Exploring the Productivity Issue of the Construction Industry: *A Case Study of a Lean Construction Project*

TDT4501 - Project Thesis

Morten Bujordet

Norwegian University of Science and Technology

N T N U

Supervisor: Eric Monteiro

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Abstract

A primary concern of the construction industry in Norway is the significant decline in labor productivity compared to other on-land industries. Statistics show a relative difference in labor productivity, compared to the ICT industry from the year 2000 up to 2016, of 106.4%. The research in this project shows a strong correlation in how the construction industry is today and how the software industry was thirty years ago. Both industries are now utilizing agile management, and software supporting these methods. This case study looks at the new life science building project, of the University of Oslo, for the purpose of exploring the fundamental reasons for the gap in labor productivity between the ICT industry and the construction industry. The study is not to do a comparative analysis of labor productivity between the two, but to explore the phenomenon causing the gap.

Using semi-structured interviews and observations, with participants from the project management organization, analysis of the interviews identified three key findings: (1) problems in interaction between personnel, (2) problems in the decision making, and (3) problems in ignorance. Furthermore, the result shows two fundamental reasons causing these problems, that is, the actors' limited understanding of the new methods and actors' traditional view of contracts, interaction, and transparency. Based on these observations, the project proposes a more extensive use of a new digital tool, Cogito, to further explore the phenomenon causing the gap in labor productivity, in a lean construction project using digital tools.

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Chapter 1

Introduction

1.1 Background and Motivation

The Construction Industry (CI) has been a significant part of engineering throughout history. Over the past century, the requirements of constructions have become more and more complex [2]. The buildings are getting higher, the tunnels are getting longer, and the roads are getting wider. Sure, the size of things is not equal to the complexity of the construction; however, when considering automated systems, multipurpose functionality, and multiple communication platforms – the complexity is increasing. The increased complexity leads to a significant decline in labor productivity (LP), seen over the past two centuries, mentioned in the article written by SSB [3]. As well, managing these projects is much more intricate then it used to, because of the increased numbers of actors participating in the project.

One can argue that the negative progress in LP in the CI has to do with the increasing complexity, and therefore not a number to consider. Even so, better productivity and efficiency are always something management dicier, simply because of improved marginal cost. Therefore, this study is interesting for managers from other industries than only construction and ICT.

The challenges the CI is experiencing, as well as the process used, are highly similar to what the ICT-industry was facing in the late '80s. The ICT-industry, using the waterfall process [4], often faced the challenge of meeting the budgets and timelines. This breach had the origin in change of requirements during production, challenges in testing, and resultingly failing to deliver a finished product without bugs. These problems have been frequently present when creating large and highly user-interactive software — making for the introduction of agile software development to manage theses problems. Over the years, most of the process- and method-management in ICT is digitilized. Giving tools in which both the software developers and project managers use to aid project progression.

One has often turnd to software when wanting to improve productivity, and hereunder knowledge sharing and interaction in a organization. The implementation of software in a large, complex organization is discussed by many and is shown hard to do well. In particular, the description of the top-down contra bottom-up strategy in implementation [5], promotes the importance of making slow change supported by the users. Furthermore, the intention of increasing productivity, by deploying new software is argued by Hammer, to be less sufficient [6]. Hammer promotes changing the process of work, rather than improving bits by pieces using specific software. Morover, introduction of software supproting collaboration is shown to be difficult, important in this context is that software break with the social taboos, and adoptation is, as mention, difficult [7].

Frank Garry, in 1997, first introduced 3D modeling in CI, when constructing the Peter B. Lewis Building (PLB). 3D modeling was used both to manage the complexity of the installation, but also led to increased cooperation between different parties within the project. The paper, describing this project [8], is reporting a change in how actors in the construction react to using computer-aided constructions, in 3D. Today 3D modeling is used in almost all construction projects and is known as BiM. Even though the PLB-project showed promising results in means of cooperation and interaction, the introduction of 3D modeling was not a single solution to the problem.

Furthermore, one has introduced Lean in the CI. A book [9] describing the making of the Bergen Academy of Art and Design-building, where Lean was one of the essential strategies. The case object of the case study in this research are using experience from this book when managing the constructions.

The motivation for this research is, therefore, to examine a construction project utilizing Lean in project management. Furthermore, looking at how a project make use of digital tools, aiding Lean has not been examined before. Taking experience from the ICT-industry, and the use of computer-aided agile development management is also desirable, as well as looking at the problem from a different perspective.

The case object chosen for this project is the construction of the new life science building. The reason for choosing this project is, first, the construction is highly complex, thus becoming the most extensive educational building in Norway, with both advanced technical and environmental requirements. Second, the announced strategies for the project includes both a lean strategy and a digitalization strategy.

This thesis is *not* to do a comparative analysis on LP between the ICT-industry and the CI, rather explore the reasons causing the phenomenon. Hence the selected singe case object.

1.2 Research and Question

Based on the background and motivation the research of this project tries to identify the phenomenon causing the poor PL in CI. The main research question is, therefore:

> *What is the fundamental reason for the striking difference in labor productivity between the ICT-industry and construction industry?*

This is then broken down to two sub-questions, which this project thesis tries to answer, using a case study of the Life Science Building project.

RQ1: Why does the difference in LP between the ICT-industry and CI appear?

RQ2: How does the difference appear in the LSB-project, which utilize both agile and digital tools?

1.3 Thesis structure

Chapter 2: Literature Review provides an overview of key findings, concepts and development relevant for the research question. Furtheremore, support the discussion as well as the case.

Chapter 3: Empirical Review gives an introduction of the case, and impede how they make use of digitalization in their Lean Strategy, as well as how this support cooperation and knowledge sharing in the organization.

Chapter 3: Method description describe the mothodology used in the project. The methodology descriptin describe and discuss the approach, data collection as well as method of anaylysis of the genereated data. Also, an evealuation of the method i provided.

Chapter 4: Case review gives an introduction of the case as context for the project. Furhteremore, descibe and discuss the result of the anaylysis of the case data.

Chapter 4: Discussion takes the data form the case study, and discuss the results with prior research identified in the literature review. The chapter is outlined by three themes discovered in the analysis of the case data. Furthermore, the evaluation of the project limitation can be found in this chapter.

Chapter 5: Conclusion and Further work answer the research questions raised in the Research and Question section. Furtheremore, proposing furhter work for the master thesis.

Chapter 2

Literature Review

This project's objective is to identify the underlying reason for the striking gap in LP between the CI and ICT-industry. For the project to identifying this gap, this thesis looks at how the construction industry, or precisely how the LSB-project, makes use of agile project management methods and digital tools to aid project management. The CI's lust for digitalization is ever-present, and often projects consist of entire departments responsible for digitalization. This chapter is using ICT as a successful case of utilization of digitalization in the context of agile project management.

First, the chapter takes a historical look at ICT and CI, and which factors made both utilize agile project management in the first place – what were the symptoms needed to be fixed? This comparison gives a surprisingly similar line of arguments, where productivity, complexity, failing to meet budgets, and requirements change during project implementation are some — additionally, similarities between the project process makes for comparison.

Secondly, the chapter discussing organizational cooperation, where one looks at software as a tool aiding organizational interaction and interaction. Furthermore, the chapter gives a brief overview of a traditional CI project, as well as a short overview of different agile project management methods as a context for the project.

2.1 Construction Engineering

This section will introduce the CI as a context for the project, as well som implications and motivation forcing a change in the way CI-projects are managed.

2.1.1 A Brief History of the Construction Industry

Construction Engineering has been a significant field of engineering throughout history. Originates from the construction of the pyramids. Continuing with Da Vinci, and some of the most skilled people, in the middle ages, forming some of the most known structures of today. In the raging of wars and through the industrial revolution, one could witness the rapid development of both civil and military engineering; as a result, one could now construct both faster and better than ever before.

Over the last century, the requirements of constructions have become more and more complex. The buildings are getting higher, the tunnels are getting longer, and the roads are getting wider. The size of things is not equal to the complexity of the construction. Adding automated systems, multipurpose functionality, and multiple communication platforms, the complexity is ever so present. Take for example a university building, which is no longer simply a place where one can lecture and read. A university building now requires to host highly sophisticated labs for various purposes, as well as several other rooms for different kinds of purposes, and some also multipurpose. Besides, that is just the requirement of the rooms; one needs to consider all the systems added in regards to, among others, ventilation, electricity, sewage treatment, internet, and telecommunication. All these systems- and room requirements, as well as other requirements, makes the construction of the modern building way more complicated than it used to be.

Even though the complexity of the construction is increasing, the process management has, for the most part, been the same — resulting in an unfortunate progress of productivity in CI.

2.1.2 Construction Industry Project as a Context for the Project

The process of constructing, in Norway, follows a pattern described by The Norwegian standard agreements (SSA). The construction process divides into five steps: (1) the early phase: where deciding both the vision of the project and process of project conduction; (2) the procuring of architect or adviser: starting by publishing the project and at the end awarding the best actor with a contract; (3) the design phase: where one produces different levels of design; (4) the procuring of entrepreneur(s): includes deciding on contracts, and choosing the correct contractors for the job; and (5) realization: where conducting the substantive implementation.

The third phase, designing, is typically conducted in three levels of granularity. First, the architect is sketching the over-all concept of the construction and delivering the concept as a set of drawings, models, and specifications. Furthermore, the concept is to realize the intention and vision of the project. Second, often called the pre-project, a team often consisting of architects, project managers, and engineers, is to define the project. The definition results in a set of user- and technical requirements, as well as further developing the functional and physical structure of the project. It is here one sets the budget and goals of the project. The pre-project is ending by handing the result and a proposal of decision for political treatment. The political treatment is known to be time-consuming, often spanning a one-to-two year period. Given the political decision, the requirements and budget set, limits and sets the basis for the rest of the project, as well as the goals used to measure. Third and finally, the detailed design is happening. The result of the detail design is the sketches used in the procurement of contractors — plus, an outline of the awarding strategy used in the next phase. Because of the time-consuming political decision, a new team is often responsible for the detailed design. Documentation of the pre-project is therefore vital. When going into the realization, it is the detail-design-team that is responsible for the project to keep the budget and achieving the goals set by the political decision, which can seem unfair if the pre-project requirements are not manageable.

A typical case is a change of requirements, required by a stakeholder, either during detailed planning or the production-phase. A change often leads to budget-breach, or if not feasible, dissatisfied stakeholders.

2.1.3 The problem of Labor Productivity in the Construction Industry

The Norwegian CI is, as mentioned, accused of having a decline in LP. An Industry that is one of the most significant industries in On-Land Norway, with 466 billion Norwegian Kroner accumulated in 2017 [10]. A common fact shared among the industry stating that CI is facing an LP decline of 10%, since the year of 2000 [11]. Often these numbers are justified by a complex and ever-changing industry and considered not representative of the industry of today. Sure the numbers are correct, but do these numbers show us the big picture?

In this section, the question of declined LP in Norwegian CI will be discussed, and if LP is *not* declining. A reminder; the goal of this thesis is *not* to measure the LP in CI, instead explore the issues causing this phenomenon to happen.

Definition of Labor Productivity

LP is a description of the value created relative to the resources used, as seen in equation 2.1. Practically speaking, a company or business achieving a high degree of LP, work less, and achieve more.

$$LaborProductivity = \frac{\textit{Labor dividends in quantity or value}}{\textit{Labor effort in hours or count of employees}} \tag{2.1}$$

Having increased productivity, make sure that a company gets the right turn on investment, rather than barely be able to endure. There are lots of different factors that come in to play why some industries have a increasing LP-rate, and some have a decreasing LP-rate, but how can this decline be, when the Industry see turnover growth?

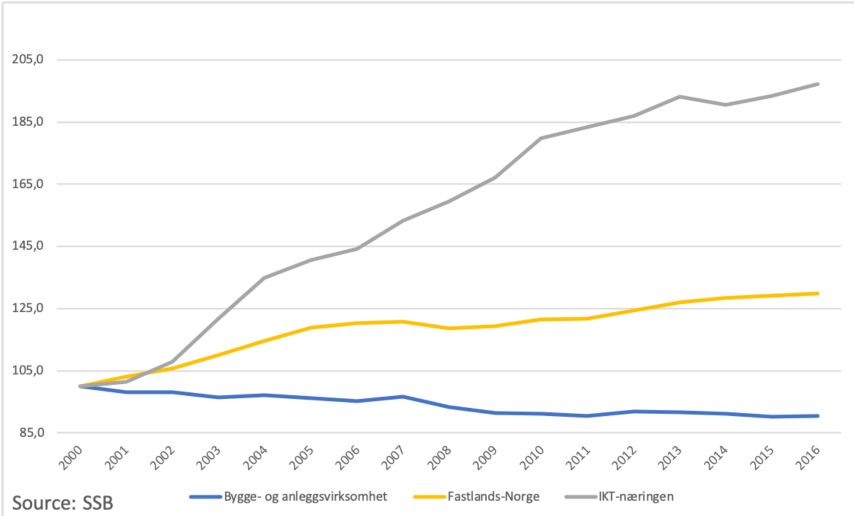

Figure 2.1: Labor productivity in the constructing industry, compared to average on-land industries in Norway, from 2000 to 2016.

Aspects of Labor Productivity in the Construction Industry

An article [11] posted by Statistics Norway (SSB) proclaiming that the constructing Industry (CI) suffer a substantial decline of 10%, since the year of 2000. The article shows that this trend is also present in both Sweden and Finland. Comparing these numbers, seen in figure 2.1 with the same statistics in LP in all on-land private sector businesses, where there has been an overall increase, by 30%, one can arguably state that the decline is a fact. What do these statistics represent? SSB' definition of CI used in this calculation is labor that is directly involved in the on-site constructing, which is not representative of what is considered CI of 2019. Much of the work done on today's building site is prefabricated, and to get construction completed, one has to cooperate with a lot of businesses and industries. SSB explains that the reason for the small definition of CI is because of an EU-standard; hence, the comparison of the northern countries. If we consider the entire supply chain, there is a minor, in fact, increase in productivity of about 2% from 2000 to 2016, as seen in figure 2.2.

An issue paper [12] posted by Sintef in 2013 raises the discussion about this topic. The issue paper states three central observations: (1) The numbers does not tell the whole story about productivity, (2) the numbers can't be used in scientific research and (3) the numbers can not be used in comparing businesses, projects or corporations, because each project is so vastly different from one another.

Looking at observation two, stating that the numbers are not to be used, measuring increased productivity in CI overall. We need, therefore, to look at a process, a specific project, or a corporation to conduct a sufficient scientific analysis. This holds for a case

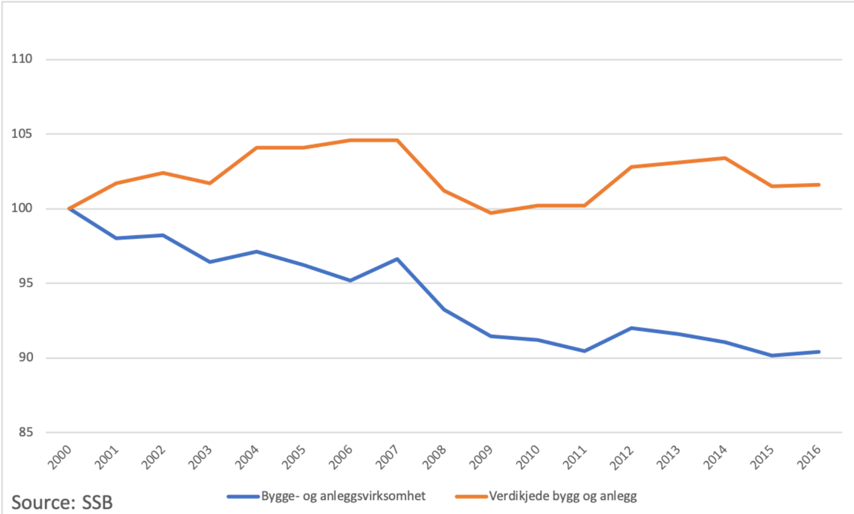

Figure 2.2: Labor productivity in the constructing industry supply chain, from 2000 to 2016.

study, where one looks at an individual project, analyzing the internal processes and project management to identify the measurements taken to boost internal productivity. Moreover, complexity makes for no comparison between different projects, because when creating a complicated construction, sometimes new invention needs to happen, and this is not something to be compared. In the same way, comparing productivity in different software development projects is not relevant. If one is to construct the same house, or the same piece of software, time after time, then a comparison is very legit. Then again, in this case, the ingenuity is discussable.

Stating that CI has declining LP is therefore not unilaterally correct - still, if we consider the total value chain, the result is considered poor. The industry is taking action to get LP closer to the average rate. The focus is to make each project as efficient and productive as possible, but that is always the case. Simply because of the marginal cost gained.

Thus yields for a bottom-up approach: Starting with a process in a project and perfecting it, continuing with each process will eventually lead to a resulting better efficiency and productivity in the entire project. Which, if done in the entire constructing industry, will lead to increased LP overall. Therefore, the industry needs to overcome the challenges, mentioned earlier, (starting with a breach of planned timeline and budget, with symptoms such as requirements change during design, increased complexity, and struggling to complete the products,) were digitalization, Agile (hereunder Lean), is promising and populare solutions to the problem.

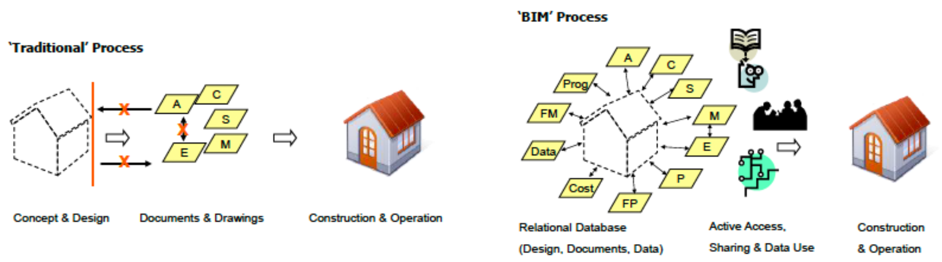

Figure 2.3: A comparison between traditional and BIM construction process. (Courtesy of: Holder Construction, Atlanta, Georgia, USA)

2.1.4 Building Informantion Modeling

BIM is of many seen as a significant contribution to increasing productivity in the CI [8, 13, 14]. Statsbygg defines it as follows [9]:

B = Building

I = Information

M = Modeling (Process) or Model (the product)

The introduction of BIM implicates a significant change, not only in software with three-dimensional models, but also in the workflow and the process [15]. With a common model shared among all stakeholders, BIM integrates all disciplines throughout the construction process. What differs BIM with traditional 2D- and 3D-modeling (CAD) technologies? The traditional technologies offered a view of the model, with its dimension in either 2D or 3D. Such as plans, sections, and elevations. If one of these views require for a change, every other view is needed to be checked and updated. Also, these models only showcase entities such as lines, boxes, and circles. Whereas BIM keeps the same traditional view but includes its physical and functional characteristics. In the BIM-model, every element and system is defined as walls, sockets, tubes, and valves. Thus, a single entity in the model, such as a socket, could include dimensions, name, manufacturer, price, and ID. BIM is, in practice, a large relation database, where every entry is defined by a set of core information, with different foreign keys to specific information about the object. Different software providers keep their BIM data in different file formats, but `.ifc` is a common non-propriety file format, which is shared among most BIM software suppliers.

Introducing BIM is, as mentioned, influencing the process and the workflow of construction. Figure 2.3, illustrates the difference between a traditional (old) process of construction versus the BIM (new) process.

3D modeling is an essential tool in construction engineering. Since the introduction of

Figure 2.4: Phases in the construction lifecycle.

Figure 2.5: MMI with different stages of the construction process.

2D data generated drawings (CAD), the evaluation has been rapid. Frank Gehry's introduction of 3D in the Peter B. Lewis building is, by many, the birth of 3D modeling in the construction business. This introduction led to a burst of innovations due to the complex construction, and the visual context 3D modeling gave the engineers [8]. The evolution of BIM has been tried synthesized by many [16]. Figure 2.6 is commonly used representation by Bew and Richards [1]. Level 3 is where one wants to be nowadays, but most are still at level 2. The difference is in the level of interaction between actors and how they can use a shared model. A distorted BIM model eventually leads to a distorted construction process. Moreover, if the coordination and interaction between disciplines are not in place, the model will eventually fail and lack much information. Hence, the process of BIM.

The BIM process includes the whole lifecycle of the construction, from programming to demolition, represented in figure 2.4. It is clear to see the utilization of BIM in the Programming- and Design-phase, where architects and engineers create a digital model of the construction to build. Furthermore, in the Construction-phase, the drawings are utilized in the installation and construction of the building. It is, though, in the last phases of the construction lifecycle that BIM is outstanding. Since the BIM model includes all the data about every system and element of the structure, a caretaker can easily follow up systems and fix an element with the exact products used in its origin. Furthermore, if demolishing a building, BIM can be used to secure this process by identifying every system and element in the building needed to be removed before takedown.

Even though the process of using BIM should promote productivity and interaction between disciplines, this is not easily done in practice [17]. The traditional way of working, in silos, still influence the construction business. Aiding the BIM process, several methods and processes have been developed. One is the model maturity index (MMI = Modell Modenhets Indeks) [18]. This index, seen in figure 2.5, make sure the model is in the correct level detail throughout the project. Also, making sure different actors uses the same language and know what to expect from each other during different phases of the project.

For a project to utilize BIM, the organization's software is critical. The goal is for the project to include all drawings from all disciplines into a central model. This central model makes for a better flow of information throughout the project [19]. A neat feature of BIM is the possibility of collision controls. Collision control is the act of checking if there is any collusion between the different objects in the drawings. Thus, reducing the chance of conflict later in the process.

Every discipline has its preferred software conducting the modeling. Thus, the diversity of software in BIM is substantial. By Norwegian law, an owner can not dictate which tools to be used in a project. What can be dictated is that every tool to be used in the BIM sphere should be able to produce and read files of the IFC-format. Cloud technology has made it easier to access the BIM model everywhere [15]. This access is the case in the shared model, put together by the models of every discipline. For the most part, every discipline and modeler work on their own, using their preferred tool. Thus, the data is stored on their local computer until exported and put together in the shared model. Using BIM promotes cooperation, and using Cloud-based BIM communication is shown to be a cost-effective implementation [13], also cloud-based BIM technology is the next step in the BIM evolvement to improve the efficiency of BIM [20]. The problem is that still, a considerable amount of data is not shared; hence the data stored on the local computer. Autodesk BIM 360 is a platform collecting all relevant disciplines with a shared platform, which includes risk management, procurement, design, and more—using a Software-as-a-Service solution, which makes for effortless view and manipulation of the model.

Designing in a web browser, using a Software-as-a-Service, is shown to be complicated. The main issue is the high demand for usability [14]. Thus, most users tend to stick to local computer software.

2.2 Agile Project Management

This section will give an overview of Agile in the context of project management, as well as provide an introduction of different Agile management methods as context for the reader. Furtheremore, a discussion of Agile as a management method, and if the introduction of Lean is in fact just a hype.

First, when discussing this topic, project methods need to be defined. Different from the *process*, which is more concerned about the different phases of the project, the *method* is about how one can manage within a given stage of a project. Thus, project management methods are about making the most effective utilization of resources within a given phase.

2.2.1 The Motivation for Agile Project Management

In the ICT-industry the urge for change in project management within distinct phases of projects led to the introduction of agile software development. The move was motivated by having a way of handling late requirements and the growing amount of documentation needed in the ever-more-complex projects. Furthermore, utilizing testing, that way, bugs

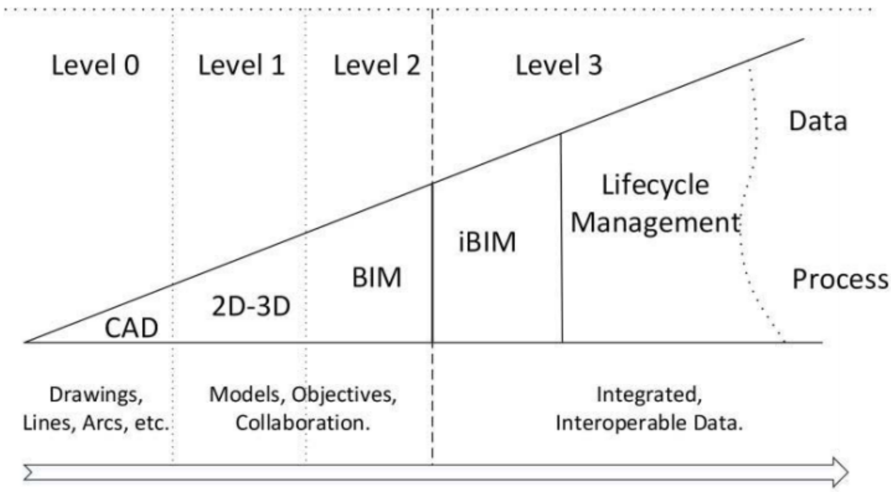

Figure 2.6: BIM Maturity Diagram [1]

can be fixed during production, when most uncomplicated. Pushing was also the headlines describing yet another software project failing to meet the schedule. All these symptoms made the software industry move into using agile software development methods as a basis for their project management, starting at the beginning of the '90s and has since been introduced in most software development developments, where needed.

As we have mentioned increasing productivity and efficiency in a project is desirable for every project, hence marginal cost. This added to the fact that LP in the CI is decreasing made the industry wanting to take action. This project is, therefore, concerned about the bottom-up approach securing more cost-effective and labor-productive management, leading to a more solid industry in the end. The LP-problem is not the only motivation for CI to utilize Agile project management methods. One can identify most of the same issues ICT had when introducing Agile. Most present, as mentioned, is: (a) increased complexity, (b) extensive documentation, (c) reporting of issues leading to change of design during production, and last (d) delivering a construction without errors.

2.2.2 Agile Project management

Seen the motivation for both the ICT and CI to make changes and introduce APM. This section will give a short introduction to APM: the bases as well as some disussion of the use. Furtheremore, the section will introduce some known ASDs, as context for the reader. These methods promote smaller teams of 5-12 people; therefore, included is also an elaboration of ASD in large scale corporations, as well as, Lean, which encourages comparison between SD and Construction.

APM diverse from linear processes; by the way, a project, or the workers, can rapidly adapt to circumstances. This lines with the problem of requirement change in SD. Moreover, it corresponds to the reporting of issues during production in the CI. The initiatives done since the adaptation of agile in SD was expressed in the Agile Manifesto [21], when published in 2001. The manifesto gave a tangible reference for project leaders, as well as developers, to steer the project with the correct mindset and focus. Moreover, the manifesto gave a baseline for creating new and potentially better APM methods. The Agile Manifesto says:

Individuals and interactions over processes and tools
Working software over comprehensive documentation
Customer collaboration over contract negotiation
Responding to change over following a plan

Including these four sentences, the manifesto also includes a set of twelve principles. Theses principles emphasize always having a working product, an enjoyable working environment, and a proper dialog with the customer. Wich eventually results in a team able to adapt to change, also late in the development. The manifesto emphasize that face-to-face conversation is the best way of proper conversation, even though much of the interaction can be supported by software.

2.2.3 Agile software development in smaller teams

The above mentioned agile manifesto, says a lot about principals and values when conducting APM and ASD. The manifesto says nothing about the actual process, that is for the different agile methods to explain. Known methods such as SCRUM [22], Extreme Development (XP) [23], and Feature-Driven Development[24] are among other descriptions and practices on how to implement scrum as a work method. Abrahamsson, identify that common for all is that they are incremental, straightforward, cooperative, and adaptive [25]. Different from the waterfall process, Abrahamsson concludes, agile emphasizes on being people-centric.

A generic view of the agile method is iterative development, seen in figure 2.7. Using the example of SCRUM, the iteration involves sprint-planning, implementation, and review. The method emphasizes growing the team, and after every iteration, a retrospective meeting is being held. Also, worth mentioning is the daily scrum, a meeting where the team discusses the progress, and issues can be raised. Most of the artifacts and events applied in SCRUM has comparable ceremonies in other ASDs.

Still, the process of creating a product has to involve more than just sprint planning. Most of the agile methods also include prior planning before the iterations start. This planning is to be found both in XP and SCRUM. When agile development methods are applied, a problem with estimation often occurs [26]. This problem is very present for the managers [27]. Traditional project managers utilize a Gantt chart, scheduling project

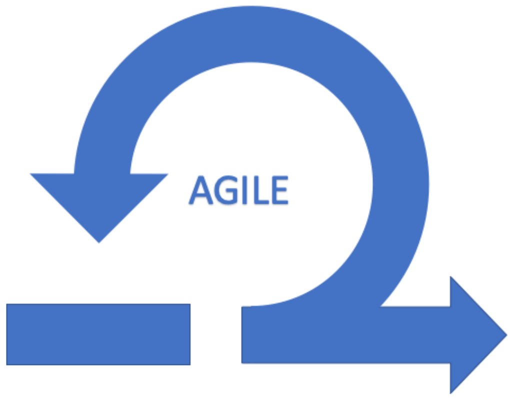

Figure 2.7: Illustration of the generic agile loop.

tasks. Sutherland, on the other hand, argues the use of Gantt is mostly a waste of time:

The only problem with them is that they are always, always wrong.

Even though most of the methods encapsulate planning in the process, Abrahamsson, in his paper [25], discovers that there are only two of the methods implementing concept creation in the process. This is an essential part of the CI project process. Still, one can argue that this is not a part of the development and is supported by the SSA e-procurement process [28].

Agile methods are, as the title of this sub-section implicates, planned for smaller teams. Challenges, when extending the team-size, of more than the recommended 5-12 people, are decision-making, communication, and control [29]. Also, when wanting to use the methodologies in large organizations, some adjustment is needen. This made for the introduction of large-scale agile organization methodologies discussed in the next sub-section.

2.2.4 Agile in Large Scale Organizations

As mentioned, most agile methodologies are designed for smaller teams. Challenges applying agile in large-organization are mostly communication and coordination [30]. These issues are well-known when considering large organizations, but are very present when the agile mindset emphasizes harmonization between different actors [31]. When considering large-scale agile, one often want the whole organization to utilize agile with diverse teams. Understanding the concept of agile methodology is problematic. This applies to the managers, and team-members not known to agile beforehand [32].

When considering large-scale agile organizations, one can divide between organizations using consultants and large in-house scale organizations. When considering projects and organizations of that size, the complexity of management is very present. Still, most of the problems are the same, including knowledge sharing, clear practices, and interacting [33]. In the case of Spotify, they promote continuously improving their practices, as well as communicating in a face-to-face fashion.

Often directors tend to employ old tools and practices not suited for agile, such as Gantt charts, detailed plans and documentation, and set-dates for production [34]. Both in the case of Spotify and the A-team-project, the discovery is that autonomous team is way more effective than typical teams managed by some leader. Thus, the managers and directors are to facilitate the best infrastructure for the teams.

2.2.5 Lean

As we know, the term agile was first introduced by Takeuchi and Nanaka in the article *The new new product development game*. They explained how Toyota utilized agile methodology in its construction line. Moreover, the systems used at Toyota are formally named Lean manufacturing and was developed by Ohno and Shingo [35]. The idea of the build-measure-learn loop has later been adopted by many other industries, especially after the international bestselling book: *the lean startup* [36]. The constant focus on added value to the product is a quintessential aspect of the methodology, which is yearned for many managers out there.

The lean startup was written by Eric Ries, which origin is software developer, and the approach explained in the book is, therefore, primarily suited for software startups. The act of creating a minimum viable product is not as applicable in the CI. Lean thinking, on the other hand, could still be beneficial for the CI [37], thus leading to the introduction of Lean Construction.

Lean Construction as a Context for the Project

Agile Construction origins from the Lean Manufacturing, and share many mutual ideas, despite operating on vastly different products [38]. While in manufacturing, one can move the product around, the physical size of a construction project induce other measures in Constructing. That is why Lean Construction has rejected many of the ideas from Laan Manufacturing [39]. The essential aspect of Agile Construction is flow. For the method to accomplish the perfect flow, it does, as in other Agile methodologies, stack each iteration with a clear set of objectives to be conducted in the planned timeframe, and the flow is kept by planning the correct amount of tasks before the set deadline. The Norwegian Lean Construction translation uses a train as an image of the flow. Where the idea is for the train to move through the construction. The movement happens when every task within a specific area is completed. The train is represented with a set of cars, each a representation of a discipline. Alining the cars, so that the correct disciplines are in succeeding order.

The output of every flow is the percent planned completed (PPC). The managers can adjust the order of carts, or the number of tasks to make the production more efficient. When utilizing Lean Construction, a top-down approach recommended [9]. This emphasizes the problem raised by Ingvaldsen, in her article, that the teams lose autonomy when applying Lean in, which conflicts with the Norwegian working model.

Measuring productivity on project-, process- and process level

Lean is an excellent method but offers no mechanism measuring the achieved improvements, such as the burndownchart in SCRUM [22]. Skappel, in her master thesis [40], suggests using KPIs measuring the improved perfomence. Ten KPIs, is proposed, ensuring continuous flow improvement in Lean design process:

1. Number of work packages (deliveries) completed and delivered within a takt time
2. Number of decisions made on the wrong basis
3. Number of revisions after products in a common BIM are frozen
4. Number of unresolved questions in the dialog matrix
5. Intensity Curve - Number of questions asked in the dialog matrix and how fast these are resolved
6. Number of approved functional descriptions prepared at the right time
7. Number of correct functional descriptions revealed during table testing
8. Number of systems with developed test procedures before sending contract to contractors
9. Number of change requests due to errors and misunderstandings
10. Percentage of project material delivered to the contractors at the right time

These KPIs are yet to be tested, but still promising ensuring LP in the first phase of a traditional CI-project evolve in the appropriate direction.

In addition, by recommendation of a issue paper [12], a project started in 2015, establishing a state-of-the-art performance measurement tool. In 2017 the resulting Nordic 10-10 [41] program was finished. Nordic 10-10 is a version of the CII 10-10 program[42], designed and translated for the Nordic countries. The CII 10-10 program is a survey-based measurement tool based on the concept of anonymously surveying members of a project, regarding their project's performance, team dynamic, and organizational relationship. The surveying is done at the end of each of the five faces of the constructing project. Opposite to a standard approach, where such analysis is done only one time; at the end of the project. Using Nordic 10-10 results in more agile project management, where changes are implemented throughout the project. In some projects, they even do the analysis even more often, allowing the project manager to make changes also within each phase of the project.

2.2.6 Agile, a populare fade in management?

Over the past decades, many new trends in project management have emerged and later faded away. A paper [43] exploring six decades of project management trends illustrates the different perspectives of project management. Every trend argues its sovereignty. This illustrates the argument of Rolfsen, in her chapter in the book *Key Issues in Organizational Communication* [44], stating that managers are slavish following new fashions of project management. Rolfsen argues that the project management literature is a significant industry of its own. Often the literature is the one answer to every problem and criticizes the older theories, often written using pathos influencing the reader. Even though the literature promotes new methods into the organization, Rolfsen emphasizes that every fade has some good points.

Even though the focus on different fades promotes different ways of management, the goal is always the same; boost the marginal cost. The results of applying agile in the ICT-industry are promising, hence the increased LP over the past decades. The effect utilizing lean construction, on the other hand, is not to be seen in the statistics, though some papers can report on increased LP [45, 46].

Applying agile and lean has, for the most part, had a positive impact on projects. Also, every project management trend bring good points into the organization. The deployment of agile is, as mentioned, a way for managers to control the production. Moreover, a tool to control a phase of the process, that has to do with designing and implementation. Added to the process management, the coordination of people in a complex organization is equally as important. The next section is going to discuss this multifaceted area of administration.

2.3 Cooperation in Large Organizations

The work of constructing a highly complex and costly structure is, as we have understood, difficult. There is no straightforward way of doing it, and the focus on project management is an essential part of it. Though, in the end, the act of design and project management is primarily making people work together. Make people interact, coordinate, and synchronize for them to create something that could not happen, if not cooperating. The challenge of making people meet and work together on a common goal, not being self-centered, is something the industry finds difficult. It is seen both in CI, in ICT, and most other industries that have to coordinate different domains of competence.

This section will discuss this challenge and examine what are the ground principals of cooperation and look at different measures one can make. How may computers support cooperative work? Furthermore, how do contracts influence the interest of different actors to cooperate?

First, a short introduction to cooperation: Cooperation is the act of communicating and share knowledge in a way that makes different actors coordinate, interact, and synchronize. The act of talking starts with a desire, or at least a reason, for various individuals to talk.

One must take for granted that the will is there, but in some cases, contracts, politics, or even physical barriers hamper this to happen. Regarding physical barriers, the internet and telecommunication have been a significant leap towards decreasing the boundaries. Computer-supported cooperative work (CSCW) is how technology supports teams cooperate in a project. CSCW will be discussed later in this section. Furthermore, this section will give a brief insight into Norwegian CI- contracts and politics as a context on how for the project, which is an import backdrop for why individuals and parties act the way they do.

2.3.1 Comunication and Knowledge sharing

The act of talking among project actors and team members is, in most cases, sharing knowledge. One often divides knowledge into tacit- and explicit knowledge. Tacit knowledge is something that is known to actors, but not written down, or otherwise, for somebody else to learn and understand. Where, on the other hand, explicit knowledge can be assimilated simply by reading a manual, or a document.

A known problem in the CI is knowledge sharing. The motivations for knowledge sharing is as Dainty describes mostly social [47]. The contractors do what others do, are following the leaders' example, and the feeling of taking part in something bigger than their problems is vital for making people share knowledge. Also, the fact that people need to get something in return when sharing [48]. They get a positive effect through feedback and the effectiveness of their work. Furthermore, Zhang and Ng note that the problem causing people not to share is the fear of losing face. For the managers to contribute to knowledge sharing, they have to create a strategy of capturing and distributing the knowledge [49], often tacit, created in each project.

Systemizing could help digest explicit knowledge because sometimes the information is there, but how to find it could be the impediment. In modern times computers are taken in to use, systemizing knowledge. Then again, the introduction of computers leads to new tacit knowledge, on how to use the systems. A platform for knowledge sharing could serve positive for the different CI-businesses [50].

Boundary Objects, introduced in the original paper [51], is a helpful tool when looking at complex situations. Defining objects where actors cooperate and exchange tacit- and explicit knowledge. A boundary object is part of the social world and is, in some way, a facilitator for communication between actors. Star and Greisemer argue that it has to be well-defined, as well as fluid, such that it can both adapt and maintain a collective identity between parties. An example in an engineering project would be documentation or a user manual, which contains explicit knowledge for different parties to share. Furthermore, a stand-up meeting in Lean Construction is a boundary object which emphasizes tacit knowledge sharing.

2.3.2 Computer-Supported Cooperative Work

Computer-Supported Cooperative Work, first defined by [52], is the theory of the technology's role in the work environment. Often considered in the same context is groupware. The artical *Computer-supported cooperative work: history and focus* [7] describe the motivation for groupware:

> *"The complexity of managing large government software contracts provided further incentive to apply technology to group work."* - Jonathan Grundin

This motivation applies to Software development as much as for CI. Software and applications as boundary objects have aided complex working groups for centuries. One of the most known, and by Kraut in [53] described as the only successful, CSCW application is e-mail. Groupware has been an essential part of collaborative work, but what makes good groupware?

To make groupware work, first, it needs to meet the needs and requirements of the group [54]. When the software is thoroughly developed and tested to meet the requirements, one can argue that the software should work. Still, after a proper software development process, the critical implementation phase begins. Implementing new software has to fit the users. The article *Transforming Work Through Information Technology* by [5], describes how the deployment of new groupware in two different counties, ends in two different experiences. Central in the succeeding county, is knowledge sharing and grooming of users beforehand. They were conducting the implementation of the software in a bottom-up manner. In this case, the users were the ones who initiated the deployment. In the other county, who did not succeed, initiating the implementation was a centralized data processing department. As well, the knowledge had to be thought through manuals and learning by doing.

CSCW could also aid knowledge sharing [55], by, for example, make use of decision-making software. This way, teams having trouble making decisions can have a trusted source guiding the conclusions. Moreover, the use of ai and big data in the context to support the teams, in ways never seen before, shows promising results, when the ethical issues [56] are kept within boundaries.

In the end, to be highly successful, when fulfilled all other terms, the application has to be usable. The software could still work, but often a lot of knowledge is needed to understand the technology, if not emphasizing on high usability.

2.3.3 Contracts in the Construction Industry

This section will give an introduction to issues concerning contracts in the CI. First, a short introduction to contracts in the CI, as a context for the project.

Contracts in Construction Industry as a Context for the project

When considering how contractors work together, one has to review the contracts and the politics related. In CI and other fields where contractors are needed, the process outline, defined by SSA, often outlines how to work. During this process, in CI, the party announcing procurements creates tailor-made contracts based on the Norwegian Standard (NS), e.g., NS 8405, NS 8406, NS 8407, and others, which do not support an agile process. This yields a waterfall process.

Tailor-made deals makes for a challenging space of agreements for the entrepreneurs. This space promotes larger companies or the ones who specialize in contracts from only a few vendors. A contractor who wants to earn a new principal has to learn the contract, giving the advantage to the more experienced contractors. Often the more advanced companies are not pleased when parties introduce new contract outlines - simply because they lose their edge.

In step 4, the procuring of entrepreneurs phase of the procurement process. In this step, one has to choose an essential element of the contracts, namely, who is responsible. There are two fundamental forms of contracts: (1) Implementation Contract (*Utførelsesentreprise*): where the contractor is answerable for the implementation; and (2) Total Contract (*Totalentreprise*): where the contractor is answerable for both the design and the implementation of the construction, which imply the contractor owns the risk. In both of them, there are different ways of implementing contracts with subcontractors.

Essential in choosing the fit contract is how one expects the contractors to support one another. A deal that supports interaction is necessary when cooperation is crucial. When is not cooperation essential, one may ask? Often when constructing a modular house, where the owner (hereafter named manager) plans everything, repeatedly building the same house. When designing complex constructions, on the other hand, cooperation is highly desirable.

When constructing a highly complex construction *Utførelsesentreprise* is often chosen. This way, the risk is at the manager. Choosing the right design of the contract is crucial when aiming for a high degree of cooperation. There is three main contract design. Different is how much coordination and progress management the manager is responsible for managing. The contract models are:

- Shared Contract or Contract Management (CM) (*Byggherrestyrt entrepriser*): The manager makes all deals with subcontractors. In some cases, a subcontractor takes the lead on coordination and progress;

- Lead Contract (*Hovedentreprise*): The manager signs a lead contractor, which is responsible for a significant amount of disciplines. Furthermore, the manager establishes subcontracts with the remaining disciplines;

- General Contract (*Generalentreprise*): The manager signs a lead contractor, the general contractor, responsible for signing subcontractors, coordination and progress in the implementation;

Issues Related to Contracts

Picking the correct contract is vital in securing desired coordination and interaction, but at the same time, it needs to fit the manager's skills and resources. In the end, choosing the right sort of contract can be vital for meeting the budget. The problem with the complex domain of contracts is that managers tend to pick the same contracts [57]. Even though construction projects often vary from project to project, the procedure of picking the correct contract for the specific project is often not done.

The politics and contracts in a fragmented CI project, with a handful of contractors and sub-contractors, makes for difficulty in cooperation. Issues related to knowledge sharing is, among others, contracts and politics [58] — the issue origins in the fact that every contractor has the goal of maximizing its marginal cost [31]. This problem is especially problematic in projects consisting of several different companies, such as in complex constructions. Miller, Packham, and Thomas, in the article, also points out the fact that cooperation and knowledge sharing in mixed teams is the cornerstone in APM. This makes Lean in the CI even more complicated when complex contracts and harmonization among team members are taken into a count.

Furthermore, the considerable cost of mistrust in CI-projects is shown to be a factor in the overall cost of a project [59]. When actors are more busy protecting their contract, rather than adding to the team, the advantages of cross-functional teams can be lost. Also, prior ties could have a significant impact on how team members interact, as described in the paper of Bruvik and Rolfsen [60].

> *Positive prior ties can have a substantial effect on the development of trust at the beginning of the project.*

Furthermore, the paper is concluded by identifying four aspects that can aid interaction and cooperation: (1) a common philosophy, (2) open communication, (3) clear role expectations, and (4) a shared climate of trust. Hence, prior ties will help in establishing these aspects. One can think that negative prior ties will especially defect the second and the fourth aspect.

Chapter 3

Method

This chapter will give an insight into why the research is needed and what method used conducting the research. Also, the chapter gives insight into the collection of data and the following analysis, as well as and who are the participants.

3.1 Methodological Approach

This study aims to understand the fundamental reason for the striking challenge in labor productivity in the CI-industry. The research is, therefore, adopting a case study-strategy of a single-case object, in the CI in Norway. Utilizing a single-case study approach, preferably than multiple, will give a more in-depth look at the problem, rather than a thin description provided by the multiple-case study [61]. This project, therefore, aims to examine a case using lean methodology, utilizing digital tools to support both the method as well as cooperation and interaction between different actors. The project selected is the construction of the new Life Science Building, managed by Statsbygg [62]. Obtaining the LSB-project was rather by chance, and followed no formal theoretical sampling procedures proposed by the literature [61]. The problem of using a case study is that it is hard to produce a generalized answer to a question. The aim of the research is not to obtain generalizable findings but to explore the phenomenon. Furthermore, identify different measures that can help this specific project. This thesis is based on a preliminary project committed in the fall of 2019. The intention is not to measure productivity, but rather understand the phenomena and propose coherent actions.

This study is related to the interpretivism paradigm — the use of empirical observation of the participants and a desire to identify how they act on the new software and methods used. Using interviews can lead to being subjective as all collection of data is done in

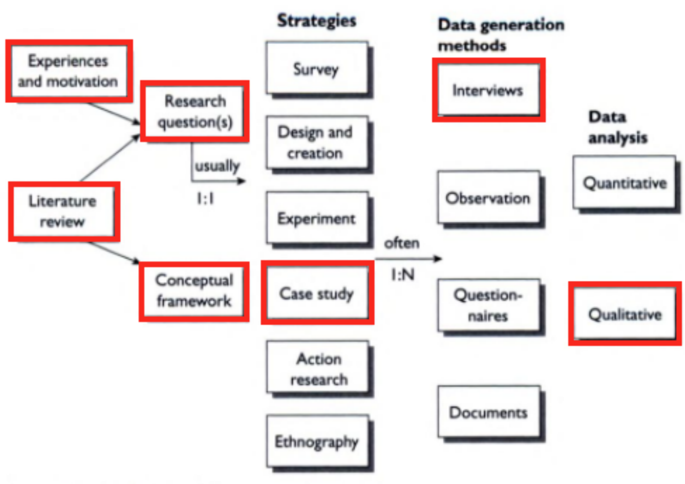

Figure 3.1: The research process used, marked with methods applied in the research.

interaction with the participants. This yields a qualitative collection of data. The purpose of this project thesis is to identify issues causing a lack of productivity and identify actions fixing these issues.

Due to the COVID-19 virus, this thesis could not implement the identified actions, and therefore only propose the actions.

RQ1: Why does the lack of productivity in labor productivity in the construction industry appear?
RQ2: How does this problem appear in the LSB-project, which utilizes both agile and digital tools?

3.2 Data Collection

This project is following a preliminary study, resulting in a project thesis, in the fall of 2019. Starting with the literature review, providing a knowledgeable background as the basis for the project. Moreover, a minor empirical study of the case object, including both interviews and observations. This thesis consists of a more in-depth empirical study, with several interviews as data generators.

Interviews

The interviews for this research was done during two phases, as seen in the 3.1.

The first phase of the research, resulting in a project thesis, was conducted in the fall of 2019. Due to a hectic period of the project, the researcher made use of video chat conducting the interviews. Using Skype and other video chat services can be cost-effective due to the ease of planning, compared to face-to-face interviews. On the other hand, because of the small window the web camera provides, it could be challenging to read the participant's body language [63]. Also, the utilization of digital interviews is reliant on highspeed internet, and that the subject is familiar with the digital tool for the interview to work well enough.

In the second phase, the interview took place at the project office, near the building site, in Oslo. The project gave up a small meeting room for a week for the researcher to use. Opposite of digital conduction, face-to-face interviews lead to more waste of time caused by the difficulty of planning and waiting. On the other hand, the conversation will not suffer from a lack of body language or depend on technical tools to work, but the recording device. Also, the researcher feels the conversation had a better flow face-to-face.

Every interview can be a source of error because of the communication element and how the actors interpret. What the interviewee sais is not only in words, but mimics, cadences, body language as well. Hence the difference in the face-to-face and video chat. Using follow-up questions helps in the case of insecurity. Also, the researcher could correspond with the participants over email and telephone after the interviews. Thus, increasing the validity of the data.

Before an interview, an email was sent to the participant, preparing for the conversation. The email consisted of a description of the research, the researcher. Moreover, the consent and interview guide described later in this section. The preparation gave the researcher more in-depth and thought-through answers. Not every participant had spent time preparing for the interview.

The conduction of the interviews followed a set of standardized questions. The researcher, beforehand, developed these questions. The guide consists of a small collection of themes relevant to the research question, listed in Appendix A. The order in which the questions where asked was not of importance, and often changed based on the interviewee—moreover, the participant was indeed the dominant part of the interviews. The interviews are, therefore, consisting of several follow-up questions. The purpose of an unstructured interview was for the interviewee to speak freely, and therefore more receive more genuine answers. The research process used is shown in figure 3.1.

In line with Norsk Senter for Forskningsdata AS (NSD), the researcher, signed an informed consent with the participants. The contract gives the researcher allowance to do the interview; keep personal data throughout the project, such as name, title, and company; and do recording of the interview. The purpose of the recording was for the researcher not to take heavy minutes during the interview, instead focus on the conversation. Also, a recording will give an exact version of the interview.

The transcription became more or less the exact recording of the interview. Sometimes, not writing the follow-up questions, if the sentence made sense. The resulting text was hard to read, due to its spoken tone of voice. The purpose was not to make a perfectly readable text, but to have documentation of the thoughts and experience of the subjects, for further analysis. Moreover, after the interview, the transcript was sent to the participants for them to approve. Every interview lasted between 15 minutes and up to half an hour.

3.3 Participants

The project researcher, Morten Bujordet, is involved in the project, creating the plans, and conducting the research.

Supervising the project is Eric Monteiro. Monteiro is contributing with experience in research in the implementation and use of new digital tools in large scale, as welle as complex organizations.

Furthermore, Statsbygg, as the manager, has an interest in the project: giving access to the participants in the study. With Darre Brecke Brenden as the point of contact.

In the research, the actors in all layers and disciplines of the project organization will be an aim for the data collection. All personal information gathered will, safely, be stored in a GDPR-compliant Cloud Service, served by NTNU. In the final report, no personal information will be published, and all participants will be anonymized. The participants chosen for the interviews are key personnel leading, modeling, and working in the design of the project. Statsbygg gave a list of 30 candidates, where 16 had the opportunity to participate in the interviews. The interviewees are listed in table 3.1. The thesis conducted a total of 18 interviews. Selecting the first two interview objects was based on a list of 6 interviewees, proposed by the first contact person. Only two subjects had the opportunity to participate, due to a hectic period of the project. The second phase of interviews started with a list of 32 potential interview objects. Every proposed interviewee was contacted; only 16 had the opportunity. The initial list of persons was handpicked, by the assisting project director, to get an insight into all different levels of seniority and different disciplines of the project. The resulting set of interviews represent a wide range of project seniority. From a month of experience and up to the very start of the project, back in 2014. Also, the set represents every discipline in the project.

3.4 Data Analysis

The analysis started by transcribing the interviews and sent to the participants for approval. Furthermore, utilizing a thematic analysis approach. The thematic analysis followed a set of steps

1. A perusal of all the material: It was essential to get to know the material, and to read through all the interviews after the transcription was a vital part of this step. The interviews was ;

Interviewee	Function	Gender	Phase 1 (November 2019)	Phase 2 (February 2020)
1	Assistant Project Director & Project Manager	Male	x	
2	Assistant Project Manager	Male	x	
3	Project Manager	Male		x
4	Engineering Manager	Male		x
5	Engineering Manager	Male		x
6	Progress Planner	Female		x
7	ITB Manager	Male		x
8	Associate	Female		x
9	Discipline Leader	Male		x
10	Discipline Leader	Female		x
11	BIM Manager	Male		x
12	Associate	Male		x
13	Associate	Male		x
14	Discipline Leader	Male		x
15	Assiciate	Male		x
16	Ass. Project Group Leader	Female		x
17	Engineering Manager	Male		x
18	BIM Coordinator	Male		x
Total interviews			2	16 = 18

Table 3.1: Overview of interviews and phases of data collection.

2. Generation of codes: After getting to know the material it the focus was to identify parts of the text based on the project question, marked with an identifying code;

3. Collection of themes: Based on the codes, a set of themes evolved. The codes find most connected were put into groups, based on the connection between them. Which themes adopted in the thesis was based on the research question;

4. Reviewing the themes: Based on the research question, a set of themes was selected. Basing the selection on different criteria, among others, how interesting the theme is, the iteration of the code, and the researcher's considerations;

5. Defining and naming the themes: The final collection of themes is selected, and will be the basis for the discussion in the rest of the thesis. The names of the themes are also selected. In this process, three themes appeared, namely: (1) Not unmitigated,(2) Lack of knowledge, and (3) digital potential;

6. Producing the report: Describing the findings in the thematic analysis, using the chosen themes as a guideline. Moreover, discussing the themes with relevant literature, previous experience, and context.

The data produced in this process is in the Appendix. The initial codes identified

Appendix C and the collection of themes in Appendix **??**. Reviewing of themes did not produce much data, due to its subjective manifestation.

3.5 Evaluation of the Method

The single-case study, as well as the use of unstructured interviews, produce results that cannot be generalized beyond the sample group. Still, they provide a more in-depth understanding of participants' perceptions, motivations, and emotions.

One can always argue that utilizing interviews for data collection can tend to be subjective. However, the use of a qualitative approach is best when wanting to describe, contextualize, and gain an in-depth insight into specific concepts or phenomena, which was the case in this empirical study. Furthermore, the project researcher has a part-time job developing the Cogito tool, which can argue for the researcher for being subjective. Though, in this case, 14 of 16 participants mentions Cogito, without the researcher asking them. Also, the participants did not know the relation the researcher had to Cogito; thus, the interviewees spoke freely. Moreover, based on the interviews, the Cogito tool was the one subject getting the most tension; therefore, discussing Cogito and themes related is arguably based on a valid reason.

The objective of this thesis was to test some of the concluding proposals and observe the change it might bring. Though, due to the COVID-19 virus, the implementation phase was not feasible. Thus, this thesis only consists of a set of proposed actions. Testing of the actions is, therefore, up to a later project, or for the project to do. The project owner has received a summary of this thesis, including the proposed actions.

Further exploration of the project question is needed to conclude on the matter, moreover, testing of the suggested actions.

Chapter 4

Case Study: The Life Science Building Project

This chapter will, first, introduce the case object, namely the Life Science Building-project. The presentation is an introduction to the project in itself, and the vision and strategies essential for project management. Furthermore, the case study will examine and discuss the findings of the empirical study. Section 4.1 inherited from the project thesis conducted in the fall of 2019, only upgraded where the information was lacking or inexact.

4.1 Introduction of the Life Science Building Project

The project case will examine the construction of the new life science building of the University of Oslo. When finished, the building will reach a cost of approximately 6,8 million Norwegian Kroner (NOK), and cover 66,700 square meters, with this, becoming the most extensive, detached university building in Norway. Construction owner is the Norwegian Directorate of Public Construction and Property Management (Statsbygg). The construction started on the 8 of February 2019 and is expected to finish in 2024, while the project management of this report started in 2017. The project group, designing the project, however, started their work in 2014.

The manager, Stasbygg, is a significant organization in the Norwegian construction industry. They are on a state mission, which means that they are to realize the politics decided by the government, achieved in architecture, cultural legacy, spatial planning, and environment.

Each year, Statsbygg constructs about 100 construction projects. Some are more complex than others. The life science Building is one of the more complex. In addition to the construction of new buildings and projects, Statsbygg managing about 600 properties of these 90 outside of Norway. Examples of properties managed by Statsbygg are embassies, royal properties, colleges, and cultural buildings.

In regards to complexity, the new life science building has to meet several complex requirements: (1) the environmental: The property is to achieve Excellent in the BREEAM NOR classification of sustainable properties; (2) usability: a group of the final users has given their feedback on what they expect from the final building; and (3) technical requirements: The building is to house several faculties, some requires highly technical labs.

4.1.1 Project Vision and Strategies

The construcionn of the new Life Science Building is, in many ways, a prestige project. Defined in the vision:

> *"An even better project"*

The project is following in the line of previous two large projects running Lean Construction, with Statsbygg as manager. Starting with the Domus Medica construction concluded in 2013. This project was the first Norwegian group applying Lean. This construction was followed by the raising of the new Bergen Academy of Art and Design (BAAD). During these projects, Lean Construction was a significant part of the project management. The first project suffered substantial scope creep, which made the managers take action, applying Lean Design and Systematic Completion *Systematisk Ferdigstillelse* on the BAAD-project. The moves made gave results, and when finished in 2017, the project was by many considered one the most successful (complex) building-constructions completed in Norway.

Based on the the BAAD-project a the *Lean methodology in design and construction*-book [9] descibing the experience from the project, was made. With the previous history and recomendations from the book, Stasbygg, as a manager, defined five superior strategies in the upcoming LSB-project:

1. The Contract strategy
2. The Lean strategy
3. Stretegy of Systematic completion
4. Digitalization strategy
5. Logistics strategy

These strategies affect how the project should run and emphasize the focus of the project

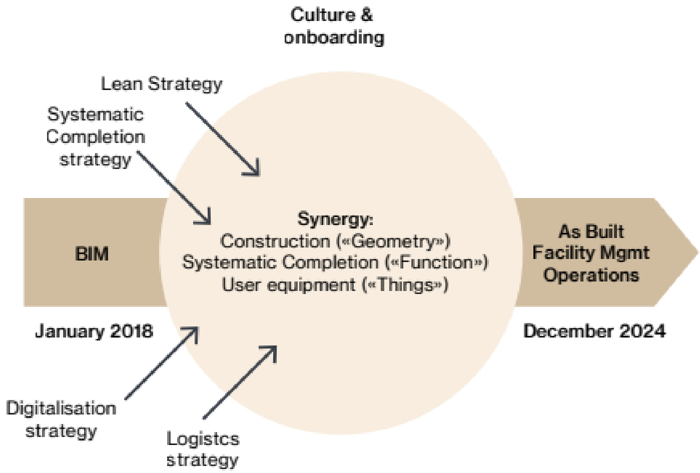

Figure 4.1: A hollistic view of Strategies in the Life Science Building-project.

managers, hopefully leading to a sustainable and productive project. Following are a brief introduction to the different strategies as a context for the case. An holistic view of the strategies in the project are illustrated in figure 4.1.

The Contract Strategy

The project has made use of a customized version of the Total Contract, named by Statsbygg as Total Contract with Prior Interaction *(Totalentreprise med forutgående samspill)*. Instead of signing single contracts with each subcontractor, the managers have assembled eight arrangements, each covering different divisions of the project. Hereunder a more Lead Contract type is applied. Figure 4.2displays the eight contract divisions. Responsible for each of the contracts, from management, is either the project manager from construction or technical. Prior Interaction applies to the design phase, where entrepreneurs are involved prior to the job they are to perform.

The motivation for this model is, first, shielding the contractors from some of the risk running this project. The project is, as mentioned, very intricate in construction, as well as in management. Moreover, getting contractors willing to apply on this project, the managers will take much of the risk. Regarding cooperation the projects adds Lead Contracts. The intention of this is cooperation; besides, sharing a contract has the plan of shared responsibility and incentives for collaboration between subcontractors. Even though there is a lead contractor per division, the hope is that the group of subcontractors should feel shared responsibility. Why not have a shared responsibility,and no leading contractor, one may ask? The answer is partly laws and politics, but moreover for simplicity in regards to management; a single point of contact. As well, motivation for adding the prior interaction creates a foundation for the Lean strategy.

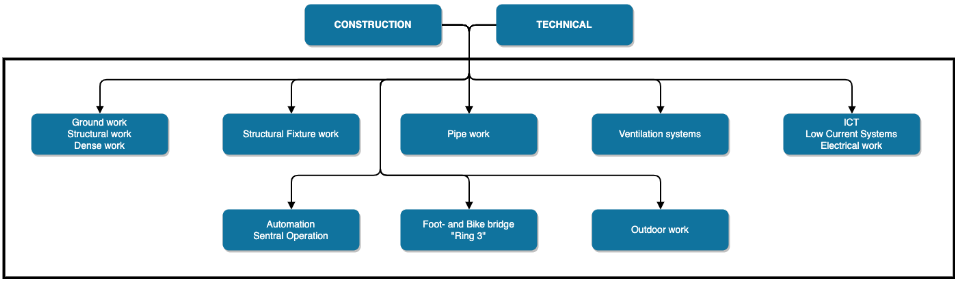

Figure 4.2: Contruction Contracts in the Life Science Building Projects, each managed by either the construction- or technical project manager.

The Lean Strategy

The Lean Strategy applied in this project is tailor-made from experience from both the Domus Medica- and BAAD-project. Two Lean strategies are applied in the LSB-project:

1. **Lean Design:** A method conserning design management and design coordination to ensure that the progress and knowledge sharing, in the Design Phase, is as good as possiblble.

2. **Lean Construction:** A method conserning the scheduling of tasks and the availability of skills and materials to ensure that the work progresses as smoothly as possiblble during the construction.

Different from the traditional design phase described in section Construction Industry Project as a Context for the Project, the LSB-project made use of an iterative method. The *Lean Design*-method has been developed by Statsbygg, after designing the Domus Medica and BAAD projects. In all projects utilizing Lean as their project methodology, this project also iterates over a product. The product, in this context, is the Building Information Model (BIM). A BIM model is a representation of the construction stored in a particular format, namely the `.IFC` format. A IFC-file can be used by several programs, in visualization, modeling, and operate the construction. Moreover, the project makes use of Level of Development (LOD), mentioned in the 2.2.5 section, where each iteration, named sequence, has the intention of getting the BIM model more mature. Also, based on the Contract strategy, the result of this process is not procurement, but the final product ready for implementation - hopefully without bugs.

A problem with the traditional design phase was evaluating the overwhelming amount of documentation at the end of the phase. Bohem is also mentioning this difficulty when evaluating the waterfall process and problems of use, in his paper mentioned in section **??**. Furthermore, it is an argument in the Agile manifesto. Having sequences, the Lean Design method, therefore, made it easier having control over all interdisciplinary correlations. In LSB-project, these sequences last up to two weeks. In every sequence, the project leaders are assigned a set of packages. Ending the sequence, the project leaders need to deliver

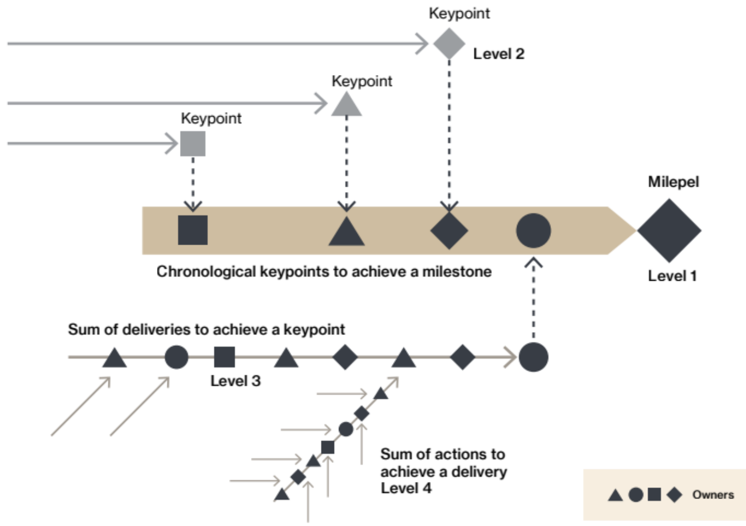

Figure 4.3: Contruction Contracts in the Life Science Building Projects, each managed by either the construction- or technical project manager.

on the packages assigned. This way, the project can identify tasks that are, or can be, risks for the project. Every week in the designing the project starts with a cermony named blackboard-meeting. In this meeting all project leaders, project managers, and responsible goes through the packages and deliveries due to that meeting, or the status if not the end of a sequence. The project chair the meeting, while the rest need to the status of the their area of responsibility.

The Detail project started with a two-week planning session, which made all trailing package-planning possible. The session resulted in the process map. The process map includes four levels of tasks, illustrated in figure 4.3: (1) the Milestones: A significant planned completion of a part of the project, e.g., steering document approved; (2) Key Points: Key Points is less significant, and with a shorter time frame than milestones, but in the same way an indication of completion; (3) Deliveries: A Key Points consists of several deliveries, e.g., finishing a room or design of a floor; and (4) Actions: Actions is everything needed to be done to complete a Delivery.

Both the Lean Construction, described in section 2.2.5, and Lean Design, make use of large planing tables. These can look like the old roadmaps used when planning the coding in Waterfall. Depending on how one makes use of the plans, the result of such planes is that they often than not end up wrong. Therefore, as Sutherland points out in his book [22], the plan is not the final solution, the plan is what is needed, and adapt thereafter. Though, in this case it seems like the time was well spent giving the project leaders valuable insight into the project. Not spendig too much time planning ahed.

The Strategy of Systematic Completion

As described in section 2.1.2, the construction process ends with the Realization phase. It is after this phase, the project, or building in our case, is tested. If tests run smoothly and the owner approves the construction, the building handover occurs. The mission of testing is to verify that the final product meets the initial requirements and specifications defined. A typical case, when conducting these sorts of tests, is discovering errors. Problems getting wors when there is no control of these errors. If the final construction has too many errors, the owner can decide not to take over the building. Consequently, the project fails to deliver on schedule. Sadly, this happens quite often.

Managing this issue, the LSB-managers has developed a method, checking the systems, functions, and geometry of the construction. The method is named *Systematic Completion* (SC). Throughout the project, SC is conducted, reducing the risk of not deliver the final project. SC follows the LOD-version, which makes for successful completion, with the correct level of quality, at the right time.

The Digitalization Strategy

The Digitalization strategy is, both important in itself, but also supportive in regards to the other strategies. The project using a digital 3D visualization of the building as the product, driving the Lean Design method. Revit, the BIM modeling tool, is, in many ways, the core of the project, supported by dRofus, which is the room database. Prominent in the strategy is connecting all software used in the project and making all entrepreneurs use the same. Hopefully, one can trace the socket implemented in a room, by an electrician, through the drawings given, back to the BIM-model, and the dRofus database, where it was first planned. The resulting system can later be used by janitors, running the building, to identify errors in the system. Figure 4.4 visualize the connected systems in the project.

A significant part of the digitalization, and unique for the LSB-project, is the deployment of the Cogito Project-system. Cogito is a tool used to visualize the planning done in the design phase, supporting the Lean Design method. The tool are beeing used tracking actions, deliveries, and Key points and milestones, who is responsible. Furthermore, calculate Planned Percent Completed (PPC), which is an excellent way of identifying delays. The project is planning to use Cogito tracking both the design- and the implementation phase of the project.

The project utilizes, added to Cogito, several other software supporting Agile project management and cooperation. Under following a list of the most crucial software, concerning Agile and collaboration.

- **Revit:** BIM modeling tool, used in the design and construction of the project. Revit is a local software for every modeler, architect, and worker modelling. The software is developed by Autodesk, which also developed the much popular Autcad; a computer aided design tool for architects, engineers and proffesionals in the construction business. Creates drawings in 2D and 3D. When finished modeleing the modeler has

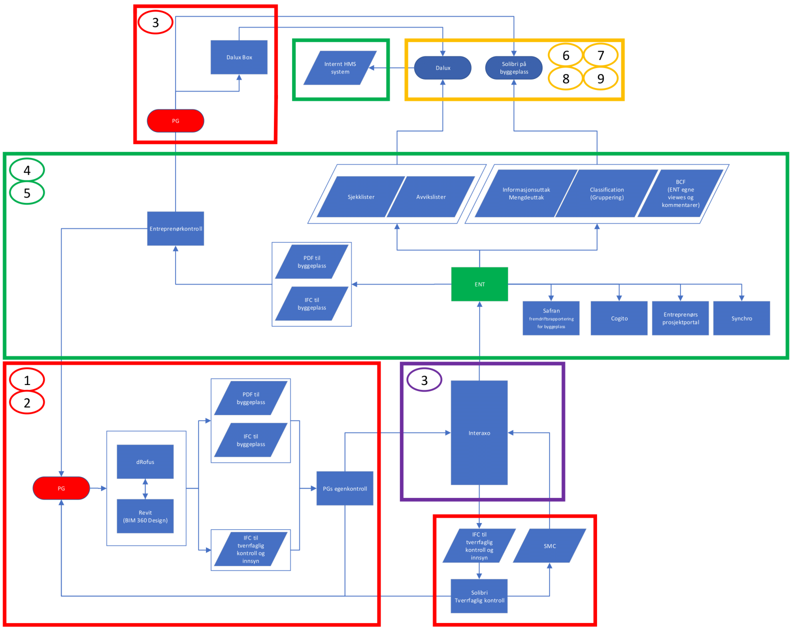

Figure 4.4: Overview over the system architecture used in the Life Science building project. Outlines representes the actors using the systems, by color: (red) Project group, (green) Entrepreneurs, (yellow) HSE, and (blue) cloud service sharing documents

to export what is done so available for the rest of the project. The exportation from every dicipline is put together in the common model, once a week.

- **dRofus:** Software supporting BIM. Whats defined in dRofus is known as the truth if there is a mismatch between BIM and dRofus. The software is used as the database for the BIM model and used in the planning of every room. Furthermore, the data stored in dRofus is being used in the procurement of systems and objects to the project. Every element in the project is given a specific id; a TFM number. This number is later used in implementation, when a object is placed in the building it recieves a corresponding TFM-tag. Later, when the building is running a janitor can fix an object and know exactly what type it is based on the object's TFM.

- **Cogito:** Visualization of ongoing and planned packages, in both the design phase and construction phase of the project. The project director and other managers of the LSB-project have formed the Cogito project, through experiance and some are also invested in the tool. Though, has to take thus are invested in the project. The idea of the tool came from the needs encountered in previous projects [9]. The tool is a supplement for a Lean Design and Construction process, specialy shapet for the construction business. The software is developed by a company named Tasctrl, and was only partly finished when introduced to the project.

- **Interaxo:** Cloud service for documents. Servicing onboarding, breach handling, and offboarding. Ineraxo is a platform gathering almost all the documents needed in a construction project. The high demand for documentation is simpler using this tool. After finishing a task in Cogito the final documentation ends up in Interaxo. Often there is a link to Interaxo in the preluminary field in Cogito.

- **Blink:** Communication tool and intranet for the project. Using BLink, interactions can happen rapid and informally without booking meetings and writing extensive emails. Moreover, Blink has wide variety of features like News feed, documentation, messaging and in depth analysis of the workforce. Though, the project main requirement was the newsfeed, the software was chosen due to its confidentiality and security policies. Other services like this are Facebook Business manager and Atlassian Confluence.

- **Solibri:** Bringing all models from all dicipline in to one view. Gives all actors access to the model, and offers advanced checking and quality assurence, like collision tests. The tool give everyone involved the possibility to collaborate and solve any found issues. A user can view the model and minimize the model as needed.

- **BIM 360:** BIM 360 brings together all aspects of construction in BIM into one platform. Autodesk develops the product, thus integrates with Revit. The software aims to remove the silo structure, often appearing in a project including different themes and disciplines. Offering a shared platform for them to see, collaborate, and develop the Revit model online. Moreover, set up teams, restrictions, and team workspaces. Also, supporting LOD throughout the model. The project has procured BIM 360 Design, hereby refered to as BIM 360, which is one of seven products offered in the BIM 360 sphere.

The Logistics Strategy

Last, the Logistics Strategy. When coordinating a large number of people and paraphernalia, having control is a major challenge. In the LSB-project, there will be up to 800 people and equipment worth over 1 million NOK. These numbers argue for the logistics strategy. The strategy involves planning for goods arriving the lot, as well as where one should tossing the garbage. Considered in this strategy is also removing packaging before arriving the lot, where the goods should arrive, securing the most effective utilization of construction workers. Should the project construct a cantina, so the workers do not have to walk to the nearest McDonald's or grocery store when having lunch? Furthermore, alining workers, equipment, and goods needed to support the train in the Lean Construction strategy. This strategy could be a significant impact when considering the overall labor productivity of the project.

4.1.2 Project management in the Life Science Building-project

To manage a project, this significant, the constructing organization makes use of several different management approaches. One can divide the project management into two levels: (1) process management: The support of the process and how the teams are working together, and in what order; and (2) implementation management or method management: The management of design and implementation of the final product. The organization structure used in the project supports the two levels of project management. The first of the two, process management, is using customized phase-based process management, inspired by agile thinking. Second, implementation management utilizing the above strategies.

The construction project organization structure is, as seen in figure 4.5. Starting at the top, in charge of the project, is the project director (PD), supported by the assisting project director (APD). The board, seen on the right, consists of four managers, each responsible for different strategies of the project. On the left HSE and project support, which is responsible for i.a. Communication, economics, progress. Beneath the four divisions in the project, where design is responsible for process and management. Paraphernalia is responsible for equipment in the final building. Construction and Technical are two divisions responsible for the eight contracts. In each of the division a Project Leader (PL) is responsible. The PL in Construction and Technical the PLs are responsible for the projects concerning their contracts.

4.2 Results of the case study

The research, described in chapter 3, resulted in three themes. These themes were selected based on their significance toward the research question. This next section introduces

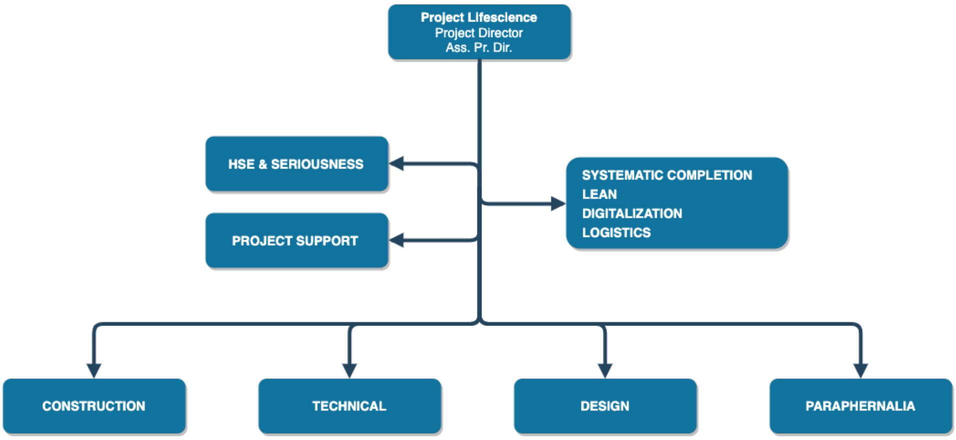

Figure 4.5: Organizational structure in the Life Science Building Project.

these themes, with general observations, such as recurring points of agreement and disagreement, trends, and patterns.

The themes chosen are as follows: (1) Not unmitigated: The project uses a lot of digital tools. Some overlap in their function and different actors in the project use them differently; (2) Lack of knowledge: The project makes use of newer, and self-made, methodology and techniques, in which require knowledge and understanding; (3) Digital potential: There is much potential in digital tools supporting the cooperation, such as automation and cloud-based systems. Who can increase productivity significantly.

4.2.1 Not Unmitigated

The project makes use of a lot of digital tools, some of them mentioned in section 4.1. In addition to all the tools that are decided by the governing organization, every contractor or team can choose to introduce new tools aiding their work. This makes for an extensive set of digital tools utilized in the project. When considering that a considerable amount of workers are only working part-time on this project, one can imagine the difficulty of getting an overview. Furthermore, throughout the project, the tools differ in use.

By the law, a project can not dictate which tools the modelers, architects, and workers use to do their work due to competition rules. For example, when contracting a contractor doing the modeling of the water and wastewater, the governing organization can only decide on the resulting file-type in which the contractor is to enrich the model. Thus, giving a variety of tools throughout the project. Even though the governing organization can not decide all the tools, some are, and these are contracted by themself. Examples of tools chosen, and contracted, by the governing organization are project management tools for coloaboration, documentation, and overview, such as Cogito, Interaxo, Blink, Solibri, BIM 360, and BIM-collab.

A project like LSB includes a variety of different disciplines, and with that follows a wide variety of working habits. Still, the PLs need to utilize some structure to control and monitor the project and project progress. Thus, implement Cogito, Interaxo, Blink aiding this control. The idea is for everyone to use these tools, giving traceability and transparency to the PLs. This is not so much the case in the project. Several workers where reporting they do not or seldom use these tools. Especially Blink, where almost everyone reported they did not use it, or see it as no necessity.

> *"Have not received an invitation, but I have heard about it. That is the social network?"*
> - Associate, about Blink

> *"Everyone in the project has Blink, but I think it is quite uninteresting. I see it more as a social thing, which could be nice."*
> - Dicipline Leader, about Blink

Blink is later proven to be important because all information regarding the measures taken due to the COVID-19 outbreak are posted there.

Moreover, a tool giving a direct overview of the project progress is Cogito. Everyone should have access to Cogito, giving them access to what is going on in the project and what is due the next days and weeks. It is, therefore, striking the disagreement about the tool. Some have chosen not to use it within their discipline. While others use it in meetings, showing the progress and the future deadlines, for the team to deliver.

> *"It is a neat way, for me, to show what is planned for the other team members."*
> - Engineering Manager, about Cogito

> *"Provisionaly we have not used Cogito in our team."*
> - Planning Consultent, about Cogito

This last quote is an example of how new software is difficult to inject into an organization. Let alone when the software supports a new way of working. Following this new way of working, this tool is leading others to choose not to integrate this tool with the team.

> *"We have used e-mail and Teams for internal tasks, but we do not put these into Cogito."*
> - Dicipline Leader, about Cogito

Several teams have been reporting using other task management tools and different tools within the team. Some of these tools offer services, which the tools set by the governing organization does not support. Though, some of them contribute to overlapping functionalities. Thus, the overlap could result in double-entry or not using the common tool, wich will hamper the transparency. The implementation of other tools will be reviewed later in this section.

The different use of tools such as Cogito may have roots in the different understanding and use of the tool. How the project uses Cogito is based on Lean Constructing and Lean Design. Thus every package has some predefined fields of input, including deadline, prerequisites, title, and description. The project does not have a common way of filling these inputs. Thus, every team and package reporter operates differently throughout the project. Especially how to write package descriptions and prerequisites wearies a lot. One engineering manager reports using previous packages as a baseline for new packages. Thus, giving consistency to the rest of the team and other disciplines reading the packages. One can argue a lack of knowledge, as of the next section, but in this case, there is no standard way defined in the methodology on how to write package descriptions. Moreover, how to set deadlines is not defined in common ground. Thus, leading to surprises and late deliveries.

Also, in Interaxo, the documentation tool, different approaches are being used. So much that several project members do not know of the structure set by the project management.

> *"In Interaxo, the same structure is not applied in all directories."*
> - Accosiate, about Interaxo

Using these tools is a part of the process set by project management, and one can not blame the tools themself. The project has defined a process of onboarding new project members. Though, it seems like several new members have not received this. Part of this process is a course in Lean, as well as how to use the applied tools. Onboarding will give an overview of the tools applied, also why the project is using them. Moreover, the underlying methodology and processes are to be understood before utilizing the tools supporting them.

Some of the tools implemented by the owner have much functionality, which overlaps with other software applied. The idea with the software applied is to solve a purpose; Cogito is for package follow-up, Interaxo for documentation, BIM 360 is for BIM-collaboration in real-time, Solibri is to look at the model, Revit is for modeling, and e-mail is for communication. All these software offers a lot more actions then described here. Some of these actions overlap with actions to be done in other tools. Thus, the project has to define which tools to do specified processes: this way, PLs, and management can follow-up processes, teams, and packages, without having to seek for it.

An example is in Cogito, a project member reports an action, and the responsible starts discussing this package with a contractor over e-mail, rather than using the discussion panel in Cogito. Thus, the transparency is lost, and going back to see how one solved the package could be difficult because where the discussion took place is not known. Also, different parts of the project use different tools for the same process. Where one theme-group does issue management in 3D modeling in BIM 360 Design, others tend to use

BIMcollab. While project management does not care how modelers work, this could be difficult for an engineer working on several themes and teams throughout the project. An engineer articulates this problem:

> *"I have been part of several themes. The same tools are not used."*
> - Associate, about unmitigation of tools

Furthermore, every contract and team can choose to add supplement tools, aiding their work. For the most part, this could be engineering tools, but also communications tools. A lot of the interviewees reported the use of Microsoft Teams internally, both to use in communication as well as task management. Some of the tools added overlap with the predefined tools, giving either double reporting, using both tools, or using the wrong tool, not using the project tool. Communication could be conducted using Blink, which include a chat service. Also, taks management could be done using Cogito, wich will eventually result in trancparancy for the both the team and the rest of the project.

4.2.2 Lack of knowledge

To construct a building like LVB is, as we have seen, a complicated project, to complete the task of constructing this building depends on ingenuity, a good process, and solid management keeping everything in place. Moreover, one needs a whole lot of people to perform and cooperate. The people collected for this project are hired because of their specialty in their discipline. Some are the best Norway has to offer in terms of expertise. That does not mean they have worked in a project this extensive or complex as the LVB-project. Perhaps they are not familiar with the process applied in the project, namely Lean Construction, Lean design, and Systematic Completion. Thus, project workers, both experienced and less experienced, can feel a lack of understanding, ignorance, or possibly a shortage of knowledge.

Lean heavily influences this project. Therefore, an introduction to Lean is mandatory in the project's onboarding process. As mentioned in the previous section, this onboarding is not fully accomplished. Hence, several project members lack knowledge of the process applied.

It is clear to say that many of the project staff do not know Lean. Some have made their interpretations; others do know something, but not enough to understand the power it can provide adequately.

> *"I do have a Lean mindset, but I am not quite sure what Lean is."*
> - Associate, about Lean

Moreover, there is only one mentioning articulating using Lean Design in the design phase. Most of the interviewees seem not to understand that there is a Lean process present in the ongoaing phase. Moreover a process come constructing.

"That is something applicable come constructing, I have understood."
- Discipline leader, about Lean

Furthermore, when not familiar with Lean, they will not recognize how and where Lean is applied.

"We need to know how the strategies are to influence our actions."
- Engineering manager, about Lean

A challenge when actors do not know the underlying method, the tools applied which are supporting the methodology is not understood. Hence, many interviewees mentioned issues with Cogito. Several mentioned reports of missing overview. Due to the fact that Cogito is under development, one can imagine that some functionality is missing. Though, what some actors are missing is the old Gantt-diagram, which the Lean Constructing methodology does not support. Thus, the frustration against tools like Cogito often builds upon the lack of understanding.

The fact that most of the actors interviewed do not recognize Lean Design in their description of the design process can point to other problems, also in the previous section. When not aligned with the same process or methodology, it is hard to cooperate and communicate. How one should assign tasks, write package descriptions, and do planning is often a part of a project methodology, and especially when considering agile project management. Therefore, the lack of knowledge considering Lean, and especially Lean design, is of a serious matter. It makes the basis of how the project is run, and therefore the tools applied and how to interact.

Added to Lean the project applies several other project management strategies, which, for some, could seem new, including Systematic Completion and Level of Detail/Level of Development (LOD).

The LOD is, in the project, implemented somewhat in a unique approach. Usually, when talking about LOD, one consider the 3D-model; the BIM-model. The LOD type applied in this project is known as MMI: Model Development Index. This approach, in itself, has shown to be difficult for some actors in the project. Especially defining the steps of the MMI-latter for every discipline, and what this means when writing package descriptions adding deliveries and actions to different parties. Actors articulate the suffering from the unawareness of LOD.

"Everything we do is done a new way. At times, it is unclear what the goal is. Thus, the planning of MMI has been difficult."
– Engineering group leader, about MMI

Furthermore, the project has implemented a sort of LOD in the rest of the project as well. Including both the digitalization and paraphernalia. Thus, project managers use this when deciding on procurement. Hence, some will say they spend too much time discussing the matter. The argument used by the owner is thus that they do not want to make the wrong decisions early on, and rather wait until their level of knowledge is acceptable. Then again, when the actors are not used to this way of working, it is difficult both in use and understanding.

The project suffers from a lack of knowledge. The project base the decisions and way of working on some pillars of methodology supported by the strategies. Though, it seems like there is a variety in the actors understanding of some these pillars.

4.2.3 Digital potential

The last pillar of the project is digitalization. Thus, the project has high expectations for digital utilization. The major digital initiative the project has done is the use of 3D modeling and the use of BIM. Several interviewees mention BIM as an essential aspect of interaction.

"Using BIM gives an exceptionally effect. This is the future of the construction business. ...It becomes very conceptual. Therefore, easier to understand a problem."
– Discipline Leader, about BIM

The design of the project started with PG, using a local server storing the BIM-files, designing the project. When the project started growing, the problem of using this local server occur. Issues with downtime and access caused the project to move, from a stationary server to a Cloud-based service run by Azure. Once every week a responsible, in every discipline, does export of the work done. The export, from every discipline, is then put together to enrich the model in Azure. Using the cloud-based system has been a powerful enhancement to the productivity of the project, and is noticed by the project staff.

Some of the disciplines, including the architects, have set up automatic exportation of the files. Though, commit the exportation on a private computer. At times the responsible forget this, then closes the computer, forcing the automatic export to quit. The disciplines who have not set up an automatic export do this manually. Which takes time - up to two hours evety time, also the responsible can forget about it. The exportation used to take place once every two weeks, but when the interviews took place, the every week iteration had started. Also, talks of twice a week was inititiated. If the exportation should take place twice a week, a person responsible has to sit and wait through the exportation for up to four hours a week!

The project has a lot to gain using automatic export throughout the project, in every discipline. See the move to a cloud-based system of how this impacts the working environment. Several responsible have expressed a need for a computer, handling the automatic export stationary in the project office.

There is much potential in digitalization and automation of the BIM- and modeling-loop. The project spends considerable time exporting and uploading files to different plat-

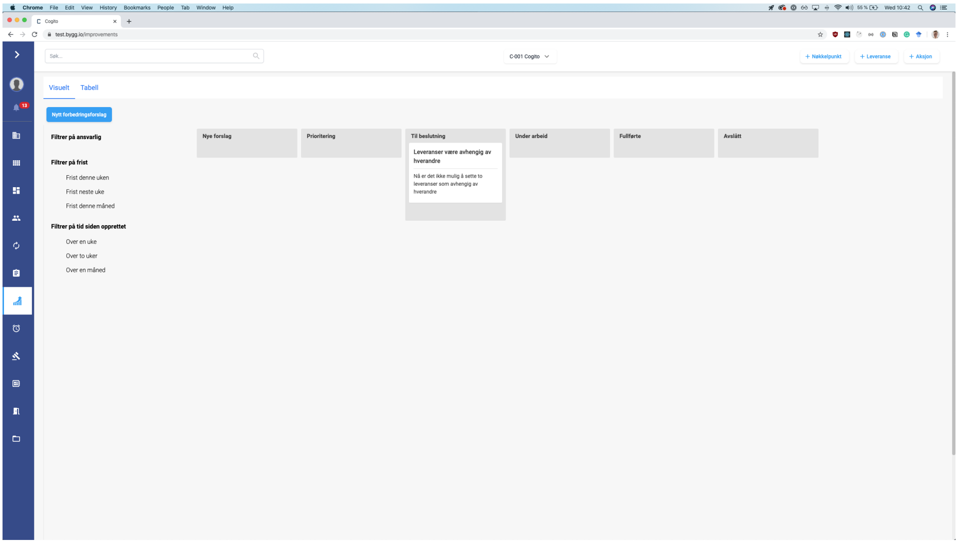

Figure 4.6: The feedback module in the Cogito tool. Serving as an continuous improvement of the tool for the project.

forms, depending on the recipient. Moreover, several interviewees report of having a central computer for automatic export would be beneficial, which will be time-reducing for the one responsible for the export. Though, no one talks about a 100% cloud-based system, where one can extract export from the sum. BIM 360, already procured by the project, could eventually do this. For now, BIM 360 suits as a web portal for others to see the modal, more than an actual design tool, furthermore tools previously used are still in use. Which once again underlines the problem of not being unmitigated.

Another vital initiative is the use and i of Cogito. Taking the risk of totally new software could cause some issues underway. Sure, not everything has been a bed of roses. The project has cooperated with the supplier, improving the software according to the feedback from the user. There is even a page within the software where the users can give feedback directly to the developers and see the progress of their issue, seen in figure 4.6. Despite the possibility of feedback, several of the participants reported issues with the software. A repeating factor was the lack of communication within the software.

Introducing Cogito had the goal of reducing email, giving packages through the tool, rather than via email. PLs are writing packages into Cogito, but the notification is more often than not given orally, in meetings or over the desk, or via email. This Causing twice the work, rather than writing it directly into Cogito. As one can see in the two quotes below, an argument for communicating the package is for the inadequate notification in Cogito. Also, describing a package is better when communicated in a conversation. One can set up push notifications to email, but then again, the goal of reducing emails is lost.

"Often, there is suddenly a package in Cogito. There are no notifications in cogito, which indicates that a package is given to you. If it is, it is not so intuitive, as it is now."
– Discipline Leader, about notifications in Cogito

"...there is a notification functionality, but that does not work optimally."
– Engineering Leader, about notifications in Cogito

Introducing Cogito is, as we now, based on an introduction of a methodology, meaning the working method is to change. Moreover, an interviewee said it quite so clear when describing what he did coming in for a new day. The plan for the day is set based on the day before, as well as what comes to mind, then checking Cogito. Thus, the way of working is not changed due to the introduction of Cogito and Lean Design.

"After finishing my tasks, I am checking Cogito for something to do. Although it should have been the other way around."
– Project Worker, about Cogito

As mentioned in section 4.2.1, the use of Blink has been misunderstood. Blink has, for the project, suited as a portal of information. Though, the potential of Blink is much broader. Several interviewees report an incomprehensive use of email, as stated by a project worker underneath. Moreover, several teams make use of a chat service. Thus, using Blink's chat service, securing both consistency and cooperation throughout the project, as well as minimize the use of email.

"Unfortunately, much of the communication happens over email. Which I think is inconvenient."
– Project Worker, about incomprehensive use of email

The project does not lack inspiration, in regards to digital possibilities. The digitalization team is planning the use of robots in construction. Moreover, they have a VR-room for user testing of rooms. One might say they have approved to many measures, hence section 4.2.1. Furthermore, new software needs to be in place, securing the logistics and deliveries, when the construction progress.

Chapter 5

Discussion

This chapter discuss the questions on the research question, and discuss the results. Using knowledge from both the litterature review and the case study. This discussion will give the foundation for the conclusion and further work discussed in chapter 6.

This project thesis tries to identify the fundamental reason for the striking difference in LP between the ICT-industry and CI, in a project utilizing lean methodology and software supporting it. The results indicate that the use of tools as lean and groupware is not as helpful as hoped, due to reduced utilization. The indication for poor LP identified in the LSB-project has a basis in the interaction between the workers, where a lack of understanding and unsure responsibility are a significant impact on the projects productivity.

This result suggests the reason for the striking difference in LP. This chapter will discuss this result around the three key themes identified in the analysis of the interview data. Furthermore, look at different approaches defeating these issues, as well as look at the limitations of this thesis.

5.1 Recommendations

5.2 Limitations

Chapter 6

Conclusion

The previous chapter analyzed and discussed the results of the research conducted in this project, as well as discuss prior research and experience identified in the literature study. This chapter aims to conceptualize the knowledge and results in a conclusion, answering the questions asked in section 6.1 and 6.2. Furthermore, giving a direction for further explorations in section 6.3.

The main research question of this projects was:

> *What is the fundamental reason for the striking issue of labor productivity in the construction industry?*

Which was broken into two sub-questions:

RQ1: Why does the issue of labor productivity in the construction industry appear?
RQ2: How does the difference appear in the LSB-project, which utilize both agile and digital tools?

Section 6.1 and 6.2 outline the answer of RQ1 and RQ2 accordingly.

6.1 RQ1

6.2 RQ2

6.3 Further Work

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Appendix A

Interview Guide

Intervjuguide
Navn og rolle:
Dato:

Avklaringer og informasjon:

- Avklare anonymitet/åpenhet
- Informere intervjuobjektet at det vil bli tilsendt transkribert versjon i etterkant av intervjuet.
- Informere om bruk av lydopptak
- Kandidat for mulighet til å presentere seg selv og sin erfaring.

Mitt prosjekt
Prosjektets påstand er at byggebransjen i dag opplever mange av de samme symptomene som programvareutvikling opplevde for 30 år tilbake og stadig opplever. Utfordringene opplevd er: Stadig endring av requirements under produksjon, slite med å nå tidsplan og budsjett, økende kompleksitet – hvert prosjekt er noe helt nytt, og sist med ikke minst problemer med ferdigstillelse. Programvareutvikling har derfor tatt i bruk agil prosjektstyring og digitale verktøy for å løse flere av disse problemene.

Sett i lys av dette ønsker prosjektet (jeg) å se hvordan et byggeprosjekt med høy kompleksitet utnytter smidige metodikker (inkluder Lean), støttet av digitale verktøy i sin prosjekthverdag.

Temaer som ønskes belyst

1. Generelt om delegering, samarbeid og kunnskapsutveksling
    (a) Hvordan fungerer delegering, samarbeid og kunnskapsutveksling?
2. Bruk av digitale prosjekteringsverktøy i prosjektet
    (a) Hvordan og hvilke digitale digitale prosjekteringsverktøy benyttes i prosjektet, i dette henseende?
    (b) Finnes det noen begrensninger ved denne bruken?
3. Andre faktorer
    (a) Er det andre faktorer som påvirker bruken av verktøyene i prosjekthverdagen?

Appendix B

Contract of Interview

Appendix C

Thematic Analysis Codes

Code	Utdrag	Kontekst/tema	Intervju
Mangler informasjon	Man har ikke klart å trenge ned å fortelle hva det skal bety for prosjektet	Bruk av Lean i prosjektet	Engineering Manager
Tiltak til strategiene	Vi trenger nok å lande hvordan strategiene skal påvirke oss i handling	Bruk av Lean i prosjektet	Engineering Manager
Cogito/Digital delegering	også dukker det opp oppgaver i Cogito	Delegering	Engineering Manager
Kommunisert delegering	Det er i de temaene vi får oppgaver	Delegering	Engineering Manager
Deling i møter	Det skjer jo i forum hvor vi tar opp slike ting	Deling av kunnskap	Engineering Manager
Tviler på plan	Man vet ikke om det man tar tak i får man fremover	Gjennomføring basert på planlegging av designfasen	Engineering Manager
Ikke rendyrket	Ikke rendyrket hvor vi skal kommunisere	Kommunikasjon	Engineering Manager
Dårlig prosjekteringsplan	Prosjekteringsplanen er ikke tilstrekkelig grad utarbeidet i felleskap	Planlegging av designfasen	Engineering Manager
Dårlig planlegging	Man har ikke samlet seg om en planleggingsmetodikk	Planlegging og resursbruk designfasen	Engineering Manager
Dårlig ressursbruk	Det er lagt mer ressurser i å planlegge produksjon av bygg enn produksjon av prosjekteringsmateriell	Planlegging og resursbruk designfasen	Engineering Manager
Mangler planlegging	Det er jo ikke et planleggingsverktøy, det er jo et oppfølgingsverktøy	Utfordring ved Cogito	Engineering Manager
For mange verktøy	at det er såpass mange	Utfordring ved mange digitale verktøy	Engineering Manager
Ikke rendyrket	Interaxo, som kan brukes i mye større grad enn det det gjør per nå	Utfordring ved mange digitale verktøy	Engineering Manager
Kommunikasjon i Cogito	...det er et varslingsvindu, men det fungerer ikke optimalt	varsling i Cogito	Engineering Manager
Ikke rendyrket	Potensiale... Dersom man hadde rendyrket en eller to		Engineering Manager
Mangel på opplæring	Opplæring... Er noe man bør fikse		Engineering Manager
Bruker ikke Cogito	Jeg har ikke brukt det, men kjenner til det	Bruk av Cogito	Associate
Lite erfaringsoverføring	Det er ikke så veldig mye erfaringsoverføring med de andre fagene	Erfaringer som deles	Associate
Missforstått Blink	Har ikke fått invitasjon, men har hørt om det. Dette er det sosiale nettverket?	Kommunikasjon	Associate
Mye mail - positiv	Jeg syntes det er veldig greit å bruke e-post	Kommunikasjon	Associate
Mye mail - positiv	Med e-post så er det enklere å passe på at man har fått gjort unna de.	Kommunikasjon, delegering,	Associate
Sitte sammen	Vi sitter sammen, både her og på kontoret i Sandvika	Samarbeide internt	Associate
Avklaring på mail	mye avklaringer på mail, gjerne etter man har snakket med hverandre	Samarbeide på tvers	Associate
Deling i møter	avklaringsmøte annenhver uke... Det håper jeg skal bidra til at vi får med oss det vi trenger inn i modellen, fra begge fag.	Samarbeide på tvers	Associate
Enkel avklaring	Fordelen med å sitte her er at det er kort vei til arkitekten	Samarbeide på tvers	Associate
Mange prosjekter	...jobber jeg på mange prosjekter i løpet av en uke		Associate
Mangler dybde	Vi bruker Cogito. Hvor det med vekslende kvalitet og hvor dypt og detaljert det kan brukes.	Bruk av Cogito	ITB Manager
Ryddig lagring	Så har vi Interaxo. Der har vi fått en fin prosess..	Bruk av Interaxo	ITB Manager
Missforstått Blink	Det fikk jeg invitasjon til	Kommunikasjon	ITB Manager
Ansvarsfordelig	...utfordringer i prosjektet med hvem som skal lage og med hvilket malverk det lages med	Samarbeide på tvers	ITB Manager
Missfornøyd med andre	Så har vi en ITB-ansvarlig i prosjekteringsgruppa som sitter å leder grensesnitts.arbeidet. Han har .. Godt verktøy for ham, men ikke for prosjektet.	Samarbeide på tvers	ITB Manager
Kommunikasjon i BIM	Der smakker man og diskuterer på et fornuftig grunnlag.	Samarbeide på tvers BIM	ITB Manager
Kommunikasjon i Cogito	Men man mangler kommunikasjonselementet	Samarbeide på tvers Cogito	ITB Manager
Mye mail - negativ	Målet med dette her er jo å eliminere e-post-bruk.	Samarbeide på tvers Cogito	ITB Manager
Samspill - utfordringer	noen utfordringer i prosjektet basert på at det er en ny modell. Hvor man har samspillet...	Samspill og kontrakt	ITB Manager
Samspill - utfordringer	Hvem er det som har ansvaret for hva?	Samspill og kontrakt	ITB Manager
Samspill - utfordringer	...Men det sitter igjen et tradisjonelt tankesett	Samspill og kontrakt	ITB Manager
Samspill - utfordringer	Man klarer ikke distansere seg fra tanken om at man har lagdet den beste løsningen, framfor å se andre innspill	Samspill og kontrakt	ITB Manager
Rotete lagring	...så er det en utfordring å finne ting... Å vite hvor man skal legge tind. Jeg har ikke sett et system som løser dette helt	Bruk av Interaxo	Discipline Leader
Missforstått Lean	jeg har forstått det så er dette noe som kommer til anvendelse når det gjelder bygging	Bruk av Lean i prosjektet	Discipline Leader
Eget verktøy	..utviklet mitt eget verktøy i Excel og Visual Basic	Jobber på sin måte	Discipline Leader
For mye diskusjon	at det kan bli for mye engasjement. At man diskuterer for mye. I stede for å si; Okay. Det er ditt ansvar.	Kommunikasjon	Discipline Leader
Missforstått Blink	men det ser jeg mer på som et sosialt medium. Jeg bruker ikke det så mye.	Kommunikasjon	Discipline Leader
Dobbel kalender	Jeg syntes det er vanskelig der hvor vi har en egen prosjektkalender. Da operer jeg med to kalendere. Da blir jeg booket i møter i den ene, hvor jeg er opptatt i den andre.	Kommunikasjon kalender	Discipline Leader
Enkel avklaring	...ta det på tomannshånd	Samarbeide på tvers	Discipline Leader
Mye mail - negativ	Det å følge med på hva som skjer er en stort utfordring for meg.	Samarbeide på tvers	Discipline Leader
Store møter	...hvor vi inkaller alle sammen, de pleier ikke bli så veldig effektive	Samarbeide på tvers	Discipline Leader
Oversikt i Cogito	Jeg syntes det er litt vanskelig å få oversikt i Cogito. Det er krevende.	Samarbeide på tvers Cogito	Discipline Leader
Oversikt i Cogito	...og lurer på om det er lagt inn allerede. Det ville jeg brukt svært lang tid på å finne ut.	Samarbeide på tvers Cogito	Discipline Leader
Møterom booking	så kan vi se når de er ledig. Det er ikke sånn helt optmal måte	Struktur	Discipline Leader
Rotete lagring	Hvor skal man dokumentere? Hvor skal man legge ting?	Bruk av Interaxo	Associate
Missforstått Lean	Jeg tenker jo egentlig Lean men jeg har ikke helt for meg hva det er,	Bruk av Lean i prosjektet	Associate
Ikke rendyrket	Jeg har vært med på ulike temaer. Det benyttes ikke samme verktøyene.	Bruk av verktøy	Associate
Delegering kommunisere	Så da pleier jeg som regel å snakke med dem	Delegering	Associate
Delegering mail	og noe mail er det også	Delegering	Associate
Ikke rendyrket	...når det ikke er entydig struktur på ting.	Lagring og håndtering av dokumenter	Associate
Ikke rendyrket	Det er ikke helt samme inndelking i mappene på interaxo	Lagring og håndtering av dokumenter	Associate
Ikke rendyrket	Det er noe med kommunikasjonen som er litt uklar	Lagring og håndtering av dokumenter	Associate
Rotete lagring	Plutselig ble det sagt i temaene at man heller skal legge det under de ulike fasene.	Lagring og håndtering av dokumenter	Associate
godt samarbeid	fungerer veldig bra! Vi snakker stort sett samme språk	Samarbeide internt	Associate
Cogito/Digital delegering	Det er masse som legges inn bare for å vise at det legges inn. Uavhengig på Cogito, som er en vanlig arbeisoppgave	Samarbeide på tvers Cogito	Associate
ikke rendyrket	det gjøres forskjellig der også. Det ene tema lagde man få leveranser, med mange aksjoner under. Mens andre temaer hadde man mange leveranser, med få aksjoner.	Samarbeide på tvers Cogito	Associate
Ikke spikret	Det er ting som ikke er spikret enda.	TFM-merking	Associate
Oppdatering av modell	Derfra exsporterer vi ukentlig ut .ifc-filer, hvor de deretter legges på Interaxo	BIM 360	BIM Manager
For mange verktøy	man kan velge det ene eller det andre, for å lage kollisjoner.	Bruk av verktøy	BIM Manager
Dårlig eksortering	Verktøyet ligger på at den skal eksportere fra min maskin. Så vi burde ha en felles PC fra Statsbygg,	Eksportering av modell	BIM Manager
Oppdatering av modell	men den skal vi sette opp til å eksportere to ganger i uken. Det er veldig bra et eller annet sted.	Eksportering av modell	BIM Manager
Definisjon av MMI	Det er jo en ganske vag beskrivelse. Så vi laget en spesifikk definisjon.	MMI	BIM Manager
Delegering kommunisere	bestemt oss i ARK at vi ikke skal bruke Cogito internt..Da er det lettere å gi en oppgave over bordet	Samarbeide internt	BIM Manager
Gammel tanke	Den med mest erfaring hadde tre år. Dersom man vil ha noen som skal kunne slå gjennom med noe, må de ha noen med litt mer erfaring.	Samarbeide på tvers	BIM Manager
Cogito/Digital delegering	Jeg får det fra en fra disiplinområde.	Samarbeide på tvers Cogito	BIM Manager
Ikke rendyrket	Så vi fortsettere å bruke BIM 360, men ikke alt som det er programmet tilbyr.		BIM Manager
Oppdatering av modell	Ja, men det er mulig man skal gå oppp til 2 ganger i uken.	BIM	BIM Coordinator
Oppdatering av modell	Ideelt sett burde man hatt en felles stasjonær PC	BIM	BIM Coordinator
Oppdatering av modell	Så sitter jeg kanskje og jobber etter lunsj på torsdag, og dette kommer da ikke med neste uke.	BIM	BIM Coordinator
Lappeteknikk	Da står vi å planlegger litt med lapper.	Bruk av Lean i prosjektet	BIM Coordinator
Netthastighet og nedetid	andre faktorer som kan påvirke hverdagen vår er netthastighet og nedetid.	Infrastruktur og fasiliteter	BIM Coordinator
Rendyrke et verktøy	Hadde man brukt SharePoint til alt i prosjektet... I stede for å bruke Cogito	Mange verktøy	BIM Coordinator
Erfaringsoverføring	Internt for oss kjører vi internmøter hver mandag. Da går man gjennom litt ting og har litt tips og triks	Samarbeide internt	BIM Coordinator
Lite kunnskapsoverføring eksternt	Det er ikke så mye... Men det er ikke så mye erfaringsoverføring fra Statsbygg.	Samarbeide på tvers	BIM Coordinator
Tverrfaglig samarbeid	Break-out-gruppe	Samarbeide på tvers	BIM Coordinator
BIM-samarbeid	Litt slik tilgang og eierskap. At folk eier ting i modeller.	Samarbeide på tvers BIM	BIM Coordinator
Cogito/Digital delegering	Det har vært litt slik at man bare legger ting inn i Cogito uten at man snakker med dem	Samarbeide på tvers Cogito	BIM Coordinator
Fast struktur og agenda på møter	Det hadde vært sykt dugg at alle må ha en agenda til møter egentlig. Ha et fast oppsett til alle møter.	Struktur møter	BIM Coordinator
Lean design	Alt det andre. Det er veldig mye mer enn takt og tog. Det har jeg kanskje sett mindre av	Lean	Associate
Mye møter	Det er veldig mye møter her, men sånn må vel vell kanskje bli. ... Det er kanskje ikke så effektivt.	Samarbeide på tvers	Associate
BIM i møter	Jeg er endel inne i den. Det er natulig i møter, dersom man diskuterer spesifikke temaer at man kikker på etter eller annet	Samarbeide ved BIM	Associate
Beslutningsvegring	Det kan jo være et problem med hvem som faktisk tar beslutning.	Samspill og kontrakt	Associate
Samspill - fordeler	Prøver å se løsninger. Komme med forslag. Fordelene er jo at vi kan plukke ut komponenter og utstyr som skal inn.	Samspill og kontrakt	Associate
Dårlig BIM-manual	Et utkast til den har vært laget for 1,5 år siden, kanskje 2 år siden. Så kunne den vært modifisert.	BIM	Discipline Leader
Missfornøyd med Blink	Alle i prosjektet har Blink, men jeg syntes det er ganske uintressant. Men det ser jeg på som en sosial ting, da kan det være hyggelig.	Blink	Discipline Leader
Mangler oversikt	det sporingssystemet når man utfører ting og sjekker ut ting, så forsvinner det. Det er ikke så lett å se dersom man har en aksjon eller leveranse. Så er det ikke så lett å se hele nettverket.	Bruk av Cogito	Discipline Leader
Delegering bort kommunisere	I min rolle delegerer jeg masse... Det går mest muntlig og e-post	Delegering	Discipline Leader
Delegering bort mail	og epost	Delegering	Discipline Leader
Dokumentere	Interaxo er endeastasjon	Dokumentere	Discipline Leader
Deling av kunnskap	Mitt inntrykk er ikke at folk ikke vil dele, men ....Det er ingen som giddere å forklare ting, dersom man ikke spør. Men på det personlig plan får jeg svar, dersom jeg spør	kunnskapsdeilig	Discipline Leader
BIM-utfordring	så er det varierende grad av kompetanse.	Kunnskapsmangel BIM	Discipline Leader
Motta oppgaver	Mail, Cogito, Muntlig	Samarbeide	Discipline Leader
BIM-samarbeid	Det som har en brutal effekt. Det er å bruke BIM. Det er jo det som er fremtiden i byggebransjen. ....Det blir veldig konseptuelt. Enklere å forstå en problemstilling.	Samarbeide på tvers BIM	Discipline Leader
BIM-samarbeid	jobbe med å få digitale og veldig visuelle verktøy det er det man kan samles rundt	Samarbeide på tvers BIM	Discipline Leader
Ikke rendyrket	Spørsmål om det er en enhetlig bruk av programvaren, eller om alle bruker programvaren	Verktøy	Discipline Leader
Cogito/Digital delegering	Men om jeg er så mye inne for å følge, det kunne man vært bedre til. Det er tiltak å logge seg på for å følge med på ting.	Delegering	Associate
Cogito/Digital delegering	Når jeg er ferdig med det jeg skal kan jeg sjekke om det er noe i cogito jeg burde ha gjort. Selv om det burde vært andre veien rundt	Delegering	Associate
Mye mail - negativ	Dessverre så foregår mye av kommunikasjon over mail. Det er tungvinn prosess, syntes jeg.	Kommunikasjon	Associate
Bruk av sky	Da hadde de en lokal server, hvor de hadde sentralfilene sinde. Det var mye missnøye blant de ulike fag-gruppene som synkroniserte, fordi det tok mye tid. Det er veldig sårbart. Dersom den var nede satt det 100 stykker som ikke kunne synkronisere. VPN	Samarbeide på tvers BIM	Associate
Gammel tanke	...slik det er gjort før....Man putter alt inn i 3D, men man putter det inn som egne objekt-definisjoner. Så fyller de ikke på med rikitg informajson, i forhold til objektene	BIM	Project Manager
Ikke rendyrket	Der er potensialet mye større enn det som ser ut til at vi ender opp med her da. Da tenker jeg på BIM-modellen. Jeg mener at det kan brukes mye, mye mer.	BIM	Project Manager
Mer bruk av BIM	Dent eneste jeg skulle ønsker var at alle hadde samme ambisjonsnivå	BIM	Project Manager
Uoversiktelig	Det er jo uoversiktelig (Bruk av Cogito og Interaxo)	Bruk av verktøy	Project Manager
Delegering til ledere	men når jeg gir oppgaver til PG, så gir jeg det til sjefen	Delegering	Project Manager
Snakke med hverandre	Man må snakke med folk. Det å totaltsett bruke systemene er viktig det også... Det er jo ikke personene som skal være oppslagsverk, men det er systemene.	Kommunikasjon	Project Manager
Delegering kommunisere	ovenfra via ledermøter og samspillmøter	Samarbeide på tvers	Project Manager
Delegering mail	Ellers kommer det jo på mail	Samarbeide på tvers	Project Manager
Legg inn selv	I Cogito skal vi legge inn oppgaver selv, på bakgrunn av oppgaver vi får på møter	Samarbeide på tvers Cogito	Project Manager
Gammel tanke	Det som irriterer meg er at byggebransjen er så utrolig sirompa. Man skal gjøre det samme som man har gjort alle andre steder.		Project Manager
Bruker ikke Cogito	Vi har forløpig ikke brukt dette i framdriftsgjengen	Ikke rendyrket	Progress Planner
Vanskelig med kommunikasjon	At de riktige folka får den riktige informasjonen. .. Man at man møter face-to-face er viktig, ikke bare digitalt.	Kommunikasjon	Progress Planner
Nevner ikke Lean design		Lean	Progress Planner
Positiv til Lean Construkting	Det er jo en smart tankegang	Lean	Progress Planner
Mange verktøy	Jeg ser utfordringen med at det begynner å blu fryktelig mange plattformer	Mange verktøy	Progress Planner
Interaxo er treigt	Jeg syntes Interaxo er ganske treigt...	Missfornøyd med Interaxo	Progress Planner
Bruker teams internt	Hvor vi bruker det som nesten chat, internt i vår entreprise.	Samarbeide internt	Progress Planner
Arbeid forsvinner	Desom man er inne og skriver en tekst og skal gjøre alt klart og må gå ut	Bruk av Cogito	Engineering Manager
Cogito er under utvikling	Tidligere slet vi med at topplinja...	Bruk av Cogito	Engineering Manager
Ikke rendyrket	Det er ikke noe fast måte å gjøre det på	Bruk av Cogito	Engineering Manager
Sløve med å lage aksjoner	Det er større utfordring med å få inn aksjoner	Bruk av Cogito	Engineering Manager
Avklare med leder først	Når man gir noen en aksjon, så må man avklare med dem på forhånd.	Cogito nye oppgaver	Engineering Manager
Cogito er transperant	Det er også en grei måte å vise til de øvrige teamdeltakerne hva som er planlagt	Kommunikasjon	Engineering Manager
Interaxo er treigt	Så er det litt for mange klikk	Missfornøyd med Interaxo	Engineering Manager
Cogito er viktig	Jeg syntes at Cogito er noe av det viktigste vi har i forhold til fremdriften, med tanke på trekk	Samarbeide på tvers Cogito	Engineering Manager
Netthastighet og nedetid	Det kan være at nettet går tregt		Engineering Manager
Dårlig varsling	Ofte dukker det bare opp et Cogito-punkt. Det er ikke så varsling	Bruk av Cogito	Discipline Leader
Bruker ikke Cogito internt	Det vi har brukt å gjøre er at på internoppgaver brukes mail og teams, men vi legger ikke disse i Cogito	Ikke rendyrket	Discipline Leader
Bruker teams internt	Så bruker vi teams, som et internt redskap	Ikke rendyrket	Discipline Leader
Kjenner ikke metodikk	Jeg er jo ikke vant med å jobbe med et slikt verktøy	Ikke vant med metode. Skylder på verktøy	Discipline Leader
Kjenner ikke metodikk	Jeg vil ikke legge inn unødvendig punkt og jeg vil heller ikke at det skal legges inn mange unødvendige punkt på meg	Ikke vant med metode. Skylder på verktøy	Discipline Leader
Vanskelig med kommunikasjon	Det betyr jo allikevel at vi har en tilstedeværelse fra Danmark som ikke fungerer helt slik den skal.	Kommunikasjon	Discipline Leader
Ikke vært på Lean-kurs	Jeg har ikke vært på Lean-kurs enda	Lean	Discipline Leader
Felles kalender	vi lager en slags kalender i Excel. Vi må ha en når kommer dere, hvem	Samarbeide internt	Discipline Leader
Delegering kommunisere	fra et møte	Samarbeide på tvers	Discipline Leader
Felles kalender	Så har vi ikke felles kalender her på prosjektet. Det er gjort et forsøk men det funger ikke for alle	Samarbeide på tvers	Discipline Leader
Dårlige oppgaver i Cogito	Det er jo ikke alltid det er kommuniseres så godt. Vi blir heller ikke spurt hvor lang tid det tar.	Samarbeide på tvers Cogito	Discipline Leader
Vanskelig omboarding	Jeg syntes det er vanskelig å komme inn i denne rollen...	Stort prosjekt	Discipline Leader
Vet ikke hva verktøyet er	(Er det noen verktøy dere bruker for å delegere?) Nei, det kan jeg ikke si.	Delegering	Ass. Project Group Leader
Tilgangsstyring	Så er det jo med slike hoteller at du ser bare det du har tilgang til. Så det tar veldig lang tid at du oppdager et rom som du burde ha tilgang til.	Dokumentere	Ass. Project Group Leader
BIM-samarbeid	De som sitter å BIMer, kan sende hverandre beskjeder via modellen. Det fjerner mail	Kommunikasjon	Ass. Project Group Leader
Kommunikasjon i WS	vi planlegger det å ha workshops...Det er det som blir de måtene å få folk til å skjønne hva vi jobber mot	Kommunikasjon	Ass. Project Group Leader
Mister oversikt	At de skjønner hva de jbber mot. Det har vært veldgi vanskelig. Mye frustrasjon, fordi de som ikke går i møter og ikke får samme info som prosjektleder.	Kommunikasjon	Ass. Project Group Leader
Mye mail - negativ	Jeg sliter jo med å klare å henge med på mailen.	Kommunikasjon	Ass. Project Group Leader
Har sin egen forståelse av Lean	Jeg tenker det er vår måte å svare på Lean tankegang på i prosjektet	Lean	Ass. Project Group Leader
Risiko ved Lean	Jeg har tro på den metodikken, men det er et voldsomt stort prosjekt å gjøre noe første gang. At veien blir til mens man går. At det er en risiko med det. Det vil jeg si at det er .	Lean	Ass. Project Group Leader
Nye metoder	Vi gjør alt på en ny måte. Det er ikke klart hva som er målet hele tiden. Det har vært vanskelig å planlegge disse MMI-gradene...vanskelig å få opp ting som blir lagt i Cogito.	Nye metoder	Ass. Project Group Leader
Funker ikke med samarbeid i Interaxo	men det fungerer ikke i Interaxo. Det er ikke en sånn SharePoint-løsning...Så det fungerer ikke som en samarbeidsplattform	Samarbeide internt	Ass. Project Group Leader
Cogito er lite visuelt	Jeg syntes det er vanskelig, fordi det er så lite visuelt	Samarbeide på tvers Cogito	Ass. Project Group Leader
Positiv til samspill	Tegne dem en gang	Samspill og kontrakt	Ass. Project Group Leader
Berike modellen	Da må vi være med å passe på at den berikes såpass mye at vi får den informasjonen vi trenger.	Samarbeide på tvers BIM	Engineering Manager
Forbedret kollisjonskontroll	Så vil man gjøre slike kolisjonskontroller som sjekker at dette er mulig å bygge, eller ikke. Så blir det jo justert i forhold til det.	Samarbeide på tvers BIM	Engineering Manager
Cogito er lite oversiktelig	Cogito er jo et slags oversiktsverktøy og det er jo ikke alltid like oversiktlig.	Samarbeide på tvers Cogito	Engineering Manager
Savner Gantt	Vi som har jobbet med prosjektet en stund har jo vært vant med den gamle prosjekt-planen	Samarbeide på tvers Cogito	Engineering Manager
Mange verktøy	Det finnes mye fine digitale verktøy, men det må liksom ikke bli for mange av dem heller.	Verktøy	Engineering Manager
Standariserte verktøy	Det er klart at hvis man kunne komme på en mer omformert standard fra prosjekt til prosjkekt	Verktøy	Engineering Manager

Table C.1: Codes produced in the first phase of coding in thematic analysis.