



FACULTY OF TECHNOLOGY

Development project to future sheet metal part production using Scrum framework

Minna Rautio

DEPARTMENT OF MECHANICAL ENGINEERING

Master's thesis

August 2023

ABSTRACT

Development project at Swegon Ilto Oy for the production of sheet metal parts using the Scrum reference framework.

Minna Rautio

University of Oulu, Degree Program of Mechanical Engineering

Master's thesis 2023, 48 pp.

Supervisor at the university: Jaakko Kujala

At the end of 2022, we investigated the possibility of manufacturing sheet metal products for our own production at the Kaarina factory in Swegon ILTO Oy. The goal was to design a unit that, when completed in 2–3 years, would be at the forefront of development, both in terms of machines and equipment, and their control. All sheet metal parts are currently procured as subcontracts, and some are transported to the factory even at long distances. The goal was to create a preliminary plan for future production units together with industry players. In this project, you were allowed to dream about the possibilities of future technology; however, the selected technologies will be in use in the next few years. The project was implemented with selected partners. The idea was developed to such an extent that budget offers could be requested from partners, and thus, completed results can be used as a basis for an investment decision.

In this research, I aimed to investigate the suitability of agile project management for the implementation of this industrial production development project as a case study. To manage the project, I used the Scrum framework to make a large development project easier to manage when we start with the basics and progress in sprints to an increasingly advanced entity. First, we learned about agile project management in general. During the project, the research focused on determining the benefits and challenges of using Scrum in this hardware project.

The project progressed as planned and was completed on schedule. With the help of the Scrum framework, we were able to combine the knowledge of the company and expertise of our partners into clear conclusions. In particular, daily meetings steered the project

forward efficiently and in the correct direction. Agile project management improved the flow of information and transfer of knowledge from an experienced person to a team member who joined the company. The month-long sprints divided and organized the project in such a way that there was no idle time or unnecessary work phases during the project.

These research results were achieved in our own operating environment in one project; therefore, I cannot generalize them. However, the results were so interesting that we decided to continue Scrum use in the future. Encouraged by this, the Scrum reference framework can be applied to the development of a product development project model in the future.

Keywords: project management, agile, Scrum, production development

TIIVISTELMÄ

Kehitysprojekti Swegon ILTO Oy:llä tulevaisuuden ohutlevyosien valmistukseen Scrum-viitekehystä hyödyntämällä

Minna Rautio

Oulun yliopisto, konetekniikan tutkinto-ohjelma

Diplomityö 2023, 49 s.

Työn ohjaaja yliopistolla: Jaakko Kujala

Loppuvuoden 2022 aikana olemme selvittäneet mahdollisuuksia valmistaa ohutlevytuotteita omassa tuotannossamme nykyisellä Swegon Ilto Oy:n Kaarinan tehtaalla. Tavoitteena on suunnitella yksikkö, joka valmistuessaan 2–3 vuoden kuluttua olisi kehityksen kärjessä sekä koneiden ja laitteiden että niiden ohjauksen osalta. Kaikki ohutlevyosat hankitaan tällä hetkellä alihankintana ja osa niistä kuljetetaan tehtaalle pitkienkin matkojen takaa. Tavoitteena on luoda tulevalle tuotantoyksikölle alustava suunnitelma yhdessä alan toimijoiden kanssa. Tässä projektissa oli lupa unelmoida tulevaisuuden tekniikan mahdollisuuksista, kuitenkin niin, että valitut tekniikat olisivat käytössä lähivuosina. Projekti toteutetaan yhdessä valittujen yhteistyökumppanien kanssa. Ideaa kehitetään niin pitkälle, että yhteistyökumppaneilta voidaan pyytää budjettitarjouksia ja näin valmiita töitä voidaan käyttää investointipäätöksen perustana.

Tässä tutkimuksessa pyrin selvittämään ketterän projektinhallinnan soveltuvuutta tämän teollisen tuotannon kehittämisprojektin toteuttamiseen tapaustutkimuksena. Projektin johtamisessa käytin Scrum viitekehystä suuren kehitysprojektin hallinnan helpottamiseksi, kun aloitetaan perusasioista ja edetään sprinteissä yhä edistyneempään kokonaisuuteen. Aluksi tutustuimme ketterään projektijohtamiseen yleisesti. Projektin aikana tutkimuksen tavoitteena oli löytää etuja ja haasteita Scrum viitekehysten käytöstä tässä projektissa.

Projekti eteni suunnitellusti ja valmistui aikataulussa. Scrum-viitekehysten avulla kykenimme yhdistämään yrityksessä olevan tiedon ja yhteistyökumppaneiden osaamisen selkeiksi johtopäätöksiksi. Erityisesti päivittäispalaverit ohjasivat projektia tehokkaasti eteenpäin ja oikeaan suuntaan. Ketterä projektinhallinta paransi tiedon kulkua ja

osaamisen siirtämistä kokeneelta henkilöltä vasta yritykseen tulleelle tiimiläiselle. Kuukauden mittaiset sprintit jaksottivat ja ryhdistivät projektia niin, että projektin ajalle ei tullut tyhjäkäyntiä, eikä turhia työvaiheita.

Nämä tutkimustulokset saavutettiin omassa toimintaympäristössämme yhdessä projektissa, joten en voi yleistää niitä. Tulokset olivat kuitenkin niin mielenkiintoisia, että olemme päättäneet jatkaa Scrumin käyttöä myös jatkossa. Tämän kannustamana Scrum-viitekehystä tullaan soveltamaan jatkossa tuotekehitysprojektimallin kehittämiseen.

Asiasanat: projektin hallinta, ketterät menetelmät, Scrum, tuotannon kehittäminen

FOREWORD

I started the search for a diploma thesis as part of a cold search. I am fortunate that the first company I contacted, Swegon ILTO Oy in Kaarina, wanted to utilize my skills in the form of a diploma thesis. After the discussions, the planning project for the production investment project was selected as the topic. The objective was to determine a technical solution for the production of sheet metal products. The research topic was related to the use of the Scrum framework in this development project. The project started in July 2022 and was completed at the end of January 2023.

I would like to thank Director Sakari Suominen for his excellent guidance throughout the project. Without Sakari's work as a product owner and knowledge of the company and the product range, it would not have been possible to complete the project and research within this time frame. Likewise, thanks to the managing director, Peter Stenström, for bringing his own know-how and experience in sprint reviews. Finally, thanks to project manager Sarita Keppola for all the practical advice I have received to get caught up in the wonderful world of the company's sheet metal parts. Thanks also to everyone else who participated in the project, and especially to my wonderful colleagues for their warm welcome to join the group.

Finally, I would like to thank Professor Jaakko Kujala, who patiently guided the written implementation of scientific research. From desperate first moments to moments of graduation, when you really realize how much there is still to learn.

Turku 16.08.2023

Minna Rautio

Minna Rautio

TABLE OF CONTENTS

ABSTRACT

TIIVISTELMÄ

FOREWORD

TABLE OF CONTENTS

1	Introduction.....	8
1.1	Background and the research questions	8
2	Literature review	11
2.1	Agile methods.....	11
2.1.1	Agile manifesto	12
2.1.2	Agile principles	13
2.2	Main differences between traditional project models and agile	14
2.3	Agile Scrum- framework	15
2.3.1	Division of tasks in Scrum project	16
2.3.2	Sprint	17
2.3.3	Meetings	17
2.3.4	Values and pillars	18
2.3.5	Progress of the project.....	18
2.4	The difference between the Waterfall model and Agile in engineering.....	20
2.4.1	Customer Involvement in Agile and Waterfall projects.....	20
2.4.2	Requirement Changes in Agile vs. Waterfall.....	20
2.4.3	Scope in Agile vs. Waterfall	21
2.4.4	Work Prioritization in Waterfall and Agile.....	21
2.4.5	Agile Team vs. Waterfall Team	21
2.4.6	Planning in Agile vs. Waterfall	22
2.5	Agile engineering in practise	22
2.6	Synthesis of literature review	23
3	Research process.....	24
3.1	Case context.....	24
3.2	Research approach.....	25
3.3	Data collection and analysis	27
4	Empirical research	28
4.1	Project case implementation methods in a production hardware development project.....	28
4.2	Working with Scrum	28

4.2.1	Creating Project Backlog	30
4.2.2	Sprint planning to Sprint Backlog.....	32
4.3	Sprint reviews.....	33
4.4	Retrospectives.....	33
4.5	Sprints.....	34
4.5.1	Sprint 4	34
4.5.2	Sprint 5	34
4.5.3	Sprint 6	35
4.5.4	Sprint 7	36
4.5.5	Sprint 8	37
4.5.6	Sprint 9	37
4.6	Summary.....	38
5	Discussion and conclusions	42
5.1	Critical evaluation of the research.....	43
5.2	Managerial implication.....	44
5.3	Further research	44

1 INTRODUCTION

Project management is often a challenge in industrial projects. The traditional waterfall model was perceived as slow and uncertain in its results for the case company. Maintaining schedules has been particularly challenging. In addition, it has been perceived that it is difficult to utilize the information accumulated during the project and reorient the project. Therefore, better ways to carry out projects have been sought, and agile methods are an interesting option to study.

The image of agile methods was related to their application only in software production, and their use had not been attempted in the case company before. However, projects are often complex and timelines short in other industries as well, which creates a need for agile methods in areas other than the software industry. Agile methods have been used in projects when there is a desire to speed up completion and manage changing priorities better. (Ciric D & al. (2019). In this case, the production development project provided the opportunity to study the agile project model in a controlled manner without pressure from customer deliveries and external schedules.

1.1 Background and the research questions

We investigated how agile methods can be utilized in production development projects. Since there was no in-house sheet metal production before, we could not really know where the acquired knowledge would lead us at the beginning of the project. We wanted to remain open to technical possibilities and move towards the end result little by little. Agile methods, especially the Scrum framework, seemed to be a good option to move towards the unknown in the project. This is mainly because Scrum employs an iterative, incremental approach to optimize predictability and control risk. (Schwaber and Sutherland, November 2020). However, experiential information on the use of Scrum in hardware projects is scarce. Since the definition of Scrum assured us that the framework is not industry-dependent, we wanted to investigate its applicability to hardware projects in more detail.

The research questions:

1. What is agile project management?
2. What are the benefits and challenges of using Scrum for the hardware- project?

In this study, we aimed to test the use of the Scrum framework and its possible suitability for wider use in our company, as well as in non-software projects. What did we learn, and what would we do differently next time using Scrum? We also want to estimate how the results of this study can be utilized in other hardware projects in the future. Experiential information about the use of agile methods outside programming projects is difficult to obtain. Despite our search, we did not find any benchmark partner. Written material is also scarce and general in quality. When a suitable project was found, we decided to investigate the issue using the Scrum reference framework to implement the project. With the help of this research, we analyzed the experiential information obtained during the project.

Of course, we hope that this project would lead to an implementation project. The investment is financially significant. The initial assumption for the use of Scrum project framework is to serve the following project goal as well as possible:

The goal is to create a plan for an advanced production system to be implemented in about 2-3 years for the production of sheet metal products in own production at the current factory in Kaarina. The product owner's starting point is that the lower labor costs made possible by automation and robotics will help shorten the repayment period and thus have a positive effect on the completion of the investment decision. As an industry, it is new to the company, although some of the group's other factories have their own sheet metal production. Currently, all sheet metal parts are purchased from subcontractors. The challenge is that when the production volume increases, the storage of parts requires an increasing amount of space. It is obvious that, with the current operating method, the turnover cannot be increased to a targeted 2.5 times level. In addition, transporting parts and subassemblies, especially case structures, is inefficient and increases costs. The size of the carbon footprint in the current mode of operation is also thought to be provoked.



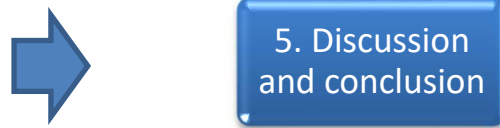


Figure 1. Structure of the thesis

The first chapter of this report describes the initial situation of the research company and the research questions. In the next chapter, we will discuss agile methods, especially the selected Scrum reference framework found in the literature. In the third chapter, the focus moves from theory to the case and research process. The execution of the project by the case company and the tools used in the research are presented in more detail. In the fourth chapter, I present the results obtained in relation to the research questions and theory. Finally, the fifth chapter provides a summary of this study. Based on this research, I want to draw conclusions about the suitability of agile methods, especially the Scrum reference framework, for non-software projects in our company. I will also consider possible subjects for further research.

2 LITERATURE REVIEW

The literature review discusses agile project methods at a general level and why an agile operating method is chosen over traditional models. Then, we go through the Scrum model in more detail. This Scrum model was originally used in software projects. However, as the model is more of an operational framework than an actual detailed model, it can also be used in other fields. They have also been used successfully in technical projects. (Rigby, D.& al. 2016)

2.1 Agile methods

Agile methods originated from the need to react quickly to changes in the environment and customer needs. Their answers were light and cyclical processes. (Rigby, D. & al, 2016). The concept of operation dates back to 2001 and was built to address the challenges of software industry projects. However, it was understood from the beginning that environmental changes, such as the market situation and rapidly changing customer requirements, were not the only software industry challenges. The software industry has faced modern societal challenges first. The tempo of living was getting faster, and the life cycle of products and services was shortened in any industry. Currently, there are very few projects where the time available is limitless and customer needs and valuations do not need to be listened to. In contrast, projects are often complex and timeline short, which creates a need for agile methods elsewhere than in the software industry. (Beck et al. 2001; Hohl et al. 2018).

Previously, projects were typically managed using traditional waterfall models. When starting the project planning, all project events were planned and scheduled as precisely as possible. During project implementation, however, it is nearly always that in the 21st century, challenging operating environments and strict schedules insist on an operating method that would be more agile in change management and would give a better outcome in a shorter time. (Ciric, D. & al, 2019). Agile methods are more similar to values and principles than strictly ordered operating practices. The principles of the agile method focus on cooperation with customers in the project. During the project, the requirements may change or new opportunities may open up. Unlike the Waterfall model, the changes are completely acceptable and sometimes even desired. When customers are interested in the project and when it is possible for them to influence the development, the final product

or service is better, and the customer is already keen on it. You are focusing on creating a working product that meets the proven needs of customers. The project team works independently, and easy communication with all stakeholders is organized as a normal part of project communication. (Rigby, D.& al. 2016)

2.1.1 Agile manifesto

Agile is a collective term used to describe different methodologies that support the values and principles of the Agile Manifesto (Doug, 2015). Agile was born in 2001, when 17 software development experts who had recognized the need for different kinds of processes to guide software development formulated the Agile Manifesto and Agile Principles (Beck et al. 2001; Hohl et al. 2018). The idea was to restructure the balance between governance and collaboration and make the development processes more adaptable (Beck et al. 2001).

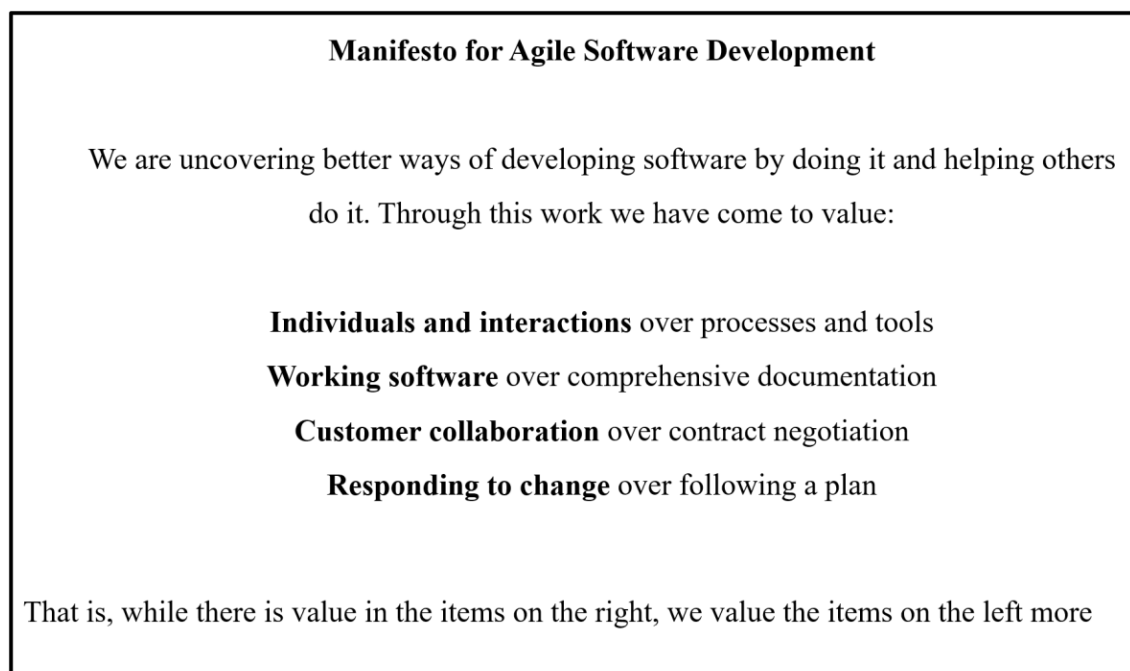


Figure 2. Agile Manifesto, according to Beck et al. (2001)

It was thought that too much attention and time is paid to the values on the right side and the focus of attention should be shifted to the values on the left side (Doug 2015). Of course, the way these values are realized depends on the industry. According to Measey and Radtac (2015) “Individuals and interactions over processes and tools”, tells that enabled and motivated people and their effective co-operation as a team are the most important factors when delivering value to the customer. Processes and tools are there only to support these individuals, not the other way around. The second value “Working software over comprehensive documentation”, tells that only documentation that adds the value of the product should be created, simultaneously with the delivery of the product. Large documentation in the beginning of the project is not needed (Measey and Radtac 2015). The third value in the Agile Manifesto, “Customer collaboration over contract negotiation”, emphasizes the customer role in the development processes and gives customer a larger role in projects. This means that the working method of agile methods must be taken into account already in the negotiation and contract phase (Hazzan and Dubinsky 2014). Fourth value is direct answer to closer operation with the customer; “Responding to change over following a plan”. This value has an idea that changes happen as the project develops and this is completely all right. This gives an opportunity to learn and achieve the best possible result, all the time fully aware of the customer needs (Measey and Radtac 2015). Often too much time is spent on planning the project in advance and experiencing the changes as a disturbance and even as a mistake. In Agile the aim is to spread the planning throughout the entire development process. (Doug 2015).

The target is universal, which makes it applicable even today. Striving for a general principle suitable for everyone means that every industry and organization must consider how its principles manifest themselves in their particular case. (Hohl et al. 2018).

2.1.2 Agile principles

Agile principles are an important and concrete tool for everyday work. They act as the foundation for all Agile methods and frameworks (Sommer 2019). The principles are illustrated in figure 3.

Principles behind the Agile Manifesto

We follow these principles:

Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.

Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.

Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.

Business people and developers must work together daily throughout the project.

Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.

The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.

Working software is the primary measure of progress.

Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.

Continuous attention to technical excellence and good design enhances agility.

Simplicity--the art of maximizing the amount of work not done--is essential.

The best architectures, requirements, and designs emerge from self-organizing teams.

At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

Figure 3: Agile Principles (Beck et al., 2001)

While the Agile Manifesto is quite abstract, the Agile Principles provide more tangible guidelines on how to be Agile in practice. Agile tools, such as Scrum, are built on these principles (Schwaber and Sutherland 2020). Understanding agile values and principles and using them in their own operating environments requires deeper understanding and commitment. There cannot be a single agile part of the organization, but all functions of the entire company must follow the same principles (Sommer 2019).

2.2 Main differences between traditional project models and agile

The main difference between traditional project models and agile project management is the customer's role in the project. In traditional models, such as the Waterfall model,

customers are behind marketing surveys or customers in meeting rooms negotiating prices. In agile methods, cooperation with the client is continuous, and changes in features of the end product are welcome even at a late stage of the project if they make the product or service more attractive to the customer. In traditional models, changes in a product can easily destroy the entire complex project plan and schedule. Every change or extra work causes the schedule to be rebuilt. In agile project models, the authority to move projects forward is given to independently functioning multi-talented teams. The objective was to create optimal conditions to achieve the best possible results. Regular, short, face-to-face meetings between project team members are found to be the best way to enable product development. Learning from the experiences of previous projects and implementing the operating methods that they have found suitable for them continuously improves the team's performance. Therefore, every team is developing in their own way and makes use of the team members' versatile know-how. (Beck, K. & al., 2001), (Hohl, P. & al., 2018). This project intends to use Scrum, more about that in the next paragraph.

2.3 Agile Scrum- framework

Because agile methods are mainly a collection of principles and values, several agile methods have been developed for everyday use, which offer more precise tools for projects. The most commonly used are Kanban, Scrum, Extreme Programming (XP), SaFE, Crystal and Dynamic Systems Development Method (DSDM). Although Agile was originally created for the needs of software projects, it is increasingly used to manage projects in other fields. According to the study, 22% of companies that used agile methods also used methods for projects other than software. The most important methods are Scrum, Kanban and Lean. This was done to improve change management in a rapidly changing environment. The time savings achieved were also evident in these projects (Ciric et al. 2019).

Scrum is based on empiricism and lean thinking. According to empiricism, knowledge comes from experience, and decisions are made based on observations. Lean thinking reduces waste, which is also a waste of time, and focuses on the essential element. Scrum is a framework that does not offer specific ways of doing things, but rather certain values, division of work and development processes. Scrum generates value by flexibly solving complex problems by maximizing the return on investment (Schwaber and Sutherland, 2020). It is important to remember that, although Scrum has been mainly used in the

software development sector lately, it was originally meant in the mid-eighties for new product development, not specifically for software development (Takeuchi and Nonaka, 1986).

Next short description of how Scrum works according Schwaber, K. and Sutherland, J., 2020.

2.3.1 Division of tasks in Scrum project

The Scrum team consists of the Scrum master, product owner, and developers.

The Scrum Master is responsible for the implementation of Scrum in accordance with the principles of the reference framework. This happens by training and helping everyone working in the Scrum team and the surrounding organization to understand the theory and practices of Scrum. The Scrum Master leads by example and strives in every way to promote high-quality, efficient operations by ensuring the implementation of Scrum's principles and values at work, as well as removing obstacles from the team's work. The Scrum Master also ensures that the practical events of Scrum take place; they are of high quality and efficiency. These included daily meetings, sprint previews, and sprint retrospectives.

A product owner is always a person. He is responsible for the product towards the customer/own company/stakeholders and creates product requirements for the team. He is also responsible for the preparation, management, and smooth functioning of the product backlog. He can delegate tasks, but is ultimately responsible for them. The product owner must always approve of changes in the development queue. He is also responsible for the implementation of the three empirical pillars of Scrum: transparency, review, and adaptation.

Team members were responsible for implementing sprints on their own. They created a sprint-development queue. The development sequence answers the questions of why, what, and how they commit to using their work input to achieve the sprint goals. The work was planned on a daily basis, and the execution method was changed if necessary to achieve the sprint goal. The goal is the increment that occurs when an item in the development queue satisfies the ready definition. It is important that within the sprint, the

developers have sufficient authority to realize self-direction toward the agreed goal. A suitable number of team members was 3-9. The smaller the team is, the easier it is to communicate effectively. However, a suitable combination of professionals is required to achieve this increment. If the team's expertise is too narrow, implementation of the entire project may be too difficult or inefficient.

2.3.2 Sprint

Sprint is the basic unit of a Scrum. A sprint includes all work required to achieve the project's targets. Sprint includes sprint planning, daily meetings, sprint review, and sprint retrospective meetings. The length of a sprint is max one month and is kept the same. The new sprint started immediately after the previous sprint was completed. Short sprints enable better predictability and the possibility of refining and negotiating with the product owner as understanding increases to achieve better results.

2.3.3 Meetings

Daily meetings are face-to-face meetings of approximately 15 minutes. During them, everyone tells how the work is progressing towards the goal, and if necessary, the development queue and future tasks are modified. Everyone working as a team member participated in daily meetings. These short meetings ensured that the focus was maintained and problems were quickly corrected.

When reviewing the sprint at the end of every sprint, the Scrum team and the most important stakeholders looked at what was achieved in the sprint and how the environment has changed. Based on this, the team decides on what should be done next. The sprint work queue can also be modified to consider new opportunities better. In a one-month sprint, the maximum length of viewing was approximately four hours.

In the Scrum retrospective study, the team tried to evaluate the quality and efficiency of the sprint. The team evaluates which way of working is successful, and what can still be developed. These changes can be implemented at once or create a separate task for the next sprint. In the one-month sprint, the maximum length of viewing was about three hours.

2.3.4 Values and pillars

The successful use of Scrum is based on the increasing achievement of five basic values: commitment, focus, openness, respect, and courage. Each member of the Scrum team commits to work and goals. They always focused on promoting their current sprint together with other team members. The work process is open, and all team members work with respect to the professionalism of the other team members and stakeholders. Courage is needed when one encounters challenges in achieving goals, and decisions are needed to change the process. It also requires courage to fail and make use of what you have learned for the next sprints.

The product owner is responsible for implementing the three empirical pillars of Scrum: transparency, review, and adaptation.

- Transparency: The process must be completely transparent to both creators and recipients of work.
- Review: When transparency of the process and the resulting product is realized, the product's outputs and progress can be evaluated in relation to its goals.
- Adaptation: As soon as someone notices that the development work is not focused correctly and that the result is not in line with the goals, it is important for the team to react quickly. The process must be adjusted so that activities can be directed in such a way as to secure the pursuit of goals. This emphasizes the team members' sufficient authority and self-direction.

2.3.5 Progress of the project

1. The product backlog is created by the product owner. It is an organized list of what needs to be improved or achieved in the product. This is the only source of work for the Scrum team. It is not just a list of features but a bigger picture of the desired product or service. One must be careful about splitting the product in advance to such an extent that false assumptions are made regarding the achievable product properties before the matter has been sufficiently researched.

2. During sprint planning, team members select tasks from a product backlog in a specified order. They go through each given task and break it down into tasks in the sprint backlog, that is, the task queue. At this stage, they roughly estimated the time required for each task. The purpose is to include as many tasks in the sprint as possible to ensure a planned increment in the product. In terms of motivation and success, it is always better to take more tasks from the backlog at the end of the sprint than to leave something unfinished.

3. Daily Scrum is a quick team meeting that lasts 15 minutes and is repeated daily, always at the same time. During this process, the progress of the tasks was reviewed and support was sought for the identified challenges. The product owner can prepare to be available if something has occurred in the work that the team cannot cope with alone or is able to decide on a matter. Only the product owner can decide whether to stop the sprint or change its goals.

4. When reviewing the sprint, the entire team with the most important stakeholders reviewed what had been done during the sprint and what results had been obtained. Representatives of both external and internal customers can participate in inspections. Once progress in the right direction has been established or the necessary corrections to the goals have been made, the next tasks are decided, that is, the planning of the next sprint is restarted.

5. After each sprint, we retrospectively reviewed how the last sprint went with regard to individuals, interactions, processes, tools, and their definition of one. Scrum team chooses the most helpful changes to improve the effectiveness of their processes. After every sprint, the most effective and feasible sprint was chosen for implementation. This can be added as a task to the next sprint to ensure that it will be completed. In this way, after sprinting, the team is getting little better every time.

2.4 The difference between the Waterfall model and Agile in engineering

In Agile engineering, teams quickly iterate, test, and gather feedback on product design. It divides big challenges into measurable chunks of work, and promises more accurate and rapid product development cycles. Teams are self-managed and work in short two-week sprints driven by user feedback. This feedback guides teams in building products that meet user needs. (Elon Musk & al., 2020)

Rather than starting with a lengthy requirements phase that covers the entire project, requirements are created as the team works. Requirements are specific according to the latest information and are tied to user value. By testing features and achieving increments, teams verify whether they are solving user problems and developing the right product. The agile approach to engineering focuses on the visualization and continuous improvement of product development cycles to solve known challenges.

Nowadays, because many new products are coming on the market every year, companies need to innovate and provide their customers' products according to their up-to-date needs continuously. Therefore, engineering companies need to have more adaptive and agile processes that allow them to change project plans when necessary. Otherwise, they are at risk of becoming uncompetitive in the market. (Agile Business Institute Inc., 2022)

2.4.1 Customer Involvement in Agile and Waterfall projects

Customer satisfaction is the first principle of an agile manifesto. In agile projects, it is important to obtain quick feedback from customers at all stages of the project. Instead, Waterfall product development requires feedback from customers only at the beginning of the project and during the product approval phase. First, in the initial phase, when the requirements are agreed upon in the contract phase, work has not yet started. The second time was at the end of the project when the finished product was published. Thus, agile methods enable faster reactions to increase information and market changes.

2.4.2 Requirement Changes in Agile vs. Waterfall

In the Waterfall model, the initial phase of project management includes the collection and documentation of project requirements. The result of this phase is a well-defined list of requirements with schedules. On the other hand, an agile project takes a positive view of changing customer expectations and new demands caused by the market, and tries to adapt to such changes as a normal part of the project's flow.

2.4.3 Scope in Agile vs. Waterfall

Similar to changing requirements, changes in the scope of projects can occur in agile project management. To respond to such changes, agile teams hold regular reviews and rely on timely customer feedback. However, for well-defined and regulated projects driven by strict compliance requirements, the waterfall approach can be quite useful. Once the scope of the work is identified, planning, designing, and monitoring its progress is much easier. However, this requires accurate information regarding the final result.

2.4.4 Work Prioritization in Waterfall and Agile

The flexibility fostered by agile project management ensures that all work is focused on meeting customer needs through early and continuous delivery, as stated in the agile manifesto. This work was prioritized based on customer feedback. This requires the customer to be involved in all phases of the project through inspection. This reduces unnecessary work and improves the chances of success. However, the Waterfall approach aims to implement what was defined as the scope of the project before work began. This can increase the risk of project failure or inability to cope with changing requirements.

2.4.5 Agile Team vs. Waterfall Team

Agile teams accept the uncertainty of the final product and react to the changes that occur during each sprint. Members of agile teams are expected to self-organize their work in the best possible way. They are open-minded about feedback, which increases their commitment and focuses on the project. Unlike Waterfall teams, which focus on individual performance, an agile culture emphasizes working together. However, teams applying the waterfall approach focus on their own part of the work. A team member can

only be involved in the definition or planning phase of the project scope, which limits the team's cooperation and wastes the existing information.

2.4.6 Planning in Agile vs. Waterfall

Waterfall projects apply a traditional project management approach in which fixed dates and scopes are the main drivers of planning and execution. In agile project management, planning remains flexible and adaptable to changes throughout the project. Although step-by-step planning can be beneficial for projects with a well-known scope, critical changes can arise in the middle of the project that need to be addressed. This, in turn, causes the entire carefully made project plan to be updated in the waterfall model. However, this is normal for agile projects and does not require large amounts of work in the update. (Deemer et al., 2010).

2.5 Agile engineering in practise

Large companies discuss experimenting and adopting agile methods of working in new product development (Cooper and Sommer, 2018). In addition, SMEs have recently adopted agile work methods to develop their physical products and processes (Edwards et al., 2019). There is a need for more specific models to implement agile non-software products, especially in small and medium-sized enterprises (SMEs) and startups that deal with limited resources. From this perspective, flexibility is crucial, and agile entities bring flexibility into the process (Conforto and Amaral, 2016). At this point, it is important to note that the State Gate is a flexible framework at the enterprise level and not a pure project planning approach. Incorporating agile iterations into the stage-gate model results in a more adaptive and agile framework (Vedsmand et al., 2016). In the resulting integrated Agile-Stage-Gate Hybrid model, the built-in agile cycle is applied to all or some stages of the project. Another hybrid approach can be found in Conforto and Amaral (2010), who proposed an iterative cycle starting from the first stage that combines the principles of the stage-gate model and project life cycle management. This process can be repeated as many times as needed during a project's life.

2.6 Synthesis of literature review

In this chapter, we review the literature from the perspective of this research. The first research question was to determine agile project management. Agile methods were born from the need to react quickly to changes in the environment and customer needs. (Rigby, D. & al, 2016). It was understood from the beginning that environmental changes, such as the market situation and rapidly changing customer requirements, were not the only software industry challenges. Software industry just faced the modern society challenges first. The agile method principles pay special attention to cooperation with the customer in the project. During the project, the requirements may change, or new opportunities may open up. This Scrum model was originally used in software projects. However, as the model is more of an operational framework than an actual detailed model, it can also be used in other fields. They have also been used successfully in technical projects. (Rigby, D.& al. 2016). Unlike in waterfall model, the changes are completely acceptable, sometimes even desired. When the customers are interested of the project and when it is possible for customers to influence the development, the final product or service is better, and the customer is already keen to it. You are just focusing on creating a working product for the proven needs of the customers. The project team works independently and easy communication with all the stakeholders is organised as a normal part of project communication. (Rigby, D.& al. 2016).

The agile manifesto (Beck et al., 2001) is the most valued. The idea was to restructure the balance between governance and collaboration and make development processes more adaptable (Beck et al., 2001), avoiding unnecessary work in all phases of the project. All work is aimed at the finished product. Agile principles consider agile at a more concrete level. Agile tools like Scrum are built on these principles (Schwaber and Sutherland 2020). Scrum is more like a framework, not a specified tool for everyday work. This enables companies to adapt their principles and pillars to their own project management. It is also important to remember that there is no such thing as an agile project or department within a company. Agile project management requires agile organizations. This emphasizes the need for quick decision making. According to research, the biggest culprit for failed agile projects is slow decision making. (Sutherland, J.J., 2019)

3 RESEARCH PROCESS

3.1 Case context

Swegon Group AB is owned by Investment AB Latour and listed on the Stockholm Stock Exchange, the market's leading indoor air-conditioning supplier. Swegon offers solutions for ventilation, heating, cooling, and optimizing conditions as well as related services and expert technical support. Swegon has subsidiaries and distributors around the world. 17 production facilities are located in Europe, North America and India. The company employs more than 3000 employees and its turnover in 2022 was around 700 million euros. (<https://www.swegon.com/fi/tietoja-swegonista/>)

Swegon ILTO Oy is a subsidiary of Swegon in Finland. The ventilation products of the factory operating in Kaarina are suitable for homes and small offices, in terms of efficiency. The goal of Swegon ILTO Oy is to increase the current turnover from 40 million euros to approximately 100 million euros by 2030. This causes challenges, especially in terms of the adequacy of the current facilities and the increase in the volume of transportation of semi-finished sheet metal products from outside the factory.

This work is carried out as an agile project in which suppliers of machines, equipment, and software are involved at an early stage. In addition to the technical specifications, the goal of planning is to obtain budget offers. The investment decision is made separately and its justification is not within the scope of this study.



Figure 4: PSBB+ coil line, Prima Power



Figure 5: Robot for unloading the finished sheet metal parts, Prima Power

The project was implemented using an agile (Scrum) framework. The Scrum framework was chosen because there were bad experiences with the traditional project methods, and we wanted to give the possibility to try different kinds of methods. The project's targets were allowed to dream big. The traditional project model would create too many innovations. The time used, 6.5 months, is also short, and the desired benefit of an agile method in time management would be welcome. In addition, the company was not familiar to me. Creating a large project plan without advanced information would be challenging.

3.2 Research approach

The research approach was a qualitative case study. A qualitative case study is a research method that enables a complex phenomenon to be researched through the identification of different factors interacting with each other. The observed case was a real-world case. (Baxter, Pamela & Jack, Susan 2010). The purpose of this research is to provide information about the use of Scrum in the production development project in question and the advantages and challenges achieved. I was involved in the project and made observations during each sprint. We also observed the prevailing project management methods of operation in the company and became aware of the differences between the methods of operation to enable further utilization.

Swegon's operational manager acted as the product owner in the project and defined the project goal. The person conducting the research was a Scrum master, who ensured that

the form of the Scrum reference framework was followed as closely as possible in order to obtain results in the research. Our small basic team was completed by the CEO, who actively participated in the reviews at the end of the month-long sprint. During each sprint review, a decision was made to continue the project until the desired result was achieved. In addition, there was a changing number of stakeholders inside the house and from system suppliers.

This research focused on the applicability of the Scrum reference framework in the planning of an advanced production development project. The target was to perform at least four sprints after selecting suppliers. Starting from the basic requirements of production, moving one area/entity at a time towards an increasingly advanced system. After each sprint, we evaluated how successful the implementation was and what should have been done differently in the next sprint. The applicability of Scrum was evaluated by analyzing the achievement of goals and the smoothness of operations.

Project success was measured after each sprint by collecting information about success and error judgements. Profitable methods of operation were used in the subsequent sprints, and the identified problems could be avoided in the future. In addition, the general applicability of using Scrum in hardware projects was evaluated. The Scrum reference framework is sometimes considered a project model suitable only for programming projects. Suspicions came up many times, so dispelling this was a big part of the work done. Fortunately, the supervisor and top management of the company were open-minded and capable of seeing the benefits right from the beginning.

In this project, the Scrum master's task was practically handled by this diploma. This means that part of the time used for managing the project should always be reserved for checking the way of working according to Scrum. The company's needs regarding what information is needed to evaluate the investment decision are defined at the start of the project. These requirements were met at the beginning of each sprint. The basic goal is to develop an efficient and technically advanced production system. How do we plan the project so that it serves as well as possible to decide on investment? What did we learn, and what would we do differently in the next sprint ?

3.3 Data collection and analysis

As the project progressed, information was collected from the following events.

- Scrum events; daily Scrums, sprint reviews, sprint plannings and retrospectives
- Discussions and interviews

All memos were saved in the ODOO project software as text under specific tasks. In addition, all product information and production analyses were saved as Excel files for the same tasks. The analyses of the pros and cons were performed separately for each sprint, and then the entire project experience was summarized.

The project module of the ODOO software was used as the project software. It aims to clearly define sprints, assign responsibilities, and enable information flow. All the data were saved in a shared network file.

After each sprint, I separately analyzed the experiences achieved using the agile reference framework based on the collected text material and interviews. Finally, I summarize the whole and compare the results with both the company's own wishes and the literature.

4 EMPIRICAL RESEARCH

4.1 Project case implementation methods in a production hardware development project

Ten sprints are named here, but the actual sprints to be studied are numbers 4-8. Sprints 1-3 are related to the preparation of the project and diploma thesis, 4 to the definition of the current state, 5 to the selection of the partners, 6-8 to the planning of the production, and 9 to the end of the project and completion of the thesis. The project is planned to be completed by the end of January 2023. The project was completed on schedule. The completion of the diploma thesis was left to February 2023, when all the information from the project was available after the project reporting on 31.01.2023.

4.2 Working with Scrum

The Scrum framework was chosen as the tool for this project. Swegon has traditionally used its own version of the waterfall model. The same model has been used in mechanical design, programming, and testing projects as well. The project's challenges include slowness and poor controllability when changes occur. The model is a Stage-Gate-Model with waterfall projects between the gates.

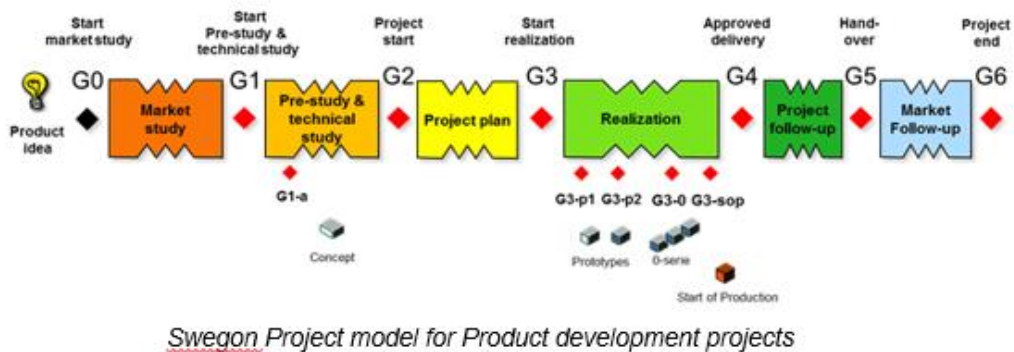


Figure 6: Swegon project model

We aimed to try agile methods on a smaller scale in the context of this production development project. There was also prejudice against agile methods, so it is good to use

such a separate, half-year-long project to embody the features of the reference framework in a safe environment without external customers.

The routines of the project were:

- Project team 2-4 persons
- Product owner
- Stakeholders
- Daily Scrums; about 15 min every morning
- One month sprint; Sprint planning, sprint review, sprint retrospective; before and after every one-month sprint about one hour/each

Tools:

- Odoo project module; Kanban board for visualizing sprints and tasks, assigning responsibilities, and enabling information flows.
- OneDrive: saving and sharing files

The target was to design, together with machine, tool, and equipment suppliers, a production line for sheet metal parts that is as automatic as possible. Based on the results of the research, budget offers were requested from the suppliers and an investment application was made to the group based on them. The initial plan did not include the investment application, but since it proved to be decisive for a deeper understanding of the project, it was added to the project's goals.

Completed Sprints:

Sprint 1: Project agreement

Sprint 2: Setting up the project

Sprint 3: The theory of the diploma thesis

Sprint 4: Examining the current situation

Sprint 5: Discovering the project partners

Sprint 6: Development round 1

Sprint 7: Development round 2

Sprint 8: Development round 3

Sprint 9: Reporting and completing the diploma thesis

Sprints 1-3 and 9 were one-week sprints, and the actual development sprints 4-8 were one-month sprints. Every sprint started with product backlog planning. The Product Owner is responsible for the Product backlog. First, the Product Backlog is not so much a to-do list, but a verbal description of what is to be achieved and how the matter under investigation is to be approached. The Product Backlog can be long and roughly contain the entire project if desired. However, the idea here is that the list lives and changes as the project progresses.

Project team:

- Product owner, (Sakari Suominen Director, Operations Swegon ILTO Oy)
- Scrum master (this diploma thesis)
- Project team members (Minna Rautio, Sakari Suominen, representatives of cooperation partners, may change during the project depending on the topic to be discussed)
- Stakeholders (managing director, production manager, purchasing manager, logistics engineer, production development engineer, product development engineer)

4.2.1 Creating Project Backlog

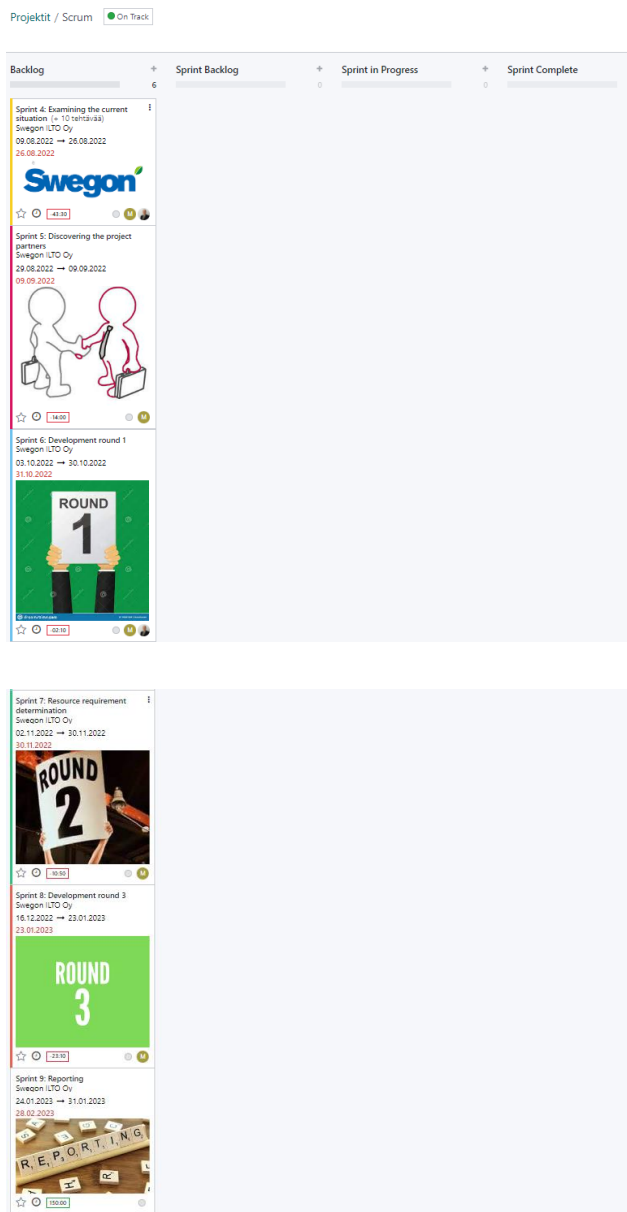


Figure 7: Sprints 4-9 in ODOO

The project began by creating a Project Backlog at an approximate level. Four weeks were chosen as the length of the sprint for the actual sprints 4-8 and initially their topics to outline the tasks ahead and their use of time. Although the final result of the project could not be known in advance, there was still an image of what work steps would be needed. At this stage, the amount of work to come was highly dependent on what the machine and equipment suppliers would require to be investigated before suitable machines and equipment could be selected. However, this was also something that could not be predicted because it was highly dependent on the properties of the parts being manufactured.

At this point, the locked initial targets of the project owner are

1. The automatic production line for the production of sheet metal products
2. The project will be completed at the end of January 2023

Using the traditional waterfall project model, creating a project plan would have been very challenging. The necessary steps cannot be visualized in advance. We also wanted to ensure that machine and equipment suppliers would definitely have the opportunity to offer the best possible existing packages. Therefore, changes during the project were greater than expected. On the other hand, thinking about the backlog together with the schedule helped outline the necessary resources in each sprint.

4.2.2 Sprint planning to Sprint Backlog

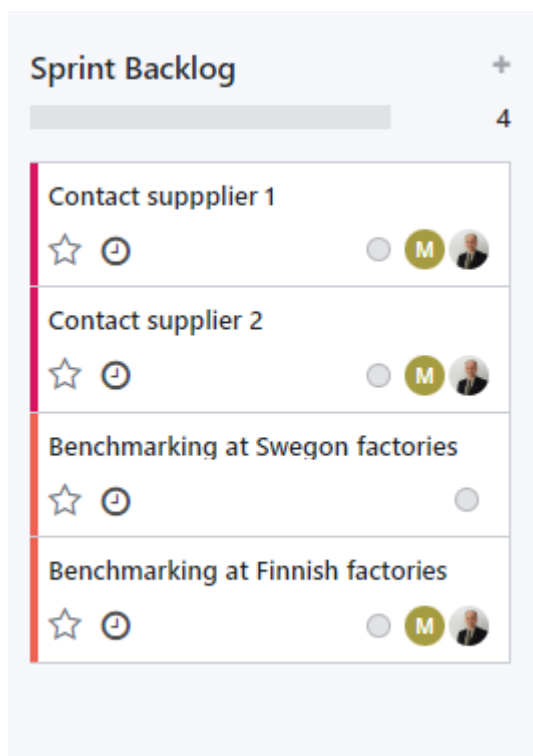


Figure 8: Sprint Backlog in Sprint 5

At the beginning of each sprint, the team created more detailed tasks to be performed during sprint planning. Responsible individuals (s) were defined for each task. Efforts were made to include the task in each sprint only to the extent that it could be done.

During the sprints, subtasks were created as needed. The project became more detailed all the time; furthermore, we progressed. If something new appeared for a task, the scope of which did not fit that sprint, it was moved to the next sprint as its own task. At this stage, a description was written for each sprint, which stated the goal for the next four weeks.

The issue was discussed such that the ongoing challenge in the Product Backlog started to form tasks that the team recognized as concrete tasks. These separate tasks were recorded in the project module as tasks in the Sprint Backlog. However, they were moved to Sprint Backlog only as much as the team thought was possible to do in the next Sprint. If there was too much to do, or its meaning was still unclear, the team did not take it up yet. When the task is in a Sprint Backlog, it cannot be deleted or changed. This requires a decision from the product owner. Similarly, new tasks are added to the Sprint Backlog only through a joint decision.

4.3 Sprint reviews

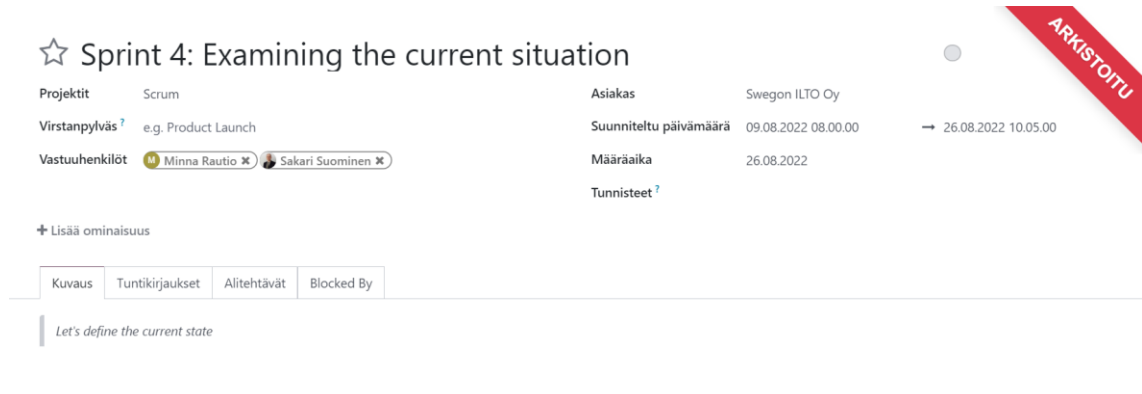
In addition to the team and product owners, the CEO was usually involved in sprint reviews. I prepared the report and sent it for review before the face-to-face meetings. Owing to the nature of the project, no other stakeholders were involved. In this report, the tasks performed during the sprint and the results obtained were reviewed and discussed. Since the goal was to train the participants in the use of Scrum, each review also contained instructions. Although other stakeholders were not involved in the reviews, issues were discussed with them during the execution of various tasks so that it was possible to obtain up-to-date and relevant information for the execution of the tasks. After reviewing each sprint, we continued directly with the planning of the next sprint, and the agile work cycle continued.

4.4 Retrospectives

Retrospectives were few and far between because there was a lot of discussion anyway. We conducted a retrospective study to test this hypothesis. As this project and its project group were one-off, separate retrospectives did not have as much importance as a permanent project group would have had.

4.5 Sprints

4.5.1 Sprint 4



The screenshot shows a Jira sprint page for 'Sprint 4: Examining the current situation'. The sprint is in progress, starting on 09.08.2022 at 08.00.00 and ending on 26.08.2022 at 10.05.00. The project is 'Scrum' and the customer is 'Swegon ILTO Oy'. The sprint goal is 'e.g. Product Launch'. The team members are Minna Rautio and Sakari Suominen. The sprint is marked as 'ARKISTOITU' (Archived). The current state is 'Let's define the current state'.

Projektit	Scrum	Asiakas	Swegon ILTO Oy
Virstanpylväs [?]	e.g. Product Launch	Suunniteltu päivämäärä	09.08.2022 08.00.00 → 26.08.2022 10.05.00
Vastuuhenkilöt	Minna Rautio ✕ Sakari Suominen ✕	Määräaika	26.08.2022
		Tunnistees [?]	

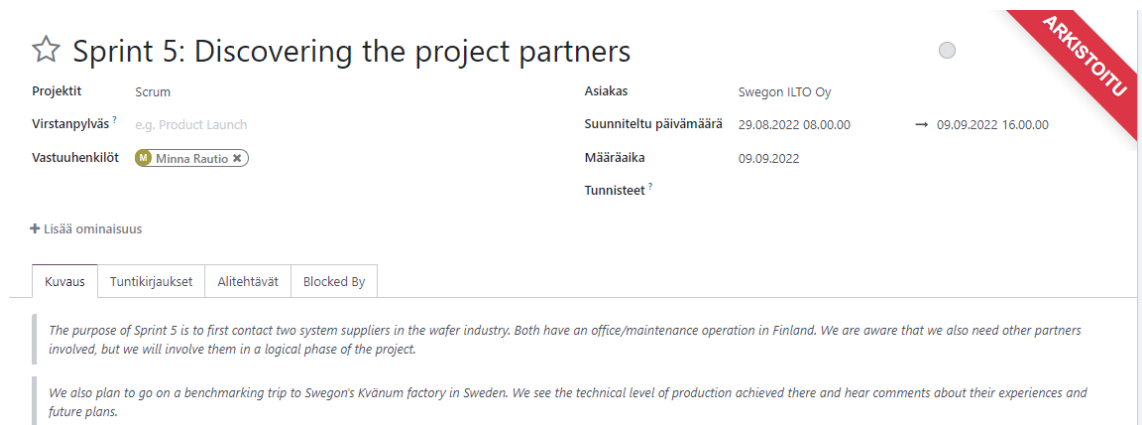
+ Lisää ominaisuus

Kuvaus Tuntikirjaukset Alitehtävät Blocked By

Let's define the current state

In the current state analysis, we examined the products, facilities, and acquisitions, as well as their controls and costs. Using this analysis, basic information was created for the project, which was used both in the initial phase to direct the project and as comparative information when evaluating the final results. This required the author to extensively understand the company's products and operations. Previous experience in production and development projects helped this study. The importance of Daily Scrums was strongly emphasized when information had to be transferred and assimilated quickly. The obstacles that came into front were dismantled daily, which enabled rapid progress. At this stage, the factors that would impose restrictions on the implementation of the project were also investigated.

4.5.2 Sprint 5



The screenshot shows a Jira sprint page for 'Sprint 5: Discovering the project partners'. The sprint is in progress, starting on 29.08.2022 at 08.00.00 and ending on 09.09.2022 at 16.00.00. The project is 'Scrum' and the customer is 'Swegon ILTO Oy'. The sprint goal is 'e.g. Product Launch'. The team member is Minna Rautio. The sprint is marked as 'ARKISTOITU' (Archived). The current state is 'The purpose of Sprint 5 is to first contact two system suppliers in the wafer industry. Both have an office/maintenance operation in Finland. We are aware that we also need other partners involved, but we will involve them in a logical phase of the project.' and 'We also plan to go on a benchmarking trip to Swegon's Kvänum factory in Sweden. We see the technical level of production achieved there and hear comments about their experiences and future plans.'

Projektit	Scrum	Asiakas	Swegon ILTO Oy
Virstanpylväs [?]	e.g. Product Launch	Suunniteltu päivämäärä	29.08.2022 08.00.00 → 09.09.2022 16.00.00
Vastuuhenkilöt	Minna Rautio ✕	Määräaika	09.09.2022
		Tunnistees [?]	

+ Lisää ominaisuus

Kuvaus Tuntikirjaukset Alitehtävät Blocked By

The purpose of Sprint 5 is to first contact two system suppliers in the wafer industry. Both have an office/maintenance operation in Finland. We are aware that we also need other partners involved, but we will involve them in a logical phase of the project.

We also plan to go on a benchmarking trip to Swegon's Kvänum factory in Sweden. We see the technical level of production achieved there and hear comments about their experiences and future plans.

Daily Scrums were held every morning in the same place at the same time. These short meetings proved to be the most effective way to advance the project. On the other hand, when the team included an employee who had just started at the company and an experienced employee, the transfer of information was smooth, and thus no time was wasted waiting or doing unnecessary work. When the product owner was an operational manager with a full calendar, meeting times booked six months in advance were important. The product owner participated in all meetings as team members.

We chose the time of the daily Scrum meeting every morning at 07:45-08:00. In the daily Scrum, we went through the tasks performed in the previous day and planned the next tasks. It was especially important to get help with the challenges and decisions for those things that needed the product owner's opinion. The pace of work thus remained fast, and the motivation at work was high, as there was no need to wait for decisions. In the Kanban table, the status of the tasks has not started - in progress - finished. The tasks can also be marked as blocked. This is because of waiting for information or because another team member's part of the task has yet to be done.

The machine and equipment suppliers were closely involved in the project throughout its duration. In advance, we thought about how to involve them more closely in the course of the project and, for example, to include them in the views in turn. However, in such short projects, it was concluded that normal correspondence and meetings were sufficient. The work was so intense that neither party had the time to think about what would happen next. The proximity to the end of the sprint kept the pace fast.

4.5.3 Sprint 6

ARKISTOITU

☆ Sprint 6: Development round 1

Projektit	Scrum	Asiakas	Swegon ILTO Oy
Virstanpylväs ?	e.g. Product Launch	Suunniteltu päivämäärä	03.10.2022 08.10.00 → 30.10.2022 16.00.00
Vastuhenkilöt	M Minna Rautio ✕ Sakari Suominen ✕	Määräaika	31.10.2022
+ Lisää ominaisuus		Tunnisteet ?	

Kuvaus
Tuntikirjaukset
Alitehtävät
Blocked By

The purpose of the sprint is to support selected machine and equipment suppliers in research and simulation work to reach the best possible end result. In addition to that, we get to know the technology on offer to understand as well as possible what we are buying. If possible, company visits are used to get to know already functioning entities.

Along with the previous work, we start preparing information to support the investment decision. Let's take the years 2024-2026 as a point of comparison (even with a fast schedule, production would be in use at the beginning of 2024 at the earliest). The comparison point for the investment is considered to be the option of continuing in the current way while the turnover increases.27.10.2022

During this sprint, preliminary information regarding the necessary machines and equipment was obtained. The initial images that had been at the beginning of the project were not very accurate. For example, the sheet warehouse was changed to a coil line and the laser cut to a cutting and punching unit. The work seemed to proceed so quickly that the investment application began to be prepared at this stage. This was not included in the original plan; however, when the resources were sufficient, it was started. At this point, the pacing effect of the sprint's four-week period was emphasized. The exact plan made using the waterfall method would have had to be modified again at this stage. Now, we identify the new tasks and divide them into appropriate sections. The tasks and their scope became flexible and not the length of the sprint.

4.5.4 Sprint 7

ARKISTOITU

Projektit / Scrum / Sprint 7: Resource requirement determination
Tulosta Toiminto 4 / 49 <

ALOITA
BACKLOG
SPRINT BACKLOG
SPRINT IN PROGRESS
SPRINT COMPLETE
OLD COMPLETED SPRINT (OHUTLEVVY PROJEKTI)

☆ Sprint 7: Resource requirement determin

Projektit	Scrum	Asiakas	Swegon ILTO Oy
Virstanpylväs ?	e.g. Product Launch	Suunniteltu päivämäärä	02.11.2022 08.00.00 → 30.11.2022 16.00.00
Vastuhenkilöt	M Minna Rautio ✕	Määräaika	30.11.2022
+ Lisää ominaisuus		Tunnisteet ?	

Kuvaus
Tuntikirjaukset
Alitehtävät
Blocked By

The suppliers have made a preliminary determination of the necessary machine types. Next, we determine whether the time needed to manufacture parts and thus the need for resources. With this, the offer becomes more precise and third-party machines and devices (robots, their security technology, etc.) are excluded from the offer.

At this stage, it was known what type of machines and equipment would be required for production. Next, the desired resource is defined, that is, the number of machines needed to make the desired production quantity. In practice, the project at this stage was guided by the information needs of machine and equipment suppliers. However, they were always told at the beginning of the sprint how much time they had to use for each work phase.

These sprints were interesting at this point. At the end of each review, a separate decision was made regarding whether to continue the project until the next sprint. The results still appeared promising; therefore, this was continued. If we had determined that for some reason this production method did not suit us, or if there was already enough information, the project would have been stopped immediately.

4.5.5 Sprint 8

The screenshot shows a Jira project page for 'Sprint 8: Development round 3'. The page is titled 'Projektit / Scrum / Sprint 8: Development round 3' and includes navigation options like 'Tulosta' and 'Toiminto'. The main content area displays the sprint name, project type (Scrum), and client (Swegon ILTO Oy). It also shows the planned start and end dates (16.12.2022 00.00.00 to 23.01.2023 00.00.00) and the lead (Minna Rautio). A red banner in the top right corner indicates the project is 'ARKISTOITU' (Archived). Below the details, there are tabs for 'Kuvaus', 'Tuntikirjaukset', 'Alitehtävät', and 'Blocked By'. A description box at the bottom states: 'Both suppliers have completed analyzes of the products under investigation. The results include the applicability of different manufacturing methods, the proposed machines, their working hours and costs. During this sprint, an understanding of the investment and operating costs and their impact compared to the current way of operating is created.'

During this sprint, we delved into which share of our sheet metal components this investment would be suitable. Making an investment application increases our understanding of this matter. Without this, information would have remained incomplete. After this review, a decision was made to end the project, and all the necessary information was available.

4.5.6 Sprint 9

OTA TEHTÄVÄ VASTUULLESI

BACKLOG

ALOITA

SPRINT BACKLOG > SPRINT IN PROGRESS > SPRINT COMPLETE > OLD COMPLETED SPRINT (OHUTLEVY PROJEKTI)

☆ Sprint 9: Reporting

Projektit Scrum

Virstanpylväs? e.g. Product Launch

Vastuuhenkilöt

+ Lisää ominaisuus

Asiakas Swegon ILTO Oy

Suunniteltu päivämäärä 24.01.2023 08.00.00 → 31.01.2023 16.00.00

Määräaika 28.02.2023

Tunnisteet?

Kuvaus
Tuntikirjaukset
Alitehtävät
Blocked By

Creating a final summary

One week was left to write the final report. Although it was shorter, it was planned as a separate sprint. However, no more time was needed for this, because in addition to the documentation of the project, an interim report was written in connection with each review. The review report was important because in addition to facts, observations, opinions, and feelings were written in it. It could also be returned during the following sprints if the team forgot the reason for a choice.

4.6 Summary

In summary, I present findings that are different from the working methods previously used by the company.

Findings	Challenges and benefits
Communication between team members	<p>Scrum meetings agreed in advance for the duration of the entire project; fewer than five meetings were cancelled due to absence during half a year, and the commitment was excellent.</p> <p>The flow of information and decisions is fast and there is no waiting. Daily Scrums play a key role in this process. It was emphasized that agility is not only the agility of the project in question, but it also requires agility from the</p>

	<p>entire organization. This requires the speed of the decisions at every level.</p>
Product backlog	<p>It is important to understand that the product backlog does not include tasks that are too specific. It only tells the target of the sprint and provides freedom for best practices.</p>
Project planning	<p>Advance planning is easy because only the next sprint is planned. When changes occur, they can react quickly in the next review and, with the permission of the product owner, in the current sprint.</p> <p>It is much easier to plan resources for the next sprint instead of the entire project. The length of sprint was chosen as four weeks, mostly because of the stakeholders.</p> <p>Each sprint was divided into tasks. Sharing was performed by the person responsible for the task. The amount of work coming into the sprint was adjusted so that it could always be done during the sprint.</p>
Reviews	<p>Sprints are like small projects. This considerably sped up the project. When the back limit is not flexible, one has to think carefully about what makes sense to do and when.</p> <p>A written report was prepared for the reviews that were sent to the participants in advance. Thus, it was possible for everyone to prepare in advance. The team members were able to compile the sprint results into a clear entity.</p> <p>All individuals whose inputs and decisions were needed to move the project forward were involved in the review. The</p>

	<p>things were not left open, and decisions were made immediately.</p> <p>A separate decision regarding the continuation of the project was made for each review. In practice, after going through the issues, the CEO was asked the question "shall we continue?" In the last sprint, the answer was, "this is enough."</p>
Involving stakeholders	<p>Stakeholders did not necessarily notice the differences from before, other than through a fast and rigid schedule. Because the project was short, they were not included in Scrum more closely.</p>
Retrospective	<p>Because the project was short, the retrospectives did not have time to complete. The development targets were mainly related to the utilization of information technology. Not everyone used the project program, which would have been impossible with a longer project program. In this case, it was not perceived as a factor that hindered the project. This mainly caused a massive amount of e-mails, which would have been avoided if the information had only been in one place in the project program.</p>
Schedule	<p>The schedule remained as planned and all necessary matters were addressed. In fact, tasks can be added to the project.</p>
Iterative way of working	<p>It is not necessary to create an exact project plan. This would have been impossible in this case because of an unknown outcome. The schedule and description of the end target were sufficient and the accumulated information was sufficient to guide the project forward. When changes are given a chance, a better result is reached.</p>

Prejudices	The team experienced no internal prejudices regarding the use of Scrum. However, it caused discussions in the organization, and the background of Scrum in the field of programming came up several times.
------------	--

During the sprints, things that were either unexplored beforehand or the information related to them were too superficial for the needs of the project. Thus, not all information was already available, but it had to be searched for, or methods of operation had to be created to find and manage information.

The results obtained at the end of the project were presented to those influencing the investment and other stakeholders. The project remained on schedule and achieved the planned results.

5 DISCUSSION AND CONCLUSIONS

Scrum was originally created as a tool for software programming projects (Rigby et al. 2016) . However, it was understood already from the beginning, that the environment changes like market situation and rapidly changing customer requirements were not only software industry challenge. The software industry first faced modern society challenges (Rigby et al. 2016). This production development project was in line with its principles. The result is not known precisely; the product version after each sprint is feasible, and the successful operating methods of each sprint can be utilized in the next sprint, although part of the project group may change, depending on the field of expertise.

The biggest advantage of using Scrum is its fast turnaround time. Working time was used efficiently when the daily Scrum meetings removed obstacles and the discussions during them directed the work in the right direction. Since I did not know the company beforehand, the information of an experienced product owner would always nudge the work in the right direction if I had thought about something the wrong way. Similarly, things that occurred during work told the product owner about opportunities that the company had not necessarily used before. In general, I consider waiting for decisions to be the worst killer of work motivation. According to research, delay in decisions is by far the biggest reason for the failure of a Scrum project (J.J. Sutherland, 2019) Now that situation did not occur. The same need for an operating method that would be more agile in change management and would give a better outcome in a shorter time has been seen in many previous studies. (Ciric, D. & al, 2019).

The post-sprint viewings always ended with the question, Shall we continue? This is how we checked every month that we were going in the correct direction. When we got confirmation on the matter, we felt successful and could very happily continue on. Thus, even a long project would be broken into shorter periods, which increases the feeling of success, regardless of the difficulty of the approved end result. Compared to a long traditional project that has been late since week two, sprints provide a sense of project control. When the customers are interested of the project and when it is possible for customers to influence the development, the final product or service is better, and the customer is already keen to it. You are just focusing on creating a working product for the proven needs of the customers. The project team works independently and easy

communication with all the stakeholders is organised as a normal part of project communication. (Rigby, D.& al. 2016)

The biggest challenge in managing the project was related to information-sharing. We used Odoo project software to maintain the Kanban table. I find it strange that even today, the Kanban board is often thought of as a board on a wall filled with post-it notes. It is very important to use a Kanban board to visualize tasks. However, today's Kanban board must be electronic. The task table must be accessible from your own place at the office, as well as from remote days at home. The tool must also enable the central storage of information and monitoring of working hours so that the costs of the project can be monitored in real time. OneDrive space was used to store files because it is also used by the company. However, learning new software and committing it are always their own tasks. Thus, we could have spent more time on this task. In addition, many files were sent via e-mail. A better solution would have been to store files centrally and share them. Ideally, the files should be stored in the same program where tasks are managed. Then, the entire process related to doing the work would be stored behind the task, and it could be returned quickly whenever necessary. The files were saved, but retrieving them was not as efficient as possible. The problem was not with the tool, but because of the one-off nature of our project, we did not utilize it. The permanent project organization should definitely fix that thing. This challenge is related to Scrum's requirement for openness. (Schwaber and Sutherland, 2020). The goal is to obtain all the project material in one project software that is easily accessible to the necessary people. In this case, the transparency requirement can be easily fulfilled. The user rights of the project software can be shared in great detail, which makes it possible to include the necessary stakeholders.

5.1 Critical evaluation of the research

Based on this study, generalizations cannot be made. However, we hoped that from the research we will gain experience in the use of agile methods and especially Scrum in a hardware project. The research carried out provided additional confidence in testing agile methods and helped dispel prejudices against them. Of course, the project group was small, and not all Scrum features were utilized. However, this did not prevent us from achieving the desired benefits.

5.2 Managerial implication

Agile methods emphasize transparency and take responsibility at the operational level. (Schwaber and Sutherland 2020). When the role of the traditional project manager is removed and each team member directs his own work according to the tasks in the backlog, it fundamentally changes the management in the organization. It can no longer be assumed that the manager tells us what to do and that he/she has to approve everything. The executive level must be ready for independent work, and the management must have trust in the team members and their work. The change affects the entire organization, not just the agile team in question. This is because an agile team cannot wait for a long time to make decisions from another part of the organization. However, the agile way of working aims to eliminate siloing.

5.3 Further research

Based on the results, we can decide whether we want to use the Scrum framework more widely in the future, for example, in new product development. We understand that we will move on to larger teams and more challenging projects. However, the basic operating method can be copied and modified according to practical requirements. With this experience, Daily Scrums remain an important part of the project team.

During the project, the company's products and operations were extensively reviewed. This raised development targets that were not directly part of the topics of this project but for the development of which it was decided to start their own development projects. The final report stated that by developing the areas of operation found, this investment could also be implemented with higher quality. I was able to continue with a project related to the area of operations to develop these challenging activities. The Scrum framework was used in the development project. The goal is to develop it as a tool for operational development. Special focus is placed on operating in accordance with the values of Scrum and the extensive commitment of personnel to the development work.

REFERENCES

Ciric, D., Lalic, B., Gracanin, D., Tasic, N., Delic, M., & Medic, N. (2019). Agile vs. traditional approach in project management: Strategies, challenges and reasons to introduce agile. Paper presented at the Procedia Manufacturing, 39 1407-1414. doi:10.1016/j.promfg.2020.01.314 Retrieved from www.scopus.com

(Rigby, D., Sutherland, J., Takeuchi, H., 2016 May, 40-48, Embracing agile. Harvard Business Review)

Agile Business Institute Inc . Waterfall methodology vs Agile, 2022: What is the difference between Waterfall and Agile <https://en.abi-agile.com/waterfall-methodology-vs-agile/>

Baxter, P., & Jack, S. (2008). Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers. *The Qualitative Report*, 13(4), 544-559. <https://doi.org/10.46743/2160-3715/2008.1573>

Beck, K., Beedle, M., van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Grenning, J., Highsmith, J., Hunt, A., Jeffries, R., Kern, J., Marick, B., Martin, R. C., Mellor, S., Schwaber, K., Sutherland, J. and Thomas, D., 2001. *Manifesto for Agile Software Development* [online]. <https://agilemanifesto.org/>. Available from: <https://agilemanifesto.org/> [Accessed 29 Nov 2021].

Ciric, D., Lalic, B., Gracanin, D., Tasic, N., Delic, M., & Medic, N. (2019). Agile vs. traditional approach in project management: Strategies, challenges and reasons to introduce agile. Paper presented at the Procedia Manufacturing, 39 1407-1414. doi:10.1016/j.promfg.2020.01.314 Retrieved from www.scopus.com)

Deemer, P., Benefield, G., Larman, C. & Vodde, B. (2010) *The Scrum Primer 1.2*. Available from: <http://goodagile.com/scrumprimer/scrumprimer.pdf> [Accessed 21 February 2013].

Doug, R., 2015. *Leading Agile Teams*. 1st ed. Pennsylvania: Project Management Institute.

Edivandro C. Conforto, Daniel C. Amaral, Agile project management and stage-gate model—A hybrid framework for technology-based companies, *Journal of Engineering and Technology Management*, Volume 40, 2016, Pages 1-14

Edwards, Kasper & Cooper, Robert & Vedsmand, Tomas & Nardelli, Giulia. (2019). Evaluating the Agile-Stage-Gate Hybrid Model: Experiences From Three SME Manufacturing Firms. *International Journal of Innovation and Technology Management*. 16. 10.1142/S0219877019500482.

Elon Musk and Sandy Munro, 2020: [Elon Musk Interview: 1-on-1 with Sandy Munro](#)

Hazzan, O. and Dubinsky, Y., 2014. *Agile Anywhere: Essays on Agile Projects and Beyond*. 1st ed. Springer.

Hohl, P., Klünder, J., van Bennekum, A., Lockard, R., Gifford, J., Münch, J., Stupperich, M. and Schneider, K., 2018. Back to the future: origins and directions of the “Agile Manifesto” – views of the originators. *Journal of Software Engineering Research and Development*, 6 (1), 1–27.

Measey, P. and Radtac, 2015. *Agile Foundations : Principles, Practices and Frameworks*. 1st ed. London: BCS Learning & Development Limited.

Schwaber, K. and Sutherland, J., 2020. *The Scrum Guide - The Definitive Guide to Scrum: The Rules of the Game*.

Sommer, A. F., 2019. Agile Transformation at LEGO Group. *Research-Technology Management*, 62 (5), 20–29.

Sutherland J.J., (2019) *The Scrum Fieldbook: A Master Class on Accelerating Performance, Getting Results, and Defining the Future*. Crown, 2019

Vedsmand, Tomas & Cooper, Robert & Kielgast, Søren. (2016). Integrating Agile with Stage-Gate® – How New Agile-Scrum Methods Lead to Faster and Better Innovation. [InnovationManagement.se](#).