents the user that is sending the message. For instance, if there is no logic in how the information is visualised by the sender, how would the sender be seen by the receiver? The receiver can possibly start to question the appropriateness of the information that the sender is sharing. There is also a potential risk that the receiver further assumes that the case is the same for the rest of the organization, where in fact it most probably isn't. The color coding would associate different meanings to distinct colors, this is already in use in the organization according to the research results and according to Fletcher (2021) the use of color in visual communication is a straightforward way to take advantage of people's assumptions. Colors are a part of universal understandings; they will convey meaning whether it is intended or not. (Fletcher, 2021, chapter 1, para. 4) If an object is colored green it indicates that it is manufactured or already installed, red indicates that it is not manufactured or not installed and yellow indicates that it is either being manufactured or being installed. According to the research results, other implications of key considerations when using visual tools is that visually it should be kept as simple as possible and only relevant elements should be shown. It is hard for people unfamiliar with the details to get their head around what is being shown if not explained in an effective manner. According to Fletcher (2021), for communication to be successful it is key to know your audience. It is always best to communicate with the assumption that the audience is completely unfamiliar with your topic. (Fletcher, 2021, chapter 1, para. 4) It was implied that, specifically for 3D-models, they should be easy to open and user-friendly and this process should not be very time consuming. This coincides with Trenholm's theory (2020) that visual aids should be simple, easy to see, easy to handle and logical (Trenholm, 2020).

6.4 Analysis of BIM methodology in work processes

An indication in the research results is that the organization's current need would be to use BIM primarily as a visual tool to increase the organizations performance and that it would not be used as an information management tool, at least initially. It is also implied that the implementation process should be done in smaller steps in order to promote a successful implementation. A potential addition at the end of these steps could be to consolidate short-term wins as Kotter (1996) describes it in his eight steps change model. This to promote maintaining momentum in the implementation process and keep people devoted to it. As Kotter (1996) mentions, people will not go on for extended periods of time without seeing results, see chapter 2.4.2.

In terms of promoting the development of a higher sense of meaning and context using 3D-models as a visual tool, the indication is that the current modelling tool that is being used is not appropriate in these terms and has restrictions. It indicates that BIM could potentially address these issues that the current visual tools in the organization has. There is a common belief that the current visual tool would need replacement if the organization were to implement a BIM methodology. The research results also indicate that there is not much knowledge in the organization regarding BIM, only a selected few had some knowledge of it but that was also limited. Though, given information about the system and how it works, the response is in majority positive and most only saw the opportunities of a new system which is vital according to Kotter (1996) and Prosci (2022). The concern that the research results is indicating is how difficult it would be to learn the new BIM tool and how difficult it would be to use the new BIM tool in the work processes. It is implied that the level of these difficulties would determine the threshold for accepting or resisting the implementation of BIM. Awareness and desire to change are two vital fundamentals in a change processes. If employees are aware of the reason of an incoming change and possess the desire to change, the possibility of successfully implementing a change is much higher, see chapter 2.4. This correlates with the indication from the research results. Using a BIM model could potentially make the daily work more interesting for people that do not have the possibility to see the build progress daily. Some projects are built on a different location than that of the employees, specifically the personnel that are only manufacturing parts for the build and not assembling them. With the possibility to visually see the build progress

through a virtual model it could increase the sense of meaning with their work, raise their awareness of the great whole and increase their interest in their own work. The challenges highly depend on the level of BIM implementation and what is possible to achieve with the BIM alternatives available on the market and that are suitable alternatives for the organization's needs.

The research results indicates that BIM implementation and BIM tools in general requires a leading role and at a certain level it also requires further assets, both internally and externally. The leading role should move the BIM progress forward as well as distribute responsibilities in the organization when the BIM capacity increases. As Berglund and Sewerin (2019) mentions, leadership is required to promote collaboration when groups of people are gathered to perform a form of task. The leader's task is to help the group of people in the right direction and to keep them on the right track during their task. (Berglund & Sewerin, 2019, p. 9)

Another possibility that the interviewees believed that would be beneficial was the information handling, that all information is stored in one place. If all information were stored in the BIM model and the personnel could extract the information from there, the possibilities for obtaining correct information could be promoted. This correlates with the findings in chapter 6.2.3. Ingram (2020) mentions that some of the benefits with a BIM model is that information and documentation is better coordinated, there is a better simulation of construction and processes and benefits of accommodating late and even ongoing changes to the construction. (Ingram, 2020, chapter 9, para. 2)

It was also implied that currently the engineering department is not capable of dealing with the time resource requirements that BIM would demand. The concern was that BIM would require the engineering to be completed in an earlier stage and that there are not enough resources in the organization for this. Even though, the use of BIM was seen as a goal for the organization and the implementation of BIM could improve their ranking in the yacht building industry.

6.5 Reliability and validity of the research

The reliability and validity of qualitative research require an absolute version of the social reality in which the research has been conducted. In qualitative research the focus is mostly set on interpretations and these interpretations can be affected by the researcher's own previous experiences, biases, and assumptions. According to Anderson (2010) the validity of a qualitative research relates to the honesty and authenticity of the research data, how accurately the findings represent the phenomena they are intended to represent. The reliability relates to the repeatability and stability of the data, in what sense can the results be reproduced in other situations or other organizations. (Anderson, 2010). Bryman and Bell argue (according to Cassell, 2015) that a way of validating the results after a qualitative analysis is to triangulate the research results through respondent validation, by going back to the interviewees with the interpreted data and ask the for their opinions on the results.

The validity of this research has been achieved through recording and transcribing of the interviews and later through respondent validation of the research results. The research has utilized multiple sources for gathering the research data, which is a part of triangulating the research study to achieve a valid research. The respondent validation has not been conducted for all the interviews that were held, so it is reasonable to question a complete validity of this research. The reliability determines whether the research is reproduceable for another context (Anderson, 2010). The result of this research is based on a specific organizations opinions and needs in terms of communication, visual communication, and BIM. Therefore, the research is not fully reliable for reproducibility in other contexts, but the research results can provide guidelines on communication, visual communication, and BIM in other areas and contexts.

When the interviews were conducted, if the interviewee had a tough time grasping the question it was hard to be objective when re-formulating the question so that the interviewee could better understand it. It easily happened that you became subjective with your explanation, and this could in turn affect the answer given by the interviewee. This was especially difficult during the first interviews when you did not have the appropriate routine for conducting the interview and had to adjust your approach on laying out the interview questions.

7 Conclusions

In this research, the status of the organizational communication as well as the visual communication was studied. It was also studied if it could be beneficial with a further use of visual communication in work processes. The aim with this research was to investigate the communication processes in the organization possibilities with a further use of visual communication.

The research also covered a study of BIM methodology in work processes, what challenges and possibilities there are with using BIM. The aim with this aspect of the research was to find what the advantages and the disadvantages of using a BIM model in work processes would be as well as provide the organization with sufficient knowledge of BIM for future implementation.

The first research question in this thesis was investigate the most efficient way of communicating and how this could be realized. The second research question was to investigate the possibilities of achieving a higher sense of meaning and context through visual communication and how this could be realized. The third and final research question for this thesis was to investigate the challenges and possibilities of implementing BIM in work processes and how this could be realized.

7.1 The most efficient way of communicating

To communicate efficiently there are several key considerations, how we should communicate depends much on the situation and on the people communicating. In some cases, group communication can be the best alternative and in other cases the individual face-to-face communication is better. People should know we are all different as individuals, we interpret messages differently and therefore the way of delivering a message is also highly dependent of the content. Sless (2019) mentions this in his book that people react and interpret the communicated message differently (Sless, 2019). People should always think in advance before they deliver a message, is the content sensitive or is this information particularly important. If so, it could be preferred to deliver the message face-to-face according to Trenholm (Trenholm, 2020). If the content is not as important

and not of a sensitive nature, then it could be delivered in group discussions or through drafting an e-mail or a text message.

In terms of information handling, people should also think of who might need this information and who doesn't. In today's world we are constantly receiving and processing enormous amounts of information, receiving excess information is not ideal for anyone and this is mentioned by Berglund and Sewerin (Berglund & Sewerin, 2019). Therefore, it would be wise for people to think twice before delivering information to others and think who needs this information and who does not.

When communicating with others, it happens easily that you discuss matters that are familiar to yourself and not paying attention to other people's reactions, that they have no clue about what you are talking. People should become better at explaining the background information, not all have the same experience as yourself and are not as familiar with the subject as you are. People should also become better at confirming if the person's they are communicating with has understood what they are saying. If they receive a proper explanation of the background and you double-check that they have understood, the possibilities of misalignments later could be reduced. Trenholm (2020) argue that this is up to both the sender and the receiver. The sender can confirm that the receiver has understood, and the receiver can ask questions to better understand (Trenholm, 2020).

People should also be aware of that for some the use of visual aids, along with their verbal explanations, can help tremendously. Explaining complex information can sometimes be hard to do only verbally and Fletcher (2021) argue that complex information is better communicated visually (Fletcher, 2021). If you can support your verbal communication with a drawing or a sketch simultaneously, there can be greater possibilities for being understood by the other person.

7.2 The possibilities of achieving a higher sense of meaning through visual communication

According to the research results there are possibilities of achieving a higher sense of meaning and context through visual communication and this could potentially occur best through 3D-models. Specifically, it could potentially be achieved through a BIM model, see chapter 7.3.

As earlier mentioned in previous chapters, the use of visual aids in communication can be extremely helpful when trying to explain complicated information. Fletcher (2021) argue that complex information is better communicated visually (Fletcher, 2021). With visual communication and visual tools in form of 3D-models the possibility of performing trial and error in the work can be reduced and the models can provide improved visualizations of components for manufacturing and how elements are in relation to each other. This is mentioned by Ingram (2020) that some of the benefits with a virtual model is that reworks are reduced, and information is better visualized. (Ingram, 2020, chapter 9, para. 2). It should be kept in mind when creating 3D-models that there are better possibilities of fully understanding the model if it is kept as simple as possible, but still containing the valuable information. The models should be easy to open, it should not take long to open a model. The models should also be structured in a logical way and the coloring of the model should also be done using a logic. This coincides with Trenholm's theory (2020) that visual aids should be simple, easy to see, easy to handle and logical (Trenholm, 2020).

7.3 The challenges and opportunities with implementing BIM into work processes

As previously mentioned in chapter 7.2, a potential way of achieving a higher sense of meaning and context through visual communication could be to implement a BIM model or a BIM methodology in the organizations work processes.

The BIM model could in a better way visualize the entire project build, the installation sequences, the build progress tracking and all the systems installed in the project build, layer on layer. A possibility with a BIM model could also be to have a model that, in terms of installation sequencing and time scheduling, automatically adjusts according to the updates done to the model elements. Ingram (2020) mentions that some of the benefits with a virtual model is that information and documentation is better coordinated, there is

a better simulation of construction and processes and benefits of accommodating late and even ongoing changes to the construction. (Ingram, 2020, chapter 9, para. 2)

In order to improve internal communication with the use of BIM there could be two possibilities for the organization to consider. First, keeping their current visual tool and organize a BIM model using the current tool. Second, replacing the current visual tool with a new alternative BIM tool. With the latter the organization would need to determine what their needs are and to what level they would like to implement the BIM methodology with the new tool.

If the organization were to implement a new BIM tool, it could be beneficial to implement this change in accordance with the change models presented in this thesis. More specifically the Prosci ADKAR model could potentially be appropriate because it emphasizes the importance of awareness prior to change. The lack of awareness was seen as an issue among the personnel, thus the Prosci ADKAR model could potentially be appropriate in that sense, see chapter 2.4.3. One aspect that this model does not consider is to introduce change in small steps which is a key part in change processes according to Kotter, see chapter 2.4.2. This aspect is considered in Kotter's model of change; thus, it could potentially be utilised from Kotter's model as well when implementing BIM. The appropriate step size would need to be determined by the organization prior to committing the change. The challenge with this alternative could be the complexity of a new tool and how difficult it is to learn, but the tool could also provide potential opportunities of raising interest in the employees' daily work. With a BIM model it could be possible to raise interest in the employee's daily work. The employees that do not have the possibility to see the build progress daily could instead see the build progress from the BIM model and this could in turn make their work more interesting when they see the fruit of their labor.

The BIM methodology and BIM models are in today's world mostly used in architectural design and in the building construction industry. BIM is not as vastly used within the yacht building industry, hence finding BIM implementation cases in the yacht industry proved to be a challenging task. But the fundamental methodology of BIM can potentially be used in other industries as well, it is perhaps not only meant for the building construction industry as mentioned by Jabłonka, Ornat, & Żółkiewski (2018) in chapter 3.3.

7.4 Recommendations

An issue that was presented in the research results was that not all personnel possess the knowledge to handle 3D-models. Based on the research results, 3D-models are considered as highly valued for the work performance. Thus, a potential way to achieve a higher sense of meaning and context through visual communication in the organization could be to arrange training for the personnel that do not have the knowledge to work with 3D-models. If more people knew how to operate the 3D-models, more people could have the possibility to visually grasp more details of the build projects. This training should involve hands-on-coaching and allow the participants to practice creating and handling 3D-models themselves. This is presented by Prosci in their ADKAR change model steps (Prosci Inc., 2022).

The issue of people not being aware of each other's responsibilities and not knowing who does what, a possibility of dealing with this issue would be to initially in a project build conduct group discussions with the people that are going to be involved in the project. During this occasion, the responsibilities for everyone would be presented for everyone to gain knowledge of who does what. If people's responsibilities change or additional assets are transferred to the project, this should be informed to the project participants that this affects to keep the awareness of each and everyone's roles in the project build.

A recommendation regarding BIM implementation would according to the research results be to implement it as any other change management process. The research results also implied that a potentially beneficial approach for this would be to: identify the needs of knowledge and roles for the implementation, encourage and create meaning for people with the interest and drive for the role, be aware of trial and error and to accept mistakes in the learning process, the need for strong support and that support should be readily available when issues are encountered. This coincides with Kotter's model of change where Kotter argues (1996) that in a change process there should be a strong team moving the progress forward, there should be a vision and strategy for the change, broad-based action should be empowered (Kotter, 1996). If resistance is met in the change process, a recommendation based on the research results would be to locate the cause based on the departments. Are there departments that are more willing than others to change vice versa and what could be the reason for this, this would need to be investigated. Prosci (2022)

mentions that during the awareness stage of the ADKAR change management process the natural human reaction to change is resistance. If the individual does not have full awareness of why the change is needed, both for himself and for the organization, it is likely that change will be met by resistance. If the individual is aware of the needed change but does not have the desire to change, the individual's direct manager would need to help this individual connect the change need to its personal motivators to remove the barriers, see chapter 2.4.3.

7.5 Suggestions for future research

In the future the organization could develop the communication between all departments and not only between the engineering- and production departments. Further discussions with personnel from other departments could be held, this research had limitations and did not involve personnel from all levels and departments in the organization. Also, future interviews could be held with accustomed sub-contractors to see if there are improvements that could be done and to ensure best collaboration between both parties.

Further research on visual communication using image-and video material as support in communication should also be conducted. The use of video material as an aid in visual communication was beyond the scope of this study.

The possibilities of a BIM methodology through already existing modelling software could be further investigated. Further research on the actual implementation of BIM from a technical perspective could also be conducted. Thus, research would focus on BIM alternatives on the market and the implementation process of a suitable BIM tool. The research would assess the BIM functionality, how effective it would be and if it would meet the organization's needs.

References

Abrahamsson, B., & Andersen, J. A. (2005). *Organisation - att beskriva och förstå organisationer.* Stockholm: Liber AB.

Anderson, C. (2010). Presenting and Evaluating Qualitative Research. *American Journal of Pharmaceutical Education*, 1-8. From https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2987281/pdf/ajpe141.pdf

Berglund, L., & Sewerin, T. (2019). *Ledarskap och Organisation.* Malmö: Gleerups Utbildning AB.

BizNews. (2022, 4 17). From Barnlund Transactional Model of Communication: https://biznewske.com/barnlund-transactional-model-of-communication/

Carpenter, M., Bauer, T., & Erdogan, B. (2012, 12 29). *Management Principles*. From https://2012books.lardbucket.org/books/management-principles-v1.0/s02-acknowledgments.html

Cassell, C. (2015). *Conducting Research Interviews for Business and Management Students.* London: Sage Publications.

Castro Group. (2022, 04 22). *What is BIM?* From Castro Group: https://castro-group.pt/en/what-is-bim/

Caulfield, J. (2022, 5 5). *How to Do Thematic Analysis*. From Scribbr: https://www.scribbr.com/methodology/thematic-analysis/

Columbia University. (2019). *Content Analysis Methods and Examples.* From Columbia University Mailman School of Public Health: https://www.publichealth.columbia.edu/research/population-health-methods/content-analysis

communicatio. (2019, 12 26). From Wiktionary: https://en.wiktionary.org/wiki/communicatio

Fincham, R., & Rhodes, P. (1999). *Principles of Organizational Behaviour* (3rd ed.). New York: Oxford University Press Inc.

Fletcher, M. (2021). *Visual Communication for Architects and Designers.* New York: Taylor and Francis.

Ingram, J. (2020). *Understanding BIM* (1 ed.). New York: CRC Press.

Jabłonka, T., Ornat, M., & Żółkiewski, S. (2018). Building Information Modelling recognition in ship's machinery designing and construction. *Scientific Journals of the Maritime University of Szczecin*, 7.

Kaufmann, G., & Kaufmann, A. (2015). *Psykologi i organisation och ledning.* Lund: Studentlitteratur AB.

Kotter, J. P. (1996). *Leading Change.* Harvard Business Review Press.

Lack of communication in project management. (2021, 3 1). From DTU - Denmark Technical University: http://wiki.doing-projects.org/index.php/Lack_of_communication_in_project_management

Liu, F., Chen, C., & Wu, W. (2017). Towards the building information modeling-based capital project lifecycle management in the luxury yacht industry. *Polish Maritime Research*, 8.

McKnight, W. (2013). *Information Management - Strategies for Gaining a Competitive Advantage with Data.* Massachusetts: Elsevier Science.

McNabb, D. E. (2017). *Research Methods in Public Administration and Nonprofit Management* (4th ed.). New York: Taylor and Francis.

PDI Vision. (2022). *PROSCI CHANGE MANAGEMENT METHODOLOGY.* From Change 2 Value: https://www.change2value.com/adkar/

Pettey, G., Bracken, C. C., & Pask, E. B. (2017). *Communication Research Methodology.* New York: Taylor and Francis.

Pettigrew, A. (1985). *The Awakening Giant.* Oxford: Blackwell.

Prosci Inc. (2022). *The Prosci ADKAR Model.* From Prosci - People, Change, Results: https://empower.prosci.com/the-prosci-adkar-model-ebook

QuestionPro. (2022, 04 29). *QuestionPro*. From Empirical Research: Definition, Methods, Types and Examples: https://www.questionpro.com/blog/empirical-research/#Empirical_research_Definition

Sanchez, A. X., Hampson, K. D., & Vaux, S. (2016). *Delivering value with BIM.* New York: CRC Press.

Shepherd, D. (2019). *The BIM Management Handbook.* Newcastle upon Tyne: RIBA Publishing. From Catenda: https://catenda.com/bim/bim-levels/

Sless, D. (2019). *Learning and Visual Comunication.* New York: Taylor and Francis.

Tracy, S. J. (2019). *Qualitative Research Methods.* New Jersey: Wiley.

Trenholm, S. (2020). *Thinking Through Communication.* New York: Taylor & Francis.

Vasiliev, V. V., & Morozov, E. V. (2013). *Advanced Mechanics of Composite Materials and Structural Elements.* Oxford: Elsevier Science.

Appendix 1. Interview questions for the external interviews.

1. Introduction
    a. Permission to record interview, interview is strictly confidential.
    b. Preamble of the research to the interviewee.
    c. Interviewee's own introduction and background.
2. What are your experiences regarding BIM?
3. How would you describe what BIM stands for if someone asked you?
4. What is your view on the implementation process, do you consider it challenging for an organization and how could it be challenging?
5. If one were to compare the organization prior versus after the implementation, how have the implementation in most cases re-shaped the organization and their work processes?
6. Does this implementation require further assets in the organization to maintain a prominent level of BIM-efficiency or is this something that can be distributed on the current assets in the organization?
7. What experience do you have of how the BIM implementation is received by the employees in an organization? Is there resistance against this implementation or is it immediately accepted by everyone
8. Do you have anything else to add or any further questions?

Appendix 2. Interview questions for the internal interviews.

1. Introduction
    a. Permission to record interview, interview is strictly confidential.
    b. Preamble of the research to the interviewee.
    c. Interviewee's own introduction, background, and organizational role.
2. What do you consider to be communication?
3. What is in your opinion the most effective way of communicating?
4. What do you think is important to keep in mind when communicating visually?
5. Do you believe that visual communication promotes the development of a higher sense of meaning and context in a work process?
6. What is your view on the internal communication in the organization and specifically between the production- and engineering department?
    a. What aspects of the communication do you view as not working versus working?
    b. Do you have knowledge of areas of improvement and what areas would that be?
7. Are there specific phases or operations where you have noticed noticeably deficiencies in the communication process?
8. What is your view on the information exchange between the departments?
    a. Does it work in both directions?

9. What is your view on the information management in the departments?
    a. Is the amount of information manageable or too high?
    b. What is your view on the channels, appropriate number of channels, too many channels or too few?
10. What is your opinion on the current method of build progress tracking?
    a. Are there issues with the current method that you know of?
    b. In what way could these issues be dealt with?
11. What is your opinion on current manuals and guidelines used in work processes and specific work operations?
    a. Are they easy to understand and is there enough guidance and information to ensure the highest quality on the work results?
    b. Are there issues that could be dealt with and how could they be dealt with?
12. The organization is currently investigating a further use of BIM in their work processes to improve performance. (The interviewee is given a brief introduction on BIM if this is unknown to the interviewee.)
13. What are your thoughts on the implementation of BIM?
    a. Do you see any immediate issues that could arise from this and if so what kind of issues?
    b. Do you see areas that could immediately benefit from this?
14. How do you believe this further use of BIM would impact the internal communication between the production- and engineering departments?
    a. Would the communication improve, remain the same or deteriorate and why?
15. Do you have anything else to add or any further questions?