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Digital Visual Planning: A Case Study of the Project Smart Factories

Master of Science Thesis in Learning and Leadership

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Department of Applied Information Technology
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Gothenburg, Sweden 2017

Master's thesis 2017:135

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Cover:

Typeset in LaTeX
Printed by Chalmers Reproservice
Gothenburg, Sweden 2017

Abstract

Visual planning has become a useful tool in projects in order to increase communication, highlight issues and organize activities. The amount of ways to communicate through different sources has almost eliminated the earlier communication problems and questions like "how should we communicate?". All the available communication tools have made it easier to share information and communicate despite physical distances. So the question nowadays is not really how the information should be shared, instead we have to ask ourselves which information we should share. In order to solve problems people need to communicate and share information with each other. Too much information can be overwhelming which makes it important to prioritize which information should be shared in order to make the communication as efficient as possible.

The purpose of this thesis was to study how well Digital visual planning works in a project, by doing a case study. The case study was conducted on the project Smart Factories, which goal was to build two demonstrators (small factories). The project includes a group of other researchers from Chalmers University of Technology where all of them are using the same digital planning tool. This group of researchers was the unit of analysis for this case study. Data from the case study was collected by observations and interviews. In addition, three independent companies were used as reference companies with the purpose to improve the action research.

Three already known weaknesses with Physical visual planning were investigated, and Digital visual planning proves to remedy all of these. However, this study shows that with the transition from a physical to a digital tool, a new weakness will emerge.

The study also shows that the prerequisites for implementing Physical visual planning (which are known from previous studies) are not the same as the prerequisites for implementing Digital visual planning. Instead, some prerequisites are confirmed, one is removed, yet another one is added and a third is considered plausible.

Keywords: *Digital visual planning, Physical visual planning, Visual planning, Visual management, Visualization, Virtual teams, Cohesion*

Acknowledgements

First of all we would like to thank Johan Bengtsson at Götebogs Tekniska College (GTC), the initiator of Smart Factories, who brought us in to this project. Him together with our supervisor from GTC, Richard Hedman, gave us a great opportunity to, by doing this study, participate and contribute to the project. We also want to thank our supervisor Dag Bergsjö at Chalmers University of Technology. You have shown a great interest in our work and your support and input to our work has been very valuable.

We would also like to thank the group of students who participated in our case study. You gave us the opportunity to observe you and also gave us a lot of input by letting us interview you.

Ludvig Lindlöf at Chalmers University of Technology has also been giving us input and feedback on our work that has been very valuable.

Daniel Andersson and Daniel Torinsson

Göteborg, June 2017

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1
Introduction

This chapter will introduce the thesis with the background to the project and its purpose and aim. The research questions will be presented followed by the method and the delimitations for this study.

1.1 Background

In January 2016 the Swedish government presented their new industrialisation strategy. The industry is facing a paradigm shift driven by globalisation, digitizing and the transformation to a more sustainable and resource efficient economy. The digitizing entails many opportunities to develop a smarter and more sustainable industry that also enables smart workplaces where people cooperate with automation and create high competitiveness.

The initiator of the project Smart Factories is working at Gothenburg Technical College (GTC) and the goal is to build two demonstrators (small factories) with accompanying exhibitions at Universeum in Gothenburg and Balthazar in Skövde. The project Smart Factocies is divided into three parts: Rig, Build and Share. The purpose of the first phase (Rig) is to promote the project, find sponsors and resources in order to prepare for the next phase. The second phase (Build) is about the physical building of the factory from design to completion. The last phase (Share) aims at sharing the learning and knowledge from the project. Many operators are included to implement this project including thesis workers, high school students, polytechnic students and external companies.

The project Smart Factories will create a platform to share knowledge about industrial digitizing in order to increase the attractiveness of technical education and attract adolescents to work in the industry.

The amount of operators in the project together with the new way of working digitally requires new demands on project management. The operating thesis workers in this project are going to use a project management tool for Digital visual planning called Yolean.

1.1.1 Previous research on Visual planning

Using virtual tools in Visual planning has received critique from several authors. See for example this quote from a licentiate thesis from as late as 2012:

"This thesis aims at giving a full picture of the method itself and to some extent raising the awareness that perhaps the end of the road might have been reached when it comes to keeping and exchanging more and more of our information via computers." (Söderberg, 2012, p. iv.)

Some research has been performed about Visual planning before. Olausson & Berggren (2010) conducted a study on a product development company to find out how to organize complexity and uncertainty at the same time. They identify one of the main components for doing this as "Transparent visual communication tools", which is similar to Visual planning. Olausson & Berggren conclude that Visual planning resulted in more fluent workflows, clearer anticipations and also that it helped with prioritizing work. They also found that it helped with starting discussions. Another study of a product development company is Bertilsson & Wentzel (2015) who conducted a case study on a product development company that used Visual planning between two sites. Their study resulted in a number of practical solutions for implementing Visual planning. Parry & Turner (2006) studied three aerospace companies using what they refer to as "visual process management tools". They concluded that physical tools are superior to virtual tools for Visual planning.

Oosterwal (2010) reports from Harley Davidson and their lean transformation. Oosterwal reports that the company implemented an Obeya[1] system, where the Visual planning part, according to Oosterwal, reduced development time and made the problem solving more focused.

Visual planning is a part of the lean product development and Hines, Francis & Found (2006) introduce a lean product development model with six steps where one of the steps is Knowledge Innovation Visible Planning - KIVP. Their conclusion is that the method heightens the motivation of the work force, it makes it easier to distinguish and resolve problems and that it improves teamwork. Mascitelli (2011) writes about lean production. The book contains suggestions on how to implement Visual planning in an organization. Another lean aspect for this thesis is Holmdahl (2010) who writes about lean product development. It contains a chapter on Visual planning, where some benefits are presented. These benefits do not seem to stem from scientific studies, as the author says that they originate from experience from companies. These benefits have therefore been treated as plausible but not scientifically proven in this thesis.

Lindlöf & Söderberg (2011a) studied four large product development companies that used Visual planning as a first step in their lean transformations. Their study re-

[1]Obeya means "large room" in Japanese and refers to a room where a project is displayed visually with graphs, drawings and simulations (Morgan & Liker, 2006).

sulted in four prerequisites for implementing Visual planning; prerequisites that are investigated in this thesis (see Research questions on page 4). The study is part of Ludvig Lindlöfs doctoral dissertation. Lindlöf (2014) is Ludvig Lindlöfs doctoral dissertation. It has summaries of 6 papers. It also explains Visual planning in depth with a thorough background and related concepts. Lindlöf & Trygg (2012) studied four companies and they conclude that Visual planning improves the communication of a team. The study is part of Ludvig Lindlöfs doctoral dissertation. Söderberg (2012) is Björn Söderbergs licentiate thesis. Except for the interesting quote in the preface (see Background in this thesis) it does not provide a lot of new information, as it contains many parts that are similar to Lindlöf (2014).

Lindlöf & Söderberg (2011b) uses the same case companies as Lindlöf & Söderberg (2011a), but with different research questions. The study results in a number of pros and cons with Visual planning, factors that are investigated in this thesis. The study is part of Ludvig Lindlöfs doctoral dissertation (see Lindlöf, 2014) and Björn Söderbergs licenciate thesis (see Söderberg, 2012).

1.2 Purpose and aim

As other universities across the country have a great interest in implementing similar projects the initiator of Smart Factories wants to examine how well it works to use a Digital visual planning tool for the thesis workers in the project.

Visual planning, as a method, has not been given much attention in previous research, but some benefits have been elucidated and mapped (Lindlöf, 2014). The only study on Digital visual planning in particular is a master's thesis from 2015 (see Bertilsson & Wentzel, 2015). Their thesis used Yolean, the same Digital visual planning tool used in this thesis. However, they studied a dispersed product development team using video and audio to communicate between two sites. The team in this study has different characteristics. The purpose of this thesis is to increase the knowledge about Visual planning with focus on Digital visual planning. The aim is, contrary to Söderberg (2012), to raise the awareness that perhaps the end of the road has not been reached when it comes to using virtual tools in Visual planning.

1.3 Research questions

Both research questions originate from the future research section in Ludvig Lindlöfs doctoral dissertation (see Lindlöf, 2014). In the dissertation the author writes:

"Third, the design of boundary objects for communication in geographically distributed teams would be a relevant topic related to the findings in this thesis. Product development organization use distributed teams increasingly, and the need for boundary objects are even higher than in co-located teams. An important aid in achieving

such boundary objects is undoubtedly IT-based solutions. Such solutions currently exist, and studying the implications in that setting and comparing to the studies in this thesis would be an important challenge for development organizations using distributed teams." (Lindlöf, 2014, p. 75).

The research questions are:

RQ_1: How can Digital visual planning be used to remedy the disadvantages of Physical visual planning?

RQ_2: What are the prerequisites for implementing Digital visual planning?

1.4 Method outline

In order to find answers to the research questions a case study was conducted on a group of students in the project Smart Factories. The case study included observations of weekly meetings and interviews with the students. Some conversational interviews were also conducted with other companies that are already using Yolean, in order to get their opinion of the tool. The purpose of these interviews was to get ideas to the action research that was performed for the weekly meetings.

1.5 Delimitations

This master's thesis will only include the second phase (Build) in the project Smart Factories.

The Digital visual planning tool from Yolean which will be used by the other students in this project is the only tool that will be used and studied. This thesis will be limited to study the project planning for the other students theses. Some sections of the building phase, for example the lens manufacturing and the exhibition, will be made by external operators or the project leader but the planning of these parts will not be included in this thesis.

This master's thesis is performed during the same period as the theses that are going to be studied and the last weeks of this thesis will be needed to finish the report. This entails that we do not have time to wait until all the other theses are finished with their work.

This thesis will not consider the effects that Digital visual planning has on the performance of the team. One of these effects is how increased cohesion affect the team.

1.6 Outline of the thesis

The Introduction chapter gives an overview of the thesis and presents the implementation briefly. The Introduction is followed by the Theory chapter which describes what is already known and researched about Visual planning, Digital visual planning and relevant subjects. The Theory chapter gives the reader the basis in order to understand the following Methodology chapter. The Methodology chapter describes how this thesis has been conducted and what has been done. The Methodology chapter is followed by Results, which describes the results from this research. The next chapter is the Discussion which contains the researchers interpretations and the Results are discussed. The thesis ends with Conclusions and recommended future research in this area.

2
Theory

The Theory chapter will introduce the areas that are included in the case study. The aim is to give the reader an introduction of the theory behind this thesis in order to better understand the setting for the Method. The Theory chapter includes areas that the researchers have highlighted in order to support the case study within Digital visual planning.

2.1 Visual management

According to Catic, Stenholm and Bergsjö (2016) the term "efficiency" has a new meaning when referring to knowledge work. Efficiency in manual work is about doing the work right and how the work is performed. In knowledge work efficiency is primarily measured in terms of doing the right work and secondary about how the work is done. It is easier to understand what the right work is when you, for example, are building a product. You can see with your eyes what has to be done in order to complete the product. What you can affect is how you perform your work. Comparing this to working in a project with a group of people where everyone is mainly sitting in front of their computer. In this situation it is more important to make sure that not more than one person is performing the same work. This type of efficiency requires methods to make sure everyone is focusing on the right things.

Lindlöf (2014, p. 30) writes that *"visualization supports human cognitive functions"*, which is an area that the author believes has been well researched. Examples of cognitive functions in the human brain is memory, stress resistance, generalization ability and perception. The cognitive functions together creates the ability to think and how the brain receives, processes and mediates information (Hjälpmedelsinstitutet, 2017). Today, the industry uses different kinds of visualization. It is well used within product development but also in many other areas in order to facilitate the understanding of the information.

Paivio (1971) and Paivio (1991) formulated *the dual coding theory* which is essential in order to understand why visualization was founded. Paivios theory argues that people have two different cognitive channels where information can be processed. At first people have a verbal channel where words are processed. According to the theory the verbal information can be written or spoken but the brain processes the information the same. The verbal channel can be seen as arbitrary. This means that people receive this information differently depending on personal experience, among

other things. For example, if two people hear or read the same word, for example *dog*, they will get different pictures of a dog in their heads. This picture will be created by the personal experiences of dogs. The other channel is the non-verbal one. Things we can see, like a picture, are processed through this channel. This channel can be seen as non arbitrary. The picture will look the same for anyone who looks at it. Paivio argues that people in general easier remember a series of pictures than a series of words.

Visual management is about visualizing information in order to activate the non verbal channel for people so that the non arbitrary process channel mainly is processing the information. By using this method people will get a more mutual perception which in turn leads to less misunderstandings. Visualization can be seen as a mixture of the two channels and is then called *deictic gesturing* (Lindlöf, 2014). Ware (2012) describes *deictic gesturing* as an indication performed by pointing at something and the gesture is often combined with speech (Ware, 2012). The benefit with this very intuitive gesture is that it is a way to create a link between visual and verbal information which makes it easier to process the information (Chapman, 2002; Ware, 2012).

2.1.1 Visual planning

The definition of Visual planning used in this thesis is coined by Lindlöf & Trygg:

"Visual planning is when development teams use frequent meetings and physical representations of tasks in order to manage deliverables and tasks throughout the execution of a project." (Lindlöf & Trygg, 2012, p. 3).

Two highlights can be derived from this definition, these are **physical representations of tasks** and **frequent meetings**, which are usually called *the board* and *the meeting* (see Lindlöf & Söderberg, 2011b).

The board
Visual planning starts with the board, represented in its most basic form in Figure 2.1. The x-axis represents *When*, usually in days or weeks (Lindlöf & Söderberg, 2011b). The y-axis represents *Who*, usually a person (Lindlöf & Söderberg, 2011b). The resources on the y-axis then write *What* they will do in the coming days or weeks on sticky notes (Holmdahl, 2010). The sticky notes can also be color coded to differentiate between activities and deliverables, which makes the board more understandable (Lindlöf & Söderberg, 2011b).

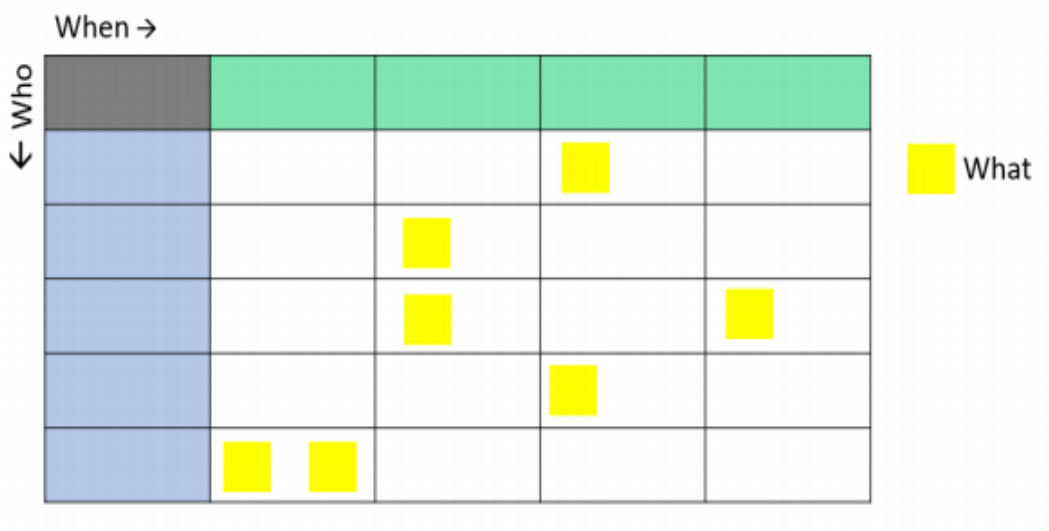

Figure 2.1: A schematic sketch of a Visual planning board: Bertilsson & Wentzel (2015)

The meeting
In Visual planning, the meeting is as important as the board (Lindlöf & Söderberg, 2011b). The purpose of the meeting is planning, follow up and deviation reporting (Catic et al., 2016). In the meeting, the leader of the meeting (usually the project leader) takes on a supporting and observing role of the planning (Catic et al., 2016). Catic et al. (2016) also point out some rules for the meeting, which are summarized in bullets below.

- The meeting should be short. 2-3 minutes per resource should be enough. Since the meeting is usually held standing up, it should not exceed 30 minutes since it could be challenging to stand up all the time. Other authors recommend meetings to be as short as 15 minutes (see Lindlöf & Söderberg, 2011b; Mascitelli, 2011).
- Do not try to solve problems on the spot. If a problem is identified, the concerned resources should meet after the meeting and discuss the problem. If people start to discuss problems at the meeting, the resources who are not concerned will merely be an audience or start to discuss problems that they do not know much about.
- Each resource owns their own plan and everyone should present their own row. If everything has gone according to plan, you do not have to spend time to summarize this. Instead, focus on the parts that did not go according to plan. For the coming activities, the focus should be on activities that are uncertain and therefore need extra attention. Simple and predictable activities do not need to be summarized. The purpose is to identify dependencies within the team.

The team should be between ten to twelve people (Mascitelli, 2011) or six to twelve people (Lindlöf & Trygg, 2012).

Benefits
According to Holmdahl (2010), experience from companies shows the following benefits of Visual planning:

- Improved control of the organization.
- Fewer delays.
- Improved control through: increased attendance, increased understanding and simplified problem solving.
- Resource adjustment.
- Increased flexibility.
- Decreased work, due to limiting the need of double work.
- Knowledge distribution.
- Efficient use of capability.

Additionally, several studies show improved communication (see Olausson & Berggren, 2010; Lindlöf & Söderberg, 2011b; Parry & Turner, 2006) and fast problem solving (see Tanaka, 2002; Morgan & Liker, 2006; Oosterwal, 2010).

Weaknesses
Up to this date, there are not many known drawbacks with Visual planning (Söderberg, 2012). One exception is Olausson & Berggren (2010) who mention that Visual planning can lead to more time spent on planning than before. Their study involved a team with 100 members. Lindlöf & Söderberg (2011b) also give three examples of weaknesses that occur since the method is physical:

- Visual planning does not work when the team is scattered globally. This is simply because a physical board is difficult to copy to another site. This problem can be remedied by using a digital tool (Mascitelli, 2011).
- Sticky notes are thrown in the bin when they are completed. This problem could be remedied by putting the completed sticky notes in a note book (Mascitelli, 2011). A digital tool could also help with this problem.
- There are no links between the sticky notes, so if a milestone is moved it is difficult to see the impact it has on other milestones. This problem can also be remedied by using a digital tool.

As can be seen above, all known weaknesses with Visual planning can theoretically be remedied by using a digital tool.

The studies mentioned above were mostly done in product development teams. However, the team in this study is not a product development team. As will be expanded upon in the Methodology chapter, it is a collection of degree projects and could be compared to an assembly team (like a carpenter, plumber and bricklayer building a house). Mascitelli (2011) supports Visual planning in these teams by writing *"Visual Workflow Management*[1] *is not just a product development tool; it will benefit*

[1]Mascitelli calls his method Visual Workflow Management, but the method is identical to Visual planning.

any group of individuals who must work together as a team toward a common goal." (Mascitelli, 2011, p. 101).

Prerequisites

As can be seen under *Benefits* above, Visual planning can be used to increase and improve communication in teams. Lindlöf & Söderberg (2011a) also argue that the demand for communication in teams is a prerequisite for implementing Visual planning, since the team would not find it useful otherwise. Their study shows that Visual planning does not work when teams do not feel a need to communicate activities and milestones regularly.

Another prerequisite for implementing Visual planning is the complexity in coordination (Lindlöf & Söderberg, 2011a). Lindlöf & Söderberg also argue that the team members' competence span is a factor for implementing Visual planning. This is because Visual planning can help to level the workload (Lindlöf & Söderberg, 2011b), but only if the team members have similar competences (Lindlöf & Söderberg, 2011a).

Since the board in Visual planning consists of physical artefacts, team members' distance is also a prerequisite for implementing Visual planning (Lindlöf & Söderberg, 2011a). According to the authors, this is for two reasons. First, team members are reluctant to use the method if they are not co-located. Second, the team members cannot bring the board with them, and thus have to enter the planning into their own calendar as well. From this, Lindlöf & Söderberg draw the conclusion that Visual planning does not work if only used for individual planning alone. They also argue that Visual planning is not mainly a method for planning, but a method used to increase and improve the communication in teams. Lindlöf & Söderbergs prerequisites for implementing Visual planning are presented visually in Figure 2.2.

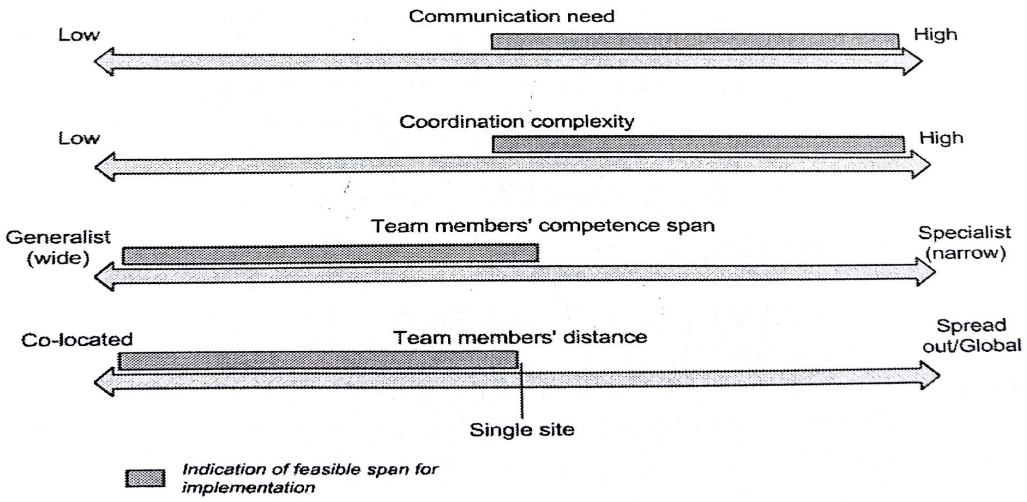

Figure 2.2: Prerequisites for implementing Visual planning: Lindlöf & Söderberg (2011a)

A powerful indicator for how successful the implementation of Visual planning will be is how committed the management is, and how well they aid it financially and with resources (Lindlöf & Söderberg, 2011a). Lindlöf & Söderberg also found that Visual planning worked better in the teams where management was committed and positive to the use of the method. They also found that some of their interviewees requested education on why they should use the method in the first place.

To prevent team members from experiencing a lack of ownership and a feeling of having the method forced upon them, they must be able to influence the use of the method to adapt it to the needs of the team (Lindlöf & Söderberg, 2011a). Lindlöf & Söderberg also argue that team members feel resistance towards the method if they believe management use it to keep track of their work.

2.1.2 Digital visual planning

Even though Digital visual planning is mentioned in the most recent literature (see Bertilsson & Wentzel, 2015) it does not seem to be defined anywhere. The definition of Digital visual planning used in this thesis is the same as Lindlöf & Tryggs definition of Visual planning, except *digital representations* are used instead of *physical representations*. The definition is therefore:

"Digital visual planning is when development teams use frequent meetings and digital representations of tasks in order to manage deliverables and tasks throughout the execution of a project."

Examples of Digital visual planning tools are Excel, Microsoft Project, Hansoft and Yolean. The latter is the tool studied in this thesis, and it will be explained in more detail in the Methodology chapter.

Parry & Turner (2006) argue that physical boards are superior to digital ones. Their arguments are summarized in these bullets:

- Digital boards have no limits to how much data they can present, which leads to data providing little or no value being added.
- Digital boards unavoidably make some people experts on the program that is used. Therefore, a few team members will be in control of the data, which results in less team ownership.
- It is hard to display all the data on a computer, which makes links between activities and milestones harder to spot. Data from computers can be shown on plasma screens, but they are more expensive than physical boards.

The drawbacks that Parry & Turner present are relevant, but not impossible to overcome. It seems that the difficulty with making a good Digital visual planning tool lies in the three points of criticism above, i.e:

- Only data that adds value must be displayed.
- The tool must be easy enough so that everyone in the team can learn it as fast as possible. There will probably be experts on the program anyway, but if everyone can use it there should be no loss of team ownership.
- Data from the Digital visual planning tool must be displayed on a large screen for it to work effectively at a meeting. These screens are, as Parry & Turner point out, more expensive than physical boards (which are basically free). According to Bergsjö (n.d.) the most important factor of the screen is a good touch interface, second most important is the resolution and third is the size. A screen that matches these criteria will probably cost more than 50 000 SEK, which is a significant sum.

Mascitelli (2011) emphasizes that Visual planning is a *"human engineering tool"* (Mascitelli, 2011, p. 90) and that most benefits will be reaped if the team interacts with the board. He further argues that physical boards should be prioritized over digital ones and that digital boards should only be used as a last resort. As support for this claim, Mascitelli makes a distinction between physical and virtual boards, which is that physical boards are used by co-located teams and virtual boards are used by dispersed teams. This is not always true, especially not for this study, where a virtual board is used by a team that meets face to face in front of the screen. However, Mascitellis main point seems to be that the most important benefit of the boards is the communication, as revealed by this quote:

"Gathering a project team together several times per week for face-to-face discussion and planning has benefits at many levels, not the least of which is the building of team identity and emotional commitment. [...] A virtual project board may be easy, but having team members see each other face-to-face is the most powerful "visual" management tool there is." (Mascitelli, 2011, p. 112)."

Other criticism against software based tools is Taxén & Lilliesköld (2008) who claim that software tools in project management easily become too complicated, overpowering and inactive. Wickstrøm Jensen, Døjbak Håkonsson, Burton & Obel (2009) also argue that increased use of software leads to more locational and relational demarcation. From this, Lindlöf & Söderberg (2011b) draw the conclusion that an increased use of software makes engineers communicate to a lesser extent.

As Taxén & Lilliesköld (2008) point out, there is a tendency to increase the number of features when implementing a digital solution (Catic et al., 2016). However, this does not have to be an inevitable truth. If the creator of the digital tool is aware that customers suggest groovy features that do not add value, it is easy to be skeptical when such a suggestion is presented (Catic et al., 2016). The author present a few questions that could be worth asking before suggesting a change to the tool.

These questions could be: Will fifteen different colors for different statements help with the purpose of Visual planning? Do we have to be able to write novels on the virtual sticky notes? Do we really need a comment section for each note? If both the user and the creator of the Digital visual planning tool use this kind of skepticism, the critique that Taxén & Lilliesköld present could be reduced to a minimum.

There could also be a reason why teams are geographically dispersed. Ulrich & Eppinger (2011) present some advantages of using dispersed product development teams:

- Gathering information from the local market is simplified and improved.
- Technical expertise from around the globe can be acquired.
- Team members can be closer to distributors and manufacturers.
- More affordable staff.
- Demand for outsourcing work to magnify product development volume.

While the critique by Wickstrøm et al. (2009) is relevant, a team could already be distributed, perhaps for one or many of the reasons above. In that circumstance, Digital visual planning could actually help the team to communicate and collaborate (Bertilsson & Wentzel, 2015).

2.1.3 Planning for students

It is important to have a thoughtful planning in order to study effectively (Umeå Universitet, n.d). According to the same article there is research that shows that students who organize their studies in a constructive way manage better and reach higher scores on exams. Umeå Universitet (n.d) also provide a list with benefits related to planning for students:

- You get an overview of your studies and your spare time.
- You get structure.
- You can easier prioritize your activities.
- You can see more clearly which tasks you have in front of you.
- You can see more clearly how much time you have at your disposal.
- It increases your motivation and you feel more goal oriented.

Planning also *"helps you visualise your week and [...] helps you make sure you have a clear idea of your main commitments each week."* (Dixon, 2004, p. 29). The author also argues that planning helps students get control over their lives, particularly when they cross tasks off. Time management is also mentioned in the book *How to Become a Straight-A Student* as a way of reducing stress levels for students (Newport, 2011). The author also writes that *"to-dos and deadlines that exist only in your mind drain your energy, distract your attention, create stress, and are more likely to be forgotten."* (Newport, 2011, p. 27).

Additionally, Dixon (2004) says that *"The single most effective way to make big academic tasks seem more manageable is to break them down into their components."* (Dixon, 2004, p. 29). McMillan & Wayers (2013) say that you should start with the important dates, your deadlines and milestones and plan the activities from that. They also say that you should look frequently in your calendar in order to keep it updated day by day. In the end of the week you should plan for the next week (McMillan & Wayers, 2013). To increase your motivation the authors argue you should break down your activities in to smaller parts and if you cross off the activities you have completed it will be clear how the work is proceeding.

2.2 Teams

Katzenbach & Smith, (2006) writes that people have been working in teams for hundreds of years. Everyone has their own experience of working in teams and most people have probably seen the benefits but also experienced some disadvantages with teamwork. Despite peoples different experiences the common opinion is that most people can see the benefits with working in teams.

Shani, Chandler, Coget & Lao (2009) highlights different types of teams and writes about formal and informal teams. A formal team is a team that the organization or the project creates. Informal teams are the teams created by individuals themselves and a consequense of personal contacts and the human chemistry between people.

Katzenbach & Smith (2006) have been observing different teams for over 20 years. They describe "the six team basics" as the most crucial for a team to perform well. These are:

- Small number of people (generally fewer than twelve).
- Complementary skills.
- Common purpose.
- Common set of specific performance goals.
- Commonly agreed upon working approach.
- Mutually accountable for the teams' performance.

Hertel, Geister & Konradt (2005) make a distinction between virtual teams and non virtual teams. A virtual team is a team where the team members are geographically dispersed and mainly use communication technologies to coordinate their work. People have been able to coordinate distributed work over the years by using different communication paths but since electronic communication media became available a new dimension was added. Since Internet and other communication tools became available the distributed work is now faster, easier and more efficient.

Hertel et al. (2005) also make a distinction between virtual groups and virtual teams. They mean that a virtual group is a group of people working for a common goal and reporting to the same manager. What divides the virtual group from a virtual team is that the members in the virtual group have to interact with each

other in order to reach common goals. Based on this theory the team in this study can be considered a semi virtual group.

The definition of a virtual team is controversial but Hertel et al. (2005) mention some aspects as the minimum consensus of a virtual team. According to Hertel et al. (2005)

"virtual teams consist of (a) two or more persons who (b) collaborate interactively to achieve common goals, while (c) at least one of the team members works at a different location, organization, or at a different time so that (d) communication and coordination is predominantly based on electronic communication media (e-mail, fax, phone, video conference, etc.)" (Hertel et al., 2005, p. 71)

2.2.1 Cohesion

Group cohesion (hereinafter referred to as cohesion) is a widely studied subject (Casey-Campbell & Martens, 2009). The definition of cohesion has however been sloppy and inconsistent throughout research (Mudrack, 1989). Casey-Campbell & Martens (2009, p. 224) define cohesion through Carron (1982) as:

"group members' inclinations to forge social bonds, resulting in members sticking together and remaining united."

This is also the definition used in this thesis. Three causes of cohesion are attraction, group pride and task commitment. They are described in more detail below.

The first cause is attraction. Some researchers consider interpersonal attraction within a group to be sufficient for cohesion (Lott & Lott, 1965), while others consider the attraction to the group as a unity to be the cause of cohesion (Hogg, 1992; Hogg, 1993). The second cause is group pride. Numerous researchers regard cohesion as a result from a profound feeling of residing to a group (Owen, 1985). The last cause is task commitment, which is the belief that cohesion is the result of team members' dedication to perform mutual tasks (Yukelson, Weinberg & Jackson, 1984; Guzzo, 1995).

Cohesion is believed to affect the motivation of a team (Beal, Cohen, Burke & McLendon, 2003) as well as the performance (Forsyth, Zyzniewski & Giammanco, 2002; Mullen & Copper, 1994; Beal et al., 2003; Carron & Brawley, 2000; Oliver, 1988; Gully, Devine & Whitney, 2012). According to Beal et al., (2003), cohesion is related to performance when it is defined as both attraction and task commitment. However, the authors argue that when defined as attraction, cohesion is more strongly correlated with performance. Group size also affects this relation, as smaller teams seem to have a stronger correlation between cohesion and performance than larger teams (Mullen et al., 1994). According to Casey-Campbell & Martens (2009), the correlation between performance and cohesion also depends on the team that is studied. The authors refer to Langfred (2000) and say that he

"found a weak but positive association between cohesion and performance in groups from a government social service agency but a strong negative association between cohesion and performance in groups from a Danish military unit." (Casey-Campbell & Martens, 2009, p. 227).

3
Methodology

This chapter describes how the thesis was conducted, for example what research design and research process that was used and why. It also includes a description of the Digital visual planning tool that was used and how Visual planning was used at the case project.

3.1 Research design

The thesis was conducted as a single case study on the project Smart Factories. A case study can be described as *"an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident."* (Yin, 2009, p. 18). Yin (2009) means that whether to use the case study method or not depends on the research questions. The author argues that when research questions are of the explaining kind, usually *how* or *why* a social phenomenon works, a case study is relevant. Additionally, according to the author, the case study method is also relevant when the questions need an extensive and thorough description of a social phenomenon. Yin (2009) argues that one strength of the case study is that it allows the researcher to triangulate data from multiple sources.

The case study was used as a model for action research. Since case studies are flexible in both design and approach, they are considered a favourable base for action research (Robson, 2011). Action research is when the researchers are part of the case being studied, and continously make changes that are observed and evaluated (Holmdahl, 2010; Robson, 2007; Robson, 2011). Robson (2007) and Rapoport (1970) argue that action research can be used to quickly tackle practical problems.

3.2 Research process

This thesis focuses on three main areas that are shown in Figure 3.1 below (Bertilsson & Wentzel, 2015).

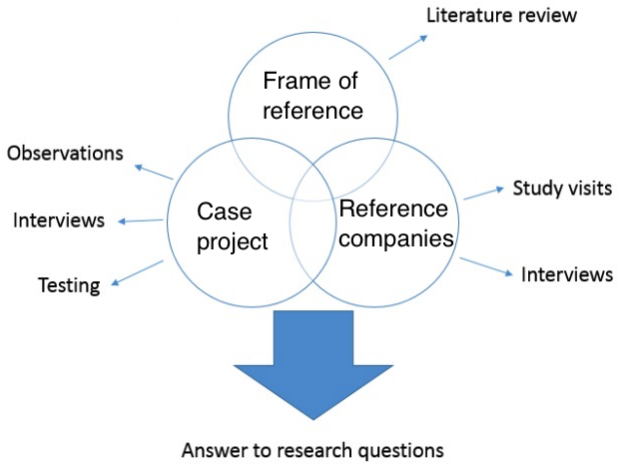

Figure 3.1: The research process. Bertilsson & Wentzel (2015).

The Frame of reference is a literature review and the foundation on which the study stands. However, only the most recent studies (see for example Bertilsson & Wentzel, 2015; Catic et al., 2016) cover *how* Digital visual planning should be implemented. Earlier studies are more concerned about *why* Visual planning should be implemented (Lindlöf, 2014).

The case project is the project Smart Factories. In this single case study, the unit of analysis is the team that was using the Digital visual planning tool Yolean, namely the other master's thesis students and the project leader. See Figure 3.2 for a visual explanation of the unit of analysis' relation to the project Smart Factories. *Companies* are companies that helped the students with their theses. *Yrgo* is an adult school that was involved in the construction of the factory. The unit of analysis was chosen as the team, rather than the individuals, because the researchers were more concerned about the opinions of the team rather than of each individual. Also, as Yin (2009) points out, the unit of analysis should be similar to previous studies. The unit of analysis of similar studies on Visual planning (see for example Lindlöf, 2014; Kaya, Catic & Bergsjö, 2014; Bertilsson & Wentzel, 2015) have been the team.

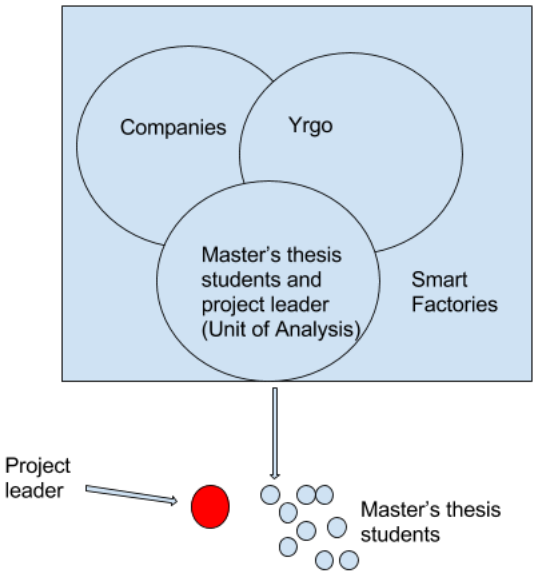

Figure 3.2: The unit of analysis' relation to the project Smart Factories.

In the case project, interviews and observations were used to collect data. The observations took place on the planning meetings, held once a week for all project participants. Before these meetings, the participants had to update their activities, deliverables and milestones for the coming two weeks. The meetings were approximately 15 minutes in duration, according to Visual planning standards (Catic et al., 2016). The members of the project were also interviewed on two occasions.

Reference companies are companies that use Yolean. In this study the companies Emerson, Rejmes Car and Autoliv have been considered. All except the latter were visited to be able to conduct interviews and observations. The communication with Autoliv was limited to phone and e-mail, and therefore no observations were made there. The observations and interviews gave data to the planning meetings, to aid in the action research.

3.3 Literature study

Literature was reviewed in a way that Bryman & Bell (2011) recommends. Books and articles that were recommended by others and that were relevant to the study were read. The read literature was noted in a document with title and key words. Through the initial literature, more references were found. To judge their relevance, titles, abstracts and conclusions were read. The starting point was literature that was recommended by the supervisor. This was a master's thesis on Visual planning (see Bertilsson & Wentzel, 2015).

Literature was also sought through Chalmers Library's search tool Summon. Search words used were especially *digital visual planning*, *visual planning* and *cohesion*.

3.4 Interviews

To collect data from the unit of analysis a focus group was conducted. A focus group is, according to Bryman & Bell (2007) when you interview at least four interviewees at once. The authors argue that this is done to emphasize a topic and explore it in depth. They also mean that the focus group practitioner is interested in how a team discuss a topic as a group and not as individuals. Furthermore, they argue that focus groups are a good way of collecting data when *"the researcher will be interested in how people respond to each other's views and build up a view out of the interaction that takes place within the group."* (Bryman & Bell, 2007, p. 510). The interview was recorded with both audio and video. This was done in order to aid in transcribing the interview, because the video should help with telling who says what (Bryman & Bell, 2007; Denscombe, 2009). However, the microphone used was of very high quality, and successfully captured the different voices of all participants. In the beginning of the interview, the interviewees were also instructed to speak one at a time. This fact, together with the quality of the microphone, made the video superfluous. Before the interview a set of questions were made. They were meant to help the discussion, and were used when the discussion came to a halt. The questions can be found in Appendix 1. All groups except for one attended the focus group.

A total of nine interviews, eight with the groups and one with the project manager, were conducted. They were semi structured because it allows the interviewee to give his or her opinion about a subject (Patel & Davidsson, 2011), it can help with catching unexpected perceptions (Bryman & Bell, 2007) and to allow for following up on new topics and insights (Edmondson & McManus, 2007). The interviews were audio recorded. The questions for the semi structured interviews can be found in Appendix 2. All groups attended the interviews but one member of one group did not attend.

The recording from the focus group and all the semi structured interviews were transcribed. This was done because it gives a more precise interpretation of any interview than other methods (Yin, 2009). It also helps tremendously with the analysis of qualitative data (Bryman & Bell, 2007; Höst, Regnell & Runesson, 2006; Patel & Davidsson, 2011; Denscombe, 2009).

The focus group and the semi structured interviews were conducted and analyzed by both researchers. By doing this, the data can be viewed in multiple ways (Eisenhardt, 1989) and it also reduces personal bias (Karlsson, 2009). The focus group and the semi structured interviews were held in Swedish, the mother tongue of all participants.

Interviews at the reference companies were also conducted. These were conversational interviews. Conversational interviews are not like usual interviews (Bryman & Bell, 2007). Instead, they are incomplete conversations that can be *"tied together as one statement"* (Dalton, 1959, p. 280). The researchers decided on conversa-

tional interviewing for the reference companies because it removes the need for audio recording and transcribing. That was feasible for this study, since the interviews were not used for the data collection. Instead, the interviews were used as input to the action research that was conducted at the planning meetings. Therefore, all that was needed from the case companies were notes taken during or immediately after the interviews.

3.5 Observations

Interviews are a fundamental source of data for case studies (Yin, 2009). However, interviews should be thought of as verbal reports, and therefore the interviewees replies could suffer from bias, poor memory and poor verbal expressions (Yin, 2009). For this reason, the author argues that interviews should be complemented by data from other sources. Therefore, observations were made at the planning meetings during the project. Observations are a good data collection method to combine with interviews (Patel & Davidsson, 2011). For example, an advantage with observations is that they are not dependent on the individuals memories (Patel & Davidsson, 2011), as is the case with interviews (Yin, 2009). Furthermore, Robson (2011, p. 321) means that participant observation might be useful in a small project when:

- *You work with small groups.* In this case, the group was 18 people (including the two researchers), which made getting to know the group manageable.
- *Events take a short time and are frequent.* Since the observed meetings were only 15 minutes long and held once a week, this criteria was met.
- *Activities are accessible to the observer.* The researchers were members of the project, and therefore this was not a problem.
- *The main motivation is to find out what is going on.* Since the research questions were explanatory, this criteria is met.
- *You have plenty of time.* The researchers worked with the case full time for 20 weeks, and therefore this was not a problem.

The observations were made by both researchers, which was done for two reasons. First, it allows the case to be viewed from different perspectives (Eisenhardt, 1989). Second, having multiple observers increases the reliability of the evidence (Yin, 2009). The observation technique that was used is called participant as observer. This is when the group is aware of the purpose of the observer, and when the observer tries to establish close relationships with the members of the group (Robson, 2011; Denscombe, 2009; Bryman & Bell, 2007; Patel & Davidsson, 2011).

3.6 Data analysis

The data from the interviews was analyzed through two different versions of what Langley (1999) calls "Visual mapping strategy". Paragraphs from the transcription from the focus group were marked with a marker in three different colors; blue if

a comment was positive, pink if it was negative, and yellow if it was neutral. The text was then written on sticky notes with the same color as the marker. The notes were then put on a wall or whiteboard, together with other comments regarding the same subject. This way, categories formed on the surface.

The semi structured interviews were analyzed in a similar way. Paragraphs in the transcriptions were marked with a marker with the same color coding as the focus group. The paragraphs were then cut out, resulting in almost the same raw data as the sticky notes from the focus group, but with a fraction of the work. The paragraphs were then placed in piles so that categories formed. The notes could then be played around with. It was easy to move a note from one pile to another if a new category emerged.

When the paragraphs were sorted into categories, they were translated and added to the report. When all paragraphs were in the report, they were gone through once more so that only the most relevant quotes remained. The quotes in the results section is therefore a selection made by the researchers. The quotes that were removed are stored in the case study database.

3.7 Yolean

The Digital visual planning tool that has been used in the case study for this thesis is Yolean. Just like Physical visual planning, Yolean consists of rows of resources and columns with time units (days or weeks). Virtual sticky notes are then placed in the intersections between the resource and the time unit to specify *who* will do *what* and *when*, see Figure 3.3.

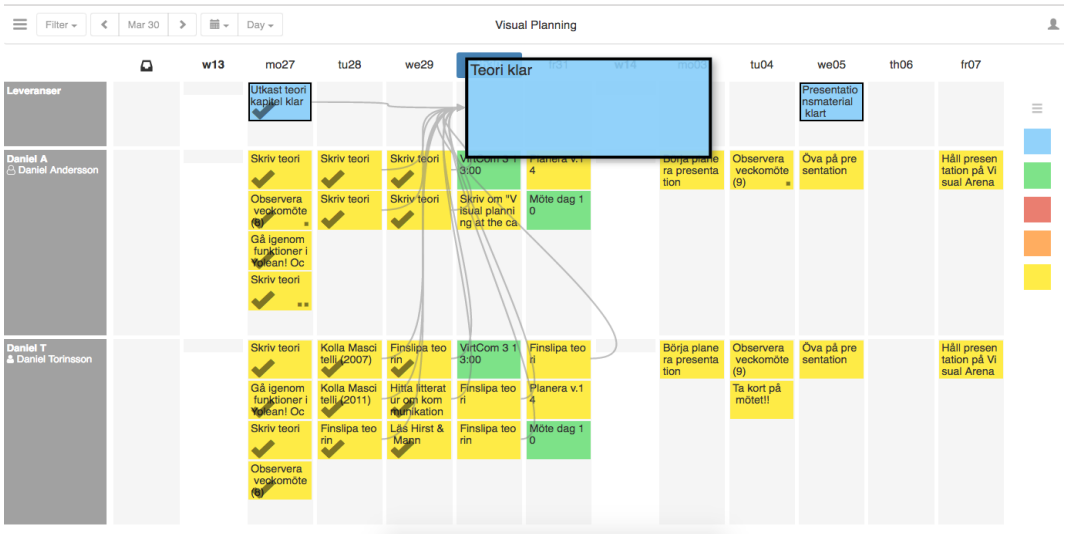

Figure 3.3: The interface in Yolean. In this view, yellow notes are activities (tick means *done*), blue with black border are milestones and green are meetings.

Yolean has been created by an associate professor at Chalmers University of Tech-

nology. Yolean has only been commercial for a few years but at the moment four people are working with developing the planning tool and six companies are using it. The software provides solutions for Visual planning, pulse status check and Checksheets (Yolean, 2017). According to D. Bergsjö (personal communication, 1 feb 2017), the intention of Yolean is to make the software as similar to sticky notes on a whiteboard as possible. The creators want to keep the software as simple as possible in order to retain the benefits with a regular whiteboard but remedy the disadvantages. Keeping the program simple also makes it easy to learn quickly. The most significant difference from the whiteboard is that Yolean is digital and can therefore be used at several sites at the same time.

3.7.1 Visual planning at the case project

The case study was performed on a team of students in the project Smart Factories. The whole team consisted of 18 people including the project leader. This team was a composition of eight different degree projects where every project (except for one) consisted of two people. Hereinafter the degree projects will be referred to as groups. Usually every single person have their own row in Yolean but in this project every thesis group of two people correspond to one row.

The case group had a meeting once a week which was held by the project leader. They used a 75 inch touch screen in order to support the meetings. The purpose of the meeting was to highlight issues and critical activities in order to share these issues before they became too big. Every group showed the activities they had completed the past week and which activities they had planned to complete the coming week. They should highlight if they had any problems or critical activities. The intention was to have a time limit for 15 minutes for the meeting. The participants stood up in a half circle in front of the touch screen for the whole meeting. A few high tables were available (see Figure 3.4).

After the common meeting everyone stayed in the meeting area so that every group could have a meeting with the project manager. Every group had a short meeting with the project manager where they had time for more specific questions if they had any issues that did not affect the rest of the group. This was also a way for the project manager to keep himself updated about every group. The other groups were still in the meeting area and then had time to do their own work and talk to other groups. This was also the time when the groups could discuss the issues that had been brought up at the meeting. In total the common meeting and the individual meetings with every group took about an hour to complete.

This project has some interesting characteristics, which are:

- The team members did not know each other beforehand.
- There is a given deadline. When the master's theses are finished by the start of June, this part of the project is over no matter the status.
- The groups are scattered and do not meet each other a lot outside the weekly

Figure 3.4: A weekly meeting at the case project.

meetings. This is interesting because literature differs between Physical visual planning (where team members are co-located) and dispersed teams, using virtual tools (Mascitelli, 2011). No previous study has studied a dispersed team using virtual tools as well as seeing each other face to face for a meeting once a week.

- The team members are degree students, which means that they will experience problems related to their thesis as well as to the project. For example, there is usually a period where the students experience a lot of uncertainty in the beginning of their thesis.
- The team members have never worked with Visual planning before.
- The team members start the project using the Digital visual planning tool Yolean.

3.8 Reliability and validity

In quantitative research, reliability and validity are fundamental for setting up and judging the quality of the research (Bryman & Bell, 2007). However, the authors claim that it is not clear how these concepts should be translated into qualitative research, as there are numerous ways to relate to these issues. The authors therefore adopt LeCompte & Goetz (1982) view on reliability and validity for qualitative research by writing about four related concepts, each expanded upon below.

External reliability is *"the degree to which a study can be replicated."* (Bryman & Bell, 2007, p. 410). This is, according to Bryman & Bell, a challenge in qualitative research since it is difficult to replicate the setting of the initial study. Their recommendation is that qualitative researchers *"needs to adopt a similar social role to that adopted by the original researcher. Otherwise what a researcher conducting a replication sees and hears will not be comparable to the original research."* (Bryman & Bell, 2007, p. 410). The researchers believe that the description of the case and methods used is sufficient for a future researcher to be able to at least to some degree replicate the study, although it will always be impossible to replicate the exact setting.

By *Internal reliability* the authors mean that the researchers (if there are more than one) are unanimous about their observations. This has been done in this study, as all observations and findings from the interviews have been discussed between the two researchers.

Internal validity is a measurement of how well the the researchers' observations and their developed theories match (Bryman & Bell, 2007). This is usually an advantage with qualitative research, since the extended involvement in the setting of a group permits the researcher to match concepts and observations to a high degree (LeCompte & Goetz, 1982). The researchers believe that the internal validity of this study is strong. As all meetings have been observed (one every week for 20 weeks, which was the entire duration of this part of the project) the researchers have spent as much time as possible with the team.

External validity is to what degree the findings can be generalized (Bryman & Bell, 2007). This is usually a difficulty for qualitative researchers since the studies commonly consist of case studies and small samples. Just as Bryman & Bell point out, the external validity of this study is not considered to be strong. As this case has some very specific characteristics, the researchers believe that it will be difficult to generalize the findings from this study. Therefore, the conclusions are not very audacious, as they specify what was found in *this* case, not what will be found in every team that uses Visual planning. The sample for the interviews is small (15 individuals), but that was also every individual in the unit of analysis, except one who did not attend the interview.

3.9 Discussion of the methodology

There are some variations of the methodology that could have been used. To compare Digital visual planning to Physical visual planning, a multiple case study with two cases would have been a viable option. However, there were no cases on Physical visual planning available when this study was executed and therefore this was not feasible. A multiple case design could also have been used in order to study several teams at different companies. For example, the reference companies (as discussed in Research process) could have been considered case companies and therefore studied in more detail. Yin (2009) argues that one rationale for using a single case-design is when the case could be considered unique. Since this case has many features that are unique (for example, this is the only study that the researchers have found where a team uses Digital visual planning from start to finish), the justification for using a single case design is strong.

Data from the focus group was never used in the final data analysis. The focus group was conducted early in the project and therefore many of the replies were hypothetical and of no use to the results. Instead, it was considered as more of a preliminary interview, where the interviewees had an opportunity to give their impressions and suggestions on the Digital visual planning tool. These suggestions were then taken into account to aid in the action research. The focus group also allowed the researchers to come up with new research questions and subjects to focus on in the coming observations and the final interviews.

3.10 Ethics

The results were based on data from interviews and observations. All the interviewees were informed of the conditions of how the material from the interviews and observations would be used. The interviewees were informed about the following conditions:

- The interviews will be recorded.
- The researchers are impartial.
- The material from the interviews will only be used for this report.
- The material from the interviews has to be saved in a case study database in order to maintain a chain of evidence.
- The interviews will be anonymous. When the interviews are transcribed your names will be replaced by a random letter.
- The interviews will be performed in groups of two since you are working with your thesis in groups of two, with two exceptions (the project leader and one student who is writing the thesis alone).
- If you mention your group members name, the name will be transcribed with the anonymous letter in order to keep the anonymity of the group. If you mention a name from another group this name will still be written as it was said since this will not risk the anonymity of your group.

- If there is something you have said in the interview that you do not want us to save you have the ability to tell us and we will delete it.
- The only thing that will be used from the observations is the researchers own notes which can include anonymous quotes.
- The report will be public.

4
Results

The following chapter will present the results and findings from the performed research. The chapter mainly contains empirical results from the observations together with findings and quotes from the interviews. The quotes are divided into headings corresponding to the prerequisites of implementing Visual planning, which are mentioned in the Theory chapter.

4.1 Findings from the observations

The observations were part of the action research which means that a few changes were made for the weekly meeting. The issues that were observed and the changes that were performed half way through the study is presented in the bullet list below.

- **The view on the screen** during the meeting was changed. In the beginning every group changed the view so their own detailed view was shown on the screen when they had their time in front of the group. It was a waste of time to change the view but it was also noticed that people lost some interest when a view was shown that they were not really a part of. Because of this the view was changed so that the overview was shown the whole time. This made it easier for the rest of the group to see their participation.
- **A software update** easily solved the issues with the screen. The update made it a lot easier to use the touch function and changing views on the screen was not a problem any more.
- **How the groups were placed** around the screen was something that was changed after a few meetings. In the beginning the project leader remained by the screen in front of the group for the entire meeting for a few reasons. He was changing view on the screen by using the computer next to the screen because the touch function did not work as expected. What was observed was that every groups presentation became more of a conversation between the current group and the project leader instead of a presentation for the other groups. In order to change this the project leader changed position so that he became part of the group.
- **The groups were told to get a little closer to the screen** when it was observed that the group could not really see the screen and it was also observed that several groups were a little uncomfortable with standing in front of everyone. When the groups came closer it was observed that every groups presentation became less formal.

- **The way the software was used by the groups** was a little different in the beginning. It was observed that the different groups were a little confused about how the other groups used Yolean. The groups used different colours for the same things and had decided their own way to use the software. This was changed by giving every group a template for how Yolean should be used in this project. The template was created with experience from the group members opinions.

Notes on the technology.
These notes are from the note book used during all the meetings. They are presented in chronological order in Table 4.1.

Table 4.1. Notes from the weekly meetings regarding the technology.

Date	Note	Comment
14/2	The screen is slow, people are laughing. it's hard to scroll	
1/3	Touch doesn't work properly, people laugh and giggle. Fix the scroll! Or use computer?	
7/3	Mouse doesn't work, giggly. Computer locks down. Need to have a good computer. It's not good when the technology doesn't work. A physical board would have been better here.	
20/3	The computer was lagging today. The touch didn't work properly. Dag believes it's a driver. Finger doesn't work. R complains that it's lagging when you draw. Dag says that it's as good as it gets. New drivers, touch with the finger is working. Touch, 4K, drawing with pens is working! The computer can't handle 4K so we have to wait for the gaming computer.	After this meeting Dag, our supervisor helped us install a driver.
27/3	Touch worked well. There was no problem whatsoever to run everything from the screen. Right click, switch between menus and views, everything worked.	This was after the software update.

Date	Note	Comment
5/4	When I was showing "Add row" the right click didn't work. People started to giggle right away.	
11/4	Giggles IMMEDIATELY when the touch didn't work when R tried to press a blue note.	
19/4	I went into SP and then back to overview. No settings were saved so we had to remove empty rows, change from 12 to 6 weeks and zoom in.	

4.2 Findings from the interviews

The findings will be presented by quotes from the interviews. If the quotes are not separated with a blank line, it means that the group members were answering the question together.

4.2.1 Communication

All the interviewees said that they have appreciated the weekly meetings. Every group mentioned that they have had some need of communication with the project leader and with other group in some way. Two groups explained that hearing what other groups are doing and what they have done, more than once has resulted in immediate problem solving. They said that some things that have been brought up at the meetings have been useful for them and that these would probably not have been brought up without the meeting, because they did not know that other groups had any information about it.

"So this could have been a thing that you wouldn't have gotten to know otherwise, maybe you wouldn't have sent an email and asked everyone because you would have expected that no one knew anything about it."

Another quote that support this is:

"If we had only asked the project leader and if he would have said "no I haven't done that" and then we would just have assumed something, so that is very good that the other group could give us something."

Two groups said that the communication with the other groups at the weekly meetings resulted in decreased communication need outside the meeting like sending emails and making phone calls.

"...partly because you get a chance to ask things that are too small but perhaps important but that aren't big enough to take via email and stuff like that. So I think the regular meetings are really good."

All the groups mentioned that the time with the project leader at the weekly meeting has been very valuable. One group explained how the project leader gets the information from every group at this weekly meeting and how that affects how the project leader can help them with this information.

"...and the project leader get the information by talking to every group so I think the combination of the project leader communicating with everyone has been very useful for us too. So we could have just seen the project leader one week and skipped the weekly meeting..."

The groups were talking about how the communication need has changed during the project. Most of them said that they did not feel the need of it in the beginning because they just need some time to start their own thesis and did not know about deadlines and deliveries. After the start up the answers differs a bit but one group explained how they have perceived the need of communication.

"No I mean the need now is... Now, now you have the communication need in a completely different way. In the beginning it was more about starting up and get the groups to concrete what they were supposed to be doing themselves, get them going. [...] Now it's a real communication need because now things need to start to match up. So that now... That need has changed a lot."

4.2.2 Coordination complexity

Most of the groups expressed that their work has not been connected to and dependent on other groups. They said that they could see the need for this type of planning when they are more linked to each other which has not been the situation in this project, according to the interviewees. Two groups said that there was a few times when they felt that they were connected to other groups, but the overall opinion was that the groups were not linked to each other.

"It was because we didn't feel any need to use it since our project was a little outside the others. And we thought that... We might as well use something else. Something that we... That we already know and are used to."

One group said that they felt that the other groups were more linked to each other:

"Yes exactly, that you are more, what do you say, connected to the others, you get what I mean. Yes, like many of the other groups here, then I think the need would increase because then you see that you have to deliver something so someone else can move on."

And the following quote supports the previous one:

"That would be if it was connected to another group. Like, the other groups. Because then you are more dependent on each other. Then you want to know what they are doing so you can synchronize."

4.2.3 Team members' competence span

No observations of groups taking over another groups tasks were made. Some questions in the semi structured interviews with the groups were aimed at finding if the groups were able to share tasks. However, most answers were hypothetical. Every group except for one thought it would have been possible, at some point, to do some work for another group or let another group do some work for them. The only exception was this group who felt that they had too much of a checking need to be confident with letting another group do their work.

"Yes... But then it has to be really clear, or yeah, otherwise you have to talk about it too but we could have done some of their stuff. But then it depends entirely on what it is. We can't do any other groups' to be honest, it's only them."

The group member with too much checking need said that:

"I think I have too much of a checking need. For it to work. Or it depends. If I would have been really stressed out over something and had a lot to do then... Then I would have liked it."

4.2.4 Team members' distance

This section is divided into two parts which both add to the results concerning the distance between the team members.

The digital tool
The interviewees expressed that they appreciated the fact that the tool was digital, which made it portable and therefore possible to use anywhere. Two groups said that it was good to be able to use it at home.

"It is very nice that it is digital. That you can take it with you everywhere."

A group that were used to plan said:

"I think it has worked well for us. We have always planned pretty thoroughly, and I think that it has been nice to be able to do it from home and have it more lucid."

One interviewee expressed the advantage of the tool being digital:

"The biggest advantage for me is that you can take it with you anywhere, it is portable. So that I can be at home or here or.."

The interviewees did not have any experience of Visual planning but some groups expressed that they could not grasp how they would be able to use the method with a physical board.

Getting to the meeting
The interviewees responded that getting to the meeting has not been a problem for them, even though team members were spread out in the city. Almost every group said that they had some kind of connection to the place where the meeting was held. One of the interviewees was passing the place anyway on her way to their company. Two groups said that they were already close to the meeting area. Some of the groups said that they had no connection to the meeting area at all but still appreciated the place so they did not have any issues with getting there.

"It has not been a problem at all. I have to go somewhere anyway, so it has not been a problem. It's a good place, too."

The group that usually was nearby the meeting place said that:

"No it has not been a problem."
"No we go to classes here at Lindholmen normally."
"The meetings are often on days that we have... It is Monday, Tuesday or Wednesday and those are days we have classes so we have to get here anyway. And also neither me or P cares about that... It is not a... We go where we need to go, it is not a problem there is no point in putting too much thought into that, it doesn't help."

4.2.5 Individual planning tool

The interviewees mentioned a few different reasons for how they experienced the use of the planning tool on an individual level. They said that breaking down their work into activities made it easier to know that to do and when to do it. Some groups also mentioned that they preferred Yolean over other tools.

"Yes, I think putting up activities and stuff like that is good, when you do it. So that you divide the work into parts and know approximately what to do. So that you don't have like ten different things going and don't know exactly what you're supposed to be doing."

One group said that, by using the tool they did not need to have as many things in their heads:

"Well I believe that it is nice that you write it down in some way there and then you don't need to think about it anymore. At least I work like that, if I write it down it disappears and it's there instead so it's nice in that way."
"Yes I thought it was nice to put all the deliverables up so you know when to do what... Time wise."
"It helps you focus on one thing at a time, because if you have everything in your head, like 'we have to do everything', 'we have to do this' and then you start and you browse your drawings and then you see these little things that you have to fix but you are not supposed to do it now. Then it becomes jumpy. It's enough to have something that says 'first we do this note, then we do this note'. It gives you some focus during the day I think."

One group changed their opinion about Outlook when they got used to Yolean:

"Yes before we used Outlook a lot but now we don't use it at all."

4.2.6 Cohesion

The interviewees said that the weekly meeting created a team feeling and also generated a feeling that you are part of something bigger than your own project. They also said that it was important to get to know the other groups.

"Yes but it feels like you get some team feeling, when we see each other every week. That you are part of a bigger project. Not only work with your own thing all the time. So that's, I think that's good."

This quote adds some benefits by seeing the other groups:

"It is, I think it's very good when you are part of a bigger project because then you keep track of how the others are doing and what they are doing. Then you can bounce ideas and if you have questions and it's really good that people can realize... Or when you talk in front of the others maybe people have contacts to someone that you need to have contact with that you didn't think about before and like, in that way it's smooth."

Some groups especially appreciated the time after the common meeting. Then the groups got the opportunity to talk to each other and bring up questions.

"Mm, I think it's been very good. Especially when you.. After, or yeah after you have the stand up meeting you have been able to sit down with the other groups and been able to talk before the meeting as well."

Some interviewees also expressed that it was fun, interesting and important to see how the project was progressing, even if the information did not affect them directly.

"Yeah... No but... It's kind of nice to hear... Even if it's not exactly what it is, I guess it's nice to hear what the other groups are doing and kind of seeing how it's going... The work is going forward. If people are managing, if people are not managing, if it's stressful, not stressful. It's nice to just know that... If it should be stressful, then it's 'alright, we're not the only ones who are stressed out'. Or... Yeah they're doing fine, we're doing fine. Or.. Ok then maybe we're on a... Or doing adequate work, kind of. So it's... It's a bit hard to explain but it's... It's just fun, interesting, nice to know how everyone is doing."

5
Discussion

In this chapter the results will be summarized and discussed. This chapter contains the researchers interpretations of the results.

5.1 Implementing Digital visual planning

Implementing Digital visual planning can either imply to take the step from Physical visual planning or, like in this project, implement it to a group of people without any experience of Visual planning. Physical visual planning is already used at many companies so if they are going to take the step from Physical to Digital visual planning they must see how that would be better for them. The two following sections will present the findings in this work for how Digital visual planning can remedy the disadvantages with Physical visual planning and also how the benefits with Physical visual planning can be preserved.

5.1.1 Remedy the disadvantages of Physical visual planning

In the Theory chapter Lindlöf & Söderberg (2011b) give three examples of weaknesses that occur when the method of Visual planning is physical. These disadvantages have been researched in this thesis in order to see if they can be remedied by using Digital visual planning. The disadvantages can be seen in the bullet list below.

- *Visual planning does not work when the team is scattered globally. This is simply because a physical board is difficult to copy to another site. This problem can be remedied by using a digital tool (Mascitelli, 2011).*

  This study confirms what Mascitelli (2011) mentioned, that the problem can be remedied by using a digital tool. People in this project have not been sitting next to each other. Since the planning tool is digital everyone can look at the planning board as long as they have internet connection available. The board is automatically updated as soon as a change is made so it never has to be copied to another site.

- *Sticky notes are thrown in the bin when they are completed. This problem could be remedied by putting the completed sticky notes in a note book (Mascitelli, 2011).*

Saving the notes is nothing you have to think about when using a Digital planning tool. The notes are saved automatically so if you need to look back for some reason the notes will be saved forever. The problem can also, just as Mascitelli (2011) points out, be solved with a note book when using sticky notes. However, the researchers opinion is that using a virtual tool is easier for this purpose.

- *There are no links between the sticky notes, so if a milestone is moved it is difficult to see the impact it has on other milestones. This problem can also be remedied by using a digital tool (Lindlöf & Söderberg, 2011b).*

  The observations at the case companies show that sticky notes can be linked in many different ways, for example by using a code system written in the corner of the sticky notes or simply drawing lines between the notes. All the methods to link notes that have been observed become complicated when there are too many links, notes have to be moved or notes are removed or added. Linking notes in a digital tool remedies all these disadvantages. There is no limit for how many notes that can be linked, the notes will remain linked when a note is moved and the linked notes will not be affected when notes are removed or added.

5.1.2 Preserving the benefits of Physical visual planning compared to Digital visual planning

The benefits with using Physical visual planning compared to Digital visual planning according to Parry & Turner (2006) were presented in the theory chapter. The first research question aims at investigating how these disadvantages can be remedied. If Physical visual planning should be replaced by Digital visual planning the benefits with Physical visual planning have to be preserved to a high degree. The benefits with Physical visual planning and how they can be preserved with Digital visual planning are presented in the bullet list below.

- *A physical board has a limited space, which entails that only value bringing notes are placed on the board.*

  It is important that everyone using the digital board is aware that only value bringing notes should be added. The digital board should not have a limited space because it is difficult to know how many notes that will be needed. However, the unlimited space can make it inviting to add unnecessary notes.

- *No one will become an expert of using the physical board. The physical board is easy to use and does not have any special features that entails that a few persons will become superusers of the planning tool.*

  The Digital visual planning tool has to be easy to use so that anyone can learn to use it after a short introduction. There should not be a lot of features

that only an experienced user will be able to use. Keep it simple because the simplicity is fundamental.

- *The physical board makes it easy to display all the data which makes links and connection between activities easy to spot.*

  It must be easy to display the data on the screen with the Digital visual planning tool. A big screen with a touch function is to prefer since that makes the screen easy to use and the size makes it easy to display the planning over a couple of weeks.

- *The physical board will always work. It does not need anything external, like electricity or internet, to work impeccably.*

  Observations show that this can be an issue with the digital board. With high quality technology (screen, internet connection etc.) this risk can be reduced to a minimum.

Holmdahl (2010) also present a list with benefits with Visual planning that he has experienced from companies (see page 10). This study can neither confirm or deny the benefits that he has found.

5.2 The prerequisites for implementing Digital visual planning

Communication need - Confirmed
The communication can consist of information such as "what I did last week" and "what I am going to do this week".

When the team members discuss things that are not necessarily problems, something interesting happens. People start thinking about things that they might have missed or something that they should do. Several times during the project, details that would have otherwise been missed have been brought to the surface. This means that contrary to previous theory (see Catic et al., 2016), you do not only have to talk about problems or deviations during Visual planning meetings. It seems to be preferable to fill your meeting time as often as you can, as long as you can keep it to 15 minutes. When all the team members have been gathered at the meeting, it could be considered a waste to run through the meeting as fast as possible and skip maybe 5 or 10 minutes by only looking at the deviations. These minutes could be crucial to reveal problems that would otherwise be hidden. Therefore, the communication need found in this study is not the same as in Lindlöf & Söderbergs (2011a) prerequisites. Instead, the communication need can come from an interest about the project as a whole. As several interviewees pointed out, the meetings led to a better understanding of what every group was doing. This could lead to increased emotional commitment and possibly increased performance for the entire

team. However, this is not proved in this study.

A reason for this change in communication need could be that many of the team members in this study did not meet each other except for the weekly meetings. Because of this, they did not get the time together that regular project groups have, for example by the coffee machine or in the lunch room. Therefore it is possible that the team members in this study felt a higher need to communicate at the meetings, as that was the only time where they could find out what the other groups were doing.

Coordination complexity - Confirmed.
More coordination complexity seems to lead to increased need to use Visual planning.

Team members' competence span - Plausible.
This prerequisite is not confirmed nor denied. The replies on questions regarding workload leveling were mostly hypothetical and not believed to be strong enough to use as evidence.

Team members' distance - Denied.
The digital tool allows the team members to use the tool wherever they are. It does not matter if they are at home or 100 meters from the board, as they can always take a look at or update the board. It is possible that when the team members can use the tool from wherever they are, the reluctance against getting to the meeting once a week is lowered. No interviewee reported that it was difficult to get to the meeting once a week, even though the board was placed in a facility detached from where they would usually work on their thesis. In fact, none of the data suggests that Team members' distance should be considered a prerequisite for implementing Digital visual planning. As this is a single case study on a team using Digital visual planning, it is impossible to know the reason for this result. It could be social factors, for example that the cohesion of the team made team members want to come to the meetings. Note that this study does not state that a digital tool removes this prerequisite. It simply states that no evidence for why the prerequisite should be present were found. To prove the correlation between Team members' distance and Digital visual planning, an experiment or a multiple case study should be conducted, see Future research. An implication from the nature of this study is that the team members did indeed meet face to face once a week. It is possible that if they would have been a virtual team, i.e. never seeing each other except through the lens of a camera, the method would not have worked as well.

Level of cohesion
This prerequisite is a new addition to Lindlöf & Söderbergs (2011a) prerequisites. It stems from evidence showing that cohesion is important when considering a team, a factor that Mascitelli noted: *"Gathering a project team together several times per week for face-to-face discussion and planning has benefits at many levels, not the least of which is the building of team identity and emotional commitment."* (Mascitelli, 2011, p. 112). Many of the interviewees reported an increased level of cohesion

through the meetings. Therefore, this study shows that if used in a team with the same characteristics as the team in this study, Digital visual planning can improve the cohesion. It is possible that this is only needed for a team with low cohesion, for example if the team is new or not working as it should. It is also possible that this prerequisite only needs to be taken into consideration if the team does not meet outside the meetings. The level of cohesion is considered a prerequisite, because if the cohesion in a team is low for any reason, Digital visual planning could be used to increase it. The level of cohesion is therefore both a reason to use Digital visual planning (if the cohesion is low to begin with) and a result from using the method. This relation is similar to the communication need identified by Lindlöf & Söderberg (2011a), where communication was shown to be both a prerequisite and a result.

A valid argument would be to consider this prerequisite to be the *lack* of cohesion, not the level of it. This is however just a play on words, because if a team lacks cohesion to a high degree, it is probably because they have low cohesion to begin with. With the same reasoning a team that does not lack cohesion probably already has high cohesion.

Theory on cohesion seems to indicate that increased cohesion leads to improved project performance. This relation is well researched and confirmed through numerous kinds of studies, including quantitative studies, qualitative studies and meta analyses. It should not be considered as too far fetched to draw the conclusion that Visual planning, with the increased cohesion that it seems to result in, should also increase project performance. However, as this relation was not the focus of this study, the researchers have not researched this relation sufficiently and will therefore not be able to draw this conclusion confidently.

5.3 Visual planning for individual planning

When the team members in this study left the meeting their board was already updated. Therefore there was no need to enter the information into their own calendars as well. Some team members even reported that during the project they stopped using secondary calendars like Outlook in favor of Yolean. For this reason, contrary to previous theory on Visual planning, Digital visual planning is believed to reap benefits on the individual *and* the team level, as it can be used as a personal to do list and calendar. Several benefits with planning and breaking tasks down into components were mentioned in the Theory chapter. Therefore Digital visual planning could be used by students to improve time management, reduce stress levels and reach higher scores.

6
Conclusions and future research

This chapter reconnects to the purpose of this study and presents the answers that have been discovered for the research questions.

The purpose of this study was to increase the research about Digital visual planning, with the aim to show that virtual tools may not be defunct. The purpose and aim was formulated into two research questions, which are:

RQ_1: How can Digital visual planning be used to remedy the disadvantages of Physical visual planning?

RQ_2: What are the prerequisites for implementing Digital visual planning?

The research questions were investigated through a case study on a team using Digital visual planning. Interviews and observations were used to capture the perceptions of the team. Two main conclusions can be made.

First, *Digital visual planning can successfully remove all three known weaknesses with Physical visual planning, but adds one new weakness, which is the delicacy of the technology that is used.* The benefits with Physical visual planning can be preserved with Digital visual planning but is not automatically kept when Digital visual planning is implemented.

Second, *the prerequisites for implementing Digital visual planning are not the same as the prerequisites for implementing Physical visual planning.* No evidence of team members' distance being a limiting factor for implementing Digital visual planning was found in this study. However, this study does not prove if this is because of the digital tool or other factors. The analysis also shows that, as every team is not the same, team characteristics such as communication need and cohesion have to be taken into account when deciding what to bring up on Visual planning meetings. The recommendations for how to use Visual planning should therefore reflect the characteristics of the team instead of a one size fits all solution. The prerequisites are presented visually in Figure 6.1 below. Note that *Team members' distance* is crossed over since no evidence that supports the prerequisite was found. *Team members' competence span* is between brackets since it was not confirmed nor denied. Level of cohesion is added since it is a contribution from this research.

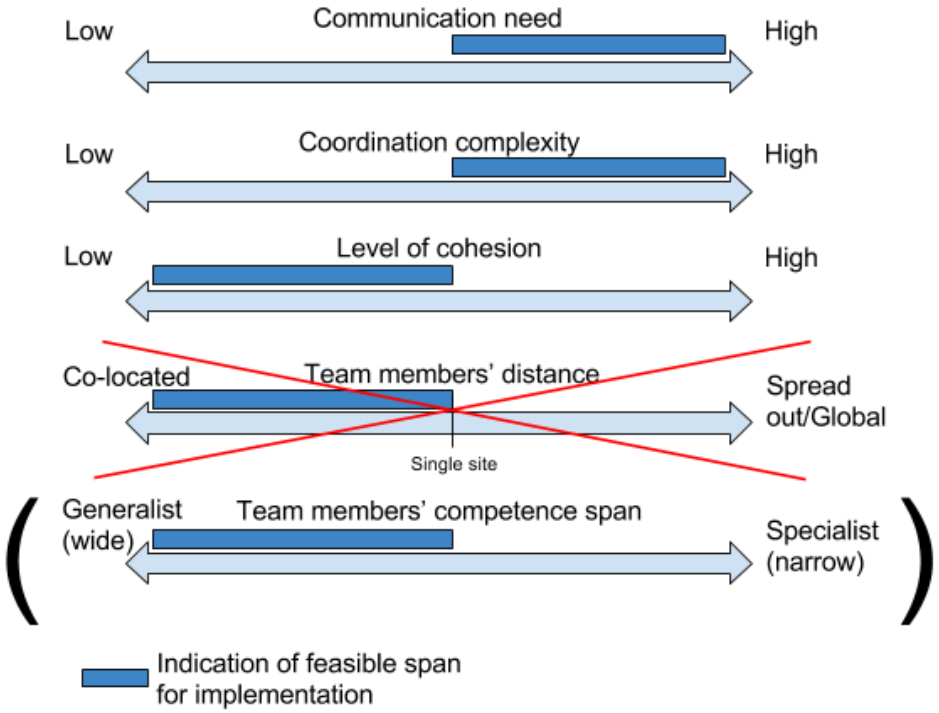

Figure 6.1: A visual representation of the prerequisites for implementing Digital visual planning. Based on work by Lindlöf & Söderberg (2011a)

6.1 Contributions

Parker & Davis (1997) present four contributions that a dissertation can make. This thesis is not a dissertation, but the researchers believe that the same framework can be used for a master's thesis. The types of contributions presented by Parker & Davis are:

1. New or improved evidence
2. New or improved methodology
3. New or improved analysis
4. New or improved concepts or theories

The methodology and the analysis used in this study are similar to previous studies. The contributions from this thesis are therefore mainly new or improved evidence and new or improved concepts or theories.

First, the study contributes to the research about Visual planning by showing that contrary to Söderberg (2012) the end of the road when it comes to using virtual tools in Visual planning has not been reached. This is because, as the study shows, all known weaknesses with Physical visual planning can be remedied by switching

to Digital visual planning.

Second, the weakness with Digital visual planning that was found in this study is something that has not been researched before and therefore a new addition to the field.

Third and last, the study contributes to the research on Visual planning with a framework for judging when Visual planning can be worth implementing in an organization. This framework only existed for Physical visual planning prior to this study.

6.2 Future research

Visual planning as a method is not very well researched, and Digital visual planning in particular is still in its infancy. Therefore, this study needs to be verified by additional studies, preferably quantitative studies that can confirm the results from this study. Another interesting way to study the difference between Physical and Digital visual planning would be a multiple case study or an experiment that compares two teams; one that works with Physical visual planning and one that works with Digital visual planning.

In a world where more and more companies turn to a global structure, more research needs to be done on virtual teams using Digital visual planning. This study confirms the superiority of using a Digital visual planning tool over a physical one when teams meet face to face regularly. However if the team is global this is not possible, hence studies on globally dispersed teams should be done to confirm this relation.

This study took the first steps on Digital visual planning as a method for individual planning. An interesting research area would be to compare individuals who plan their work using Digital visual planning and map their performance compared to individuals who do not plan at all.

An interesting finding in this study is the increased cohesion that Visual planning brings to a team. As was mentioned in the Discussion, this could lead to increased project performance. This relation should be researched further and preferably be verified through quantitative studies that investigate cohesion and project performance simultaneously.

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A

Appendix 1

A.1 The framework for the semi structured focus group

- Hur har ni upplevt att arbeta med visuell planering?
  - Nackdelar
  - Fördelar
- (RQ1: Effektivitet och tydlighet)
- Hur många gånger (i snitt) använder ni verktyget per vecka?
- Har ni upplevt något behov av användningen av visuell planering?
- Tror ni att behovet kommer ändras under projektets gång.
- Vad skulle krävas för att ni skulle känna ett ökat behov?
- Hur tror ni att det hade varit att arbeta med visuell planering om tavlan varit fysisk här på Lindholmen? (Whiteboard med post-it)(RQ2)
- Är det någon som har använt eller sett visuell planering förut?
  - Erfarenheter
- Vad skulle krävas av verktyget för att ni skulle vilja använda det i ett kommande projekt?
- Vad är viktigt för att veckomötet skall kännas värdefullt? om ni fick ändra vad ni vill, vad skulle ni ändra då? (möten, Yolean, skärmen, projektledare)
- Allmänt, övriga synpunkter, kommentarer eller frågor till oss.

B

Appendix 2

B.1 The framework for the semi structured interviews

- Frågor: Fråga om små-mötena efter
- Hur har ni upplevt att arbeta med visuell planering? (Ni och teamet?)
  - Nackdelar
  - Fördelar
- Hur har det varit att arbeta i Yolean nu efter förändringarna?
- Hur skiljer sig er användning nu jämfört med innan? (Mer eller mindre, annat arbetssätt etc.) Varför tror ni att det är så?
- Hur har ert behov av att använda Visuell planering ändrats under arbetets gång?
  - Tror ni att behovet kommer ändras under projektets gång?
  - Vad skulle krävas för att ni skulle känna ett ökat behov?
  - Förutsättningar för att implementera Digital Visuell Planering
  - Hur stort behov har ni av att kommunicera med de andra grupperna och Richard?
  - Hur stort behov har ni av att samarbeta med de andra grupperna och Richard?
  - Hur är er arbetsbelastning? Skulle ni ha möjlighet att utföra någon eller några aktiviteter åt en annan grupp? Skulle ni vilja att en annan grupp gjorde någon av era aktiviteter?
  - Hur tycker ni att det är att ta sig till mötet varje vecka?
- Hur tycker ni att våra veckomöten har fungerat?
- Hur har det känts att berätta vad ni har gjort? Hur har ni upplevt att lyssna på andra?
- Vad skulle ni vilja berätta på mötena? Vad skulle ni vilja att de andra grupperna berättade?
- Vad har ni fått ut av mötena? Hur har mötena påverkat teamets sammanhållning?
- Om ni fick ändra vad ni vill, vad skulle ni ändra då? (möten, Yolean, skärmen, projektledare)
- Allmänt, övriga synpunkter, kommentarer eller frågor till oss.