Designing a Tool for Improved Decision Documentation in Collaborative Projects

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DIVISION OF ERGONOMICS AND AEROSOL TECHNOLOGY | DEPARTMENT OF DESIGN SCIENCES | FACULTY OF ENGINEERING LTH | LUND UNIVERSITY | 2021

MASTER THESIS

yolean

Designing a Tool for Improved Decision Documentation in Collaborative Projects

A visual approach to better decision management in the design phase of construction projects

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Abstract

When working in collaborative projects with team members with different expertises, often from different companies, communicative and collaborative challenges that obstructs decision-making can arise due to team members having different objectives. In order to avoid problems and conflicts, good documentation of decision related information is required.

The project was performed at Yolean AB, a company that provides a digital tool for visual planning which is used by many companies within the construction industry, and the project was carried out with a human-centered design approach. The decision-making process during the design phase of construction projects was explored through both observations and interviews, investigating what challenges and needs existed regarding the handling of decisions in collaborative projects.

The user study findings showed that even though there are specific decision-making meetings, decisions are also made during other meetings such as focus meetings, creating a gap in cohesive and proper documentation of the decisions made. The decision-making meetings are often ineffective since not all decisions are properly prepared, and time consuming discussions arise during the decision-making meetings.

Through three iterations, a feature in Yolean, the digital tool for visual planning, was designed and evaluated, to meet the needs and requirements found during the user study. The aim of the design was to facilitate the documentation of both the decision-making meetings and the focus meetings, and the final design includes two different kinds of meeting pages in Yolean, one for decision-making meetings and one for focus meetings. Both types of meetings are thereby documented within Yolean, which will give the design manager better control over all decisions made throughout the construction projects.

The project resulted in an interactive prototype that was designed and tested through scenario-based testing on both design managers, which are the potential users, and on users without previous experience of Yolean. Both the user studies and the user tests had to be adapted to be performed remote over video calls. The tests showed that the design was easily understandable and had good usability, and would both make decisions better documented and easier to find, and the meetings more effective.

Keywords: Decision management, collaborative projects, construction design phase, visual planning, usability, interaction design

Sammanfattning

I samarbetsprojekt med gruppmedlemmar med olika kompetens, ofta från olika företag, kan utmaningar i kommunikation och samarbete uppstå, som sätter hinder vid beslutsfattande på grund av att gruppmedlemmarna har olika mål och avsikter. För att förhindra problem och konflikter är det viktigt med god dokumentation av beslutsrelaterad information.

Detta projektet genomfördes på Yolean AB, ett företag som tillhandahåller ett digitalt verktyg för visuell planering som används av många företag inom byggbranschen, och projektet genomfördes med en människocentrerad designprocess. Beslutsprocesser i projekteringsfasen av byggprojekt studerades genom såväl observationer som intervjuer, och undersökte vilka utmaningar och behov som fanns när det gällde hanteringen av besluts i samarbetsprojekt.

Användarstudien visade att även om projekten har specifika beslutsmöten, så fattas beslut även på andra möten så som fokusmöten, vilket skapar en lucka i den sammanhängande och korrekta dokumentationen av fattade beslut. Beslutsmötena är ofta ineffektiva eftersom alla beslut inte är ordentligt förberedda, och tidskrävande diskussioner förs under beslutsmötena.

Genom tre iterationer designades och utvärderades en funktion i Yolean, det digitala verktyget för visuell planering, för att möta de behov och krav som identifierats under användarstudien. Syftet med designen var att underlätta dokumentationen av både beslutsmöten och fokusmöten, och den slutgiltiga designen innehåller två sorters mötessidor i Yolean, en för beslutsmöten och en för fokusmöten. Båda typen av möten dokumenteras därmed i Yolean, vilket ger projekteringsledaren bättre kontroll över alla beslut som fattas i byggprojekten.

Projektet resulterade i en interaktiv prototyp som testades med hjälp utav scenarion på både projekteringsledare, som är de potentiella användarna, och på användare utan tidigare erfarenhet av Yolean. Både användarstudierna och användartesterna var tvungna att anpassas för att kunna genomföras på distans genom videosamtal. Testerna visade att designen hade bra användbarhet, och skulle förbättra dokumentationen av beslut och göra dem lättare att hitta, samt skulle göra mötena mer effektiva.

Nyckelord: Beslutshantering, samarbetsprojekt, projektering, visuell planering, användbarhet, interaktionsdesign

Acknowledgements

Even though I executed this project on my own, I was never alone throughout the project, and it could not have been accomplished without the help of everyone involved along the way.

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Lastly, a special thank you to everyone who has let me into their projects to observe meetings and project days, and to everyone who have been interviewed and participated in user tests. Without the users, this project would have been nothing!

Gothenburg, April 2021

Idun Davidsson Bremborg

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1. Introduction

This chapter sets up the context of this project, and provides the aims and delimitations of it.

In any development process, whether the development is concerned with a new innovative product, a service, or building a new house, decision-making is crucial for the progression of the project. The study of decision-making becomes especially important as these kinds of projects more often than not are of a collaborative nature, meaning that the team is made up of people from various disciplines, often from various companies.

Despite all the benefits that comes with working in collaborative projects, there are also some challenges when a team consists of different expertises, with different objectives. The different objectives are often conflicting, resulting in a more complicated decision-making process (Eriksson, 2009).

Visual management has the potential to increase the transparency in projects and thus enhance the processing of information, and studies shows that it also can support communication between individuals with different knowledge and perspectives (Lindlöf, 2014).

The construction industry is a sector with a lot of experience of multidisciplinary collaborative projects. Projects, in which decision-making and communication can be a real challenge. Therefore, it is an interesting branch to look further into when studying collaborative projects and decision-making.

This project is a part of Kidsam, a research project at Chalmers University of Technology, funded by Vinnova. Kidsam stands for Knowledge and information sharing in collaborative projects, with the goal to *"demonstrate methods for enabling secure digital collaboration for customized knowledge sharing in an extended supply chain"* (Vinnova, 2018).

The Kidsam project focuses on problems that exist within collaboration in two different types of projects: low-intense collaboration that extends over several years, and shorter and more intense projects with many decisions and where traceability, transparency and clarity in these decisions can benefit later in the product's life (Chalmers, 2019). This work will be under the latter of the two types.

This project will study the process of decision-making and the handling of decisions made in the design phase in collaborative construction projects, and especially how it is done with the help of the tool Yolean, created by the company Yolean AB. As the tool is called the same as the company, the tool will be referred to as the Yolean tool or simply Yolean, and the company will be referred to as Yolean AB. See more about the tool in section 1.1.3.

The findings from the user studies will make up the foundation for the development of concepts and designing of a tool, to fulfill the needs identified.

1.1 Background

In order to understand the problem and the reasoning for the thesis, some background information regarding decisions, the construction industry, and the Yolean tool is provided in this section.

1.1.1 Decisions

A major theme in this thesis is decision-making, therefore it is important to clarify the term decision. However, when studying the literature on decision theory, it became clear that most researchers never mention what they mean by the term decision, but take the term for granted.

The Oxford English Dictionary defines a decision as *"The action, fact, or process of arriving at a conclusion regarding a matter under consideration; the action or fact of making up one's mind as to an opinion, course of action, etc."* (Oxford University Press, 2020, definition 2b). Other definitions, such as the one from Cambridge Dictionary also clarifies that making a decision involves a consideration of options: *"a choice that you make about something after thinking about several possibilities"* (Cambridge University Press, 2020, definition 1).

In general, these definitions mean that a decision is made after comparing different alternatives and that the decision will result in an action or steer the course on how to move forward.

When it comes to decision-making in collaborative projects, Jankovic (2006), provides the definition: *"Collaborative decision-making is a collective decision-making where different actors have different and often conflictual objectives in the decision-making process"*. This definition will be used for this thesis.

1.1.2 The construction industry

The process of constructing a building is usually long, and can be divided into four main phases: the planning phase, the design phase, the construction phase, and the closing phase. Design management includes leading and coordinating the design, construction, and documentation for procurement, execution and operation.

It has been argued that the development in productivity in the construction industry is low, especially in comparison with other sectors such as the manufacturing industry, and has barely evolved at all during the past 20 years (Anjou, 2019). Anjou's research (2019) showed that when it comes to digitization, the construction industry is among the very least digitized, together with the transportation sector and agriculture. In other words - there is room for improvement.

1.1.3 Yolean AB

This thesis was done at Yolean AB, an IT-company that also assist Kidsam with development. Yolean AB's main product is a digital tool for visual planning, to make communication within collaborative projects more efficient. Yolean AB's product is used at larger collaborative projects and by several well-known companies, many within the construction industry.

The Yolean tool is a web-based digital board for visual planning (Yolean, 2020). The horizontal axis represents a timeline and the vertical axis includes the disciplines represented in the project, each represented by a different color. The board shows milestones, deliverables, and meetings throughout the process, and the disciplines can post questions to each other.

An example from a Yolean board is shown in figure 1.1.

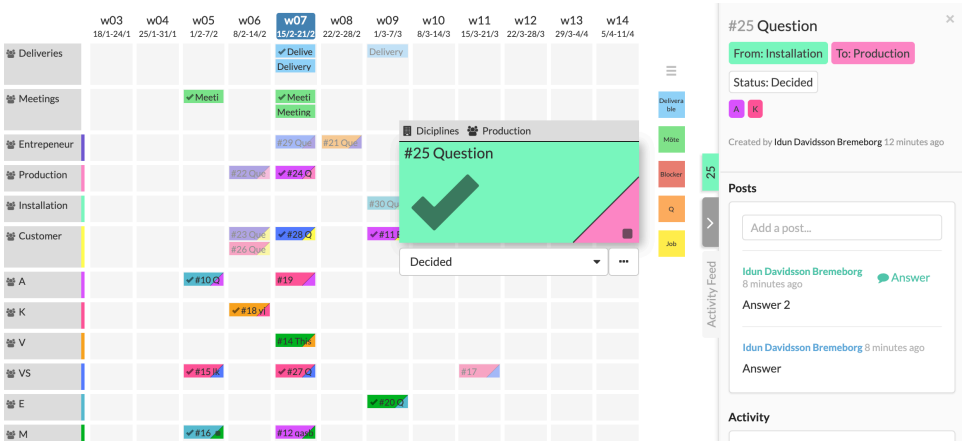
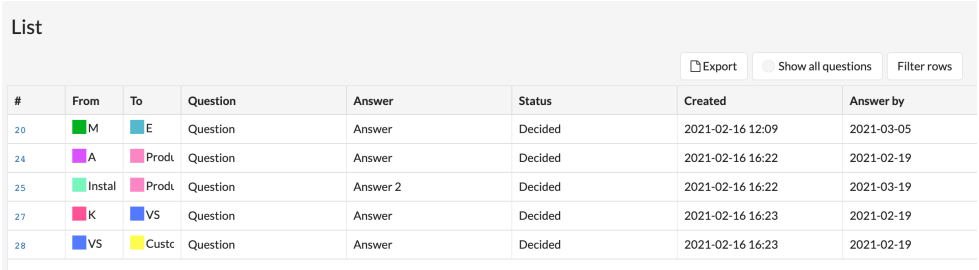


Figure 1.1: An example from a Yolean board showing a question and the answer.

Besides being presented in the visual timeline board, all questions can be found in the decision list. The decision list shows the number of the question, the sender and the receiver, the question and eventual answers/solutions, the status of the question, and dates when it was posted, the deadline and when answer was received. It also shows who posted the answer and the number of posts in the question. An example of a decision list is shown in figure 1.2.


List

Export | Show all questions | Filter rows

#	From	To	Question	Answer	Status	Created	Answer by
20	M	E	Question	Answer	Decided	2021-02-16 12:09	2021-03-05
24	A	Prodı	Question	Answer	Decided	2021-02-16 16:22	2021-02-19
25	Instal	Prodı	Question	Answer 2	Decided	2021-02-16 16:22	2021-03-19
27	K	VS	Question	Answer	Decided	2021-02-16 16:23	2021-02-19
28	VS	Custc	Question	Answer	Decided	2021-02-16 16:23	2021-02-19

Figure 1.2: An example of the decision list in Yolean (Yolean, 2020)

1.2 Aim and objectives

The aim of this project is to examine the needs and requirements regarding communication of information generated during decision-making meetings in multidisciplinary projects, and to design a digital tool that can facilitate communication of such information. The focus will be on decisions made in the design phase in construction projects.

Even though this thesis was done at Yolean AB, there were no requirements from the company that any tool designed in the project should be integrated within the existing Yolean tool. The company acted as a starting point for the project, without any requirements on the outcome of the thesis.

1.2.1 Research questions

The following research questions were formulated as an aid to reach the goal of the thesis.

RQ 1 What existing methods for visual management are being used in connection with meetings in decision-making processes?

RQ 2 What problems exists regarding documentation of information generated on decision-making meetings in collaborative project?

RQ 3 How can this information be presented in an interactive digital tool in such a way that everyone involved clearly understands what decisions have been made?

1.3 Delimitations

The time frame for the project is set to 20 weeks.

The project will only regard design-related decisions of the design phase. It will not focus on the actual decision-making, but rather on how the decisions made are communicated.

With regards to the covid-19 pandemic, user studies and testing may have to be made solely through virtual means. Some data gathering methods may be affected in such a way that non-verbal information is lost.

Furthermore, the number of relevant projects that can be accessible for user studies and fit the time frame can be limited and thereby affect the outcome of the thesis project.

2 Method

This chapter will go through the method and overall approach of the thesis.

2.1 Human-centered design

The design project was carried out with a human-centered design approach. Human-centered design aims to ensure that the technology is adapted to the human user's behavior, rather than forcing the human user to adapt its behavior to the technology (International Organization for Standardization, 2019). Gould and Lewis (1985) defined three principles to be used in human-centered design for computer systems. Their principles are:

- *Early focus on users and tasks*
- *Empirical measurement*
- *Iterative design*

These have since then been used by many companies and designers, and have also been further developed. The standard *ISO 9241-210: Human-centered design for interactive systems,* recommends the following six principles to be included in the design process:

- *The design is based upon an explicit understanding of users, tasks and environments*
- *Users are involved throughout design and development*
- *The design is driven and refined by user-centered evaluation*
- *The process is iterative*
- *The design addresses the whole user experience*
- *The design team includes multidisciplinary skills and perspectives*

(International Organization for Standardization, 2019)

2.2 Double diamond

The outline of this project has been to follow the Double Diamond process, developed and evolved by the Design Council (2020). As the name implies, the Double Diamond is visually presented as two diamond shapes, as illustrated in figure 2.1. There are four phases, two diverging and two converging, that together form the two diamonds (Design Council, 2020). Norman (2013) describes the first diamond to be about finding the right problem, and the second diamond to be about finding the right solution.

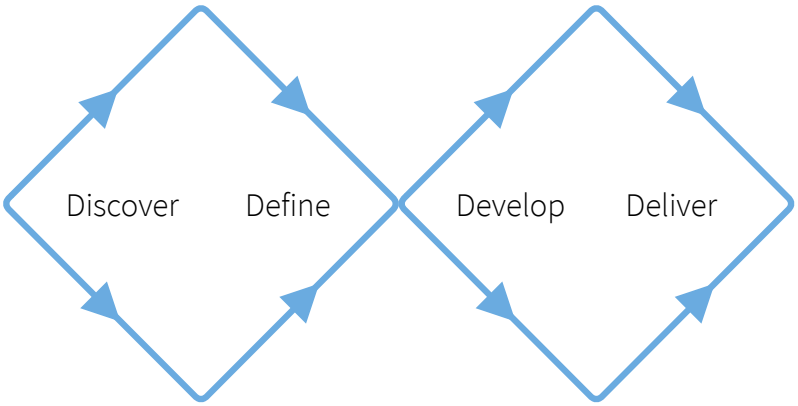


Figure 2.1: Illustration of the Double Diamond.

The four phases are described by Design Council (2020) and adapted for this thesis as listed below. Each phase represent a chapter in this report, that together form the entire process.

Discover

The discover phase means learning more about the problem and gathering information, as well as gaining an understanding of the users.

In this project, this was done partly through a literature study to gather previously studied information about the problem, and also through a user study, including both observations and interviews.

Define

The data from the discover phase is analyzed, and from this analysis, the problem can be defined into a clearer picture with needs and requirements for the product.

Develop

The development phase includes ideation, where ideas and different concepts are generated. Furthermore, prototypes (both low-fi and hi-fi) are created, tested on users and further designed in an iterative process with the users in focus.

Deliver

In the last step, the final prototype is selected, and also includes testing and final adjustments of it.

2.3 An iterative approach

Although the Double Diamond process might seem quite linear, it is not. The process require constant iterations in all its steps, not only the development phase. This has been adapted in this thesis as well, and needs to be kept in mind when reading the report. As an example – the Discover chapter starts with a literature review and continues with a user study, but findings from the user study resulted in further topics to be studied in literature. A design process is never linear but a continuously back-and-forth going process between the different steps. The flow chart in figure 2.2 describes the design process of this thesis project.

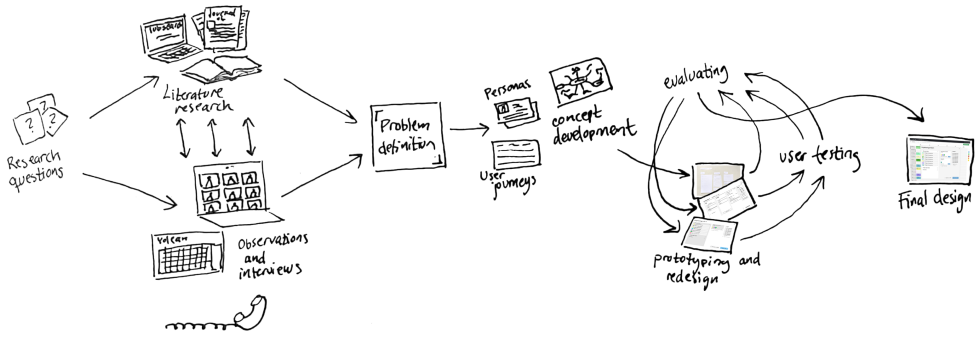


Figure 2.2: The design process.

2.4 Design theory

This section describes the design theory that formed the foundation when creating the design in the develop phase.

2.4.1 Norman's fundamental principles of design

Don Norman's seven fundamental principles of design (Norman, 2013), can be used when designing both physical and digital products, to enhance the user experience.

The principles are described below:

- *Discoverability*
  The ability to find the possible actions to do in the system, and the state that the system is in.
- *Feedback*
  Feedback is information provided as the result of an action, and also shows how that action affected the state of the system.
- *Conceptual model*
  The understanding of the system and how it works. A good conceptual model increases the feeling of control when using the system.
- *Affordances*
  Affordances makes the actions possible, such as buttons.
- *Signifiers*
  Signifiers - such as signs and text - increases both discoverability and feedback.
- *Mapping*
  Mapping is the visual relation between the affordances and their action.
- *Constraints*
  Constraints guides the users to actions by limiting other actions, making the system less complex and easier to understand.

2.4.2 Usability goals

When designing interactive products, usability goals can act as guidance to make sure the products are effective and enjoyable to use. The following usability goals are presented by Preece, Rogers and Sharp (2015):

- *Effective to use (effectiveness)*
- *Efficient to use (efficiency)*
- *Safe to use (safety)*

- *Having good utility (utility)*
- *Easy to learn (learnability)*
- *Easy to remember how to use (memorability)*

2.4.3 Gestalt laws

The gestalt laws are important to consider when creating a design that should be easy to understand and appealing to users, as they tell a lot about how the users will see and interpret visual elements of the design (Interaction Design Foundation, 2021).

- *The law of proximity*
  Elements that are close to each other indicate that they belong to the same group. It can be several elements of the same sort, or different elements such as a text and a box. See figure 2.3.
- *The law of similarity*
  Elements that are similar in shape, color or composition are grouped together. See figure 2.4.
- *The law of closure*
  The user has the ability to automatically fill in gaps between elements to complete a shape or image. See figure 2.5.
- *The law of continuation*
  The user will follow lines and paths of the design to create a continuous flow rather than several different elements.
- *The law of figure*
  The user will see items in the foreground before they see the background.
- *The law of symmetry and order*
  The user wants a balanced design with symmetry, or they will have a hard time grasping the overall picture.

Figure 2.3: The law of proximity

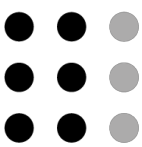


Figure 2.4: The law of similarity

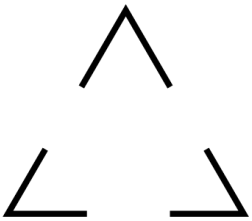


Figure 2.5: The law of closure

3 Discover

This chapter presents the methods and the findings from the discover phase.

The aim of the studies was to explore the problem domain and gather information in connection to the problem, to help gaining an understanding about what needs exist that this project could provide a possible solution to. The discover chapter is divided into two parts: a literature study and a user study of decision-making within the construction industry.

3.1 Literature study method

A literature study is a way to gather information that is of relevance to the project, by exploring what research has been made prior. It should be systematic and methodical, critically reviewing the existing research regarding the subject (Garson & Lillvik, 2020). To complement the systematic literature study, other publications such as books on the topic can be considered as well.

The following theme questions were created to provide guidance for the literature study.

- *Decision-making in collaborative projects:* How are decisions made and further communicated in projects of a collaborative nature?
- *Communication in collaborative projects:* How is information and knowledge communicated within collaborative projects?
- *Meetings:* What types of meetings are there, and what is considered a good meeting? How does decision-making meetings differ from other kinds of meetings?
- *Visual management:* What is visual management and in what ways can visual management aid communication in collaborative projects?

The search for literature was mostly done in LUBsearch and Google scholar, search engines that includes results from several databases. From the questions above, search words were formulated and used in the search engines.

The searches yielded a very large number of search results and to find relevant articles, the ones that seemed relevant from reading the titles were singled out. By reading their abstracts, further sorting could be done. In complement to the searching, articles were also found through the references that authors of the

articles previously found had used in their study. In total, 96 abstracts were read and finally 21 articles were selected and used in the study.

3.2 Literature study findings

The findings from the literature study is presented in this section, and they are organized into the categories shown in table 3.1.

Table 3.1: Literature findings structure

Section		*Category*
3.2.1		**Decision-making in collaborative projects**
3.2.2		**Communication in collaborative projects**
	3.2.2.1	Information sharing
	3.2.2.2	Knowledge sharing
	3.2.2.3	Knowledge visualization
3.2.3		**Meetings**
	3.2.3.1	Decision-making meetings
3.2.4		**Visual management**
	3.2.4.1	Visual planning
	3.2.4.2	Question-answer (Q&A) matrix
	3.2.4.3	Building Information Model (BIM)
	3.2.4.4	Visual management in the design phase of construction projects

3.2.1 Decision-making in collaborative projects

In any design process, a big challenge is decision-making. It is of importance that a decision is made properly, or there is a risk that it might not be treated as a decision by all involved (Clifton, 2009). A decision is something that needs to result in commitment of future action, by someone that is legible to make that decision (Clifton, 2009). It is an advantage to decentralize the decision-making, as that will take the decision-making closer to the source of information and to the ones affected by the decision (Lindlöf, 2014). The information leading up to making a decision also impacts how a decision is being made. Lindlöf (2014) states that fast decision-makers often uses more and richer information than slow decision-makers.

Furthermore, the decision-making process in a collaborative context is even more complex. Eriksson (2009) have studied collaborative decision-making in a product development process, and he lists some of the reasons of the complexity of collaborative decision-making. One major reason is that as the actors involved have different knowledge and different frames of reference they also possess different preferences on the outcome of the decision.

Eriksson (2009) identified what factors could enhance the effectiveness and efficiency of collaborative decision-making and created a model that summarized them and their relations as shown in figure 3.1.

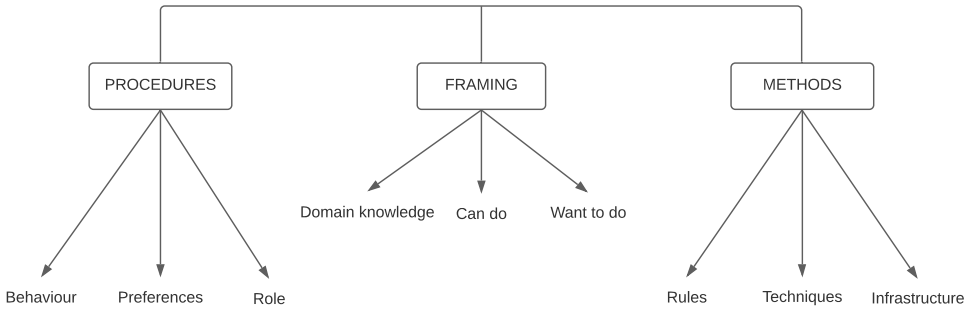


Figure 3.1: Competencies for collective decision-making, after Eriksson (2009, p 79)

Framing is the basis for the decision, and includes the goals, the limitations and what knowledge is needed for the decisions to be made (Eriksson, 2009). Procedures includes the strategy and tactics of the group, as well as the individual and organizational preferences to the decision. Methods refer to the decision-making techniques that aid in understanding complex decisions, the infrastructure that are formal decision structures such as IT-system, templates and product development process models, but it also refers rules that usually are rooted in the company culture.

If communicated correctly, the framing sets up a shared mental model for the decisions in the project, an important factor in making sure that the right decisions are made at the right time.

Arroyo and Long (2018) studied the implementation of lean methods in decision-making process in collaborative projects, which resulted in both large economical savings and increased meeting efficiency when combining the implementation with coaching the decisions as conversations for action. The cost benefits and the increased meeting efficiency was not seen until the coaching was added to the lean methods, which further suggest that the mind-set of the team, the framing, is as important as the procedures and methods.

3.2.2 Communication in collaborative projects

Interdisciplinary collaborative projects are common practice in both product development and construction design projects, and involves specialists from various professions with a diversity of skills (Pedo et al., 2020). However, collaboration comes with challenges such as communicating the common goals and the progress. The understanding of a project can differ among the collaborating partners, creating a confusion about the project vision, making not only what to communicate but also how to communicate ever so important (Lloyd & Simpson, 2005).

3.2.2.1 Information sharing

There are many traditional ways to communicate information, among them e-mails being the most common and it is used for both formal and informal purposes (Zahiroddiny, 2016). The use of e-mails is very well-known and wide-spread, and many employees keeps using e-mails to communicate, even in situations when they are provided with better tools for communicating project information.

3.2.2.2 Knowledge sharing

Knowledge sharing is the mutual exchange of knowledge between individuals, which also creates new knowledge, because the person receiving knowledge combines it with their own experiences (Razmerita, Kirchner, & Nielsen, 2016). Collaborative projects have a positive effect on innovation performance in an organization, and that positive effect is also closely related to knowledge sharing (Wang & Hu, 2020).

Knowledge can be divided into tacit and explicit knowledge (Nonaka, 2007). Tacit knowledge is individual to each person and can be hard to communicate, since it is made up from a combination of ”know-how” and a cognitive part that includes mental models, beliefs, and precious experiences. Explicit knowledge however is formal and systematic, and can easily be communicated in text. Examples of explicit knowledge is that which can be found in manuals, guides, or in product specifications.

Nonaka, (2007) describes the following patterns through which tacit and explicit knowledge is communicated, enabling the creation of new knowledge:

- Tacit to tacit – *socialisation*
- Explicit to explicit – *combination*
- Tacit to explicit – *articulation*
- Explicit to tacit – *internalisation*

3.2.2.3 Knowledge visualization

The concept of knowledge visualization means to aid the sharing of – and thereby the creation of new – knowledge through visualization (Lindlöf, 2014). Visualization especially enhances the more complicated translation of tacit knowledge to explicit knowledge.

Four central perspectives can be used as a framework for knowledge visualization, shown in table 3.1 as originally described by Burkhard (2005). However, through his research, Lindlöf (2014) expanded this by adding five more perspectives closely related to communication. These added perspectives are shown in table 3.2. There are no horizontal relationships in the tables 3.2 and 3.3.

Table 3.2: The four perspectives of knowledge visualization (Burkhard, 2005)

Function	***Knowledge types***	***Recipent***	***Visualisation types***
Coordination	Know-what	Individual	Sketch
Attention	Know-how	Group	Diagram
Recall	Know-why	Organisation	Image
Motivation	Know-where	Network	Map
Elaboration	Know-who		Object
New insight			Interactive visualisation
			Story

Table 3.3: Lindlöf's five added perspectives (Lindlöf 2014)

Bidirectional	***Organisational level***	***Synchronicity***	***Update frequency***	***Canonical / Non-canonical***
Yes	Team	Synchronous	Real-time	Canonical
No	Project leader	Asynchronous	Delay	Non-canonical
	Organisation		Fixes	
	Management level			

3.2.3 Meetings

There are many different kinds of meetings that occurs in companies, and they can vary from informal briefings or discussions to well planned and structured meetings with high impact on the future approach for a project. A meeting can be defined as a conversation with a purpose, between three or more people. Different kinds of meetings have different purposes, and depending on the purpose of the meeting, the character of the meeting varies (Foley & Macmillan, 2005).

Meetings represent a large part of organizational communication, and as they take up a lot of time, especially on managerial level, they make up a huge cost for companies. According to a summary of research on meetings, managers spend 69% of their work days in scheduled and un-scheduled meetings (Romano & Nunamaker, 2001), and up to 75% if the preparation for those meetings is included as well (Allen, Beck, Scott, & Rogelberg, 2014).

Since meetings are such a big part of corporate life, the effectiveness of meetings is crucial. Svenska Möten (2019) concluded in their annual survey that employees who regularly participate in workplace meetings spend 50 hours in ineffective meeting time every year. Furthermore, they found that meeting attendees only thought 46% of their meetings was well spent time.

However, a lot of research has been done on how to make meetings effective, and although it varies depending on the type of meeting, table 3.4 roughly summarizes the findings.

Table 3.4: Summary of the fundamentals of conducting an effective meeting

What	*Details*	*References*
Prior to meeting		
Agenda	An agenda should be prepared and communicated to the participants prior to the meeting.	(Leach, Rogelberg, Warr, & Burnfield, 2009), (LeBlanc & Nosik, 2019)
Participants	Only the participants of direct importance to the meeting should participate in the meeting.	(LeBlanc & Nosik, 2019), (Mroz, Allen, Verhoeven, & Shuffler, 2018)
Environment and equipment	The meeting facilities have a big impact, as has having prepared the right tools and equipment needed for the meeting.	(Leach et al., 2009), (LeBlanc & Nosik, 2019)
Purpose	The meeting needs to have a specific purpose. A lack of goal or purpose means the meeting is not necessary.	(Tropman, 2016), (Mroz et al., 2018)
Scheduled time	Schedule only as long time as needed.	(Mroz et al., 2018)
During meeting		
Meeting leader	Having a facilitator to run the meeting, making sure the meeting purpose is fulfilled.	(Leach et al., 2009), (Mroz et al., 2018)
Minutes	Make sure the meeting is properly documented.	(Mroz et al., 2018)
Participant involvement	Avoid non-meeting related activities, such as smartphones, and make sure to participate in the discussion and decision-making.	(Leach et al., 2009), (Mroz et al., 2018)
After meeting		
Documentation	The meeting minutes and action items should be distributed as soon as possible, within 24-48 hours after the meeting.	(LeBlanc & Nosik, 2019, (Mroz et al., 2018)
Evaluate	Evaluation of the meeting provides an opportunity to improve the meeting process.	(LeBlanc & Nosik, 2019)

3.2.3.1 Decision-making meetings

The purpose of decision-making meetings are to make decision regarding questions, problems, or what to do next. For such a meeting to be effective, the preparation is crucial (Tropman. 2016). An agenda with the items to decide on should be presented to the attendees in time for them to prepare for the meetings, and the discussion behind the decision should already had taken place. The process of when decisions are made described by both Tropman (2016), and Clifton (2009), is displayed in figure 3.3, highlighting that the decisions should be fully prepared before the meeting, making the meeting more effective, and that the decision should lead to some kind of action.

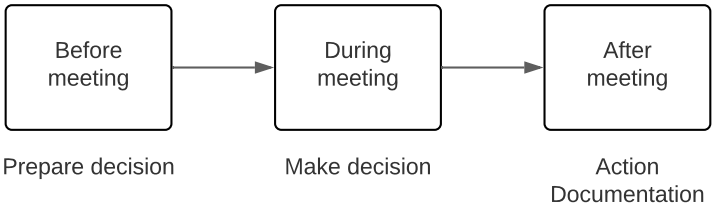


Figure 3.3: The ideal process of a decision-making meeting

3.2.4 Visual management

Visual Management aims to increase transparency in project processes, thus increasing the efficiency in the project. As the process becomes more visible to the managers as well as the employees, deviations will be discovered earlier and the required adaptions can be made (Catic, Stenholm, & Bergsjö, 2016). Not only does the process become more transparent, visual management methods also aids the communication and information sharing within organizations (Lindlöf, 2014).

The use of visual methods in management enhances collaborative work and improves communication – both internal and external (Bititci, Cocca, & Ates, 2015). It also has an effect on employment engagement in the strategic thinking process.

There are many different tools for visual management that can be implemented at different parts of product development. Below are two visual management tools that are being used in connection with decision-making meetings described.

3.2.4.1 Visual planning

Traditionally, planning is something that occurs in the beginning of a project and that is being checked or updated now or then during the project execution phase. The long term planning is kept at one place, for example in a Gantt chart, and the short term planning is kept in another place, for example in an action list showing ”what, who, and when”. Visual planning is a concept that shows all this in the same place, thus increasing the transparency throughout the project (Catic et al., 2016).

Visual planning consists of two parts: 1) a board that visually displays activities and deliverables, and, 2) meetings where the team is gathered around the board to discuss it (Lindlöf, 2014). It is the interplay between the board and the meetings that is the central part of visual planning, and increases both communication and coordination in projects. Figure 3.4 shows an example of a board for visual planning, with blue sticky-notes showing deliverables and the yellow sticky-notes showing activities to be done.

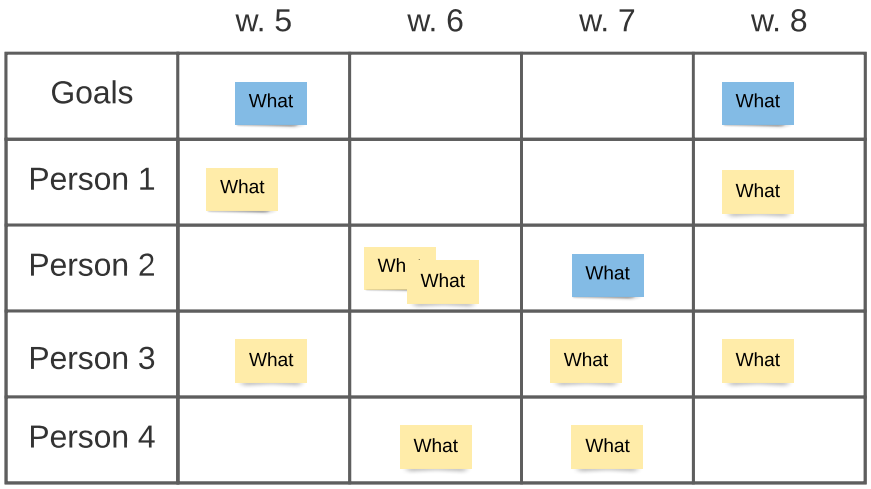


Figure 3.4: An example of a visual planning board, after Catic et al. (2016)

3.2.4.2 Question-answer (Q&A) matrix

The Q&A matrix is presented on a physical board with all professions involved in the project represented both horizontally and vertically (Dalman 2005). One axis represent *from* and the other represent *to*, allowing participants from one profession to ask questions to another by writing the question on a post-it note and place it accordingly on the board. The respondent then writes the answer to the question on the post-it note. An example of the matrix is shown in figure 3.5.

The Q&A matrix provides a possibility for project participants from one discipline to post questions to other participating discipline by posting a note on the appropriate place on the board (Dalman, 2005). The questions make up the basis for decisions to be made in the project. The board provides a holistic view of the project, visualizes how many decisions are being made in projects, and eases communication with actors involved in the project.

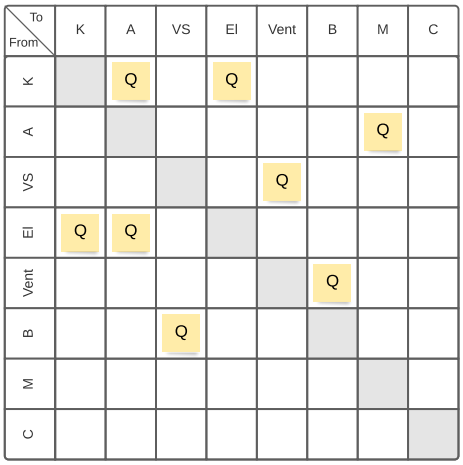


Figure 3.5: An example of a Q&A matrix board, after Dalman (2005)

3.2.4.3 Building Information Model (BIM)

Building Information Models (BIM) are four dimensional interactive drawings used to visualize and coordinate building project, and can contain all information and details of the design (Paavola & Miettinen, 2019). BIM also enhances the decision-making in collaborative projects, as it eases the communication between disciplines with different objectives, making it easier to reach a decision.

3.2.4.4 Visual management in the construction design phase

Most research found on the use of visual management in the construction industry has regarded the construction phase, rather than the design phase.

3.3 User study method

The user study was performed by combining both observations and interviews, as it is good practice to combine several data gathering techniques to thoroughly understand the users (Preece, Rogers, & Sharp, 2015). The methods used for data gathering are explained below, as well as the method used for analyzing the data.

Initial research was done to gain an understanding about the Yolean tool. One important part of gaining an understanding of the tool is to actually use it. Therefore, the tool was used for planning this thesis project, providing a good opportunity to thoroughly explore it.

As well as using the tool, an interview with an employee at Yolean AB was conducted, to learn about the thoughts behind the product, how it was intended to be used and the reason behind various features.

3.3.1 Selection

The user study focused on the decision-making process within the design phase of construction projects. The design managers who manage all decisions made when designing a build was selected as the main objects to study. However, it was also important to study the ones who contribute in making the decisions: usually consultants from different professions.

3.3.2 Data collection, observations

Several observations were performed in order to gain an understanding about the users and their context and tasks. Most observations were done by joining weekly meetings in the design process of two different construction projects stretching over several months. In addition to these continuing meeting observations, single meetings in two other projects were studied as well, with a total of seventeen meetings being observed. The observations were passive, meaning that there was no interference by the observer during the meetings.

As it was not possible to record the observations, notes were taken during the meetings by the observer. A framework that helped direct focus and aided the note-taking during the observation (Preece et al., 2015), was prepared and can be found in Appendix B.

The main objective of the observations was to get an understanding of how decisions were made during meetings. They also showed how the Yolean tool was used, and how the decisions made were documented, in the tool or elsewhere.

Both projects that were studied over time used the Yolean tool during the meetings, as well did one of the additional projects. The fourth project did not use

Yolean, but a competitor's tool with the same purpose. A summary of the conditions for the observations can be found in table 3.5.

Table 3.5: Summary of observation conditions

	Project 1	*Project 2*	*Project 3*	*Project 4*
Number of meetings	9	6	1	1
Meeting time	~2 hours	~2 hours	2 hours	1 hour
Total time	~18 hours	~12 hours	2 hours	1 hour
Meeting location	Office conference room and/or conference call	Office conference room and/or conference call	Conference call with video	Conference call with video
Observer location	Conference call	Conference call	Conference call	Conference call
Screen sharing	Yolean project board	Yolean project board	Yolean project board	Yolean competitor project board
Participants	The design manager, 10-15 consultants working on the project, and one customer representative.	The design manager, 10-15 consultants working on the project, and one customer representative.	The design manager, 12 consultants working on the project, and two customer representative.	The design manager, 10 consultants working on the project, and one customer representative.

One of the projects allowed access to their Yolean board, providing it to be analyzed to get an even deeper understanding about how they used it to make and document decisions in relation to the meetings, and served as a good complement to the observations.

It also provided a possibility to get a deeper look at the decisions and what information was documented along with the decision.

3.3.3 Data collection, interviews

Interviews were held with three design managers and a consultant to gain an understanding of their thoughts and behaviors regarding decision-making and meetings. Follow-up interviews with two of the design managers were also done to gather complementing information. The interviews were semi-structured, meaning that they were conversational-like with both closed and open-ended questions (Preece et al., 2015), and an interview guide with themes and questions was prepared beforehand to support the interview (Wikberg Nilsson, Ericsson, &

Törlind 2015). The interview guide, made up with themes rather than questions, used during the interviews in this project can be found in Appendix B

The semi-structured form allowed the interviewees to elaborate the questions and to bring up issues that might have not been mentioned otherwise (Preece et al., 2015). The interviews provided a deeper understanding of what they found important concerning decision-making, but also gave an insight into how decisions are used later in projects, and the importance of proper documentation. They also provided an understanding about the users opinions, motivations, and behavior concerning it.

Before starting the interview, all participants were informed that they and their personal data would not be exposed, but to be kept anonymous. The interviews were recorded and transcribed to make sure that all data from the interviews was captured.

Table 3.6 summarizes the interview conditions. Two of the design managers were interviewed twice, due to the fact that insights that came up in the analysis needed a deeper investigation.

Table 3.6: Summary of interview conditions.

	Interview 1	***Interview 2***	***Interview 3***	***Interview 4***	***Interview 5***	***Interview 6***
Profession	Design manager 1	Design manager 2	Design manager 3	Design manager 1	Consultant	Design manager 2
Interview lenght	40 min	40 min	30 min	30 min	20 min	40 min
Interview location	Telephone	Personal meeting	Telephone	Video call	Telephone	Video call
Uses Yolean?	Yes	Have before, switched to competitor	No	Yes	Yes	Have before, switched to competitor

3.3.4 Analysis

The findings from the user study was analyzed with the affinity diagram method. Creating affinity diagrams is a common way to analyze qualitative data, and it aids sorting and categorizing of the data collected during the user study (Preece et al., 2015). From the affinity diagram themes and patterns could be retrieved, to help identifying both what problems exist and the user needs. The analysis was done in the following steps:

1. The data was first formulated into words or short sentences and written down on notes.

2. The notes were then clustered into groups with other notes that all related to each other in some way.
3. The groups were then named according to what they included.
4. The groups were combined and reiterated into new clusters, allowing more themes to be identified.

3.4 User study findings

The analysis with the affinity diagram resulted in several categories, which are introduced and explained below.

3.4.1 Meeting process

All projects had ”meeting days” once a week, when all consultants working on the project was gathered. Most meeting days were planned for a total of three to four hours, and an overview of the day can be seen in figure 3.6. The first part of the day included presenting the participants and going through the agenda for the day.

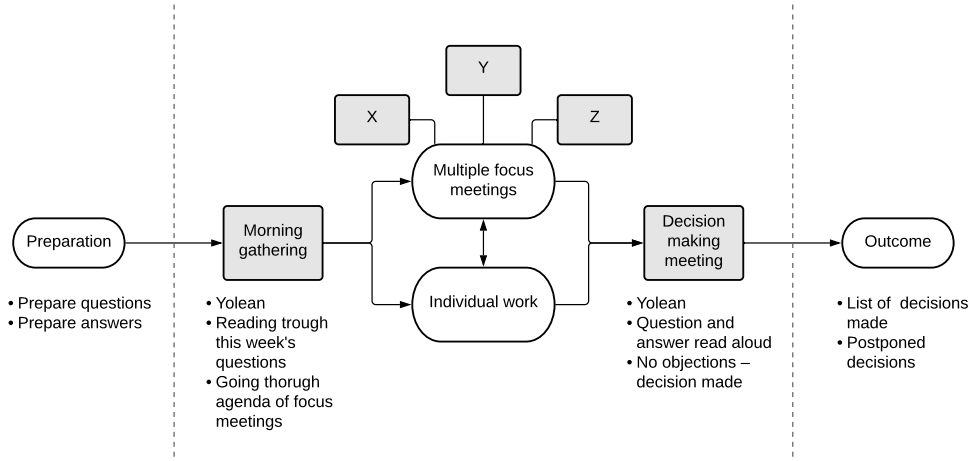


Figure 3.6: Flowchart of the meeting days, meetings are marked in gray

The agenda usually included going through all questions for the current week on the Yolean board, then a number of focus meetings in smaller groups depending on what problems needed a deeper discussion, and then a reassembly of all participants to go through all questions, making sure they are answered, and closing them. Although the questions in many cases had answers before the

meeting day started, it was only the last part of the day that was the official decision-making meeting, where the decisions were made. The Yolean board served as the protocol for the decision-making meetings.

The interviewed design manager who had never used Yolean described using the same meeting process as the other managers, but used an excel-document for visual planning and decision documentation, instead of the tool.

3.4.2 Decisions

Many different kinds of decisions of various importance were made in the projects. Decisions that had a cost impact or that concerned several disciplines usually required a more thorough investigation, while some smaller decisions or decisions that only concerned one specific discipline were made without any discussion at all, due to the fact that all parts could trust the expertise of the consultant from each discipline.

Sometimes a conflict could arise over a question due to different views on the matter by the various disciplines, but in the end there was always consensus to the decision. Tools such as BIM were often used when discussing a matter.

Decisions have impact on the speed in which the team can move forward. For that reason, it was often better to make a quick decision and later overrule that decision by another, than to leave the decision open for too long.

Decisions were usually implemented in the project by consultants within a few days after the meeting on which it was made. The decisions were found by either clicking on the notes in the Yolean board, or by checking their own notes.

3.4.3 Decision-making and documentation at meeting

Most decisions in the projects were made during the decision-making meetings. Those decisions were documented as answers on the questions in the Yolean board.

The process of making a decision was as follows: the question was read out loud, then the answer was read out loud, and if no-one had any objection, the question was marked as closed, meaning that the decision was made.

If there were several posts discussing the question, or if someone had any objection during the meeting, either the discussion was held at the meeting, or the decision was postponed so that a separate discussion meeting could take place before the decision was made, or information needed in order to make the decision could be gathered.

When a discussion was held at the decision making meeting, the answer was noted by the design manager, rather than by the one who was responsible for the answer.

The decision-making process is described in the flowchart in figure 3.7.

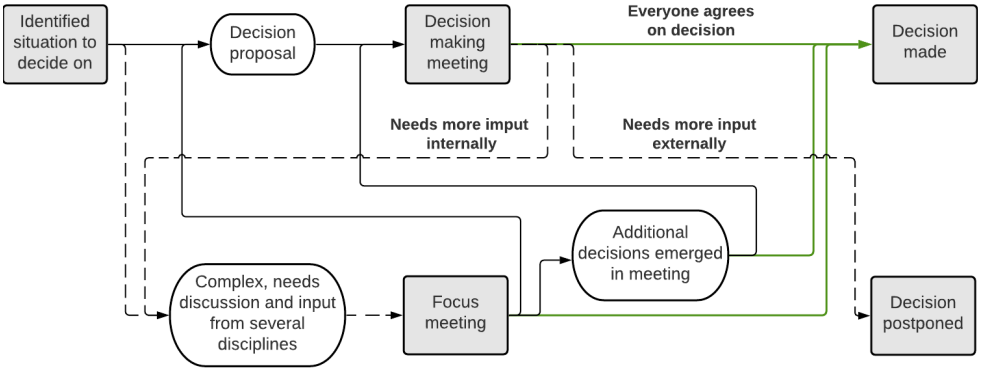


Figure 3.7: Flowchart of the decision-making process

3.4.4 Decisions outside of decision-making meeting

Even though all interviewees agreed that keeping all decisions in the same place would be an advantage, many decisions were being made through email conversations as well, even among the same people who participate at the weekly decision-making meeting. Those decisions were usually not stored elsewhere, but only documented in those emails.

Other decisions, usually larger ones with a bigger cost impact, were made at the internal project group at the building company, including the project leader and the design manager, among others. Those decisions are usually documented in the meeting minutes and stored internally.

3.4.5 Focus meetings

Some of the focus meetings were observed as well. They usually regarded more tricky questions that needed input from several professions. Those meetings included more open discussion, and a protocol was written and uploaded on the internal project portal.

During the focus meetings, some decisions were made as well. If the decision was connected to a question in the Yolean board, they would either write the decisions as an answer to the question, or simply write ”see focus meeting”. However, even though one single question was the reason for the focus meeting, it usually led to more decisions being discussed. Those decision were usually only documented in the protocol and not the Yolean board. In some cases, they were not documented at all, more than in personal notes by the consultants.

3.4.6 Tracing decisions

All design managers interviewed mentioned that it is very important to trace decisions, as it can have a big impact later in projects, especially economically. The customer might say that they want one thing - an extreme example could be that they wanted eleven instead of ten apartments on each floor - during the design phase, and then during the construction they question why it is being built that way, and that they neither want it nor want to pay for it. Being able to trace the decisions and prove that the customer in fact did wish for that extra apartment is now very important.

Another situation when it is important to trace decisions is during the production phase. When designing, the consultants have a holistic view of the project, meaning that sometimes the best way to do one thing might impact other things, and in that case coming up with a compromising solution is a better idea. During the production however, the entrepreneurs does not have that holistic view, and might question why they are not doing it in, according to them, the best possible way. To be able to trace the decision and show the basis with other parts impacted by the decision becomes an important way to prevent a conflict.

It is very important to have a clear documentation of decisions made in a project, that shows *when* the decision was made, *who* made the decision, and the *decision basis*.

To find previous decisions, most design managers used the search function in their visual planning tool, to search text contents of the board. This worked well most of the time, however it required that the manager knew which words to search for, and that the same words were used when writing questions and answers. If not formulated correctly, an older decision might be the only one showing up during the search, if the latest decision was formulated using other words.

3.4.7 Usability issues within the tool

Some usability issues within the Yolean tool could be observed as well, resulting in that is was not used to its full potential. A question in the tool can be *closed* but also further *marked as a decision*. When closing a question a check is graphically illustrated on it, but when marking as a decision, no further graphic illustration is showed. This resulted in that some design managers would not bother using the mark as decision function, as to them - there was no difference between a *decision*, and a *closed answer*. The decision log in Yolean only shows the questions marked as decisions, unless manually filtered on showing all decisions. That further resulted in not using the decision log at all in those projects, but only the board.

There also seemed to be some uncertainties on how the tool could be used, more than posting questions and replying to them.

Another usability issue was that many ”clicks” needed to be made when using the tool. This was one of the reasons mentioned to why a design manager who previously used Yolean had switch to a competitive company’s tool.

4. Define

In this phase, the discoveries from the previous phase are analyzed deeper, needs are formulated, and the problem is narrowed down into a definition of the product to be designed – the design brief.

4.1 Define methods

To define the problems, several methods for user-centered design was used, and they are explained below.

4.1.2 Needs

User needs were established from the problems identified in the data from the user study. A need is a general term that describes the driving forces of human behavior, and it is important to keep the focus on the customer needs rather than a solution to a specific problem (Wikberg Nilsson et al., 2015). By focusing on needs rather solutions, one is allowed to think more freely and come up with solutions that exceeds any expectations.

4.1.3 Function analysis

After the need were identified, they were translated into functions. A function is a concept that describes an activity of a solution (Wikberg Nilsson et al., 2015). The function analysis provides the purpose of the solution, rather than the solution itself, and this was done by identifying what functions would fulfill the user needs. Some needs needed several functions to be fulfilled, and some functions could fulfill several needs.

The functions were then rated according to their priority. The ratings are (in order of importance): Main Function (MF), Necessary functions (N), Desirable functions (D), and Unnecessary functions (U).

4.2 Define results

The results from define is presented below. The section includes who the users are, the identified user needs and what functions should be included in the solution.

4.2.1 Users

The primary users in this project are design managers that engage in a decision-making process in collaborative construction projects. However, the project should still consider other users who are involved in the decision-making process in projects, such as team members and clients which are considered to be secondary users.

4.2.2 Needs

The identified problems translated into needs are shown in table 4.1.

Table 4.1: Needs

Identified problem	***Need***	**#**
Without a protocol, it is hard to tell what happened at a decision-making meeting	Need to get a protocol for the decision-making meetings	1
Decisions are hard to find because they are documented in different places Finding decisions by search function require that the right words were used when writing the question or answer Decisions made in focus meetings are usually only documented in the meeting minutes, or personal notes	Need to gather all decisions made in the project in one place	2
Problems can arise if certain information regarding a decision cannot be found	Need to find who made a decision, when it was made, and the basis of it	3
Decisions are only valid if the right people are involved in making them The decision-making meetings lack a protocol showing who participated	Need to register who participated when making a decision	4
A decision sometimes overrules an earlier decision	Need to find the newest decision on a matter	5
Some decisions are made in email-conversations, due to thinking that the answer will come more quickly than in the tool	Need to make the features in the tool inviting to use	6

Decisions are not marked as decisions due to no graphical difference between *closed* and *decision* in the tool		
Some questions are left open several weeks after the decision due date	Need to make sure all decisions are made in time	7

To be noted is that some of these needs are partly fulfilled by the Yolean tool today, however not to the full extent.

4.2.3 Function analysis

From the needs in table 4.1, the functions of a tool that would fulfill the needs was established. The functions and their ratings are shown in table 4.2. The table also shows which need the function will fulfill.

Table 4.2: The functions and their ratings (main function - MF, necessary - N, desirable - D, unnecessary - U)

Rating	***Function***	***Need #***
	The tool should….	
MF	Allow decision-meeting documentation	1
MF	Ensure decision traceability	2
N	Provide possibility to include decisions from other places	2
N	Show when the decision was made	3
N	Show who made the decision	3
N	Show the basis on which the decision was made	3
N	Show the participants during a decision-making meeting	4
D	Allow sorting of decisions related to a specific subject	5
D	Show all decisions on the same subject	5
N	Invite to usage	6
N	Show which decisions are left to be made	7

4.3 Design brief

The purpose of the continuing of this project is to come up with a solution regarding documentation of decisions in collaborative development projects, that fulfill the needs as stated in table 4.1. This will be done by developing a tool for design managers and team members in collaborative projects based on the functions presented in table 4.2.

The expected outcome is one or several prototypes of a tool that can be tested for scenarios, but not permit inputing and storing of data.

5. Develop

In this chapter, the development process of the digital tool is presented. When developing a product, several iterations should be made. This means that there is a continuous cycle of design, test, and redesign that ensures design choices are based on actual usability issues and not assumptions made by the designer (Gould & Lewis, 1985). The chapter is divided into four parts: Ideation, First iteration, Second iteration, and Third iteration.

5.1 Ideation

The purpose of the ideation phase was to develop as many suggestions and ideas for suggestions as possible, and the process was done with the help of various design tools. The methods used and the results of the ideation process are shown in this section.

5.1.1 Method

The process of the concept development and what design tools were used are described below.

5.1.1.1 Personas

Personas were created to assure that the product was designed for the users, and it also helped in getting into the user's mind and understanding how they would react when using the product (Wikberg Nilsson et al., 2015). The personas are made up persons that were created from the insights found through the observations and interviews. Several different personas were made to try to cover the different types of users that would potentially interact with the tool.

5.1.1.2 Brainstorming and concept development

The ideation process generated ideas of concepts to develop. This was done by brainstorming and writing or sketching all ideas that came up, no matter how *good* or *bad* they seemed. All kinds of ideas were noted – they could be words, headlines, doodles, and other quick sketches, as the important part of brainstorming is to get all ideas out on paper to have something concrete to work with (Wikberg Nilsson et al., 2015).

When all ideas were out on paper, they were evaluated and combined to generate concepts that could be further designed.

5.1.1.3 User journey

Two user journeys were created to examine the users thoughts and experiences when interacting with the product (Wikberg Nilsson et al., 2015). The user journeys were created to reflect the different concepts that were developed, to see which one should be further developed.

5.1.2 Results

5.1.2.1 Personas

The four personas created are showed in figures 5.1-5.4. They represent the three types of roles that are represented at decision-making meetings in the design process, and the consultant role is represented by two different personas, due to the large variety of persons represented in that role.

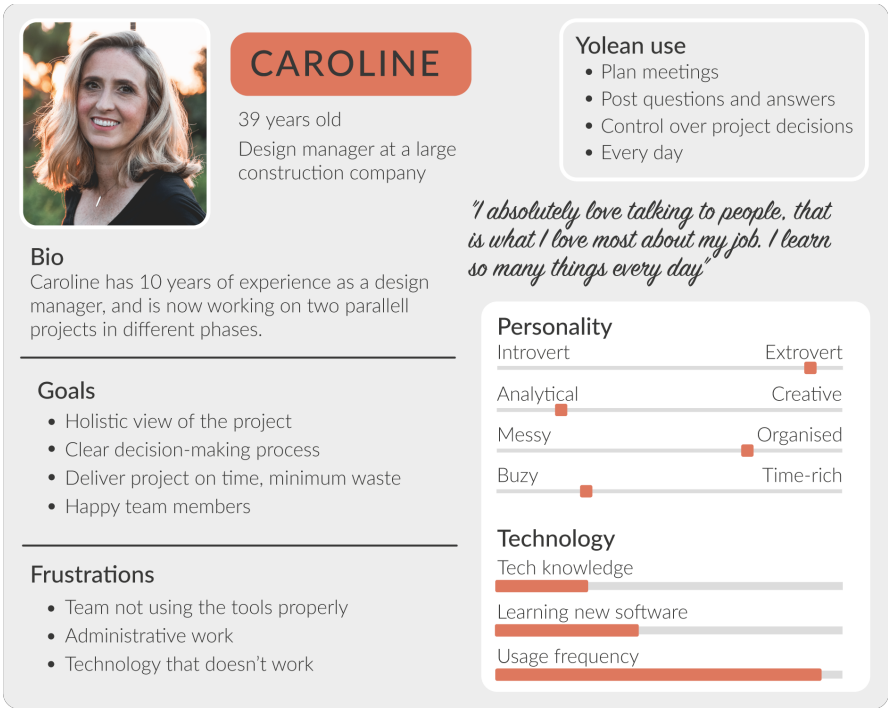


Figure 5.1: Caroline – Design manager

Figure 5.2: Marcus – Architect consultant

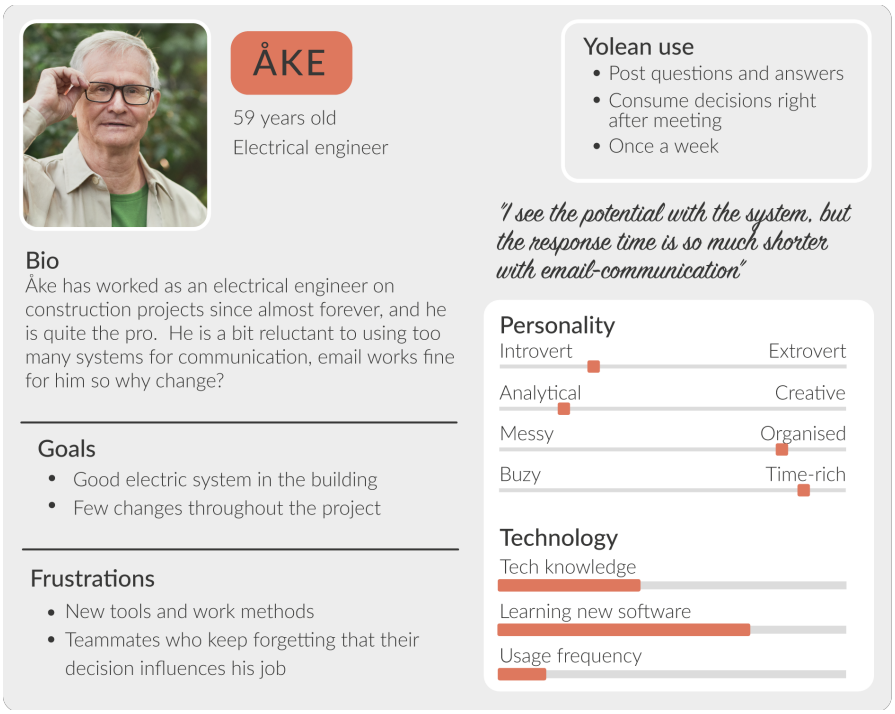


Figure 5.3: Åke – Electrical engineer consultant

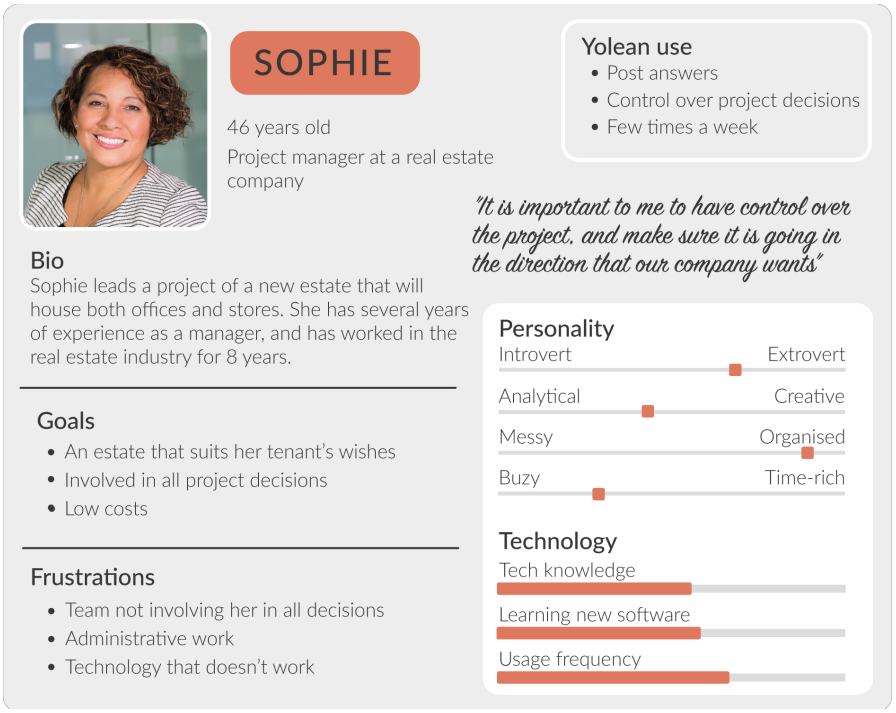


Figure 5.4: Sophie – Customer representative

5.1.2.2 Brainstorming and concept development

The ideas generated through the brainstorming could be divided in two parts, each representing a different concept:

1. Focusing on creating a new decision log with the possibility of sorting the decisions according to different subjects and areas
2. Focusing on the decision-making meetings and how to create better documentation already at the meeting

Figure 5.6 shows a mind map created during this phase.

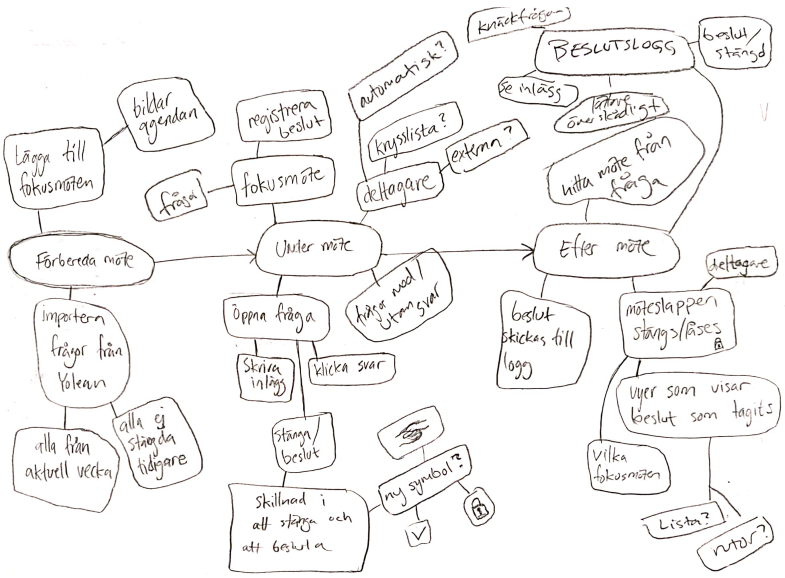


Figure 5.6: A mind map created during brainstorming

5.1.2.3 User journey

The user journey shows the interactions between the user and the system as well as the thoughts and feelings of the user, when a user wants to find a decision made at a previous meeting, through the two different concepts developed during the brainstorming. The user journeys are both shown in figure 5.5, where the decision log concept is represented by the blue color, and the meeting page concept is represented by the orange color.

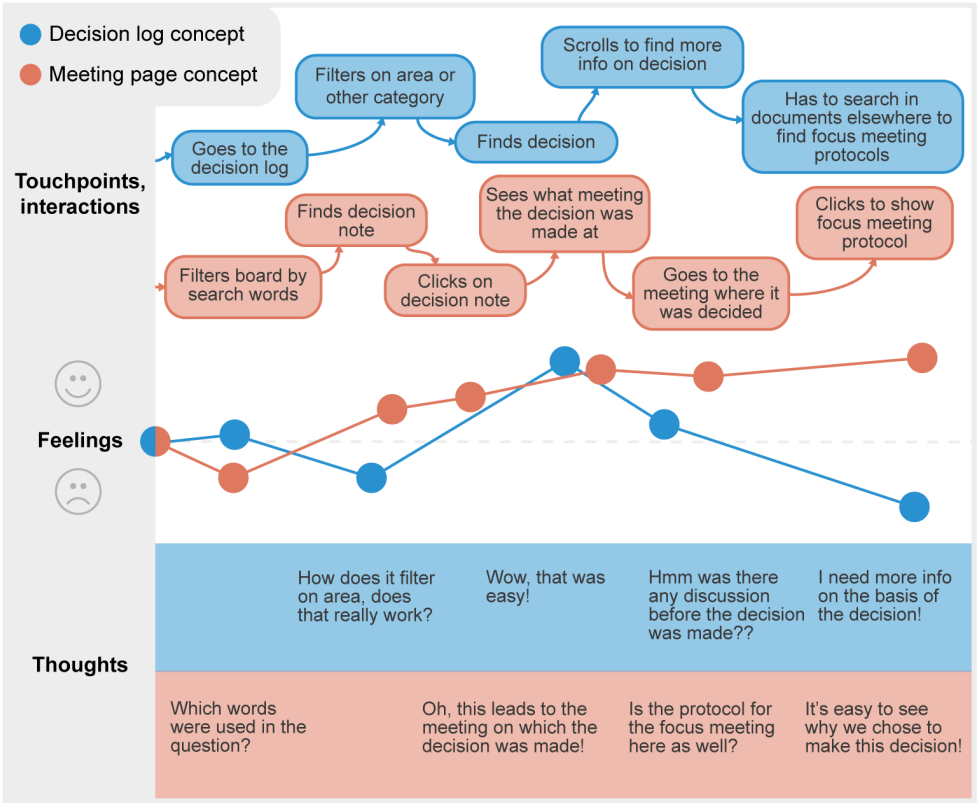


Figure 5.5: User journey

The user journey helped evaluate the two alternatives generated through brainstorming, and to decide what concept to further develop. From this, it was decided to focus on the meetings on which the decisions are made, rather than the decision log, as it was regarded that more user needs could be fulfilled that way. As can be seen in figure 5.5, the meeting page concept would probably generate less confusion and irritation for the user, and lead to a better user experience.

5.1.3 Concept description

The concept's idea is to gather decisions made in focus meetings at the same place as the decisions made in the decision-making meetings, and also contribute with a better overview of the decisions to be made during the meeting, making the meetings more efficient.

It was not pre-determined that the tool should be created as a feature in Yolean. However, the user study showed that the question-answer notes were the very starting point for all decisions made in the projects, and that principle was used by all the project managers, the ones that did not use Yolean as well. Therefore, it

seemed the most logical thing to design an additional feature within the Yolean tool, rather than creating a whole new tool.

The main part of the concept is a new meeting note in Yolean, and when started it shows up as a page with all questions that lacks a decision. The page serves as an agenda for the day, showing both the decisions to be made and the focus meeting that will be held during the day. It will also make the decision-making meeting more effective as the questions with an answer, and thereby those that are ready to be decided, will be separated from the rest.

There will also be another kind of meeting page for the focus meetings, that allows documentation of the focus meetings directly in Yolean. If questions are linked to the focus meeting, the answers to them can be added within the meeting page, along with other topics being discussed.

After the meeting is closed, the meeting note will show the participants during the meeting, and the focus meetings that were held, and the what decisions were made during the meeting.

5.2 First iteration

The purpose of the first iteration was to further develop the concept before testing it on actual users.

5.2.1 Method

The process of the first iteration was to firstly create a design, and then to evaluate the design with the help of a cognitive walkthrough with the personas. A cognitive walkthrough helps the designer understand how the user would interact with the system, and what usability issues would occur (Magnusson et al., 2009).

5.2.1.1 Design

Prototypes were created to visualize the idea and concept. The first step was to create a low fidelity (lo-fi) prototype that would show the structure of the tool. The purpose of lo-fi prototypes is to communicate the basic concept or idea with minimum effort and cost, and they allow for quick and easy changes to the concept (Preece et al., 2015).

The rough wireframes were sketched up with pen and paper to come up with what sections were needed and how the layout could look like. By cutting out the sections in paper, the layout could easily be altered, as shown in figure 5.7 and figure 5.8.

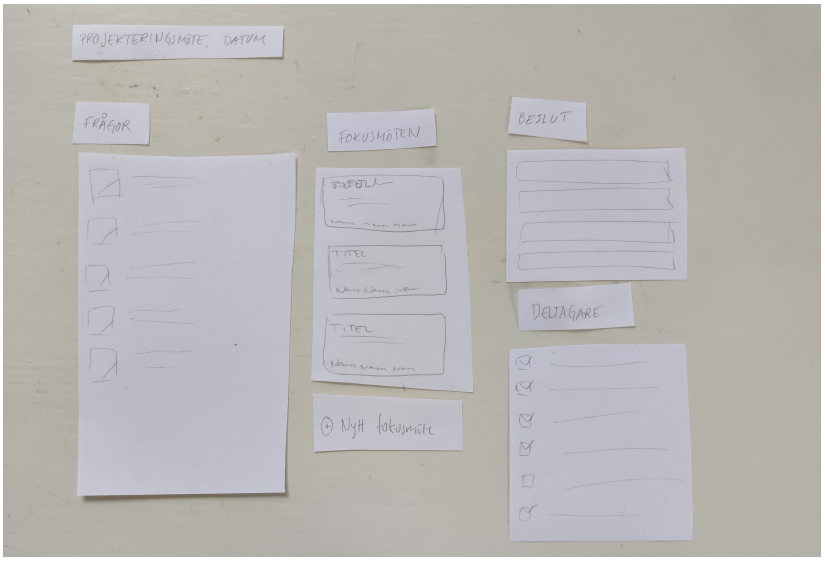


Figure 5.7: One of the layouts for the meeting page created from cut out paper pieces

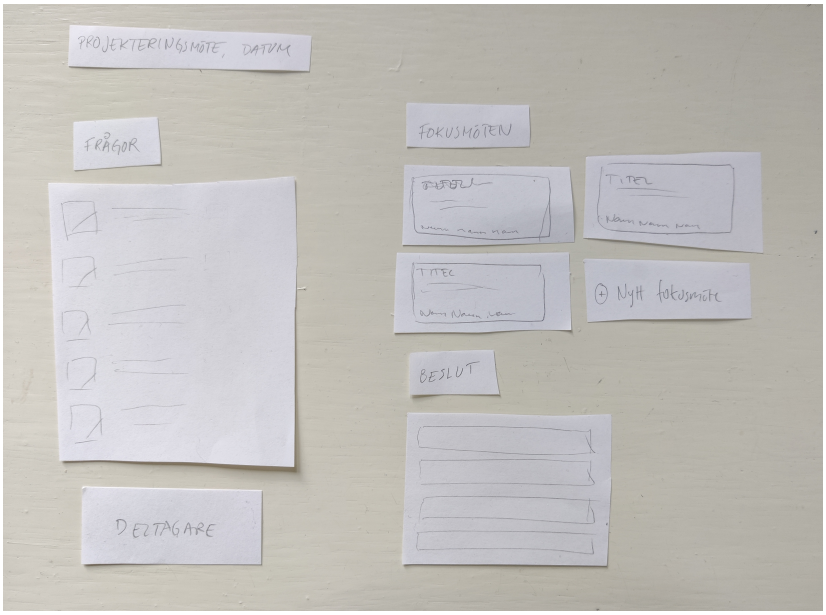


Figure 5.8: An alternative layout for the meeting page

5.2.1.2 Evaluation

Two different variants of the concept was evaluated by a cognitive walkthrough with the personas, to get an idea of which one to be further developed (Preece et al., 2015). This gave a better idea on how the different kinds of users would interact with the tool, what would work and what would not.

The walkthrough was done four times - once with each persona - where tasks such as creating a meeting, documenting a focus meeting, and retrieving a decision made at a previous meeting was completed. The walkthrough with the design manager seemed as the most significant one, as they are the primary users of the tool

5.2.2 Results

The first iteration resulted in a list of design criteria for the tool, and a layout suggestion that could serve as a foundation for further development.

5.2.2.1 Design criteria

Table 5.1 shows the list of design criteria that should be included in the concept.

Table 5.1: Design criteria

Design criteria
Create and edit a project meeting
Create and edit focus meeting
Add participants with accounts in the Yolean tool
Add participants without accounts in the Yolean tool
Choose what questions to show (current, previous, future)
Document focus meetings
Make decisions
Input decision not connected to a question in Yolean
Show decision data (who, decision basis, when)
Show participants during decision making meeting

5.3 Second iteration

The purpose of the second iteration was to keep the design simple with wireframes, but to make a prototype that could be tested on real persons, rather than with the help of persona, to further test the concept.

Below is the process of the iteration described, along with the results of both the design and the evaluation.

5.3.1 Method

The process of the second iteration was made in two steps: firstly the design was created, and secondly it was tested on both a design manager who uses the Yolean tool, as well as on users without previous experience with the Yolean tool.

5.3.1.1 Design

The selected idea from the first iteration was created as wireframes in Google Presentations, which would enable simple testing through remote video calls. Some screenshots from the Yolean tool were also included in the design to create a context to the otherwise simple prototype.

5.3.1.2 User testing

A test plan was created, and can be found in appendix B. All testing was done through video calls where the test person got a link to the presentation with the prototype and was asked to put it in presentation mode and share their screen. They were also asked to use the ”pointer” function in Google Presentations, so that a red dot showed up where the mouse pointer was, and their actions could easily be followed. The test persons were also encouraged to think aloud during the test.

The presentation provided instructions to the test, which the test persons followed to complete the test. Two kinds of data was collected during the tests:

- Notes from observing the test, both on how the user performed the test, questions asked during and other comments from the user during the test.
- A short interview after the test.

Four tests were completed at this stage, one with a design manager and the others with people of various insight in the process.

In addition to the interview, the design manager got to fill in a short questionnaire, in which they was asked to rate their experience on a semantic differential scale. As only one person was asked to fill in the questionnaire, it was not used during the evaluation of the test, but rather considered a pilot test of the questionnaire to be used during the tests in the following iteration. The questions in the questionnaire can be seen in appendix B.

The interview with the design manager mostly discussed the concept as a whole, along with some usability issues, and the interviews with the other test persons were more focused on the layout, how easy it was to navigate through the tool, and understanding the concept.

All data from the tests was summarized and categorized depending on if it regarded the usability or the concept as a whole, to pinpoint what needed to be reconsidered in the next iteration.

5.3.2 Results

This section presents the results - both of the design and the of the evaluation of the design - from the second iteration.

5.3.2.1 Design

Figure 5.9 shows the display when a meeting note has been created. The desired parameters, such as the time, which questions to include in the meeting, and the attendees can be altered. Focus meetings that would be part of the agenda for the meeting day could also be included.

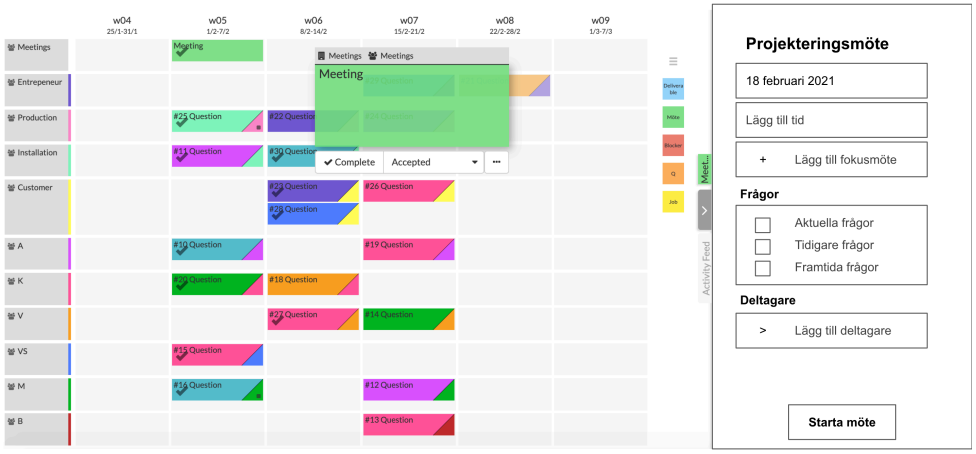


Figure 5.9: Create a meeting

The focus meeting can also be adjusted. If the focus meeting is to discuss one or more questions that already exist in Yolean, they can be drag-and-dropped into the meeting. A short description can also be added, as well as the time, and the attendees. See figure 5.10.

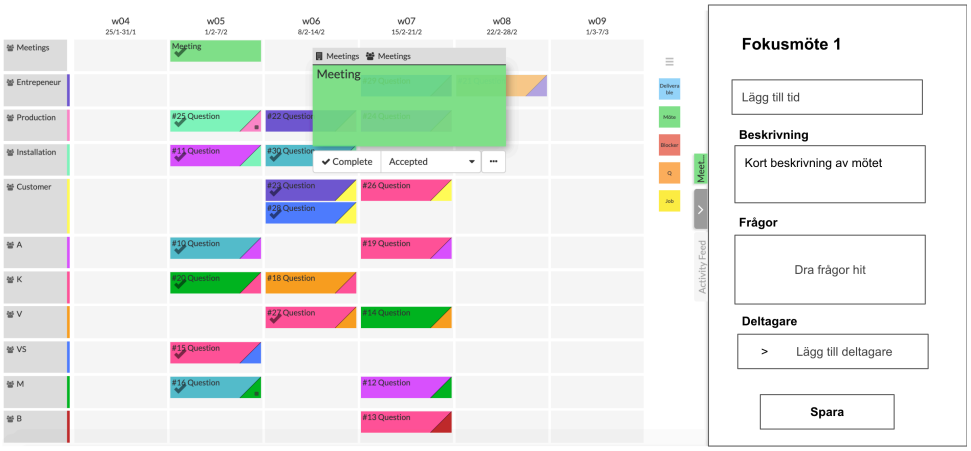


Figure 5.10: Create a focus meeting

When the meeting starts, the page in figure 5.11 is displayed. The left column is called *Questions* and includes all questions without answers that are due up until the meeting day, and the second column called *To decide* includes the questions that have been answered.

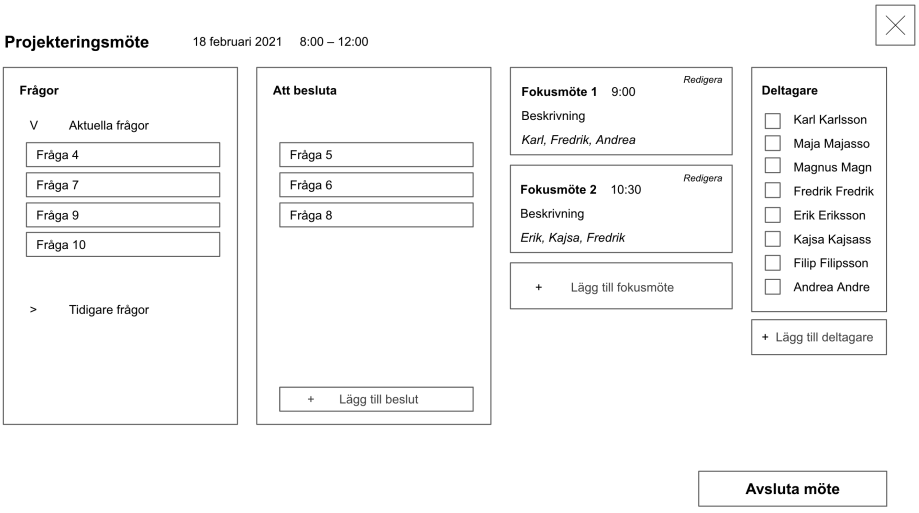


Figure 5.11: The meeting page

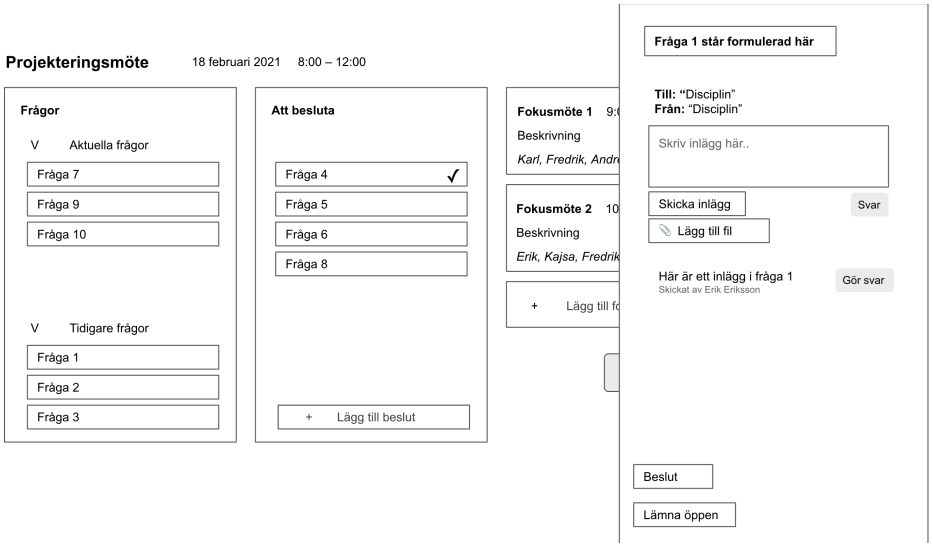


Figure 5.12: Decide on question

The meeting page also allows decision making, when a question is clicked on, the answer can be entered and then marked as a decision of the meeting agrees, as shown in figure 5.12. Then question will the be provided with a check mark to show that it has been decided on.

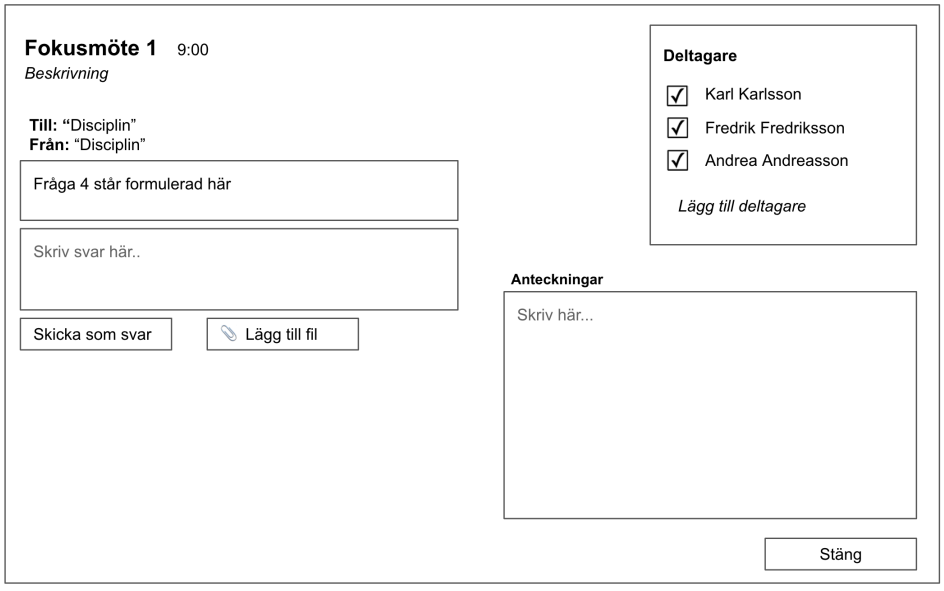


Figure 5.13: Open focus meeting

The focus meeting page allows for note taking, and for putting in answers to the questions linked to the meeting, as seen in figure 5.13.

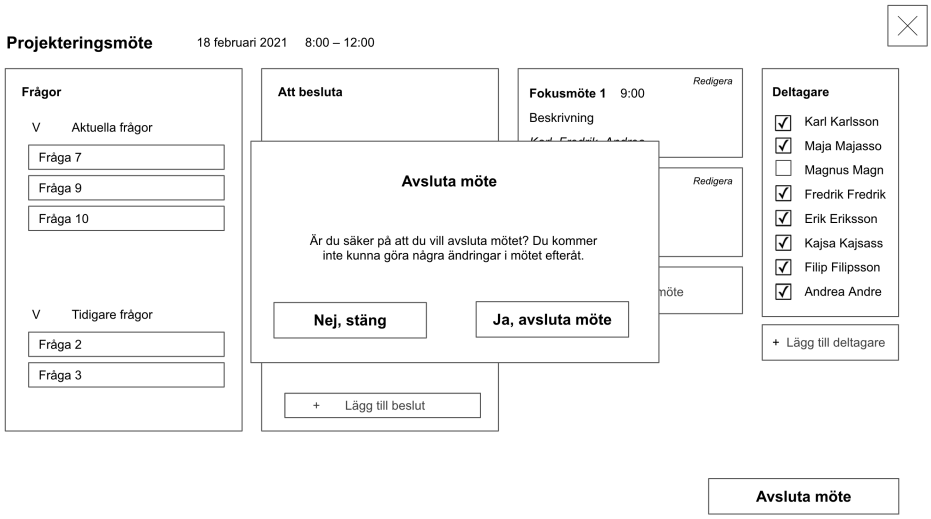


Figure 5.14: Close meeting

When closing the meeting, a pop up display is shown that reminds the user that after the meeting is closed, no further edits can be made, as shown in figure 5.14.

After the meeting has been closed, the display as in figure 5.15 will be shown. It is no longer editable, but the protocol from the focus meeting can be shown, along with the participants during the meeting and all the decisions made during the meeting. When clicking on *Show decisions*, the display in figure 5.16 is shown, with all the decisions made during the meeting.

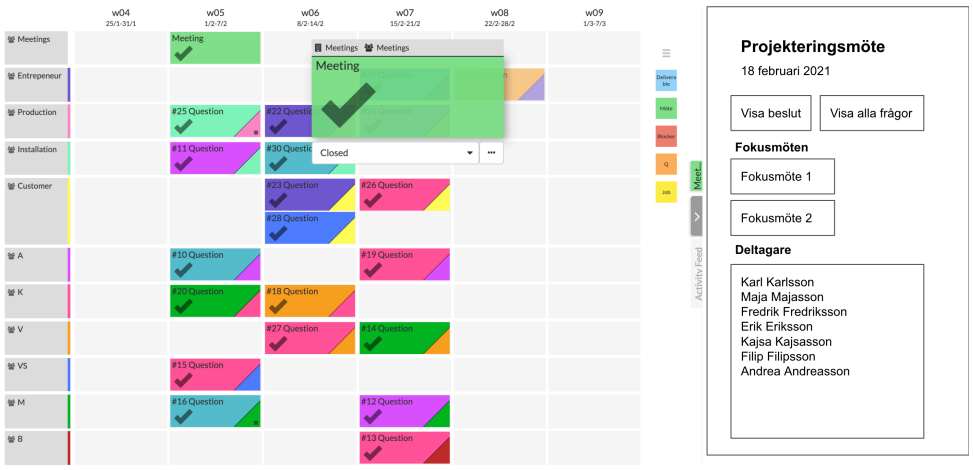


Figure 5.15: Open meeting after it is closed

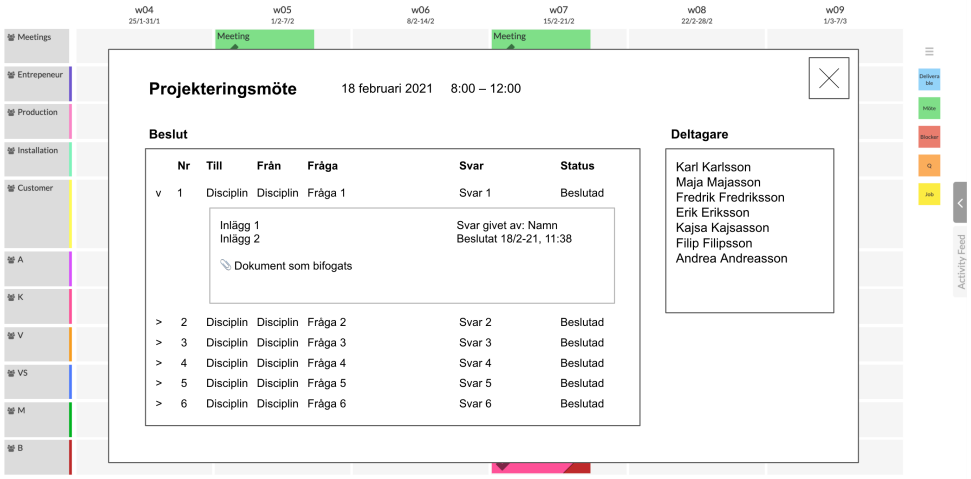


Figure 5.16: View decisions made during the meeting

5.3.2.2 User testing

The tests showed that the concept had a good potential to improve the decision handling during the design phase of construction projects. The over all structure of the tool was appreciated and for the most part easy to navigate through.

However, not all participants completed the tests without having to ask questions to understand all features of the tool, because it did not correspond to their mental model of the tool. One reoccurring issue was when the test persons were asked to select what questions to include in the meeting, with the options being *current questions*, *past questions*, and *future questions*, as all test persons interpreted *current questions* as also including previous un-answered questions, which would make the *past questions* option unnecessary.

Further more, the participants provided suggestions on what more to include in the tool, such as the possibility to export meeting minutes and what details to include in the decision documentation.

5.3.2.3 Evaluation against user needs

The first iterations was also evaluated against the user needs, to see if it fulfilled its purpose. The result from that evaluation is shown in table 5.2.

Table 5.2: Evaluation against user needs

#	*Need*	*Comment*	*Fulfilled?*
1	Need to get a protocol for the decision-making meetings	The *after meeting* page shows all decisions made at the meeting.	Yes

2	Need to gather all decisions made in the project in the same place	The tool provides a better integration for decisions made in focus meetings.	Partly
3	Need to find who made a decision, when it was made, and the basis of it	All information regarding the decision is made possible to document together with the decision, including the decision-making meeting participants.	Yes
4	Need to register who participated when making a decision	Meeting participants are registered at the same place as the decision is registered.	Yes
5	Need to find the newest decision on a matter	Not targeted in the design.	No
6	Need to make the features in the tool inviting to use	Difficult to tell with the lo-fi prototype.	?
7	Need to make sure all decisions are made in time	The tool shows all previous questions that is still to be decided.	Yes

5.3.3 Outcomes from the second iteration

The outcomes of the second iteration was an updated list of design criteria according to what had been found during the evaluation.

5.3.3.1 Design criteria

The list of design criteria was updated according to what had been shown in the evaluation of the second, as shown in table 5.3. Some functions were added to the list, and some were disregarded. The column to the right shows in which iteration the criteria was or would be added.

Table 5.3: Design criteria

Design criteria	***Iteration***
Create and edit a project meeting	1
Create and edit focus meeting	1
Add participants with accounts in the Yolean tool	1
Add participants without accounts in the Yolean tool	1
~~Choose what questions to show (current, previous, future)~~	1
Document focus meetings	1
~~Input decision not connected to a question in Yolean~~	1
Show decision data (who, decision basis, when)	1

Show participants during decision making meeting	1
Show all current and previous non-answered questions	3
Show all questions that are ready for decision	3
Navigate to the meeting from a decided question on which the decision was made	3
Export focus meeting protocol	3
Export project meeting protocol	3
Possibility to tear up decision	3

5.4 Third iteration

From the results in the second iteration, the tool was further developed in a third iteration. Both the process and the results of the third iteration is described below.

5.4.1 Method

The process included updating the concept according the the evaluation of the first iteration, and creating and evaluating a more realistic prototype.

5.4.1.2 Design

For this iteration, a high fidelity (hi-fi) prototype was created in Figma, that would allow for more interaction than Google Presentation, and would provide a design that looked more in line with a finished tool.

Hi-fi prototypes are of higher quality finish than lo-fi prototypes, and they should include functions and provide possibilities of interaction. The prototypes should resemble the finished product and allow the user testing the prototype to imagine they are using the finished product (Preece et al., 2015).

5.4.1.3 User testing

The Figma prototype was tested by 12 persons, of which 4 were considered potential users: design managers who already uses Yolean in their projects.

The tests were done similarly to the ones in iteration 1, through video calls where the test persons received a link to the prototype and shared their screen with the prototype during the test. They were asked to complete tasks in the prototype and they were encouraged to think aloud as much as possible during the test.

Data was collected in terms of observation notes from the test, a short interview after the test, and the same questionnaire as in iteration 1, see appendix B. All participants were asked to fill in the questionnaire this time, however only the

design managers were asked to fill in questions 3, 4, and 5, that regarded the potential usage of the tool in real projects.

The data from the tests was analyzed and categorized according to Norman's seven fundamental principles of design (Norman, 2013).

5.4.2 Results

The results of the third iteration is shown below.

5.4.2.1 Design

The aesthetic design of the prototype was made similar to the way the Yolean tool looks, as there were no intentions of changing the over all look of the system, only to add a new feature in the system.

Design principles were considered in several ways. The buttons were all made with a drop shadow to clarify that they afforded being clicked on, and signifiers, descriptive texts or signs, such as the plus sign when adding an attendee, were added as well. Feedback was provided in ways such as that the plus sign changed into a graphic of a person when the attendee had been added, as seen in figure 5.18, and the check that shows up when a decision has been made, as seen in figure 5.22.

Figure 5.17 shows the side panel that is displayed when clicking on the already created meeting "Projekteringsmöte 4". Possible features to edit are the *title*, *time,* and *place*. One can also add one or several *focus meetings*, and the *attendees* to participate in the meeting. Figure 5.18 shows the side panel when some of these features are edited. The list of names are the ones who have access to the board in Yolean, but when clicking the + *Add attendee* below the box with attendees, it is possible to add the name of an attendee that is not included in the Yolean system.

A change in the design from the previous iteration is that the user no longer have to choose which questions to bring up during the meeting, as that caused a lot of confusion. Instead, all questions from the current and previous weeks are presented in the meeting page, and sorted into respectively category. This is further explained along with figure 5.20.

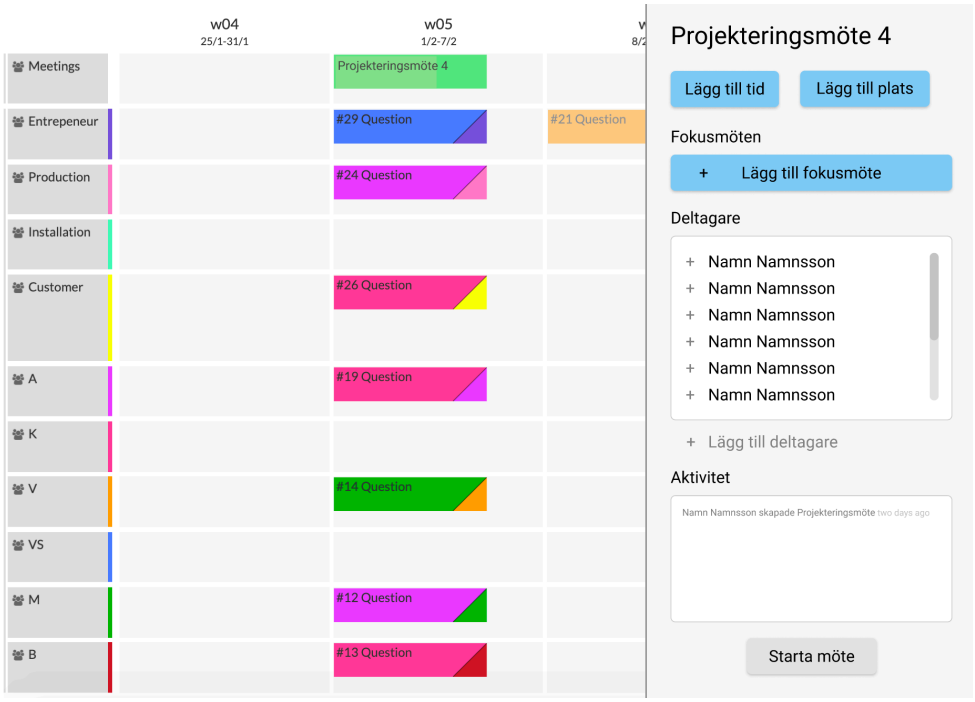


Figure 5.17: Creating and editing the project meeting

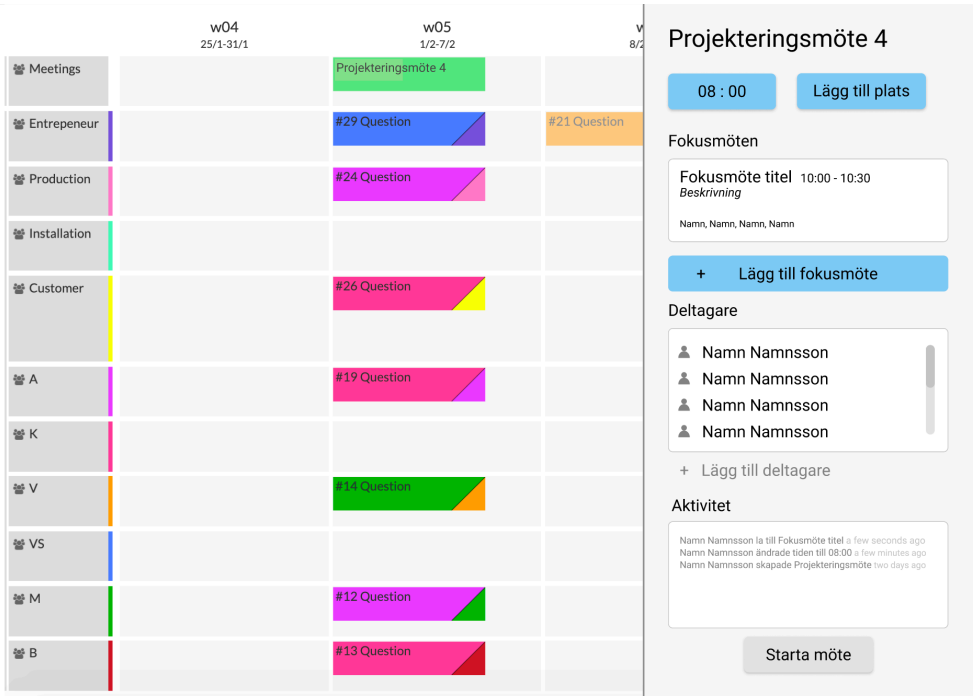


Figure 5.18: The project meeting after adding the time, a focus meetings, and participants

Figure 5.19 shows the side panel when adding a focus meeting, with the possibility to edit the *title*, *time*, and *place*, as well as a *description* and the *attendees* to participate. One can also drag and drop *questions* that the focus meeting should discuss.

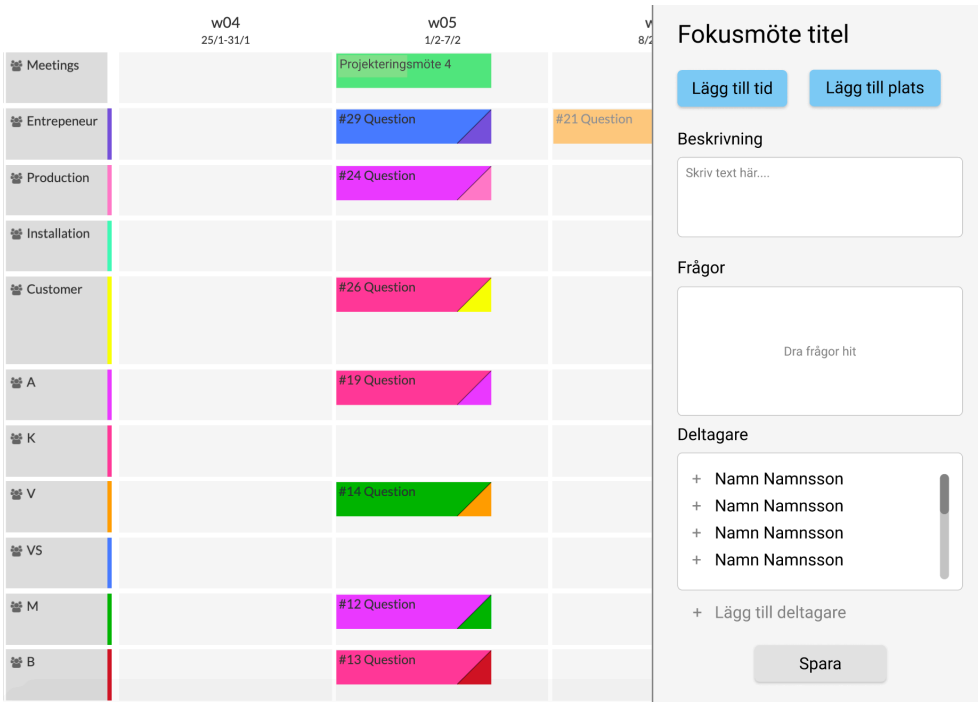


Figure 5.19: Adding a focus meeting

When clicking the *Start* button in the meeting side panel, the page in figure 5.20 is opened up as an overlay over the board. To the left are all questions with deadline this week or prior to this week, sorted as: unanswered questions with deadline this week, unanswered questions with deadline previous weeks, and lastly all questions with answers and deadline this or previous weeks.

In the middle, the focus meetings show, with any questions added to is shown as the two-colored square. It is also possible to add more focus meeting while in the meeting page, if needed. To the right, the ones attending the meeting can be noted.

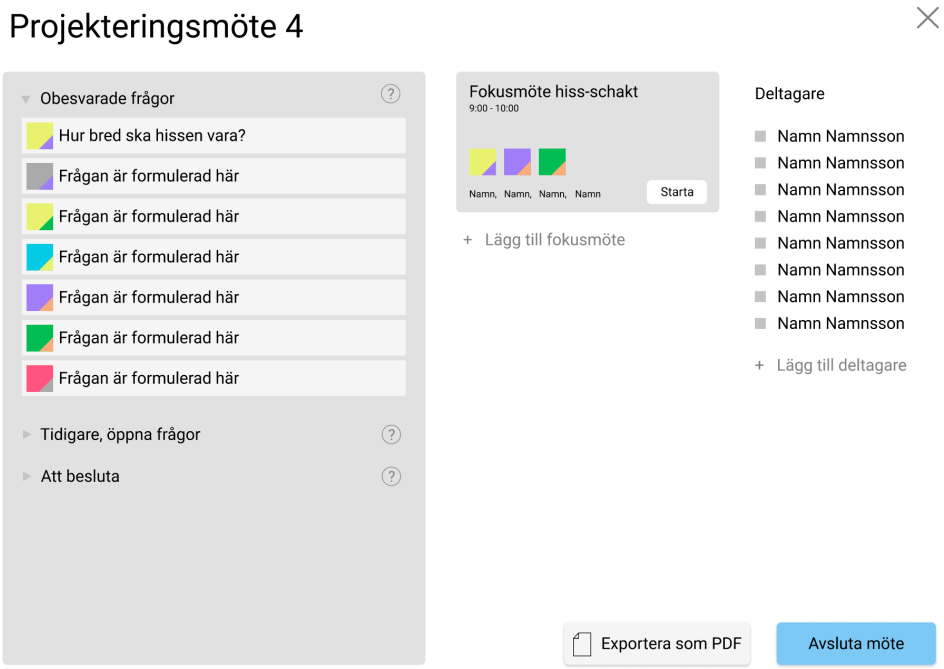


Figure 5.20: The meeting page

Clicking on a question opens up the side panel with the question, and if it has a green-marked answer, the button that makes it possible to mark as decision is shown, as in figure 5.21. After a question has been marked as decided, a check-mark, shown in figure 5.22, shows up next to it.

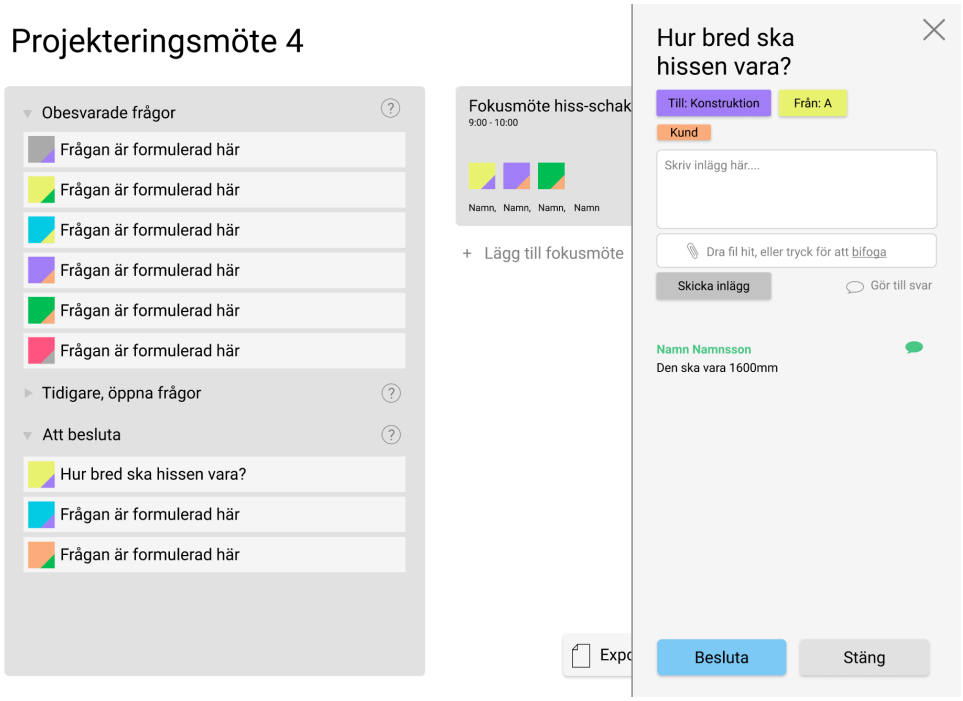


Figure 5.21: Opening a question inside the meeting

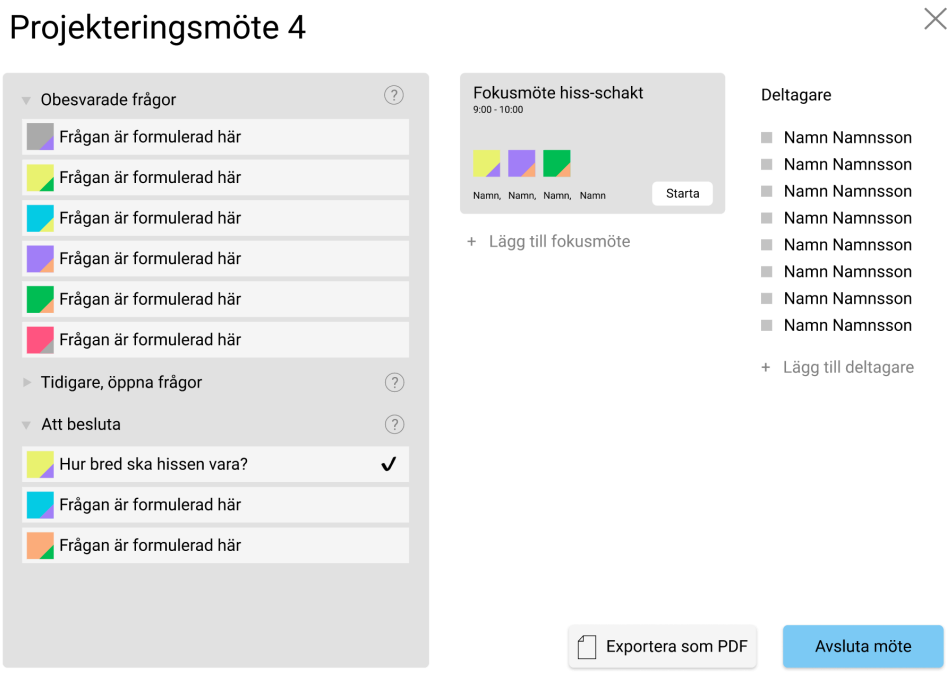


Figure 5.22: After a question has been marked as decided

Figure 5.23 showed the page opened when starting a focus meeting. The questions connected to the meeting are shown to the right, with the possibility to write posts and answers. It is also possible to add other notes, if things that are not directly connected to a question are discussed during the meeting.

Figure 5.23: Focus meeting

When the project meeting is finished and closed, the side panel shown in figure 5.24 if clicking on the green meeting note. The panel shows the attendees, the focus meetings, and if clicking on in the *Show questions* button, the page shown in figure 5.25, with all questions decided on, opens up. If clicking on the focus meeting, a similar page but with questions discussed on the meeting along with other notes opens up. Both these pages have the possibility to export meeting minutes as a pdf document if needed.

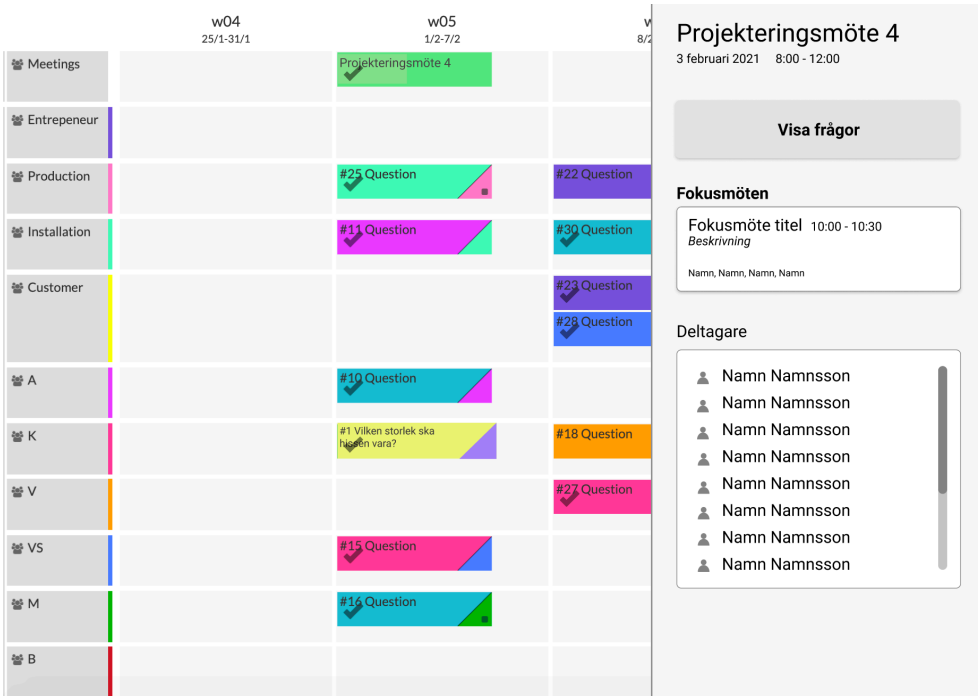


Figure 5.24: Project meeting after it is finished

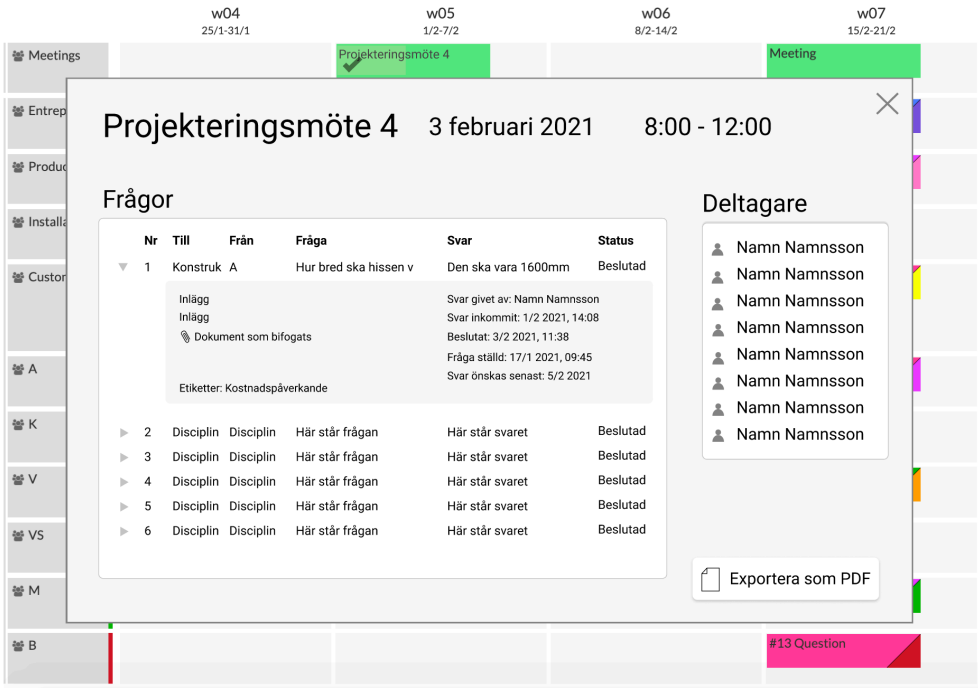


Figure 5.25: All decisions, with details, made in the meeting

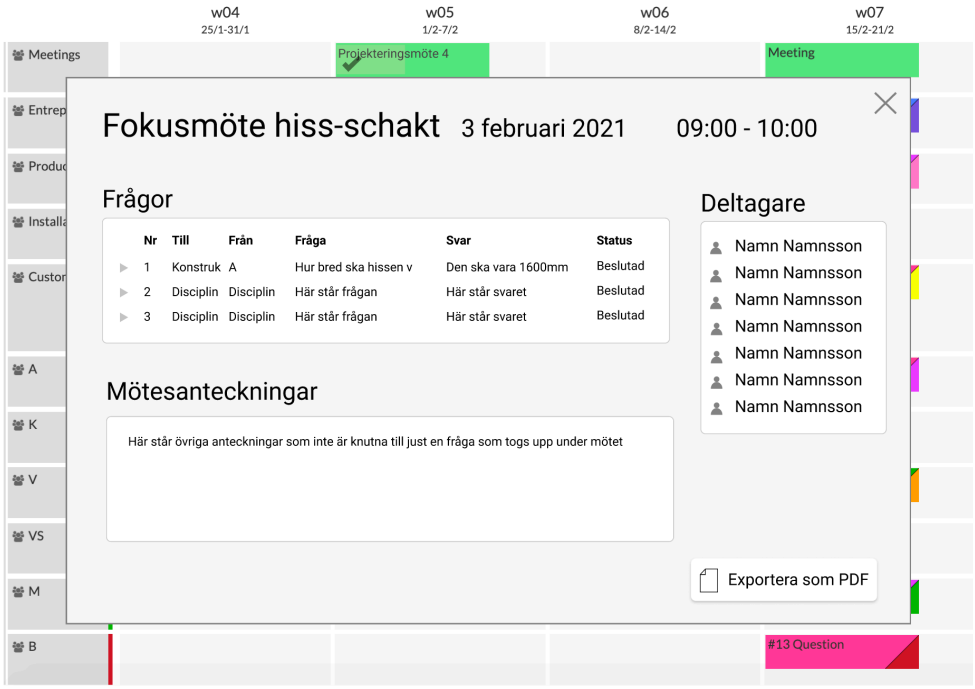


Figure 5.26: The focus meeting

It is also possible to find the meeting on which the question was decided from the side panel shown the clicking on the question (perhaps found by the search function in Yolean). A question that is marked as decided, as in figure 5.27 shows on which meeting it was marked as a decision. There is no longer the possibility to write new posts or answers, but it is possible to tear up the decision to make new posts, and then a new decision has to be made on the next meeting.

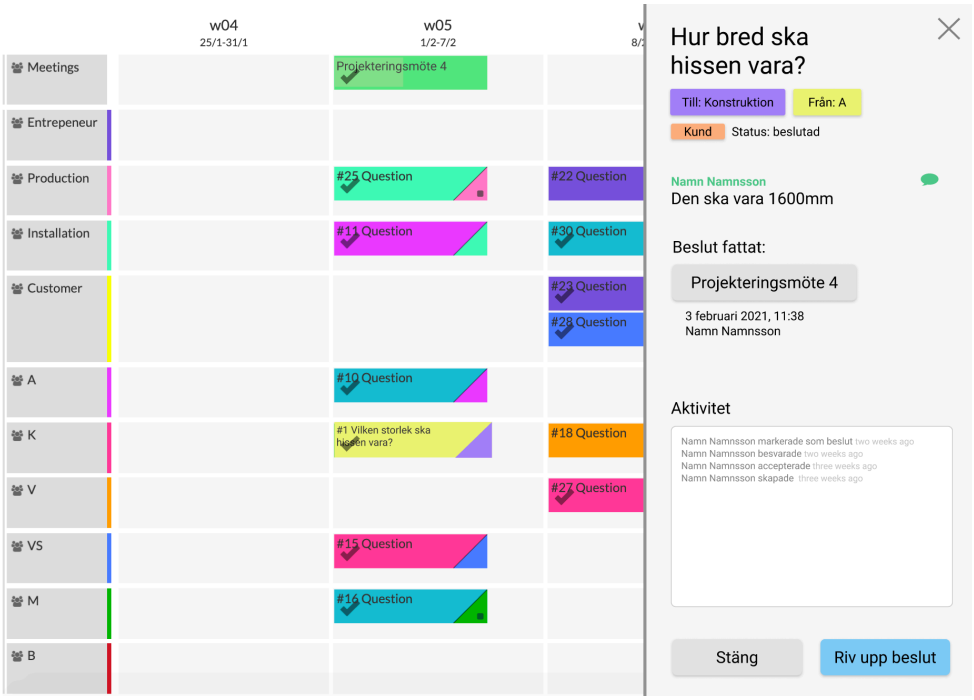


Figure 5.27: A question after it has been marked as decided

5.4.2.2 User testing

All design managers responded well to the prototype, and appreciated the overview of all questions to bring up during the meeting. They also liked the simplicity of the tool, because the less complex, the more likely that the tool would be used frequently. This was also proved by the tests as the persons who did not have any previous experience with Yolean could all still quite easily navigate through the tool and finish the tasks.

> *"This gives a whole new dimension and meaning to our meetings"*
> Comment about the general meeting page with overview of the questions and focus meeting.

One of the most appreciated parts was the ability to export the decisions made at a meeting, because that would simplify the distribution of decisions and meeting protocol.

> *"This is good. Wow this is really good!"*
> Spontaneous reaction when a design manager opened the meeting note after it had been closed, with the list of all the decisions made at the meeting.

> *"The tool is clearly improved and made more effective"*

The new *tear up decision*-function was discussed with the design managers, and they had some different thoughts on that function. Some did not think it would add value, but rather create confusion, because if a decision log was exported and distributed to people without access to Yolean, a later change in the decision would not be logged. Some design managers however thought it was important to be able to go back and edit the decision.

The results from usability evaluation questionnaire are shown in table 5.4 and 5.5 below:

Table 5.4: Usability evaluation questionnaire , replies from design managers

Usability evaluation questionnaire , design managers			***Average score***
1. How did you experience the structure of the tool?			
Cluttered	| 1 2 3 4 5 6 |7 |	Organized	6,75
2. How did you experience the navigation of the tool?			
Complicated	| 1 2 3 4 5 6| 7 |	Easy	6,25
3. How would you rate the tool's effectiveness?			
Ineffective	| 1 2 3 4 5 6 |7 |	Effective	7
4. How would you rate the tool's usage during a design phase consultant meeting?			
Obstructive	| 1 2 3 4 5 6 |7 |	Supportive	6,75
5. How would you rate the tool's aim to support the handling of decisions in the design phase of a construction project?			
Unnecessary	| 1 2 3 4 5 6 | 7 |	Valuable	6,5
6. How was your experience with the tool as a whole?			
Unclear	| 1 2 3 4 5 6 |7 |	Clear	6,75

Table 5.5: Usability evaluation questionnaire , replies from inexperienced users

Usability evaluation questionnaire , inexperienced users			*Average score*
1. How did you experience the structure of the tool?			
Cluttered	| 1 2 3 4 5 6 7 |	Organized	6,125
2. How did you experience the navigation of the tool?			
Complicated	| 1 2 3 4 5 | 6 7 |	Easy	5,75
6. How was your experience with the tool as a whole?			
Unclear	| 1 2 3 4 5 | 6 7 |	Clear	5,75

Table 5.6 shows the results of the tests sorted into Norman's seven principles of design.

Table 5.6: Usability evaluation

Principle	***Evaluation***
Discoverability	In general it was quite easy to find everything, some had trouble finding the *decide*-button, because it was so far down.
Feedback	The feedback was clear, especially with the checkbox showing up when a decision was made. There were no uncertainties on what had happened when a button was clicked on.
Conceptual model	Better conceptual model in this iteration. It seemed quite easy to understand even for used that lacked precious experience with the Yolean tool.
Affordances	Buttons are large and easy to click on. The question-marks that when hovered told the user the difference between the categories was a bit too small or light, so they were hard to find. Too many options to close some of the sidebars, with both an X and a button that says *close*. Is there a difference? Does it mean closing the question?
Signifiers	Different colors on the buttons raises some questions, is there a difference between a blue, a white, or a gray one? Both text and graphics are clear.
Mapping	No comments on mapping.
Constraints	The constraint that it was not possible to make new post on a question that had been decided was appreciated, because that meant that the decision was final. The possibility to tear up the decision contradicts the constraint.

5.4.2.3 Evaluation against user needs

The prototype was also evaluated against the user needs, to see if it fulfilled its purpose. The result from that evaluation is shown in table 5.7.

Table 5.7: Evaluation against user needs

#	*Need*	*Comment*	*Fulfilled?*
1	Need to get a protocol for the decision-making meetings	The *after meeting* page shows all decisions made at the meeting, and is also possible to export es a PDF.	Yes
2	Need to gather all decisions made in the project in the same place	The tool provides a better integration for decisions made in focus meetings.	Yes
3	Need to find who made a decision, when it was made, and the basis of it	All information regarding the decision is made possible to document together with the decision, including the decision-making meeting participants.	Yes
4	Need to register who participated when making a decision	Meeting participants are registered at the same place as the decision is registered.	Yes
5	Need to find the newest decision on a matter	Not targeted in the design.	No
6	Need to make the features in the tool inviting to use	As the design was appreciated, simple, and easy to understand, the tool is considered inviting to use.	Yes
7	Need to make sure all decisions are made in time	The tool shows all previous questions that is still to be decided.	Yes

5.4.2 Outcomes from the third iteration

Once again, the list of criteria was updated, according to what had been found during user tests. The column to the right shows in which iteration the function was or would be added, where FD is short for final design.

Design criteria	***Iteration***
Create and edit a project meeting	1
Create and edit focus meeting	1
Add participants with accounts in the Yolean tool	1
Add participants without accounts in the Yolean tool	1
~~Choose what questions to show (current, previous, future)~~	1
Document focus meetings	1
~~Input decision not connected to a question in Yolean~~	1
Show decision data (who, decision basis, when)	1
Show participants during decision making meeting	1
Show all current and previous non-answered questions	3
Show all questions that are ready for decision	3
Navigate to the meeting from a decided question on which the decision was made	3
Export focus meeting protocol	3
Export project meeting protocol	3
~~Possibility to tear up decision~~	3
Add participants as disciplines instead of individuals	FD
Add documents to meeting notes in focus meetings	FD
Show when a focus meeting is closed	FD
Indicate what question is clicked on	FD
Possibility to switch between meeting page and the board easily	FD

6. Deliver

From the evaluation of the third iteration, some final changes were made to the design, and this chapter presents the final design proposal for the concept. Included is also a list of requirements, which were all found through the user studies and user testings. The board in the background in all of the pictures below are screenshots from the Yolean tool, to put the concept designed into context.

6.1 Final design proposal

The main concept in the final design are the meeting pages, one page for project meetings, and one for focus meetings. A project meeting is created the way all notes are created on the Yolean board: by drag-and-dropping a note on the desired place on the board.

After a meeting has been created, the sidebar as in figure 6.1 shows up when clicking on it. The sidebar provides the possibility to add time and place, attending disciplines, and focus meetings. It is also possible to change the title of the meeting. When adding a discipline, the plus sign turns into a graphic of a person, indicating that the discipline has been added to the meeting. Figure 6.2 shows when some of the settings for the meeting have been adjusted, and figure 6.3 shows the feedback when adding a discipline.

By clicking on *Add focus meeting*, the sidebar is changed into the one in figure 6.4, which allows editing the focus meeting. Questions to be discussed can be dragged from the board into the meeting, and the disciplines that should be attending can be added.

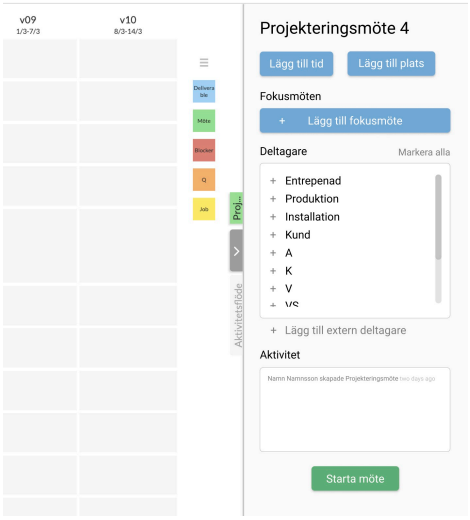


Figure 6.1: Edit project meeting

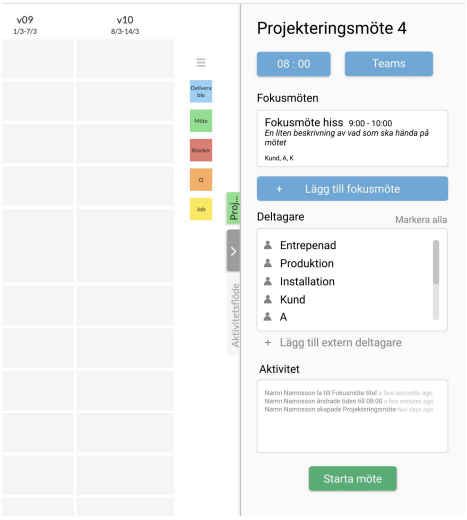


Figure 6.2: Edit project meeting with time, attendees, and a focus meeting added

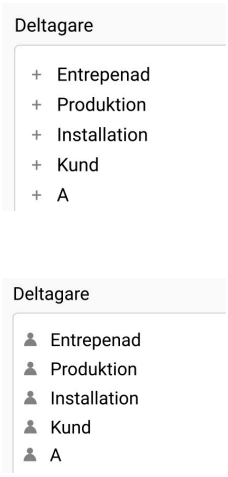


Figure 6.3: The feedback provided when a discipline is added

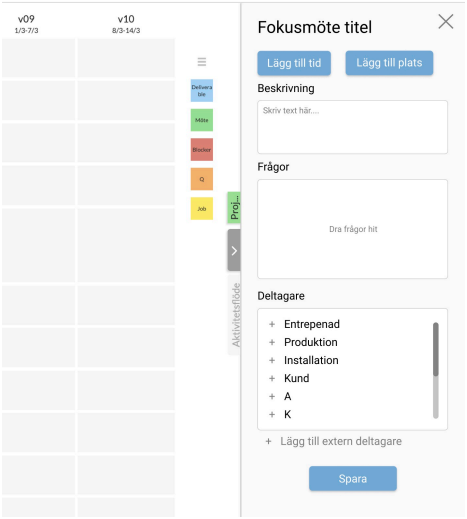


Figure 6.4: Add focus meeting

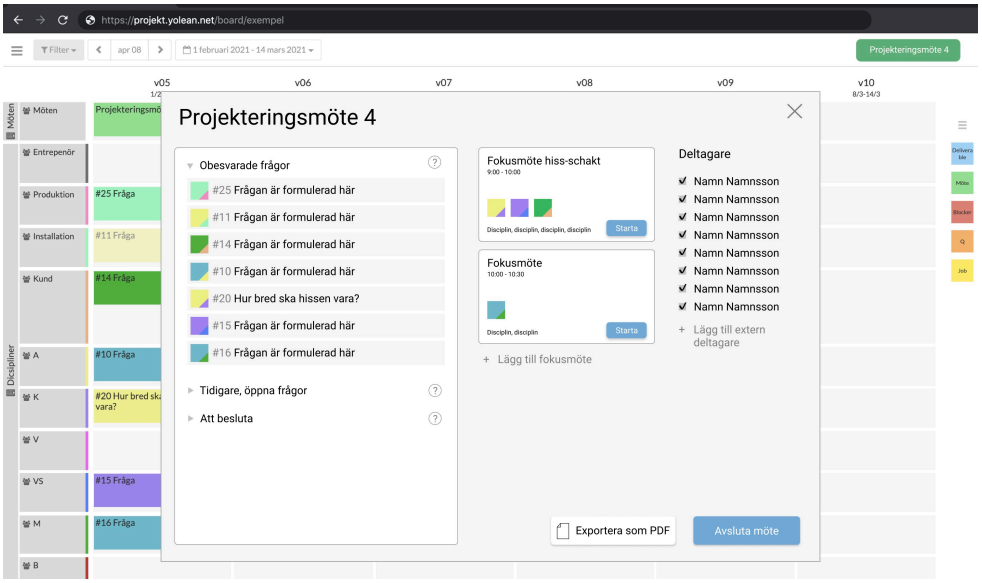


Figure 6.5: Project meeting page

When starting the project meeting, the meeting page shows up as an overlay over the board, as in figure 6.5. If needed to add or move a question on the board during the meeting, a click on the X in the corner will close the meeting page. The meeting is till active however, and is found again by clicking on the green button in the top right corner.

To the left in the project meeting page, all questions up to the current week is shown, divided into three categories. The first category, *Unanswered questions*, holds all questions placed in the current week that lacks an answer. The next category, *Earlier open questions*, shows any questions from previous weeks that have not been answered yet. If this category is empty, the category will be hidden. The third category, *To decide*, holds all questions from this or previous weeks that has an answer and therefore are ready to be decided on.

The middle panel shows what focus meetings to be held throughout the day, and it is also possible to add more focus meetings if needed. To the right, there is an attendance list to be checked. The list includes the names of the people from the disciplines chosen to attend the meeting. What discipline a person belongs to is thought to be set up in the Yolean account needed to access the project board. It is also possible to add external participants to the list.

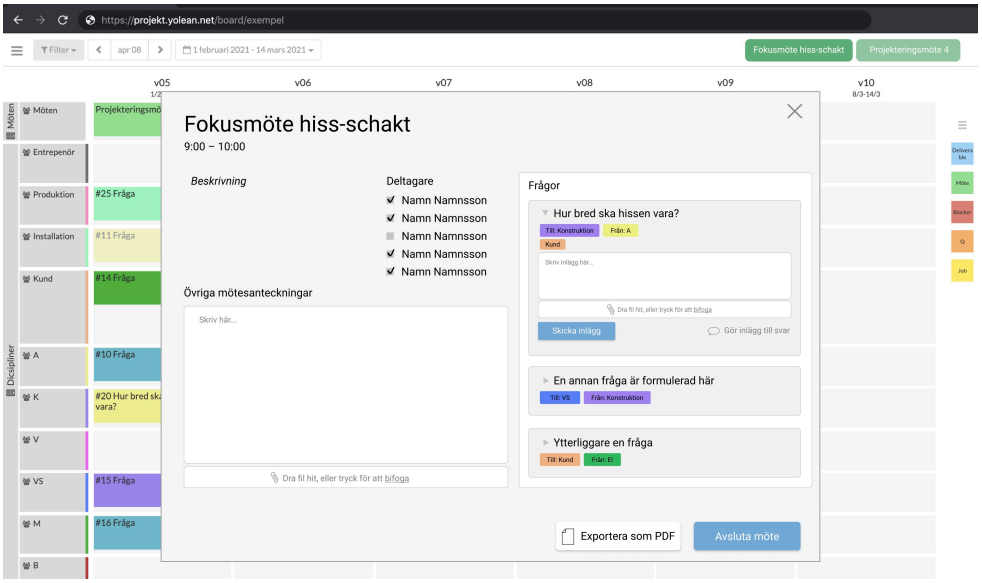


Figure 6.6: Focus meeting page

The focus meeting page, shown in figure 6.6 allows answering of questions, and also to make other notes for the meeting. It is possible to attach documents to the answers in questions, but also to the general meeting notes, something that was noted as missing by several test participants.

From the focus meeting, it is also easy to navigate to the board if needed, once again by clicking on the X in the corner.

In the top right corner of the board, two buttons show, one leading to the focus meeting, and one leading to the project meeting. They are both green indicating that they are active meetings, but the project meeting is a bit transparent since the meeting page is not open at the moment.

After the focus meeting is finished, the meeting box in the project meeting page turns a darker grey to indicate that the meeting has already been held. It is still possible to open the focus meeting if accidentally closed too early, up until the project meeting is finished. Figure 6.7 shows the difference between a focus meeting that is finished, and one that is yet to be held.

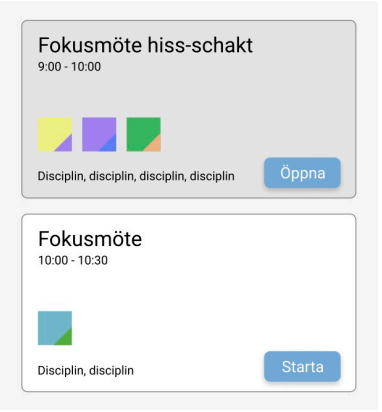


Figure 6.7: Focus meeting that is finished and not yet started

When clicking on the questions that are ready for a decision, the sidebar as in figure 6.8 shows up. The active question gets a slightly darker color. When clicking on the *Decide* button, the sidebar closes, and a check turns up in the question, as in figure 6.9.

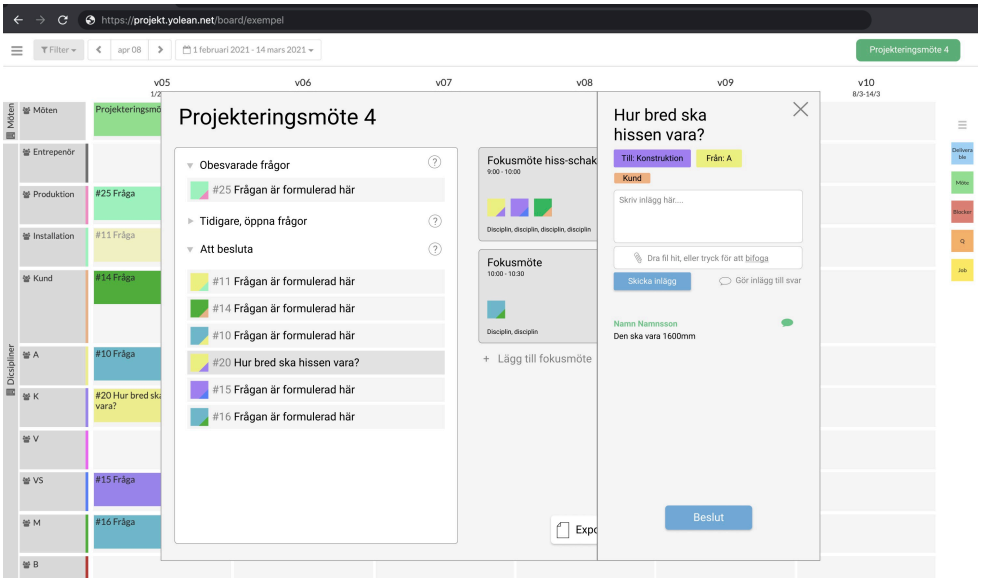


Figure 6.8: Making a decision

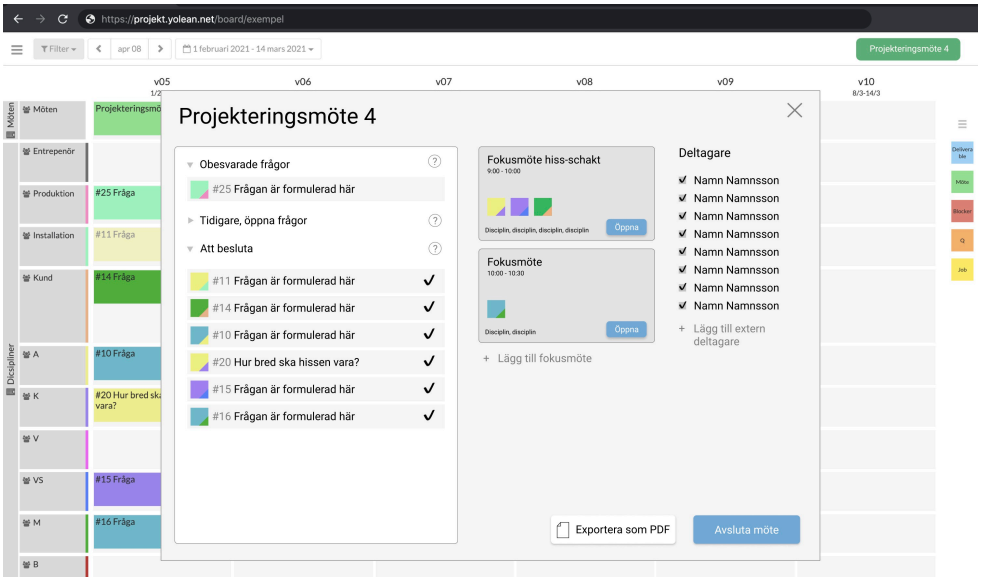


Figure 6.9: Questions decided

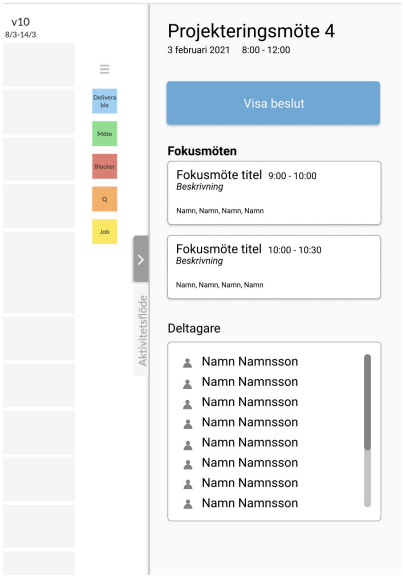


Figure 6.10: Project meeting after it is finished.

When clicking on a meeting note after it is closed, the sidebar in figure 6.10 is shown. All attendees during the meeting can be found, as well as what focus meeting were held. A button with the text *Show decisions* opens up the page shown in figure 6.11, showing all decisions made during the meeting.

In the list of the decisions shown in figure 6.11, the decisions can be expanded to see all details. Any document attached is shown here as well, so that visual attachments as drawings or similar is easily accessible. The list of the decisions made at the meeting can easily be exported into a PDF to share with external parties, by clicking the button *Export as PDF*.

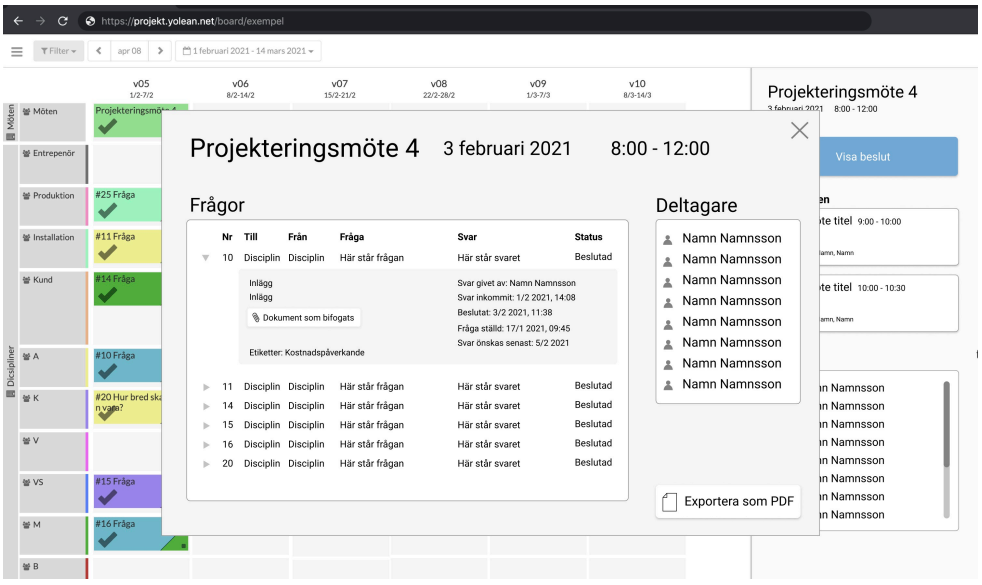


Figure 6.11: The list of decision made at the meeting.

If clicking on one of the focus meeting boxes in figure 6.10, the page shown in figure 6.12 is shown, which can also be exported as meeting minutes from the focus meeting by clicking the *Export as PDF* button, with an example of this export shown in figure 6.13.

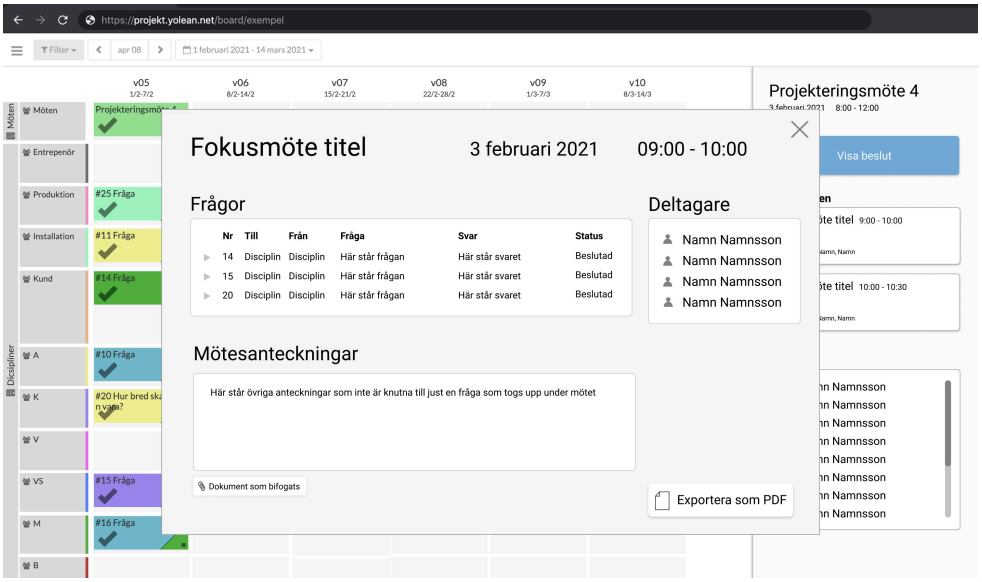


Figure 6.12: The focus meeting after it is closed.

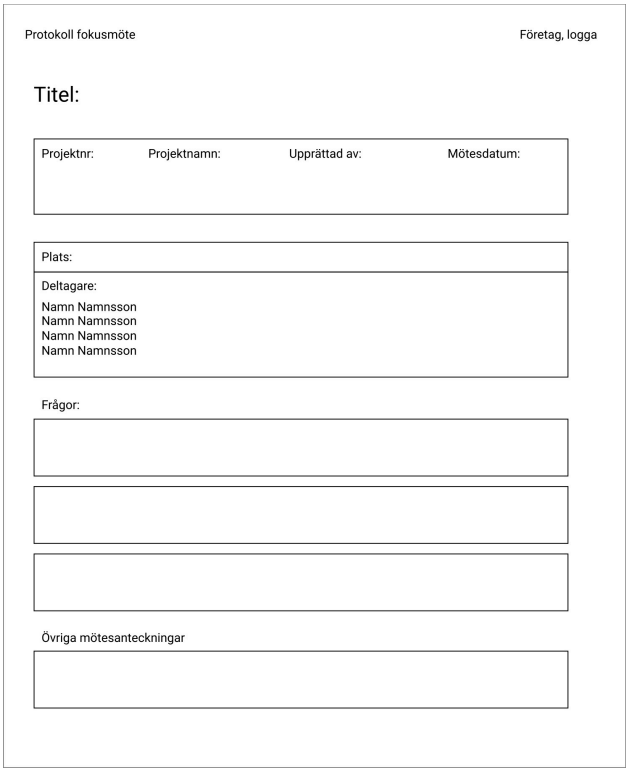


Figure 6.13: Focus meeting protocol.

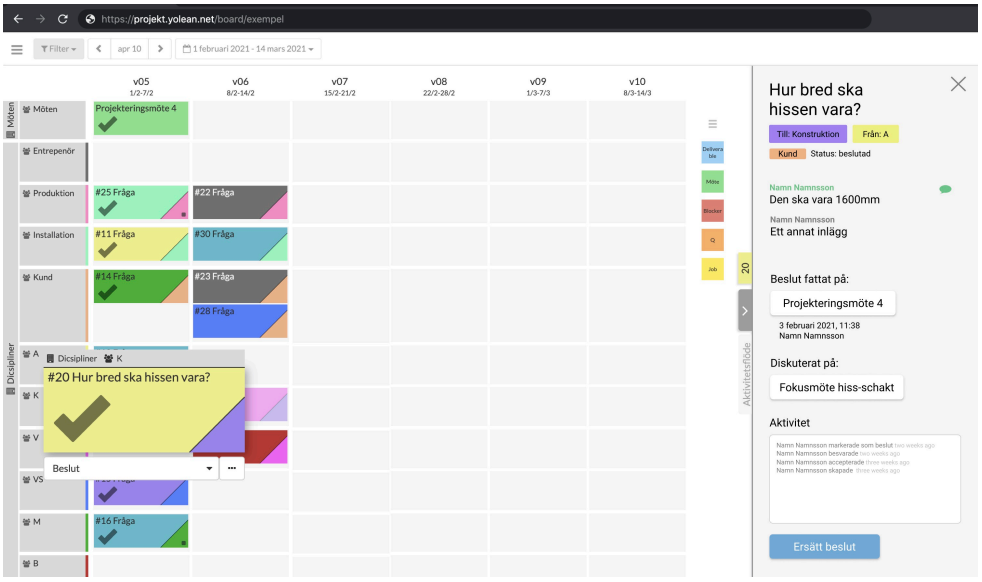


Figure 6.14: A question after it has been marked as decision.

After a question has been marked as a decision, the question looks like in figure 6.14 if clicked on. In addition to the answer and any additional posts, there is a button linking the question to the meeting on which it was decided on. If the question had been discussed at a focus meeting, a button to that meeting shows up as well. The buttons respectively leads either the project meeting sidebar shown in figure 6.10 and the focus meeting overlay shown in figure 6.12.

Instead of a *tear up decision*-button, there is a *replace decision*-button. When clicking this, a box that allows another question to be drag-and-dropped is shown, see figure 6.15. This will make the decision cancelled, and the new decision will be shown on both the old and the new question note, as shown in figure 6.16 and 6.17. After a decision has been replaced, the graphically shown check is replaced by an X on the question, indicating that the decision is no longer valid, as shown in figure 6.18.

This feature has not been tested in user tests, but serves as a suggestion for continued design.

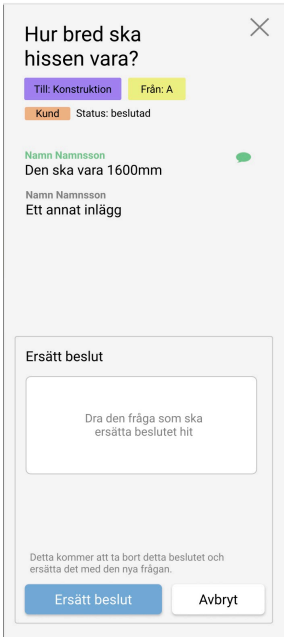


Figure 6.15: Replacing a decision.

Figure 6.16: The old question that is now replaced.

Figure 6.17: The new decided question that replaces the earlier decision.

Figure 6.18: The graphic indication that the question has been replaced.

7. Discussion

In this chapter, the results and the methods are discussed.

7.1 Final design

The concept with the meeting page was well received by the users, and especially the page after the meeting was closed, which showed all decisions made during the meeting and also enabled exporting to PDF of the decisions made. However, as all of the projects observed and most interviews conducted were from the same company, the design reflects the way they worked, with a specific project day one day of the week, where all focus meetings and decision-making meetings were held during that day. The testing included users from other companies as well, showing that the way companies work differs a bit, but those users did still think that the tool would be useful for them as well.

An important part of the design of the tool was to make it appealing to use, so that users would send less construction design related questions through email, but to use the tool instead. The new tool clarifies the decision-making process and makes it more understandable. Now each question leads to a decision that needs to be documented properly, thus enhancing the importance of using the tool.

It was also important that the tool would be intuitive to use and have good usability, so that consultants working on projects would not need to put in a lot of time and effort to learn how to use yet another digital tool. This was something that the tool was proven to be, as the inexperienced users could easily navigate through and understand it after a very short time, during the tests.

A question that was raised was if it was justifiable to create a meeting page to be used during meetings instead of the board, as the board together with a meeting is such an important part of visual planning. However, the meeting page was very appreciated by the design managers, and the board was still easily accessible as the meeting page was created as an overlay on top of the board.

7.1.1 Functions

The functions formulated served as a foundation for the development of the tool. Some of the functions however were not regarded, as they were not considered to be a realistic part of the concept chosen, along with the fact that they were not rated to be as important as the others. To the left are the ratings of the functions: MF - main function, N - necessary, D - desirable.

MF	*Allow decision-meeting documentation.* The new tool provided documentation of the decision-making meetings in a new way in the Yolean tool, as it did not only document the decisions made, but connected the decisions to the meeting, and also documented the participants and the focus meetings held in connection with the decision-making meeting.
MF	*Ensure decision traceability.* The decision traceability is increased through the functions below.
N	*Provide possibility to include decisions from other places.* This function was added in the first prototypes, but was disregarded after testing.
N	*Show when the decision was made.* The date and time is shown, as well as at what meeting.
N	*Show who made the decision.* The tool showed both who typed in the answer, who clicked make the decision, and all that participated during the decision-making.
N	*Show the basis on which the decision was made.* The users still have to type the basis of the decision, or add documents, for the basis to be shown in the documentation. However, if the question was discussed at any focus meeting, this shows up on the question note, thus it becomes possible to see additional discussion notes from the meeting, and also to see who have discussed the question, besides the one typing in the answer.
N	*Show the participants during a decision-making meeting.* Function fulfilled with the attendee-list.
D	~~*Allow sorting of decisions related to a specific subject.*~~ Function not regarded in the design.
D	~~*Show all decisions on the same subject.*~~ Function not regarded in the design
N	*Invite to usage.* As both design managers and inexperienced users found the tool both simple and appealing to use, the function is considered fulfilled.

N *Show which decisions are left to be made.*
The left column on the meeting page shows all questions up until the meting day that lack a decision, showing all decisions that are left to be made. This makes sure no questions are forgotten along the way, and the *earlier questions* category shows any unanswered questions from previous weeks that are now delayed.

7.1.2 Needs

As the functions were directly connected to the needs, they made sure the identified needs were fulfilled as well. Table 7.1 lists the needs, and after which iteration the need was considered to be fulfilled. Need number 5 is only considered to be partly fulfilled, as the feature fulfilling that function was added to the final design (FD) and was thereby not tested during the user tests. In addition, as the design contributes to a better overview of all decisions and gathers documentation from both decision-making meetings and focus meetings in Yolean, and it can be argued that it also facilitates in finding the newest decision on a matter.

Table 7.1 Needs

#	*Need*	*Fulfilled?*	*Iteration*
1	Need to get a protocol for the decision-making meetings	Yes	2
2	Need to gather all decisions made in the project in the same place	Yes	3
3	Need to find who made a decision, when it was made, and the basis of it	Yes	2
4	Need to register who participated when making a decision	Yes	2
5	Need to find the newest decision on a matter	Partly	FD
6	Need to make the features in the tool inviting to use	Yes	3
7	Need to make sure all decisions are made in time	Yes	2

7.1.3 Interaction design

The design theory presented in chapter *2 Approach* was followed throughout the development process. The gestalt laws were a natural part of creating the interface, where the law of proximity and the law of similarity were the ones mostly implemented within the design. Norman's fundamental principles of design were used as for analyzing the tests and evaluation the design, making sure that the design had a good user experience.

Most of the usability goals could be considered to be fulfilled by the design, which was shown through the user tests. The goals listed below, were fulfilled as described below.

- *Effective to use (effectiveness)*
- *Efficient to use (efficiency)*
- *Safe to use (safety)*
- *Having good utility (utility)*
- *Easy to learn (learnability)*
- *Easy to remember how to use (memorability)*

Since the tool was designed to meet the needs, it also became effective, meaning that it would produce the desired result. This was further strengthened by the result of the user study where all the design managers gave the tool the maximum score on the usability evaluation questionnaire. The tool was also efficient with good utility, as it was easy for the users to navigate the tool to finish the tasks.

The goal of safety is considered to be fulfilled in the aspect that only authorized users with accounts in the Yolean board can access the information, unless willingly distributed by the authorized users. The tool have good learnability, which was proven as even all the test persons without previous experience of Yolean got a good understanding of how to use the tool, and could finish all the tasks during the tests.

To be able to test the memorability goal, it would have been required that the tool was tested by the same people on multiple occasions, which was not done due to the time limit of the project.

7.2 Methods and results

The Double Diamond served as a good process outline for this project, and human centered design was considered all through the project. The six principles from the ISO standard, listed below, were followed as described below.

- *The design is based upon an explicit understanding of users, tasks and environments*
- *Users are involved throughout design and development*
- *The design is driven and refined by user-centered evaluation*
- *The process is iterative*
- *The design addresses the whole user experience*
- *The design team includes multidisciplinary skills and perspectives*

The three first principles were followed through the process, by doing an extensive user study to understand both the users and their context, and by involving the users in testing the tool during the development process.

The fourth principle was followed by doing three iterations in the development process, with evaluations and redesign based on the feedback.

To be able to test the whole user experience, a working prototype that could be tested in a real project would probably have been ideal, to be able to test the prototype during a meeting. However, the prototype was tested with both project managers and users without previous experience of the tool, providing a lot of input on their user experiences, within the scenarios being tested. Therefore, it is considered that this principle was at least partially followed.

The last principle was hard to follow, as the project team only consists of one person. However, this was compensated by talking to other experts, such as employees at Yolean AB, through the process, to gain additional knowledge to the team.

7.2.1 Discover

The explorative phase had to be stretched out over a longer period of time than originally planned, due to circumstances. However, this provided an opportunity to follow a project for a longer period of time, and see how the usage of Yolean during decision-making meetings changed throughout the project. It also allowed for observations of other projects, that would not have fit the time frame with the original plan.

7.2.1.1 Observations

The observations served as an important part of the data gathering, and provided a lot of useful information. However, since the meetings were on conference calls, often with no video, a lot of things that could have been observed in physical meetings, such as the behavior of participants when not actively participating, was been left out. In the first meetings, one group was gathered in an office room, combined with conference call with the ones who could not participate physically, including the observer. This made it was hard to clearly define who was talking at what point, as well as made it impossible to see the behaviors of the ones not talking. When the corona-related restrictions became stricter (in November), all the participants were attending the meetings through conference call, making it easier to follow the meeting and define who was talking at what point.

Despite the circumstances, the observations were considered well performed and provided a lot of insight and therefore fulfilled its purposes. They were performed with an ethical aspect as all the participants were informed that the meetings was being observed and that their identities would be kept anonymous, as would all the information regarding their project that they shared between each other and within the Yolean tool.

7.2.1.2 Interviews

The interviews held with design managers and consultant provided a lot of information about how the make and document decisions. However, as interviews were only held with three design managers and one consultant, a greater number of interviewees would have given wider knowledge about the processes.

As the interviews were semi-structured, they required the interviewer to play an active role during the interviews. Because of this, it was considered a good idea to record the interviews, which was always done with consent from the interviewee. Going through the audio records was time consuming, but it made sure no information was lost through incomplete note-taking.

7.2.2 Define

The define phase narrowed down the explorative phase into a clearer picture of what to be designed.

7.2.2.1 Needs

The needs were identified from the problems discovered in the previous phase. However, the needs were hard to define because some of them were already partly fulfilled by the Yolean tool as it is today, but not to the full extent. An example is the *need to easily find all decisions made in the project*, because the search function in Yolean does this, as long as the ”right” words (without spelling mistakes) are formulated in the questions and replies.

7.2.2.2 Functions

An initial thought was to redesign the decision log of Yolean, but by formulating functions, the design could be focused on fulfilling the needs, rather than to be limited to the concept the decision log. Through the concept development phase, it was considered that focusing on the meeting page would allow for covering more functions, and thereby fulfilling more needs, and with better usability, than a redesign of the decision log would do. Therefore, the functions served an important purpose during the project.

7.2.3 Develop

The development process was conducted with well-known design methods as the foundation. The ideation and concept development phase generated ideas to develop, but since the project team only consist of one person, the brainstorming process was limited, as it should ideally include more persons to combine and discuss their ideas.

7.2.3.1 First iteration

The first iteration was evaluated with the help of a cognitive walkthrough with the personas, which it provided a good foundation for further design. This was considered a good way to go, as it would not be possible to test physical lo-fi prototypes on users during the pandemic, and an evaluation of the design was needed before creating digital prototypes, as they are much more time consuming.

7.2.3.2 Second iteration

Creating the design in Google presentations was a simple method to get a testable digital prototype. By using screen shots of the Yolean board in some of the slides, the context of the tool was easily understandable, while still keeping the prototype lo-fi.

Ideally the design would have been tested on more than one design manager, but due to circumstances and the time limit, it was only possible to conduct one test. This was however complemented with three other tests, which gave insights on the usability and the users understanding of the conceptual model of the tool.

7.2.3.6 Third iteration

As the results of the tests of the second iteration were good, the main changes in the third iteration was going from a lo-fi prototype to a hi-fi prototype, to give it a more realistic look and added complexity. The feature of choosing what questions to show was removed, and some constraints were added, such as not being able to add additional posts to an already decided question. When adding this constraint, the possibility to tear up the decision was also added to make it possible to add new information to the decision, but during the tests, it was pointed out that if the decision list is exported after a meeting, and the decision has been torn up after the export, the decision will remain on that exported document. Therefore, the possibility to tear up a decision was removed.

Even though all testing had to be done remotely, it worked surprisingly well. With the test persons sharing their screen, it was easy to follow their path when navigating through the tool. Testing on people who did not have any previous experience with the tool gave insights on how new consultants would react to the tool, as it was important that consultants that had not worked with the tool before would quickly adopt to using it.

When testing over remote video calls, there is a unique opportunity to record the test, as that is a feature provided by most video call tools. Recording the test is a simple way to not miss any details, but it is time consuming to go through afterwards, and since the test leader did not have to guide or interact with the tests too much, it was considered that the note-taking could be carried out properly, and the tests were not recorded. If the test were to be recorded, there is the integrity aspect to be considered as well.

7.3 Delimitations

The project was in a large part limited due to the ongoing pandemic, as all user studies and user tests had to be adapted to be performed digitally. However, these limitations were also considered to be possibilities, as they made it possible to observe projects not within the regional area, allowing for more observations than would have been possible otherwise.

7.4 Future recommendations

There are reasons to do some further investigations on this topic.

To fully understand the possibilities with this tool, further tests with the design should be made, possibly with a working prototype to be used in a real context. Testing on design managers from more and other companies would further develop the concept. One goal with the tool was to keep it simple to use and understand, and as all test participants found it quite easy to navigate the tool, there could be a possibility to add more features or functions if needed, while still keeping the simplicity of the tool.

This thesis focused on decisions made in the design process within the construction industry. However, it would be interesting to see how the tool could be adapted into other collaborative processes, such as product development. For continuous work within the construction industry, it is suggested to study decisions along an entire project to deepen the understanding of decision management in collaborative processes, as the lead times on construction projects can stretch over several years.

8. Conclusions

Three research questions were formulated in the beginning of this project, and answered throughout the project.

- *What existing methods for visual management are being used in connection with meetings in decision-making processes?*

This question was replied to through the literature study on visual management performed. Most visual management tools regard other phases of development processes, but the most common tools used during meetings and in decision-making processes are the visual planning boards that shows the project timeline and all deadlines along the way, the question-answers matrix, and building information models that visualize the design, simplifying collaboration. The use of visual management creates transparency in the project, and make deviations easier to find, and decisions easier to make.

- *What problems exists regarding documentation of information generated on decision-making meetings in collaborative project?*

This question was replied to through the user study, however as all the users studied used either Yolean or a similar tool, the problems identified were related to the use of the tool. The problems existed mainly regarded the lack of cohesiveness in documenting decisions, and the lack of protocol from each decision-making meeting. Table 4.1 in chapter *4 Define*, displaying the identified problems and translating them into needs, and provides the answers to this question.

- *How can this information be presented in an interactive digital tool in such a way that everyone involved clearly understands what decisions have been made?*

An interactive tool was designed and tested, which fulfilled nearly all needs discovered during the user study. By creating a meeting protocol for the decision-making meetings in Yolean, the tool facilitated both the finding and distributing of the decisions made during a meeting. The tool also provided a feature for documenting the focus meeting, making sure that decisions made there are also documented in Yolean.

With these questions answered, the thesis is considered to have fulfilled its purpose.

References

Allen, J., Beck, T., Scott, T., and Rogelberg, S. (2014). Understanding workplace meetings: a qualitative taxonomy of meeting purposes. *Management Research Review, 37*(9), 791-814. http://doi.org/10.1108/MRR-03-2013-0067

Anjou, M. (2019). *Den ineffektiva byggbranchen.* Stockholm: Ekerlids förlag.

Arroyo, P., and Long, D. (2018). Collaborative Design Decisions. In: *Proc. 26th Annual Conference of the International Group for Lean Construction (IGLC).* González, V. (ed.), Chennai, India. 463-472. https://doi.org/10.24928/2018/0509

Bititci, U., Cocca, P., and Ates, A. (2015). Impact of visual performance management systems on the performance management practices of organisations. *International Journal of Production Research, 54*(6), 1-23. http://doi.org/10.1080/00207543.2015.1005770

Burkhard, R. (2005). Knowledge Visualization: The Use of Complementary Visual Representations for the Transfer of Knowledge: a Model, a Framework, and Four New Approaches. (PhD Thesis, Swiss Federal Institute for Environmental Science and Technology, Zürich). Retrieved from: https://www.researchgate.net/publication/36382932_Knowledge_Visualization_The_Use_of_Complementary_Visual_Representations_for_the_Transfer_of_Knowledge_a_Model_a_Framework_and_Four_New_Approaches

Cambridge University press. (2020). Decision. In Cambridge Dictionary. Retrieved January 20, 2021, from: https://dictionary.cambridge.org/dictionary/english/decision

Catic, A., Stenholm, D., and Bergsjö, D. (2016). *Visuell styrning*. Gothenburg, Sweden: BoD.

Chalmers. (2019). KIDSAM: Knowledge and information-sharing in digital collaborative projects. Retrieved Aug 28, 2020, from: https://www.chalmers.se/en/projects/Pages/KIDSAMQ-Knowledge--and-information-sharing-in-digital.aspx

Clifton, J. (2009). Beyond Taxonomies of Influence: “Doing” Influence and Making Decisions in Management Team Meetings. *Journal of Business Communication, 46*(1), 57-89. https://doi.org/10.1177/0021943608325749

Costa, A., Thomann, G., and Noël, F. (2019) Interactive technologies facilitating collaboration. between projetists and non-projetists: A laboratory design

experience, *Procedia CIRP, 84*, 55-60. https://doi.org/10.1016/j.procir.2019.04.245

Design Council. (2020). What is the framework for innovation? Design Council's evolved the double diamond. Retrieved August 19, 2020, from: https://www.designcouncil.org.uk/news-opinion/what-framework-innovation-design-councils-evolved-double-diamond

Eilon, S. (1969). What Is a Decision? Management Science, 16(4), B172-B189. Retrieved January 20, 2021, from http://www.jstor.org/stable/2628797

Eriksson, J. (2009). *Collaborative product development: A collaborative decision-making approach.* (Licentiate Thesis. School of Innovation, Design and Engineering. Mälardalen University, Västerås, Sweden). Retrieved from http://umu.diva-portal.org/smash/get/diva2:208401/FULLTEXT03

Foley, J., and Macmillan, S. (2005). Patterns of interaction in construction team meetings. *CoDesign, 1*(1), 19-37. http://doi.org/10.1080/15710880412331289926

Fox, N. (1998). Trent Focus for Research and Development in Primary Health Care: How to Use Observations in a Research Project. Trent Focus.

Garson, D and Lillvik, C. (2020). The Literature Review: A Research Journey. Retrieved Sept 4, 2020, from: https://guides.library.harvard.edu/c.php?g=310271&p=2071512

Gould, J. And Lewis, C. (1985). Designing for Usability: Key Principles and What Designers Think. *Communications of the ACM, 28*(3), 300-311. https://doi.org/10.1145/3166.3170

Interaction Design Foundation. (2021). Gestalt principles. Retrieved April 15, 2021, from: https://www.interaction-design.org/literature/topics/gestalt-principles

International Organization for Standardization (ISO). (2019). *Human-centered design for interactive systems* (ISO 9241:210), Genève, Schweiz: International Organization for Standardization (ISO).

Jankovic, M. (2006). Prise des décisions collaboratives dans le processus de conception de nouveaux produits: Application à l'automobile. (PhD Thesis, Department of Industrial Engineering, École centrale des arts et manufactures, Paris, France) Retrieved from: https://tel.archives-ouvertes.fr/tel-00181452/document

Leach, D., Rogelberg, S., Warr, P., and Burnfield, J. (2009). Perceived meeting effectiveness: The role of design characteristics. *Journal of Business & Psychology, 24*(1), 65-76. https://doi.org/10.1007/s10869-009-9092-6

LeBlanc, L., and Nosik, M. (2019). Planning and Leading Effective Meetings. *Behavior Analysis in Practice, 12*, 696–708. https://doi.org/10.1007/s40617-019-00330-z

Lindlöf, L. (2014). *Visual Management – on Communication in Product Development Organizations.* (PhD Thesis, Department of Technology Management and

Economics, Chalmers university of technology, Gothenburg, Sweden). Retrieved from https://publications.lib.chalmers.se/records/fulltext/204392/204392.pdf

Lloyd, S. and Simpson, A. (2005). Project management in multi-disciplinary collaborative research. *Proc. International Professional Communication Conference,* 602–611. https://doi.org/10.1109/IPCC.2005.1494229

Magnusson, C., Rassmus-Gröhn, K., Tollmar, K., and Deaner, E. (Eds.). (2009). User Study Guidelines. *HapitMap*. 1st ed. Lund: Seventh Framework Programme.

Mroz, J., Allen, J., Verhoeven, D., and Shuffler, M. (2018). Do We Really Need Another Meeting? The Science of Workplace Meetings. *Current Directions in Psychological Science, 27*(6), 484-491. https://doi.org/10.1177/0963721418776307

Nonaka, I. (2007), The knowledge-creating company, *Harvard Business Review, 85*(7/8), 162-171.

Norman, D. (2013). *The design of everyday things, Revised & expanded edition.* New York: Basic Books.

Oxford University Press. (2020). Decision. In OED Online. Retrieved January 20, 2021, from: https://www.oed.com/view/Entry/48221

Paavola, S., Miettinen, R. (2019). Dynamics of Design Collaboration: BIM Models as Intermediary Digital Objects. *Comput Supported Coop Work, 28*, 1–23. https://doi-org.ludwig.lub.lu.se/10.1007/s10606-018-9306-4

Pedo, B., Brandalise, F., Viana, D., Tzortzopoulos, P., Formoso, C., and Whitelock-Wainwright, A. (2020). Digital Visual Management Tools in Design Management. In: Tommelein, I.D. and Daniel, E. (eds.). *Proc. 28th Annual Conference of the International Group for Lean Construction (IGLC28).* Berkeley, California. https://doi.org/10.24928/2020/0071

Preece, J., Rogers, Y., and Sharp, H. (2015). *Interaction Design – beyond human-computer interaction.* West Sussex, United Kingdom: John Wiley & Sons Ltd.

Projektledning. (2018). Projektering. Retrieved September 14, 2020, from https://projektledning.se/projektering/

Razmerita, L., Kirchner, K., and Nielsen, P. (2016). What factors influence knowledge sharing in organizations? A social dilemma perspective of social media communication. *Journal of Knowledge Management, 20*(6), 1225-1246. http://dx.doi.org/10.1108/JKM-03-2016-0112

Romano, N., and Nunamaker, J. (2001). Meeting analysis: findings from research and practice. *Proc. 34th Annual Hawaii International Conference on System Sciences*. https://doi.org/10.1109/HICSS.2001.926253

Tropman, J. (2016). *Effective meetings: Improving group decision meetings.* (3rd ed). Los Angeles: SAGE Publications.

Vinnova. (2018). Kidsam: Knowledge and information sharing in collaborative projects. Retrieved August 17, 2020, from: https://www.vinnova.se/en/p/kidsam-knowledge-and-information-sharing-in-collaborative-projects/

Wang , C. and Hu, Q. (2020). Knowledge sharing in supply chain networks: Effects of collaborative innovation activities and capability on innovation performance. *Technovation, 94-95.* https://doi.org/10.1016/j.technovation.2017.12.002

Wikberg Nilsson, Å., Ericson, Å., and Törlind, P. (2015). *Design: Process och Metod*. (3rd ed). Lund, Sweden: Studentlitteratur AB.

Yolean. (n.d.). Yolean for visual management. Retrieved September 26, 2020, from https://www.yolean.com/projectmanagement/

Zahiroddiny, S. (2016). *Understanding the impact of Building Information Modelling (BIM) on construction projects' communication patterns.* (PhD Thesis, Northumbria University, Newcastle, UK). Retrieved from http://nrl.northumbria.ac.uk/30221/

Appendix A – User study

Observation protocol

Table B.1: The observation protocol that was used to take notes during the observations

What meeting	Company name, project name
Date and time	xx/xx-xx, xx:xx – xx:xx
Location	Office room and MS Teams/Only MS Teams
Agenda	Agenda of the meeting
Participants	How many, and which project roles were represented in the meeting
Yolean	Notes on how the Yolean tool was used
Questions	Question 1, any discussion, who is talking, if they came to a conclusion, etc
	Question 2
	Question 3
	…
Other notes	Notes on how they discuss matters, and other things that happens at the meeting

User study interviews

This is the basic interview guide that was used for the user study interviews. Because of the semi-structured form of the interviews, the guide is made up of themes rather than strict questions, and the answers given often provided further questions not previously noted in the interview guide.

1. Presentation of myself and this project. Information about that the report will be published, but that the interviewee will remain anonymous, as will any information about the company that work for. Asking if it is OK to record the interview, for note-taking purposes only.
2. What the interviewee work as, their role in the projects.

3. Do they use visual planning, and in that case, how they do it. Physical boards versus digital boards. If digital, what type of digital tool, and how they use it, in general.
4. Decision-making, describe the process.
    1. How
    2. Where
    3. Why
    4. By who.
5. Decision-making meetings
    1. Before meeting
    2. During meeting
    3. After meeting
6. Decision documentation
    1. How
    2. Where
    3. When
    4. By who
7. Consuming of decisions
    1. How
    2. When
    3. By who
8. Traceability of decisions
    1. Is it needed?
    2. Why
    3. When
    4. For who
    5. How
    6. What information is important to find
    7. Give some examples
9. If they have any other thoughts regarding the topic

Appendix B – Test plan

Purpose

The purpose of the test is to evaluate the concept as a whole, as well as the user experience of it, and to see if it fulfills the needs that have been identified.

Questions

Does the user find all edit possibilities for the meeting?

Does the user find all the functions asked for in the test tasks?

Can the user finish the tests by them self, or do they need guidance

Does the user ask many questions during the test?

Data gathered

Three types of test data is gathered:

- Observation during the test
- Short interview after the test
- Questionnaire after the test

Test tasks

- Create a project meeting
- Edit the time and add attendees
- Edit what questions to show (only iteration 2)

- Create a focus meeting
- Start the meeting
- Start a focus meeting and type an answer to a question
- Make a decision on one question
- Close the meeting
- See what questions was decided on a meeting
- Export meeting notes (only iteration 3)
- Find what meeting a specific question was decided on (only iteration 3)

Selection

It was important to test the real potential users of the tool, because only they could give input on if the tool could be useful in the real context. However, since it was hard to gather a larger amount of real potential users, some ”non-users" were also included in the selection.

The non-users were users without previous experience of the Yolean tool, and could not give input on the context of the tool. However, they provided valuable input on the usability and how easy or hard it was to figure out what functions were included, how to use them, and on the structure as a whole. This also gave input on how easily consultants that usually does not work with the system would adopt the using the tool.

Interview questions

Was anything unclear/confusing?

Was anything missing that you consider should be added to the tool?

Was anything unnecessary?

Could the tool be useful in practice?

Do you have any other thoughts about the tool?

Questionnaire

1. How did you experience the structure of the tool?
Cluttered 1 2 3 4 5 6 7 Organized

2. How did you experience the navigation of the tool?
Complicated 1 2 3 4 5 6 7 Easy

3. How would you rate the tool's effectiveness?
Ineffective 1 2 3 4 5 6 7 Effective

4. *How would you rate the tool's usage during a design phase consultant meeting?*
Obstructive 1 2 3 4 5 6 7 Supportive

5. How would you rate the tool's aim to support the handling of decisions in the design phase of a construction project?
Unnecessary 1 2 3 4 5 6 7 Valuable

6. *How was your experience with the tool as a whole?*
Unclear 1 2 3 4 5 6 7 Clear

Reply from design manager, Iteration 1:

1. How did you experience the structure of the tool?
Cluttered 1 2 3 4 5 (6) 7 Organized

2. How did you experience the navigation of the tool?
Complicated 1 2 3 4 (5) 6 7 Easy

3. How would you rate the tool's effectiveness?
Ineffective 1 2 3 4 5 (6) 7 Effective

4. How would you rate the tool's usage during a design phase consultant meeting?
Obstructive 1 2 3 4 5 6 (7) Supportive

5. How would you rate the tool's aim to support the handling of decisions in the design phase of a construction project?
Unnecessary 1 2 3 4 5 (6) 7 Valuable

6. How was your experience with the tool as a whole?
Unclear 1 2 3 4 5 6 (7) Clear

Replies from design managers, Iteration 2: (average score)

1. How did you experience the structure of the tool?
Cluttered 1 2 3 4 5 6 7 Organized **(6,75)**

2. How did you experience the navigation of the tool?
Complicated 1 2 3 4 5 6 7 Easy **(6,25)**

3. How would you rate the tool's effectiveness?
Ineffective 1 2 3 4 5 6 7 Effective **(7)**

4. How would you rate the tool's usage during a design phase consultant meeting?
Obstructive 1 2 3 4 5 6 7 Supportive **(6,75)**

5. How would you rate the tool's aim to support the handling of decisions in the design phase of a construction project?
Unnecessary 1 2 3 4 5 6 7 Valuable **(6,5)**

6. How was your experience with the tool as a whole?
Unclear 1 2 3 4 5 6 7 Clear **(6,75)**

Replies from other test persons, Iteration 2: (average score)

1. How did you experience the structure of the tool?
Cluttered 1 2 3 4 5 6 7 Organized **(6,125)**

2. How did you experience the navigation of the tool?
Complicated 1 2 3 4 5 6 7 Easy **(5,75)**

6. How was your experience with the tool as a whole?
Unclear 1 2 3 4 5 6 7 Clear **(5,77)**

Appendix C – Time plan

This appendix presents and discusses the time plan of project.

Time plan and outcome

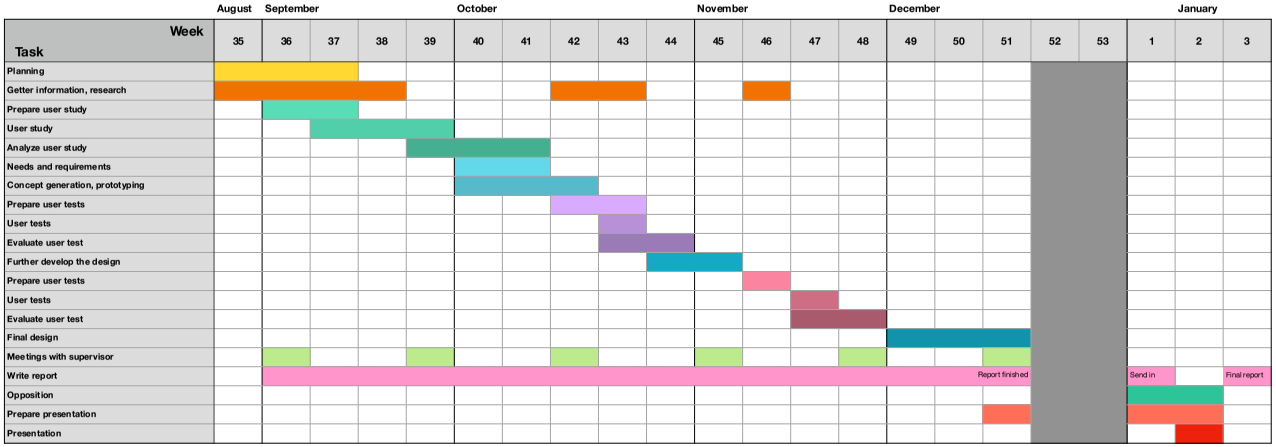
At the start of the project, a time plan for the project was set up as a Gantt chart. Figure C.1 on the next page shows both the time plan that was set up prior to the execution of the project, and also the activities actually performed.

Reflection

As showed in the figure below, there are some large differences between the original plan and the outcome. This was partly due to that a project that was supposed to be a part of the field study was no longer was accessible, and another project that could be studied would not start until some weeks later.

The main difference however is that the project was paused during several weeks due to covid19 illness, which pushed forward the finishing date. Furthermore, the project was supposed to be done in 20 weeks, but was stretched over a longer period due to the aftermath of the illness, as the continuing of the project had to be done at a slower pace, until at least the end of February. The total time put into the project still reflects about 20 weeks of full time working.

Planned timeline



Executed timeline

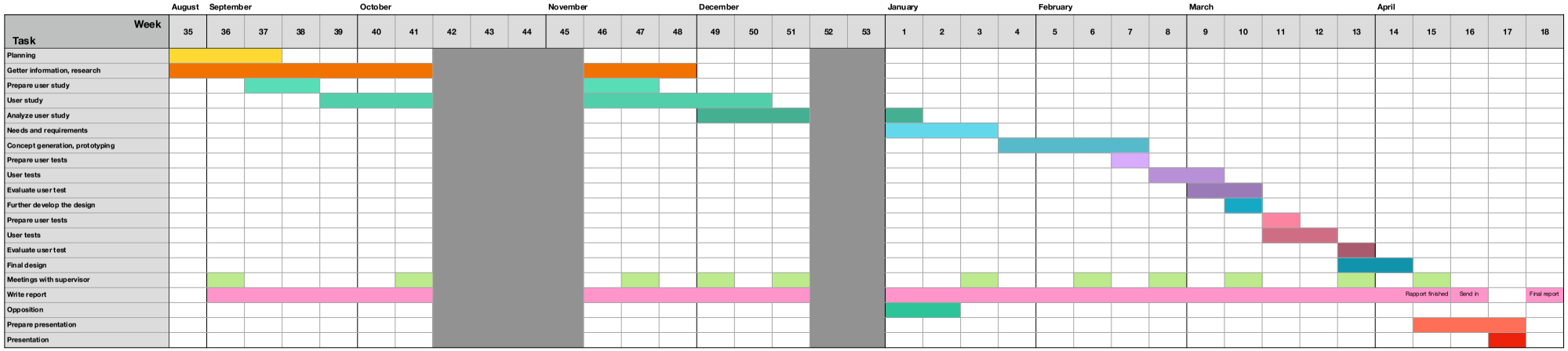


Figure C.1: Planned and executed time plan