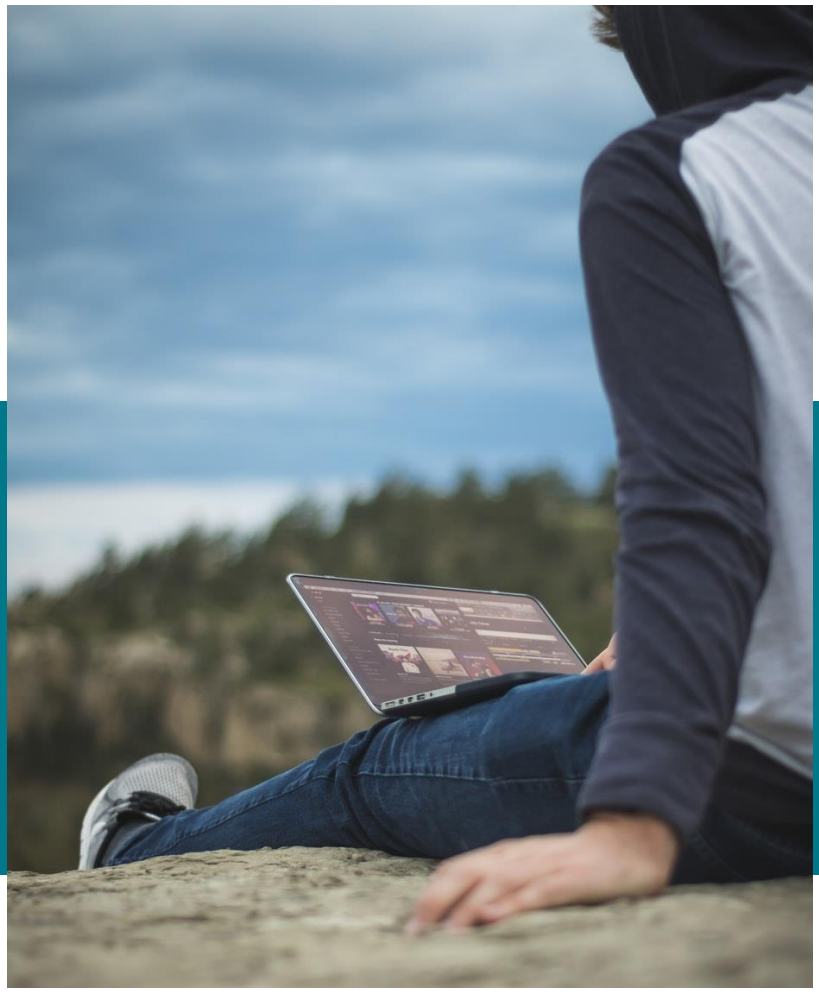


How Remote Work Affects Agile Practices in Physical New Product Development

Nicoline Hvidt

| Supervisor: Kasper Edwards |
| DTU Management | 24th February 2021 |

Abstract

Characteristics of several elements of the agile framework Scrum are considered best practices to improve remote conditions within performance and psychological well-being (well-being). This reveals an opportunity to combine agile practices and working remotely to harvest benefits of both while mitigating challenges. No previous research is found within the use of remote agile practices in physical New Product Development (NPD). To close this gap in the literature, this research project explores how agile practices can be used in a remote setting for physical NPD projects and their implications on performance and well-being. A structured literature review revealed that previous literature on remote work focused on three challenges related to performance, two challenges related to well-being, three benefits related to performance, and three benefits related to well-being. A number of triggers and effects/consequences connected to the challenges and benefits can be identified when analyzing previous research. Previous literature also revealed that the Scrum framework can be applied in physical NPD and improve performance with some adaptions.

A series of interviews with people who have practiced remote agile NPD during the 2020 lockdown brought by the COVID-19 pandemic clearly implied that agile practices did improve both the performance and well-being of the remote team members. This was due to especially frequent communication, clear structure and focus, the definition of tasks, and visual communication. The remote conditions provided a better work environment for some, eliminated most disturbances, and created equal access to information across all team members' locations. However, some challenges related to remote practices were also highlighted, including: technical issues, loss of communication leading to misunderstandings and delays, and loss in motivation due to isolation. Thus, to optimize remote agile practices in physical NPD, some additions must be made to the Scrum framework, including weekly check-ins and project kick-off to ensure the best conditions for well-being and performance in remote agile teams. Also, resource coordination, milestone planning, and maintaining the role of the project leader improve the dynamics of using the Scrum framework in a manufacturing organization. The findings in this project make ground for further exploration of this area both within research and industry.

Acknowledgments

I would like to take this opportunity to acknowledge the people who have helped and supported me through the process of writing this thesis. First, I would like to thank my supervisor Kasper Edwards for providing constructive feedback and showing great engagement and interest throughout the project. Second, I would like to thank Tomas Vedsmand, who was a great help in the scoping and planning of this project. Third I would like to acknowledge the great support from my mother, who always had open doors when needed, and her dog, who have provided cheerful optimism, my brother, who has listened and shared good advice through the process, and my father, who helped by providing qualified feedback, finally, my boyfriend, who has supported me in the difficult phases and helped to celebrate the milestones. Writing a thesis alone in a time of isolation and personal limitation is not something I would recommend, and I believe that the support between people has been crucial for making this report.

Learning objectives

In order to live up to the academic requirements of a master thesis at The Technical University of Denmark (DTU), a number of learning objectives must be met. These objectives should be used as evaluation criteria for this report and are presented in the following.

Official Learning Objectives

Eight learning objectives have been defined as general competences for all master graduates at DTU.

A Master graduate from DTU:

- Can identify and reflect on technical scientific issues and understand the interaction between the various components that make up an issue
- Can, on the basis of a clear academic profile, apply elements of current research at international level to develop ideas and solve problems
- Masters technical scientific methodologies, theories and tools, and has the capacity to take a holistic view of and delimit a complex, open issue, see it in a broader academic and societal perspective and, on this basis, propose a variety of possible actions
- Can, via analysis and modelling, develop relevant models, systems, and processes for solving technological problems
- Can communicate and mediate research-based knowledge both orally and in writing.
- Is familiar with and can seek out leading international research within his/her specialist area.
- Can work independently and reflect on own learning, academic development, and specialization
- Masters technical problem-solving at a high level through project work, and has the capacity to work with and manage all phases of a project – including preparation of timetables, design, solution, and documentation

Specific Learning Objectives

In addition to the general learning objectives, a set of specific objectives is sat for this particular thesis. This consists of eight points, targeting different taxonomic levels, presented below.

The student conducting this thesis project can:

- Identify and analyze previous research to gain new knowledge for the research society
- Analyze the collection of findings in relation to the effect of using agile practices in a remote setting
- Express knowledge within the field of non-software product development processes
- Conduct, document, and analyze qualitative interview with academic quality
- Express deep comprehension and the ability to interpret findings concerning agile frameworks in a remote context both on a practical and theoretical level
- Synthesize key findings to develop coherent and applicable implications for both the industry and the research society
- Be aware of limitations and own biases weakening the research process
- Dynamically adjust project focus to relevant findings and project status

Table of Contents

INTRODUCTION

Factors such as new technologies and globalization are leading to growing competition, increasingly complex customer needs, and rapidly changing markets. To overcome this challenge, organizations are implementing new ways of working to survive and grow.

Within these new ways of working, two emerging trends are:

(1) R*emote working*, allowing flexible work hours, a potential global recruitment pool, and distribution of workforce placed in key markets or countries with a cheaper workforce. Remote work has been practiced for several decades, and the number of remote workers has increased as communication technology evolved and is expected to increase significantly in the future (Péréa & von Zedtwitz, 2018; Suzuno, 2019). As remote work prevents people working together from being co-located and communicate face-to-face, new collaboration methods must be found. Investigations of the area show that this brings several challenges, leading remote work to have negative consequences for both performance and psychological wellbeing (wellbeing) of remote teams and individuals. However, working remotely is also found to lead to significant benefits within the same areas, posing a great opportunity (Kurland & Bailey, 1999; Poulsen & Ipsen, 2017).

(2) *Use of agile methods for New Product Development (NPD) projects in the manufacturing industry* (physical NPD). This is found to increase product development speed, increase customer value of products, and decrease project risks by executing the project in smaller sprints, breaking down tasks, and communicating daily, with dedicated teams and continuous feedback loops from customers and management (Cooper, 2017; Cooper & Sommer, 2018a; Edwards et al., 2019). Agile methods in physical NPD have been investigated for some years and show promising results. This makes it possible that NPD processes with agile elements will be preferred for complex projects in the future (MacCormack et al., 2012). However, as agile frameworks are explicitly developed for software development, research has shown that adaptions must be made to the agile processes to fit manufacturing companies (Cooper & Fürst, 2020; Edwards et al., 2019).

Research concerning remote work reveals that, among others, elements as frequent touchpoints, clear task definition, and autonomy, which are present in agile methods, corresponds with identified best practices within remote work (Kurland & Bailey, 1999; Olson & Olson, 2014). This leads to an exciting opportunity to apply agile practices in remote work to potentially improve remote teams' performance and well-being. However, as one of the core elements of agile is that the team must be physically co-located, little research has been made exploring agile teams working remotely. No research at all focusing on agile teams within physical NPD working remotely is found.

During the year 2020, remote working has been practiced more than ever due to the COVID-19 pandemic. Despite bringing a series of negative consequences for both societies and industries worldwide, these conditions have also brought an opportunity to explore the dynamics and practices of remote teams that do not usually work remotely, including agile teams within physical NPD. This enables an investigation of the combination of remote work and agile practices to explore the opportunity of improving both project performance and psychological well-being in remote project teams. In this research study, the aim is to develop and investigate implications of a framework for remote agile practices by analyzing previous research studies within the two fields (agile for physical NPD and remote), as well as a series of practitioner interviews conducted in this project.

1 PROJECT BACKGROUND

In the following, the project background is presented to ensure that the reader has a sufficient understanding of the key subjects in this project, *agile* and *remote work*, as well as the project purpose and scope.

1.1 AGILE

Agile has been used for many years in various management and product development fields (Rigby et al., 2011). This project will not focus on the history or origin of agile. Instead, the agile manifesto is used as a starting point. This was created in 2001 by 17 software engineers (Beck et al., 2001). Despite that the manifesto was created from a software development perspective, it is seen as an essential element within agile practices, also in physical NPD. It defines a set of core values and principles that should be considered when discussing agile practices within a team or organization regardless of the industry (Rebentisch et al., 2018).

The agile manifesto can be seen as the backbone for agile product development Today (Hazzan & Dubinsky, 2014). The authors aimed to uncover better ways of developing software, and in this process, they defined four core values:

Individuals and interaction **over** processes and tools

Working software **over** comprehensive documentation

Customer collaboration **over** contract negotiation

Responding to change **over** following a plan

From: Agile Manifesto 2001 (Beck et al., 2001)

In addition to the four values, the authors defined 12 principles that lay the ground for transforming the values into practice (Beck et al., 2001).

	Principle
1	Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
2	Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
3	Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
4	Business people and developers must work together daily throughout the project.
5	Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
6	The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
7	Working software is the primary measure of progress

8	Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
9	Continuous attention to technical excellence and good design enhances agility.
10	Simplicity-the art of maximizing the amount of work not done-is essential.
11	The best architectures, requirements, and designs emerge from self-organizing teams.
12	At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly

Agile frameworks have been developed to transform the manifesto's values and principles into a tangible and practical context (Hazzan & Dubinsky, 2014). The layers of working agile can be seen in figure 1.1.

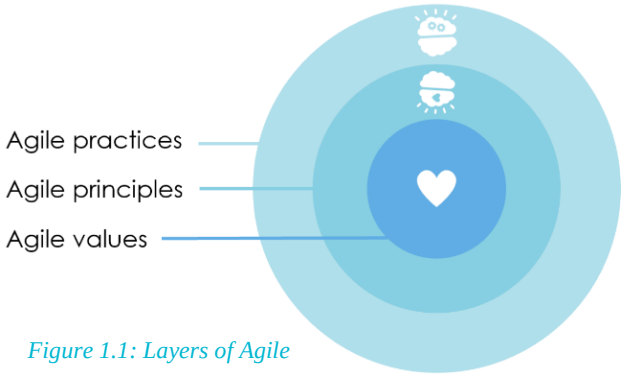


Figure 1.1: Layers of Agile

Today, nine different frameworks have been developed and described, each with a number of methods and tools (Friis Sommer et al., 2015). This research will focus on the framework called Scrum, as this is by far the most used framework (Ays et al., 2019; Digital.ai, 2019). Also, it is found that Scrum practices are spreading to physical product development (Cooper, 2014; Friis Sommer et al., 2015), which is the focus of this study. Thus, the framework is presented.

Scrum practices are described in the Scrum Guide (Schwaber & Sutherland, 2011). The framework is illustrated in figure 1.2.

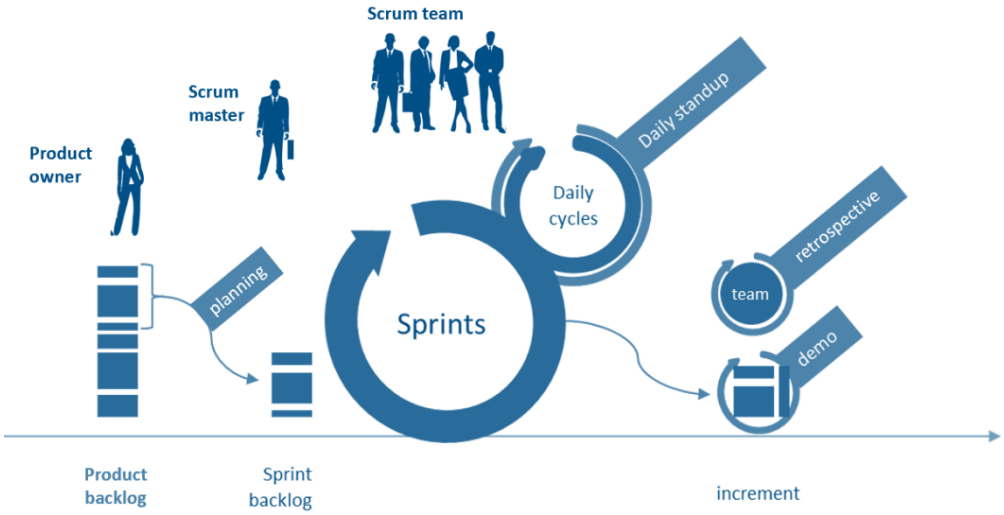


Figure 1.2: The Scrum Framework (Based on: Schwaber & Sutherland, 2011)

To support figure 1.2, a brief description of each Scrum element is provided in table 1.1, which gives an overview of the three categories: Artifacts, roles, and ceremonies. The descriptions are based on the Scrum guide.

Table 1.1: Description of Scrum elements (source: (Schwaber & Sutherland, 2011))

Artifacts	
Product Backlog	The product backlog is an ordered list of everything that is needed in the product. The items on the product backlog are specified throughout the project.
Sprint Backlog	The sprint backlog is the selected items from the product backlog that the team will work on in an ongoing sprint. Items in this backlog should be specific on a task level. And the task progress is continuously updated moving tasks from to do, to, doing, to, done on a visual board (Scrum Board)
Increment	An increment is the sum of all product backlog items completed in a sprint. It should be in a useable condition meaning it must be testable.
Roles	
Product owner	The product owner is responsible for prioritizing and managing the product backlog's prioritization and is responsible for maximizing the value of the product.
Scrum Master	The Scrum master is responsible for facilitating the Scrum process, helping the team by removing external challenges, and helping people outside the team understand how to interact most efficiently.
Development team	The development team is cross-functional and empowered to organize and manage their work. The team members are the ones doing the development work and must be fully dedicated to the project.
Ceremonies	
Sprint	A sprint is a time-box of no more than one month in which a testable increment is produced, and all Scrum ceremonies are executed
Sprint planning	Sprint planning is a meeting with the Scrum team, master, and product owner, where the initiated sprint is planned. This is done by moving prioritized tasks from the product backlog to the sprint backlog, estimating how much work the team can get done. The meeting should be no longer than eight hours.
Daily stand-up	The daily stand-up is a maximum 15-minute-long coordination meeting repeated daily with the entire development team facilitated by the Scrum master
Sprint demo	The sprint review/demo is a four-hour or less time-boxed meeting where the team and product owner presents work that has been done to the relevant stakeholder (ex. users or the business). Stakeholder feedback is directly integrated into future sprints.
Sprint retrospective	The sprint retrospective is a maximum three-hour time-boxed meeting where the team and Scrum master discuss the process and collaboration and how to improve this.

It is clearly stated by the Scrum Alliance, that if a team does not follow all practices according to the Scrum guide, the team is *not* practicing Scrum (Alliance, 2020). However, the Scrum process elements are adapted successfully in many teams both within software and hardware development (Cooper & Sommer, 2018a; Pikkarainen & Passoja, 2005; Rigby et al., 2011).

One core element of agile is the co-location of team members in the same room during the development process. Sommer et al. state that co-location is a crucial factor for project success in agile development projects (Sommer et al., 2014). However, there is a gap in the literature within non-co-located agile NPD teams who carry out the process using *remote work*.

1.2 Remote Work

There are several definitions of the term "remote work," also referred to as "telework," "distance work," and "e-work" (Grant et al., 2013; Kurland & Bailey, 1999; Poulsen & Ipsen, 2017). In this report, remote work occurs when team members execute their project-related tasks without being located simultaneously, thus, communicating using digital tools.

There are multiple possibilities for the location and context of a remote employee. Hereof two types are found relevant for this project, presented by Kurland and Bailey (Kurland & Bailey, 1999)

- **Home-based:** The employee executes the work from his or her domestic address.
- **Satellite office:** The employee executes the work from a corporate office, however, away from the people directly connected to their work.

When working remotely, communication must go through technological media. Concerning technology-assisted communication, the media richness theory can be applied to understand the level of 'richness' a communication media provides. Schiller and Mandviwalla discuss this theory in their article from 2007 (Schiller & Mandviwalla, 2007). The richness of a media is expressed from (1) the number of cues the media can convey, (2) timeliness of feedback, and (3) capacity of natural expression. A face-to-face conversation is considered the richest media as it covers the factors to the biggest extend. In table 1.2, an overview of standard media and their richness coverages is showed.

Table 1.2: Richness of different media (from: (Weimann et al., 2010)*)*

Medium	Timely feedback	Body language	Facial expression	Tone of voice	Convey emotion	Convey message	Equivocality
Face-to-face	✓	✓	✓	✓	✓	✓	Equivocal
Video conferencing	✓		✓	✓	✓	✓	Equivocal
Phone	✓			✓	✓	✓	Equivocal
Chat	✓				✓	✓	Equivocal
Email						✓	Unequivocal
Text message						✓	Unequivocal
Written documents						✓	Unequivocal

As remote work in most cases provides a large degree of flexibility both for the individual and the organization related to time and place of the work being executed, it is found to lead to several benefits, both within performance and wellbeing (Gajendran & Harrison, 2007; Kurland & Bailey, 1999; Staglin, 2020). However, remote work conditions also lead to some challenges, counting: decreased productivity, feeling of isolation, and miscommunication (Kurland & Bailey, 1999; Poulsen & Ipsen, 2017).

When investigating previous research on remote work, the concrete benefits and challenges are found to differ from context to context. This makes it highly relevant to examine these challenges and benefits to investigate how remote work can be optimized.

1.3 Purpose and Project Scope

This study will investigate the identified literature gap in using agile practices in physical NPD while working remotely. This includes gaining insight into both the practical set-up of using agile NPD methods in a remote setting as well as the expected implications this will have on project performance and wellbeing.

The overall purpose is summarized in the purpose statement below:

> *The purpose of this qualitative study is to develop a Remote Agile Framework for the execution of physical NPD projects, based on an analysis of the challenges and benefits arising from remote work and agile practices in physical NPD, as well as an investigation of the practical application of agile in a remote setting during the COVID-19 lockdown in 2020.*

1.3.1 Scope and Limitations

The combination of agile in physical NPD and remote practices leads to several relevant sub-topics and perspectives connected to this study's purpose. To ensure a streamlined research process and an outcome suitable for the project timeline, this study will only concern a limited selection of these sub-topics. Below, it is listed which topics this study will focus on and which topics will be excluded in the project scope, despite the topics being relevant for the overall purpose.

This study will focus on:

- The practical use of the Scrum process in a remote setting for agile NPD projects
- Challenges and benefits related to well-being and performance connected to remote work
- Adaptions needed to fit the Scrum process to physical NPD projects
- Adaptions needed to fit the Scrum process to a remote setting
- Implications on performance and well-being led by remote agile project execution
- Best practices for remote and agile project execution

This study will not cover the following subjects despite being strongly related to the topic:

- Elements related to cultural differences in cross-national project teams
- Challenges related to time-differences between locations
- The physical well-being of a remote worker
- Evaluation of specific IT-tools used for remote agile NPD projects
- The societal perspective of remote working
- Issues related to the implementation of agile practices (agile transformation)

Despite that this project focuses on physical NPD, it has been decided to include data based on the software industry in the primary and secondary data collection. The reason for this is three-fold.

1. **Agile maturity**: As agile originated in the software industry, teams and organizations within software development are far more mature in the application of agile practices

2. **Remote maturity**: In software development, it is commonly seen that parts of the development team are stationed abroad. Thus, these teams have extensive experience with remote working
3. **Inclusion of relevant literature**: Some research has been made on the use of remote agile practices within software development, while no research has been done within remote agile practices in physical product development

Finally, it should be noted that this research project focuses on the perspective of the project leaders and managers working with physical NPD projects which already use or consider using agile methods in a remote setting or distributed team. However, the findings can also be interesting and relevant for team members working remotely and/or agile and general management within organizations that want to succeed with agile and/or remote practices within all industries.

*

This was the final element within the project background. The following chapter will present the research methods and design.

2 RESEARCH METHODS AND DESIGN

In the following, the research design and included methods are presented to provide an insight into the set-up and execution of this research project.

This project will be exploratory due to the low maturity within this research area. Thus, the results are implications and not conclusive findings. A secondary aim of the research project is to investigate whether it is relevant for researchers and organizations to look further into the area.

2.1 BIASES IN THE RESEARCH PROCESS

Before diving into the research design and methods, it is important to consider whether pre-conditions for the research can impact the research process and results. In this project, the author has significant previous experience within both subjects: Agile in physical NPD, obtained through work experience within the field, and remote work, due to the lockdown in Denmark led by COVID-19 pandemic. This pre-gained knowledge and experience lead to biases as the author had a clear understanding of the topics before initiating this project.

Such biases are threatening for a research study, as they risk twisting the data collection and/or interpretation in favor of the initial understanding. Thus, it is crucial to be aware of these and consider a research approach that allows for continuous reflection of new insights to ensure that these lead to a new and more profound understanding.

For this, the hermeneutic approach is relevant, as it allows an acceptance of a pre-established understanding of the topic. It seeks to evolve this understanding through an interpretation of qualitative data. It has the purpose of forming a theory rather than confirming a theory (George, 2020). Thus, this approach is seen as a good fit to ensure that the author considers biases and develops results based on a deep understanding evolved through multiple research methods.

The hermeneutic approach can be described as a spiral process. The hermeneutic spiral forming this research project is illustrated in figure 2-1. As seen in figure 2-1 each cycle from the research process is expected to provide a cycle of interpretation of the information brought by the cycle, resulting in a new understanding. As the lockdown continued throughout the entire process of executing this project, it is expected that subconscious biases based on the subjective experiences in the process were continuously mixed into the understanding, despite striving to avoid this.

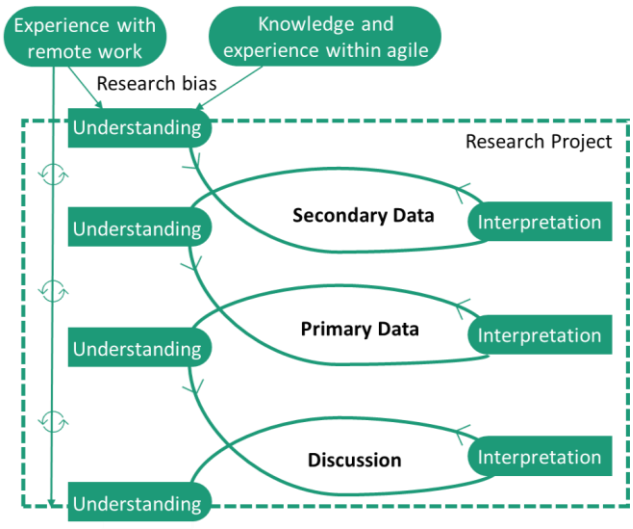


Figure 2.1: The Hermeneutic Spiral

To avoid biases interrupting the research process, a focus is on specifying *objective* data gathering and data analysis methods.

2.2 Research Design

In the following, the research design is presented. It has been decided to use a research framework inspired by the Design Science Research (DSR) method as presented by (Dresch et al., 2015b) to structure and set up the research.

The primary motivation for this is three-folded:

1. A desire to create a tangible outcome as proposed in the DSR method (Dresch et al., 2015b) (illustrated in the center of figure 2.2). In this study, the artifact will be a Remote Agile Framework (RAF) that is a part of the outcome of this research process.

2. A desire to benefit both the research society's knowledgebase and the industry environment. This is proposed by the DSR method as "rigor" and "relevance" (Dresch et al., 2015b) (illustrated on the sides of figure 2.2). This is done by including a systematic literature review (rigor) and interviews with practitioners (relevance). Also, a focus is put on presenting findings in a way that benefits the research and industry.

3. A desire to have a research process where biases do not harm the process – in this research design, no hypothesis which demands a clear answer is present, the scope of the outcome is clear, and will be directly based on the understanding developed during this research.

The research process will consist of three research steps (1) a systematic literature review, (2) practitioner interviews (3) development of a project execution framework. An essential fourth step in the DSR method includes testing the developed artifact (Dresch et al., 2015b; March & Storey, 2008). This is not possible to do within this project's scope, as it is time-demanding to implement and evaluate an NPD framework in practice. An additional deviation from the traditional DSR method is that each research step is executed only one time. The DSR method proposes an iterative execution of each research step throughout the research process. Thus, the research design is only inspired by the DSR method using it as a guideline to achieve the desired outputs and does not follow the method completely.

The research design is shown in figure 2.2, including used methods, characteristics of the environment, and the research knowledge base. In the following, each research cycle is described.

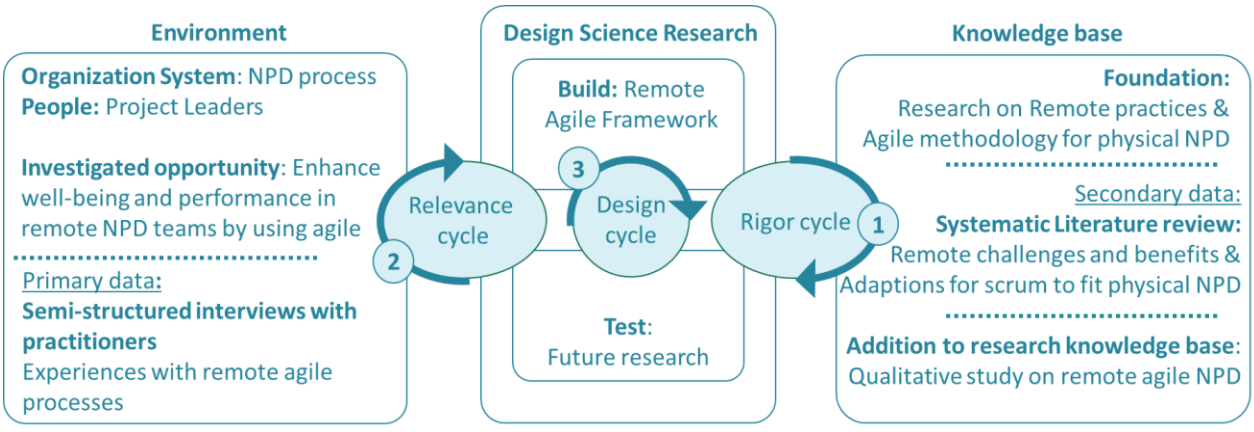


Figure 2.2: Research Design

2.3 Systematic Literature Review

The systematic literature review is the method chosen to investigate previous literature within the scope of this project. This method is chosen, as the research on especially remote working is found to be scattered and contradicting in results. Thus, it is vital to investigate the combined knowledge base to identify potential reasons for differences in results.

A systematic literature review is a secondary study that aims to identify, map, evaluate, consolidate, and aggregate results of relevant research studies, including primary data, within a specific research area (Dresch et al., 2015a). In contrast to a standard review, the systematic review aims not just to collect and present relevant literature; it should be analyzed and synthesized to contribute with new knowledge to the research society (Dresch et al., 2015a; Griffith University, 2020). The systematic review should be unbiased, accurate, and replicable (Dresch et al., 2015a; Gough et al., 2012), which corresponds to the aim of avoiding biases.

To meet the above requirements, the systematic review in this research project:

- Is focused on the explicit contribution of knowledge through specific research questions
- Have objectively selected literature identified through pre-planned and replicable activities
- Have a structured, objective, and replicable approach to data analysis

2.3.1 Research Questions

The systematic review will be divided into two main areas (1) remote work and (2) agile practices in physical NPD, leading to two separate research questions.

Several studies have been done within the field of remote work, putting a focus on various challenges and benefits both connected to performance and wellbeing. However, the literature within this field lacks an overview of the collection of identified challenges and benefits and a focus on the factors and dynamics that cause these challenges and benefits. It is known from the theory of change management that focusing on the causes of challenges, and the enablers of desired benefits is essential, as these need to be treated or promoted to achieve the desired behavior and, thus, the targeted improvements (Christensen & Rytter, 2018; Hayes, 2018).

Based on this, the *first* part of the systematic literature review focuses on making an analysis of challenges and benefits related to remote work, resulting in the following research question:

RQ1: *Based on previous research, what are the main challenges and benefits of remote work related to performance and psychological wellbeing, and what are the triggers and consequences/effects of these?*

The investigation of remote work does not target physical NPD in particular. To gain the best overview of remote work dynamics, it was chosen not to limit the search based on the industry but instead the areas of performance and wellbeing as highlighted in the research question.

Two relevant points are identified within agile in physical NPD, which is the *second* topic in the systematic review. First, this research is not looking at software development where Scrum originates from. Second, this research focuses on remote work, ignoring one of the critical elements of agile, co-location. These points lead to the following research question.

RQ2: *Based on previous research, what changes should be made to the Scrum practices to fit physical NPD projects, and what is the effect of co-location in agile for physical NPD?*

In addition to the two main subjects within the literature review, a brief investigation is made, looking into the limited literature concerning the combination of remote and agile practices, creating a *third* part of the systematic literature review. This subject has only been investigated within software development. However, it is still seen as relevant to examine, as it provides insight into the experiences and best practices within remote agile practices and indicates whether it is a relevant opportunity to investigate further within the physical NPD area.

2.3.2 Selection of Literature

The first step of the review is to identify the literature to be included. This list should be reliable yet a definite selection of literature that is both unbiased and updatable. Thus, a structured literature identification and selection process is executed. This process is seen in figure 2.3.

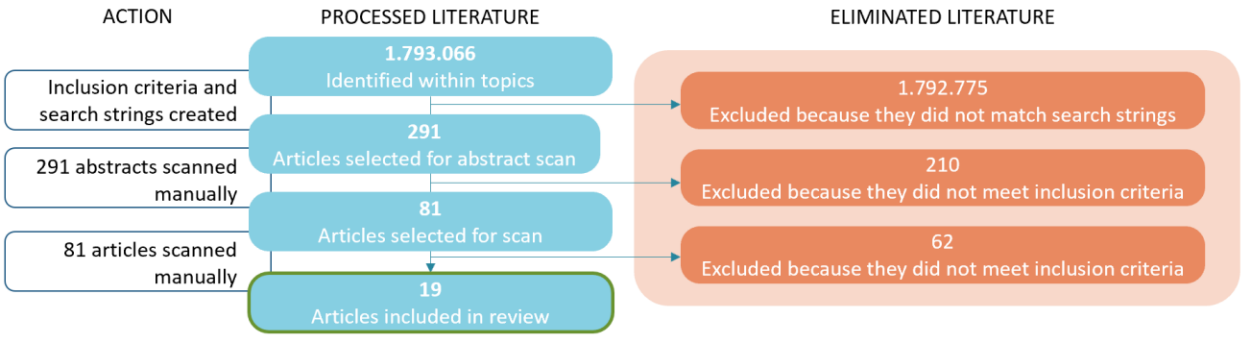


Figure 2.3: Literature Selection Process

Literature inclusion criteria and search strings

Inclusion criteria were created to make the literature selection possible and ensure a focus on the specific research questions. The inclusion criteria are:

- The text concerns one of the following topics:
  - Agile practices in physical NPD **AND** Performance
  - Agile practices in physical NPD **AND** Psychological wellbeing
  - Remote work **AND** Performance
  - Remote work **AND** Psychological wellbeing
  - Agile practices **AND** remote work
- The text is available in English or Danish
- The full text is available on DTUFindIt, Research Gate, or through Google Scholar
- The text includes primary data
- The data is related to organizations outside the educational field (no experiments based on ex. children in primary schools nor university classes)

To limit the number of articles to review manually, search strings were created within each sub-topic addressed in the first inclusion criterium. 40-100 hits on DTU Findit were the target range. This was seen as manageable to review and appropriate to ensure a good knowledge base and little risk of important literature not being included. If 40 scientific hits could not be identified, it was chosen to include popular research. The strings can be found in appendix 1. The search was executed in September 2020.

The process resulted in 19 selected articles. One article was added, which was published and identified during the project period. An overview of selected literature is seen in appendix 2.

2.3.3 Analyzing the literature

To have a clear boundary for the data included in this literature review, it was decided only to include primary data from the identified literature and findings related to this. Thus, the review will not concern statements or discussions relying entirely on additional literature.

As stated, the literature review is divided into three parts, and the literature analysis approach will differentiate between them. In the following, the analysis approach for each part is presented.

Part 1 - Remote challenges and benefits

A new *inductive* method was used to analyze the literature regarding remote work. The author developed this method to map and identify the main challenges and benefits related to the performance and wellbeing of remote work and the linked triggers for these. The method can be explained in three steps.

1. Document challenges and benefits identified in each included article and track potential related triggers. These are written on small cards seen in figure 2.4.

Figure 2.4: Challenge and Benefit Cards

2. Print out all cards and place them in the four main areas (benefits for wellbeing, benefits for performance, challenges for wellbeing, and challenges for performance). Cards related to wellbeing are defined as elements that can be connected to the individual and its feelings, where performance is defined as elements that can be related directly to the outcome delivered by the individual or team. The map is put on a wall. This is illustrated in figure 2.5.

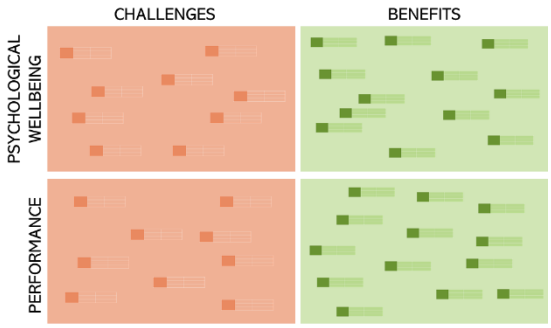


Figure 2.5: Challenge and Benefit Map

3. Cluster the identified challenges and benefits according to themes. The themes are identified through an inductive thought process trying to identify connected cards from various studies. The identified theme clusters are named according to the main challenge/benefit they are found to represent. These names are used as categories to structure further analysis. See figure 2.6.

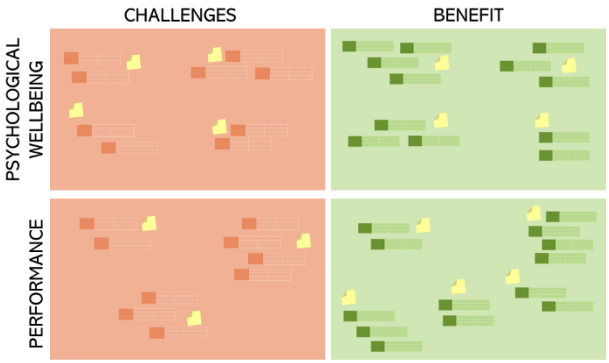


Figure 2.6: Clustering of Challenges and Benefits

Based on the identified categories, the triggers for challenges and benefits and the consequences and effects for these can be investigated and discussed with great structure, enabling a good overview of the accumulated results from previous research.

Part 2 – Agile practices

The analysis of agile practices for physical NPD is made with a *deductive* approach. This was done by analyzing findings from the literature in the categories of the Scrum elements (as presented in table 1.1 in the introduction). The focus is put on adaptions made to the traditional Scrum process made to make the process work for physical agile NPD.

Part 3 – Agile and remote

Remote agile practices are also discussed with a *deductive* approach. As there is only limited literature within this subject, findings are divided into the three categories from Scrum: roles, ceremonies, and artifacts. Again, the focus is put on identified changes. In this context, it is adaptions made to fit remote conditions and the best practices and challenges specified.

2.4 INTERVIEWS WITH PRACTITIONERS

During the Spring of 2020, the COVID-19 pandemic hit Denmark as well as the majority of the world. This forced a large part of the community to work from home – thus, work remotely (Therkildsen & Dansk Industri, 2020). This enables a unique research opportunity within the area of remote work, making the primary research of this study possible.

The practical execution of the primary research is based on the seven phases described by Kvale and Brinkman (Kvale & Brinkmann, 2014). The phases are Thematization, Design, Interview, Transcription, Analysis, Verification, Documentation.

2.4.1 Research Questions

The practitioner interviews give an insight into the application and experience of using agile practices in remote NPD projects. This leads to the question:

RQ3: *What are the experiences with using agile practices in a remote setting for NPD projects, and what are the best practices recommended by current practitioners?*

In addition, the interview data can provide insights into the experienced effects and consequences of using a fully remote agile NPD process. This is an essential part of the scope in this research project and leads to the following research question:

RQ4: *What are the experienced effects and/or consequences on a teams' performance and psychological wellbeing when executing a remote agile NPD process?*

The research questions do not specify that the findings must be related to physical NPD. This is a deliberate choice, as it is found relevant to include data both from physical NPD practitioners and software developers. In software development, agile practices have been used for many years, and distributed teams leading to remote practices are widespread. Thus, some people within this area are very mature in agile and remote practices, making it highly relevant to include their experiences to learn from these. Practitioners within physical NPD are also included in the data gathering to enable an investigation of the topic in scope, namely remote agile in physical NPD. The inclusion of both software development and physical NPD also enables insights into whether there are

significant differences in the use and effect of agile practices in a remote setting between software development and NPD.

The research questions link the interviews to the study, creating the *thematizations* of interviews.

2.4.2 Selection of interviewees

The interviewees were identified through personal network. People who were contacted were chosen based on the following selection criteria:

- Must be a full-time employee
- Must have worked remotely within the past six months
- Must know and work with agile practices in product development

Seven appropriate interviewees from three different companies who could participate in a one-hour interview were identified and selected. Based on the study's explorative nature and the time-frame and scope, it was decided that this was a sufficient amount of primary data. This was confirmed by the data gathering process, as clear connections in relevant topics could be made across interviews, indicating a satiated point in the data collection. Results within investigations of the scope in this project are expected to be influenced by several factors. Thus, if the purpose had been to draw clear conclusions and causalities between behavior and effect/consequences, a larger interview pool would be required across factors as nationality, personal life, position, gender, and personality type.

2.4.3 Developing the Interview Guide

The interviews must have a predetermined focus and an appropriate level of consistency to answer the research questions. However, due to this project's explorative purpose, it is also essential to dig into relevant aspects revealed during interviews. This is fulfilled by the standardized open-ended interview (Turner, 2010). Thus, this type of interview guide is the basis for the interview dialogue, asking the interviewees an identical set of open questions that are fundamental for this research.

An explorative mindset is used by putting a focus on exploring the interviewees' experience, with an open dialogue, and following an informal interview approach in the conversations subsequent for each predefined question (Turner, 2010). This open dialogue can be discussed to allow the introduction of biases into the interview process, as the interviewer can guide the conversation. Thus, it was a focus during the interviews to keep follow-up questions to topics introduced by the interviewee or the knowledge gained during the research project. The selection of participants and the development of the interview guide make the *design* of the study.

The interview guide was tested prior to the interviews on three people, all full-time employees with varying knowledge of agile, who have worked remotely during 2020. This allowed a refinement of the guide, ensuring that all questions were perfectly understandable and that the composition of the questions makes sense to people outside the research process.

The interviews were conducted in the period from November 3rd, 2020 to November 28th, 2020. The final interview guide is seen in appendix 3. The execution of the interviews is the *interview* phase.

2.4.4 Interview Analysis

The interviews were transcribed, following the fourth phase *transcription*. Hereafter, the interviews were coded, first with a deductive approach, coding in relation to the predetermined subjects of remote and agile practices and effects/consequences of the practices. Hereafter, sub-coding was

done using a visual inductive approach. Here each initial code category was printed on physical paper and categorized into identified sub-codes by connecting related comments across interviews within each main code category. This provided an overview of the findings and their connection, making the base for the interview *analysis* step. During the interview phase and the analysis phase, the data was verified, ensuring that it had a sound quality, was unbiased, and that the interviewees had the expected experience and knowledge. The analysis is documented to present findings in a meaningful way for the reader, finalizing the interview process with the steps, *verification*, and *documentation*.

2.5 Developing the Remote Agile Framework (RAF)

Using the knowledge gained from practitioner interviews, the RAF could be developed, leading to the following research question.

RQ5: *What is a qualified project execution framework for remote physical NPD projects based on analysis of practical experiences with remote agile NPD practices during the lockdown in 2020?*

The development of the framework takes a starting point in the Scrum framework. It focuses on adaptions needed to make a version of the framework fitting requirements for remote work and physical NPD requirements. The RAF is connected to the findings from the secondary research elements in order to investigate whether it is supported by previous research within remote work and agile practices for physical NPD. This is also used to verify whether the data collected in this project is consistent with data from previous research.

2.6 Research Process

To structure and manage the six-month research process of this project, the author used the Scrum method. This included dividing the project into sprints, using sprint goals, and using a Scrum board. On the last day of each sprint, the outcome was presented to the project supervisor at a sprint demo meeting. Subsequently, the sprint planning for the next sprint was executed, incorporating supervisor feedback. Each morning 2-5 minutes were dedicated to considering the day's work, representing an individual daily stand-up meeting.

In addition, a milestone plan was created to ensure keeping the overall timeline, as the deadline of this project was fixed. Examples of the used Scrum Board are seen in appendix 4.

It is highly recommended for fellow and future students to consider using the Scrum approach to execute large projects. It (1) provided a great overview, (2) made ground for constructive feedback, and (3) helped to finalize research elements continuously, which mitigated the risk of having a large amount of work in the last project phase.

*

To summarize the Research Method and Design section, an overview of the research elements is provided, including a brief presentation of their contribution to the research process and the research questions answered (see figure 2.7). It can be seen that the research elements are followed by a discussion. This is used to connect the findings to the general area of the research scope both in a practical and theoretical perspective, as well as discuss relevant limitations and future work.

The summary is the final part of the Research Method and Design chapter. The following chapter will present the rigor cycle of the research process – the systematic literature review.

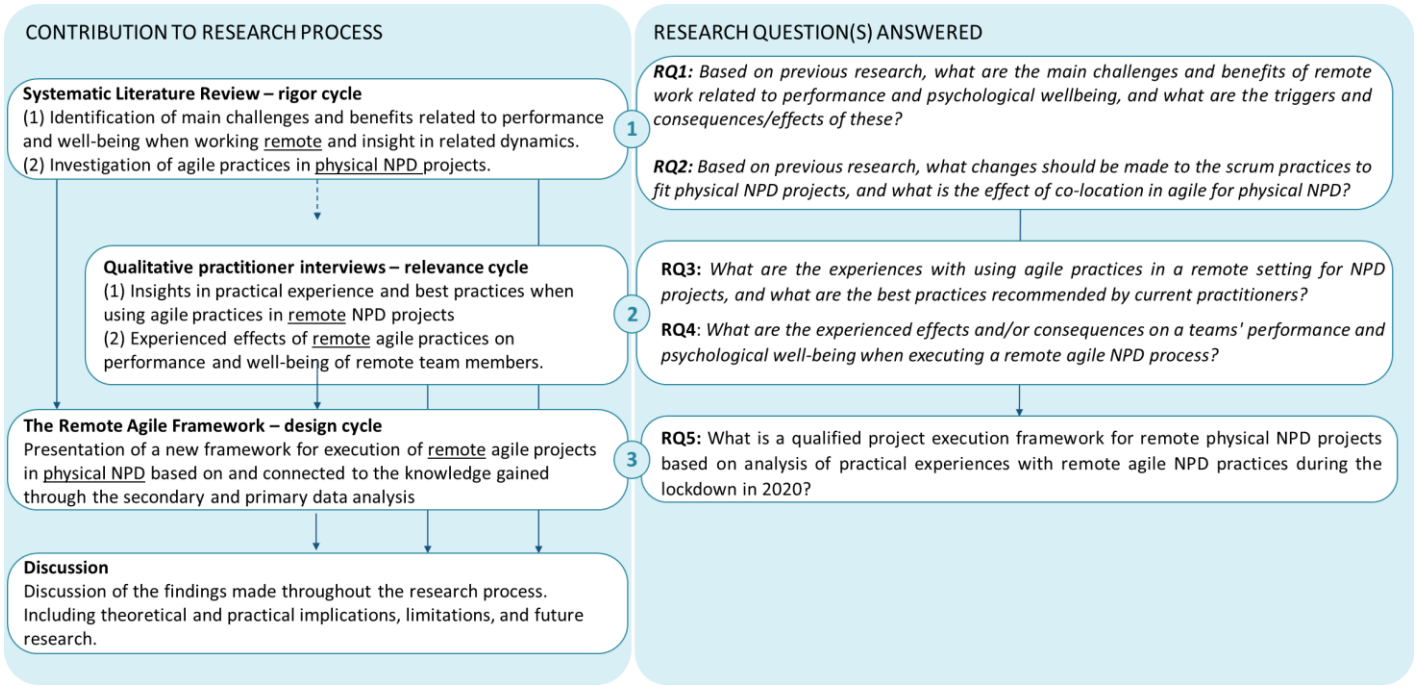


Figure 2.7: Research Process Overview

3 SYSTEMATIC LITERATURE REVIEW: RIGOR CYCLE

To answer the first two research questions existing literature is thoroughly examined through a three-split literature review. As stated, the three sections look into (1) the challenges and benefits of working remotely, (2) changes to agile practices when applying it on physical NPD projects, and (3) working remotely and agile combined.

3.1 REMOTE CHALLENGES AND BENEFITS

In the literature search, the articles were categorized in the areas of *performance* and *wellbeing*. Despite this, several studies were found to address topics related to both areas. Thus, all literature included within remote work is analyzed throughout the entire review.

It should be noted that the studies vary in types of remote work. Five studies focus on working fully remote from home (Grant et al., 2013; Johri, 2015; Kurland & Bailey, 1999; Lattemann et al., 2017; Olson & Olson, 2014), three focus on part-time remote workers - working from home and from the office (Bentley et al., 2016; Gajendran & Harrison, 2007; Wang et al., 2020), and two focus on cases where workers are stationed in satellite offices/project sites away from their manager and functional division (Poulsen & Ipsen, 2017; Weimann et al., 2010). Some challenges and benefits vary depending on the type of remote work. However, it is relevant to include all of these to provide a holistic overview of remote challenges and benefits.

The inductive process of identifying main challenges and benefits led to 11 categories. The categories are seen in table 3.1, and an image of the visual set-up of the method is in appendix 5.

Table 3-1: Categories for Remote Challenges and Benefits

Benefits **Performance**	Challenges **Performance**	Benefits **Wellbeing**	Challenges **Wellbeing**
Increased quality of communication	Decreased quality of communication	Decreased stress-level	Increased stress-level
Increased productivity	Decreased productivity	Increased quality of remote worker relationships	Decreased quality of remote worker relationships
Increased recruitment pool	Lack of performance monitoring	Increased job satisfaction	

This section will be divided into sub-sections concerning *performance* and *wellbeing*. Each of the 11 categories is discussed independently within the related sub-section to gain insights into the triggers and effects/consequences which are put in scope by the first research question.

3.1.1 Remote Challenges and Benefits Related to Performance

In the following, the findings within each of the six categories related to performance are presented. A summary of the results, including identified triggers and effect(s)/consequence(s) for each challenge and benefit, are found at the end of this sub-section in table 3.2.

Increased quality of communication

Working remotely instead of co-located changes the means of communication fundamentally, as it is not possible to communicate face-to-face; thus, employees must use digital tools (email, video call, phone call, message, etc.) to communicate and exchange information with others.

The case study by Johri (Johri, 2015) zooms in on one specific company, which operates with a complete distribution of its workers despite being a development organization. The study investigates how the use of "blogging" increases the performance of remote development work (the blogs' functions are found to be equal to a common MS Teams channel or Slack channel). An interviewed leader states that the distributed way of working works even better than a centralized one. This statement makes the case relevant to investigate, as it represents an organization that is successful with complete remote work. The study found that one key element was the continuous sharing of progress, results, and other information that could be relevant. Not just to the same one person or a team, the entire organization was equally available, all working remote. This allows (1) high transparency of progress leading to a shared understanding within groups supporting high productivity (Johri, 2015), (2) quick communication of potential problems to a wide range of people both within the same project if needed, within the same functionality if needed, and people who in one way or another is interested in the project, all allowing quick problem solving within the development.

Remote tools also allow communication to be documented. This ability to record communication (both written and video conferences) allowed excellent knowledge sharing and shared understanding. Especially the functionality of chats was highlighted:

> *"There are many advantages to chat as the conversation can be archived, search, and made visible to the entire team"* (Johri, 2015)

This element of documenting communication and reviewing/using it later and at different times is also referred to as asynchronous communication, which is argued to be beneficial by other studies as well. In the case study executed by Latteman et al. (Lattemann et al., 2017), a team was asked to test a framework for remote execution of a design thinking process. It was found that the asynchronous communication, led by documentation of group process, made it easy to catch up with the progress and gave an improved workflow.

In the explorative qualitative study by Grant et al. (Grant et al., 2013) based on interviews with 11 remote workers in five organizations, it was discovered that the remote workers utilized the possibility of making decisions outside regular work hours instead of waiting for people to be reachable again. This was enabled by greater access to up-to-date information. It was noted that the quality of these, often late-night decisions, could be doubted. However, it was stated that decisions made using technology would have been the same as on-site decisions (Grant et al., 2013).

Decreased Quality of Communication

Contradicting the arguments above, a decreased quality of communication is identified as a challenge when working remotely.

In the study by Lattemann et al., the switch to remote communication is found to increase the amount of written communication. The study reveals that most interviewees prefer face-to-face communication due to the lack of verbal communication in a remote setting (Lattemann et al., 2017). In relation to this, Olson and Olson states, in their popular report, revolving around: how to make distance work – work (Olson & Olson, 2014), that remote teams tend to choose technologies that they know from their usual (non-remote) work life, such as emails. Thus, they miss the possibilities provided by other technologies such as shared documents and rich communication media as video conference (Olson & Olson, 2014).

This issue is also discussed in the qualitative case study by Weimann et al. investigating a German manufacturing company that executes distributed projects (Weimann et al., 2010). Here most participants argued that too many emails were sent and that 11% of these emails were unclear, leading to misunderstandings. Besides, it was stated that receivers of unclear messages rarely phoned back to clarify the information verbally. The increase in unresolved misunderstandings can be linked with an increase in project risks (Weimann et al., 2010).

Even when using richer communication media, including verbal communication such as video conferences, issues can be identified. Grant et al. point out that when using teleconferences, important social body language cues are missed. This can result in some people talking too much without being stopped, interrupting a meeting flow (Grant et al., 2013).

In Kurland and Bailey's extensive qualitative study, including data from 54 on-site and remote supervisors and their remote workers, another challenge related to communication is identified. As a consequence of the lack of face-to-face communication, a lack of informal communication is found. Organizations tend to have a large amount of informal knowledge sharing "by the watercooler" (Kurland & Bailey, 1999). This makes it highly difficult to maintain organizational learning and sharing of culture and values when people work remotely. People do not engage in conversation without an explicit context or engage in small talk with colleagues. The importance of informal communication is highlighted in several studies. (Kurland & Bailey, 1999; Wang et al., 2020; Weimann et al., 2010).

A tangible issue is pointed out by Lattemann et al., namely, that technical problems can lead to an interruption in the workflow when working remotely (Lattemann et al., 2017), which is a crucial challenge since technology is the only way to share information.

The challenge of decreased quality of communication includes an essential sub-challenge: a *decrease in team collaboration*. This is a relevant aspect as team collaboration is a crucial part of NPD practices.

Kurland and Bailey highlights the challenge of coordination and organization of work. This is identified to be difficult when working remotely (Kurland & Bailey, 1999). To overcome this challenge, the coordination of who does what and how work should be handed over must be managed explicitly. Also, a clear outlining of how the team is expected to coordinate must be made to avoid misunderstandings (Kurland & Bailey, 1999; Olson & Olson, 2014; Weimann et al., 2010).

Also, the element of availability can challenge team collaboration. The flexibility for remote workers to choose when they work leads them to might be unavailable, thus not responding, during regular work hours (Kurland & Bailey, 1999).

A final identified challenge related to a decrease in team collaboration is the prevention of rapid and continuous knowledge sharing between team members.

> *"There is no looking over the shoulder of one's colleagues"*(Olson & Olson, 2014)

This leads to the detailed context of ongoing work is often missing due to the physical separation of team members.

Increased Productivity

A benefit widely discussed is the increase in productivity. In Kurland and Bailey's study, an improvement in workplace productivity was identified as an effect of remote work, and it was found that remote workers have higher performance ratings (Kurland & Bailey, 1999).

The increase in productivity is found to be led by great flexibility (to work when and how it is preferred) and a distraction-free environment (Grant et al., 2013; Kurland & Bailey, 1999). It is also seen that remote workers take fewer sick days and have more available work-hours due to the elimination of commute time (Grant et al., 2013; Kurland & Bailey, 1999). This argument for flexible scheduling is supported by the quantitative study by Gajendran and Harrison based on a meta-analysis of 46 studies involving 12.883 employees who find that flexible work schedules had a significant effect on performance (measured as productivity) (Gajendran & Harrison, 2007)

The study by Grant et al. also supports this. Here most respondents reported that their productivity increased. This happened when working remotely from home and resulted in work completed on time and increased concentration. Here it is found that the main reason for the increase in productivity is the elimination of disruptions. It is also stated that working without having the social pressure of colleagues and social interaction around in an open space office leads to an increase in productivity (Grant et al., 2013).

Lattemann et al. (Lattemann et al., 2017) also conclude an increase in productivity in the remote team. Here, the increased productivity is found to be led by an increased focus on using a structured virtual platform.

Decreased Productivity

On the opposite side, decreased productivity is a discussed challenge in literature.

First of all, if working from home, distractions from colleagues, small-talk, and managers, are eliminated, but others arise. Grant et al. observed one respondent who stated that working from home resulted in more time in front of the TV during the workday (Grant et al., 2013). The study also finds that family-members being home during work hours can be distracting and decrease concentration, affecting productivity negatively. To overcome this challenge, the remote worker must have the ability to self-manage (Grant et al., 2013).

Kurland and Bailey also highlight the issue of having obligations, such as children, when working from home (Kurland & Bailey, 1999).

Besides, Kurland and Bailey find that remote workers' productivity decrease because of a lack of informal interaction, decreasing sharing of valuable information throughout the day (Kurland & Bailey, 1999). One manager interviewed in the study stated:

> *"Productivity gains are measured when you put people into an office environment, and a lot of synergies is created...When you telecommute... there is a lack of energy that I notice in the office..."* (Kurland & Bailey, 1999)

Finally, Grant et al. state that individual preferences for work environment can influence productivity. Some people feel more productive when sitting at their desk at the office, out of the comfort zone and mental environment of home (Grant et al., 2013). This is a crucial point to note, as individual preference can explain contradictions in research studies, as individuals vary within and across studies.

Increased Recruitment Pool

A great benefit from a remote work setting is that it enables distributed teams and organizations. This allows a potential global recruitment pool and the possibility of stationing workers in different geographic locations.

This benefit is mentioned by several articles but not explicitly addressed by all of them. Kurland and Bailey state that remote work leads to the possibility of hiring more talented people and a broader range of customer service (Kurland & Bailey, 1999).

In the case study by Weimann et al. (Weimann et al., 2010), some project teams must be onsite (on a specific project location). Remote work allows this set-up to function globally while the manager and other stakeholders remain at HQ or can travel between several ongoing projects while managing.

The element of being able to hire people close to or at customer sites while managed from a distance is also emphasized by Poulsen and Ipsen in the qualitative study of distance manager practices (Poulsen & Ipsen, 2017). The study reveals that this type of work-structure occurs in multiple industries, including Management consulting, Software development, Engineering consulting, and Advanced Manufacturing, where remote management is needed.

Lack of Performance Monitoring Practices

Performance monitoring is a problematic practice when dealing with remote work (Gajendran & Harrison, 2007; Grant et al., 2013; Kurland & Bailey, 1999).

Grant et al. identified a varying approach to performance monitoring for remote workers. People in roles with a high degree of autonomy were responsible for monitoring their own work and reporting progress. People in positions with less autonomy were monitored directly, sometimes by IT-systems constantly measuring their log-in times and work completed. The latter type of monitoring was found to decrease trust, as the worker felt untrusted by the constant monitoring. It was also revealed that several of the respondents' organizations did not recognize or measure e-working practices (Grant et al., 2013).

Poulsen and Ipsen support that managers should not micromanage remote workers but give them autonomy and authority to make decisions regarding their work (Poulsen & Ipsen, 2017). In the study, several interviewees stated that different types of surveys were used to measure performance. However, here it was the customer that the remote worker was stationed at, who responded, giving the manager of the remote employee insights into the work (Poulsen & Ipsen, 2017).

Kurland and Bailey state that a lack of monitoring of the employees' performance might make it difficult to develop skills (Kurland & Bailey, 1999). When managers cannot physically observe their employees, it is challenging to note the employee's weaknesses and strengths and provide reliable and constructive feedback.

Lack of performance monitoring practices was the sixths and final category within the area of performance. Below, the summary of key findings is shown in table 3.2.

Table 3-2: Overview of Challenges and Benefis Related to Performance

Category	Triggers	Effects/Consequenses
Increased Quality of Communication (Grant et al., 2013; Johri, 2015; Lattemann et al., 2017)	**Documentation of information and communication** (Johri, 2015; Lattemann et al., 2017) **Continuous sharing of information** (Grant et al., 2013; Johri, 2015; Lattemann et al., 2017) **High Responsiveness** (Johri, 2015)	**Increased knowledge sharing** (Johri, 2015) **Shared understanding** (Johri, 2015; Lattemann et al., 2017) **Improved workflow** (Lattemann et al., 2017) **Quick problem solving** (Johri, 2015) **Decision making outside normal workhours possible** (Grant et al., 2013)
Decreased Quality of Communication (Grant et al., 2013; Kurland & Bailey, 1999; Lattemann et al., 2017; Olson & Olson, 2014; Poulsen & Ipsen, 2017; Weimann et al., 2010)	**Lack of Verbal communication** (Lattemann et al., 2017; Olson & Olson, 2014; Weimann et al., 2010) **Lack of responsiveness** (Kurland & Bailey, 1999; Weimann et al., 2010) **Lack of informal communication** (Grant et al., 2013; Kurland & Bailey, 1999) **Technological issues** (Lattemann et al., 2017)	**Misunderstandings** (Kurland & Bailey, 1999; Olson & Olson, 2014; Weimann et al., 2010) →**increased project risks** (Weimann et al., 2010)) **Decreased collaboration** (Kurland & Bailey, 1999) **Decreased knowledge sharing** (Kurland & Bailey, 1999; Olson & Olson, 2014) **Lack of org. Learning and culture** (Kurland & Bailey, 1999)
Increased Productivity (Gajendran & Harrison, 2007; Grant et al., 2013; Kurland & Bailey, 1999; Lattemann et al., 2017)	**Flexible workhours** (Gajendran & Harrison, 2007; Grant et al., 2013; Kurland & Bailey, 1999) **Distraction free environment** (Grant et al., 2013; Kurland & Bailey, 1999) **Increased concentration** (Grant et al., 2013; Lattemann et al., 2017) **Elimination of social pressure** (Grant et al., 2013)	**Higher performance** (Gajendran & Harrison, 2007; Kurland & Bailey, 1999) **Tasks finished on time** (Grant et al., 2013) **Increased efficiency in team collaboration** (Lattemann et al., 2017)
Decreased Productivity (Grant et al., 2013; Kurland & Bailey, 1999)	**Distractions from home environment** (Grant et al., 2013; Kurland & Bailey, 1999) **Decreased concentration** (Grant et al., 2013; Kurland & Bailey, 1999) **Lack of informal communication** (Kurland & Bailey, 1999) **Individual preferences for separation of work and home** (Grant et al., 2013)	**Decreased performance** (Grant et al., 2013; Kurland & Bailey, 1999)
Increased Recruitment Pool (Kurland & Bailey, 1999; Poulsen & Ipsen, 2017; Weimann et al., 2010)	**Ability to distance manage** (Kurland & Bailey, 1999; Poulsen & Ipsen, 2017; Weimann et al., 2010)	**More talented workers** (Kurland & Bailey, 1999) **Ability to be located close to customers/projects** (Poulsen & Ipsen, 2017; Weimann et al., 2010)
Lack of Performance Monitoring Practices (Gajendran & Harrison, 2007; Grant et al., 2013; Kurland & Bailey, 1999)	**Remote workers cannot be observed** (Kurland & Bailey, 1999) **Some employees are micro monitored** (Grant et al., 2013)	**Difficult for managers to develop employees** (Grant et al., 2013; Kurland & Bailey, 1999) **Employees with little authority feel untrusted** (Grant et al., 2013)

3.1.2 Remote Benefits and Challenges Related to Wellbeing

Five categories, distributed in three benefits and two challenges, were identified related to wellbeing. These are presented in the following. Again a table summarizing key findings is created and can be found at the end of the section in table 3.3.

Decreased Stress-level

One of the benefits often mentioned when discussing remote work is a decrease in stress level.

The quantitative study by Gajendran and Harrison, confirms a hypothesis stating that *remote work reduces employee (work-related) stress* (Gajendran & Harrison, 2007). One mentioned possible enabler for this is that remote workers have a greater opportunity to participate in social or sports activities due to their flexibility. Another factor pointed out is that work-life conflict decreases, leading to reduced stress levels (Gajendran & Harrison, 2007). This is supported by Grant et al., who states that most remote workers in the study experienced reduced stress levels as an effect of remote working, as it frees up time for family (Grant et al., 2013). Also, Grant et al. found that remote workers used the flexibility in work hours to adapt their work to fit their private life, improving their work-life balance (Grant et al., 2013).

Another quantitative study, including data from 804 remote workers, focuses on organizational support related to remote work (Bentley et al., 2016). This study also identifies a decrease in stress levels. It was found that a weak link between the reduced stress-level and support for teleworkers was present. However, it is discussed that reduced travel time, cost, and increased free-time have a more substantial impact on the reduced stress-level.

Increased Stress-level

Previous research also shows that remote work can lead to an increased stress-level.

One explanation for this is given by Grant et al., who found that remote workers tend to blur lines between work and free-time, never completely shutting down feeling an obligation always to be reachable (Grant et al., 2013).

Kurland and Bailey support this issue of setting boundaries between work and home. They state that some people, for example, use the commute time as a “warm-up” or “cool down” period, ensuring that concerns from work are not interfering at home and vice versa (Kurland & Bailey, 1999). Thus, the removal of this transition time can increase the load of concerns and reduce focus.

In the study by Grant et al., respondents stated that the constant availability of technology and temptation to work on all hours led to a burn-out point and complete exhaustion. This significant increase in stress-level resulted in a significant decrease in productivity (Grant et al., 2013).

In the study by Poulsen and Ipsen, it is found that too high expectations from day one, and lack of response from managers, negatively affect the wellbeing (including work-related stress) and motivation for a remote worker (Poulsen & Ipsen, 2017). This is also highlighted by Grant et al., who states that expectations must be clear between manager and remote worker (Grant et al., 2013). This indicates that managerial behavior is essential for a remote worker’s stress level. In relation to this, it is mentioned by Bentley et al. who finds that good support, both organizational and social, is vital to decrease the amount of stress, as a lack of support leads to an increased feeling of psychological isolation, which is found to increase workplace stress (Bentley et al., 2016).

Increased Quality of Remote Worker Relationships

Remote conditions prevent people from having face-to-face contact with colleagues. However, the quantitative study (Gajendran & Harrison, 2007) found a positive effect of telecommuting on the employee–supervisor relationship. Two possible explanations were proposed as factors that could lead to this. (1) Remote workers had higher objective performance ratings, which can imply that

high-performing workers who were in good standing with their supervisors were the ones offered the opportunity of remote work. (2) An increased focus on building a relationship based on the knowledge that remote work often makes this a challenge (Gajendran & Harrison, 2007).

In the quantitative study by Wang et al., based on an online survey of employees working remote at least some of their time (N=446), investigating the connection between remote work and organizational commitment, it was proposed that the availability of modern technology is an essential factor. It is possible that telecommuters can overcome distance and psychological isolation through technologies that provide interaction quality comparable to face-to-face meetings (Wang et al., 2020).

Decrease Quality of Remote Worker Relationships

It is argued by literature that it is difficult to establish and maintain good interpersonal relationships when working remotely (Grant et al., 2013; Poulsen & Ipsen, 2017; Wang et al., 2020; Weimann et al., 2010). A big challenge connected to relationships is found to be the tendency for remote workers to be "out of sight – out of mind" (Kurland & Bailey, 1999). This leads to remote workers not being included in informal communication at the office, decreasing the amount of interaction with colleagues.

In the study by Wang et al., it was found that telecommuters being psychological and/or physically isolated either have or perceives themselves to have low network power. It is suggested that the physical isolation led by remote work has a negative impact on the remote workers' ability to maintain meaningful collegial relationships. However, the implementation and use of rich communication media can eliminate this challenge (Wang et al., 2020).

The same study found that psychological isolation can be present even when being physically co-located – people can feel alone while being surrounded by colleagues. It is also found that physical isolation does not directly lead to psychological isolation (Wang et al., 2020). In addition, the study by Gajendran and Harrison concludes that there is no evidence for remote work to negatively affect coworker relationships (Gajendran & Harrison, 2007).

Concerning this, it is pointed out by Bentley et al. that ineffective support for remote workers results in inadequate social interactions leading to a feeling of psychological isolation and decreased relationships (Bentley et al., 2016). This need for support and frequent dialogue and feedback is also recognized by Poulsen and Ipsen, who state that this is a crucial capability to practice for a distance manager, to establish a relationship with remote workers (Poulsen & Ipsen, 2017).

It is concluded by Wang et al. that the feeling of isolation (both physical and psychological) decreases the worker's continuance commitment (the desire to remain within the organization) (Wang et al., 2020). This can lead to higher turnover rates, which harms an organization as it loses knowledge built up in an employer. In line with this, Bentley et al. conclude that insufficient support from organizations, managers, or coworkers decreases the job-satisfaction (Bentley et al., 2016). This emphasizes the importance of maintaining strong relationships with remote workers.

An essential sub-topic within relationship challenges is found to be *lack of trust*.

Kurland and Bailey state that resentment among workers who have *not* been chosen to work remotely can arise. This is expressed by colleagues who do not believe that remote workers are

working as hard as non-remote workers and do not trust that the remote workers are as productive as they should (Kurland & Bailey, 1999).

Grant et al. argues that it is more challenging to build trust when workers are remote (Grant et al., 2013). It is stated that it is essential for remote workers to feel trusted to trust others. This is done by giving the remote worker autonomy and trust that tasks are completed both on time and with high quality. If this is fulfilled, trust can be built. Olson and Olson also point out that behaving in a way that engenders trust is crucial (Olson & Olson, 2014). However, trust is slow to develop in a remote setting (Olson & Olson, 2014).

One way to deal with trust challenges is to establish a team made up of people who "have worked together, have common ground and common work styles, and like working together" (Olson & Olson, 2014). This is also pointed out by one of the interviewees in the study by Weimann et al.

"If I do know the people personally, it is not important where they are when working together in a project"(Weimann et al., 2010)

However, doing this eliminates the possibility of creating a team across locations that have not been co-located, which is a central point of remote work benefits. Thus, it is needed to find solutions for creating trust and good relationships between remote workers who have not worked closely together before.

Increased Job Satisfaction

Kurland and Bailey find that remote workers experience higher job satisfaction, which several interviewees stated in their study (Kurland & Bailey, 1999). One reason proposed to enable this is the increase in work-life quality.

Another potential reason for this benefit is given by Wang et al., who states that,

"sSome telecommuters, particularly those who are introverted, may prefer to work separate from their colleagues, cherishing the distance from others rather than feeling psychologically isolated because of it" (Wang et al., 2020)

This indicates that the effect on job satisfaction is individual and dependent on personality traits. Again it is implied that variation in personal preferences can explain contradicting results in research on remote work.

The study by Gajendran and Harrison confirmed a hypothesis stating that *remote work leads to greater job satisfaction*. It revealed a partial mediation for job satisfaction and turnover intent, indicating a lower turnover intent as a result of higher job satisfaction created by remote work (Gajendran & Harrison, 2007).

The study by Bentley et al. finds that low-intensity remote workers (employees who work from home less than half of the time) experience the most significant increase in job satisfaction. These part-time remote workers can utilize most remote work benefits without experiencing disadvantages such as long periods of isolation (Bentley et al., 2016).

This was the final category identified within remote challenges and benefits in the systematic review. In table 3.3, key findings are summarized.

Table 3-3: Overview of Challenges and Benefits Related to Well-being

Category	Triggers	Effects/Consequences
Decreased Stress-level (Bentley et al., 2016; Gajendran & Harrison, 2007; Grant et al., 2013)	**More free time (elimination of commute time)** (Bentley et al., 2016; Grant et al., 2013) **Flexible workhours** (Gajendran & Harrison, 2007; Grant et al., 2013)	
Increased Stress-level (Bentley et al., 2016; Grant et al., 2013; Kurland & Bailey, 1999; Poulsen & Ipsen, 2017)	**Blurred line between work and home** (Grant et al., 2013; Kurland & Bailey, 1999) **Lack of support** (Bentley et al., 2016; Poulsen & Ipsen, 2017) **Unclear or too high expectations** (Grant et al., 2013; Poulsen & Ipsen, 2017)	**Decreased performance** (Grant et al., 2013) **Decreased motivation** (Poulsen & Ipsen, 2017) **Decreased focus** (Kurland & Bailey, 1999) **Potential burnout** (Grant et al., 2013)
Increased Quality of Remote Worker Relationship (Gajendran & Harrison, 2007; Wang et al., 2020)	**Good quality of communication technology** (Gajendran & Harrison, 2007; Wang et al., 2020) **Focus on updating supervisor continuously** (Gajendran & Harrison, 2007) **Focus from supervisor to reach out to remote workers frequently** (Gajendran & Harrison, 2007)	
Decreased Quality of Remote Worker Relationship (Bentley et al., 2016; Grant et al., 2013; Kurland & Bailey, 1999; Olson & Olson, 2014; Wang et al., 2020; Weimann et al., 2010)	**Decreased amount of interactions** (Bentley et al., 2016; Kurland & Bailey, 1999) **Lack of informal communication** (Kurland & Bailey, 1999) **Out of sight (not physically present)** (Wang et al., 2020) **No previous collaboration** (Olson & Olson, 2014; Weimann et al., 2010)	**Lack of trust** (Grant et al., 2013; Kurland & Bailey, 1999; Olson & Olson, 2014; Weimann et al., 2010) **Feeling of isolation** (Bentley et al., 2016; Wang et al., 2020) **Decreased job satisfaction** (Bentley et al., 2016) **Decreased commitment** (Wang et al., 2020) →**Increased turnover intent** (Wang et al., 2020)
Increased Job Satisfaction (Bentley et al., 2016; Gajendran & Harrison, 2007; Kurland & Bailey, 1999; Wang et al., 2020)	**Increase in work-life quality (decrease in stress-level)** (Kurland & Bailey, 1999) **Introvert personalities can be alone** (Wang et al., 2020)	**Lower turnover intent** (Gajendran & Harrison, 2007)

3.2 AGILE IN PHYSICAL NPD

In the following, the second part of the systematic review, focusing on Agile Practices in Physical NPD, is presented to answer the second research question. Seven articles are reviewed to investigate this area.

Within the literature on agile practices in manufacturing companies, the most explored method is the Agile Stage-Gate model. The Agile Stage-Gate model combines Scrum and the traditional product development and project portfolio management process Stage-Gate invented by Dr. Robert Cooper in the 1980s (Cooper, 1990). As this study does not focus on Agile Stage-Gate, the Stage-Gate model will not be explained. However, it should be noted that the implementation of agile practices in physical NPD is often combined with a traditional project governance model.

In the following, the Scrum elements are analyzed based on the included literature.

3.2.1 Roles

Four roles can be identified when investigating agile in physical NPD: Development team, Scrum master, Product Owner, and project leader.

The development team should be fully dedicated according to software agile. However, a significant discussion evolves around the level of dedication needed. Different studies concerning agile NPD conclude that this is difficult in hardware development and concludes that teams improve performance despite not being fully dedicated (Cooper & Sommer, 2018b; Edwards et al., 2019). However, it is stated that fully or almost fully dedicated teams achieve the best results (Cooper & Sommer, 2018b; Sommer et al., 2014)

In literature, it is seen that large organizations, despite struggling with the dedication of team members, are able to dedicate core team members in a focused team with 60-75% dedication. This is concluded in a recent article exploring Agile Stage-Gate in practice (Cooper & Fürst, 2020).

An aspect of the discussion revolving around dedication is the diversity in the competencies needed when developing hardware products. In a study investigating the use of Agile Stage-Gate in three Danish SMEs, it was observed that some team members dedicated no more than 10% of their time to the agile project. This is far from the dedication proposed by agile norms. However, since they could still participate in frequent coordination meetings, their knowledge was still applied in the project (Edwards et al., 2019). A reason for the low dedication seen in this study could be the limited resources available in a small or medium-sized organization. This can cause that people must work on multiple projects or maintain operational tasks to keep the organization running. This point opens the possibility of allowing some project resources to be less dedicated while contributing with the needed competencies. Cooper and Fürst also propose this in their analysis of Agile practices in physical NPD (Cooper & Fürst, 2020).

The team should be cross-functional, as known from agile in software (Sommer et al., 2014). This aspect is already known in physical NPD from the Stage-Gate model, where people from marketing, sales, and operations work with the technical people through-out development (Edwards et al., 2019). The aspect of cross-functional teams are in general not in focus in the literature.

The Scrum Master is a central role in software agile. In hardware development, this role is, however, up to debate. It is seen in multiple cases distributed over several studies that the role of the Scrum Master corresponds to the one seen in software agile, responsible for facilitating the process (Cooper & Sommer, 2018b; Sommer et al., 2014, 2015). In connection to this, Cooper and Fürst state that Scrum Masters are used more as an agile coach and that the role may be excess when the team gains enough experience to facilitate the Scrum process by themselves (Cooper & Fürst, 2020). Sommer et al. noted that it was team members who were trained as Scrum Masters in the investigated cases.

The Product Owner is a role weakly investigated by the identified existing literature. All literature focusing on the Scrum practices starts by shortly explaining the roles presenting the Product Owner (Cooper & Fürst, 2020; Cooper & Sommer, 2018a; Edwards et al., 2019; Sommer et al., 2014), like the short description in the introduction for this report.

However, the impact or practices of the specific role is not in focus. In the case study done by Cooper and Sommer in 2018, only one of six companies were mentioned to implement the role (Cooper & Sommer, 2018a), and the implications of this were not discussed. In the SME case-study done by Edwards et al., it was mentioned that the Product Owners in all companies were coached and participated in demo meetings (Edwards et al., 2019). Cooper and Fürst do not mention the Product Owner at all in their results and discussion, despite presenting in the introduction. In the study by Sommer et al. (Sommer et al., 2014), it is mentioned that the former project leaders became Product Owners in the agile set-up.

The above implies a gap in the literature when it comes to the Scrum Master and Product Owner role when implemented in non-software NPD.

The Project Leader does not exist in traditional Scrum (Cooper & Sommer, 2018a). However, it is concluded by Cooper and Fürst that most manufacturing companies keep the role of the Project Leader (Cooper & Fürst, 2020). One of the reasons for this is argued to be that the agile projects usually only represent a minority of all projects. Also, not all team members have the same level of dedication, and thus, more synchronization, coordination, and leadership are needed comparing to complete Scrum projects (Cooper & Fürst, 2020). MacCormack et al. propose that the leadership style and structure should be fitted to organizations. Besides, the type of process should be chosen for individual products, as not all types of products need the same level of agility to be successful (MacCormack et al., 2012).

3.2.2 Ceremonies

In relation to ceremonies, literature agrees that these should be similar to those presented in traditional Scrum as described in the project background.

Edwards et al. observed that the **sprint planning** meeting provided a common understanding of the following project steps, what is needed, and goals for the development and management team. Sprint planning was identified as one of the elements that improved the innovation process, as it provided a clear structure for project planning (Edwards et al., 2019).

Daily Stand-up meetings are discussed in the literature to be a challenge for some physical NPD teams to execute as in traditional Scrum. This relates to the issue of team dedication. Cooper and Sommer state that daily meetings might be impossible when team members are dealing with more than one project (Cooper & Sommer, 2018a). In the recent case-study, Cooper and Fürst propose that the stand-ups are only held 2-3 times per week (Cooper & Fürst, 2020) as the desired effect of coordination, synchronization, and problem-solving is still obtained. In the comparative study by Sommer et al., it is seen that all five companies implementing an agile approach held the stand-up daily (Sommer et al., 2015). It is not elaborated how much this element contributed to the improvements identified. However, several of the stated improvements have to do with improved coordination, communication, and collaboration. Based on this, it can be derived that frequent communication is essential, as the mentioned improvements are associated with daily scums (Cooper & Sommer, 2018a; Schwaber & Sutherland, 2011).

In the study completed by Edwards et al., the frequency of these stand-up meetings varied significantly between companies, emphasizing the challenge of resource allocation for the meetings stated by Cooper and Sommer. Here one company held the meetings daily, one company 2-3 times a week, and one company only 0-1 a week. The discussion concluded that the Scrum meetings had

a critical function in relation to team synchronization related to project progress (Edwards et al., 2019). A relevant finding was the fact that all team members should be present at each stand-up meeting. If some team members are not current, valuable insights are not shared across the team, and decisions made on the stand-ups are not accepted and must be revisited at a later point, which *decreases* efficiency (Edwards et al., 2019).

Demo meetings are also implemented in physical NPD projects in the same way as in software agile. The most discussed difference from using agile in software vs. physical product development is that teams cannot show a functional prototype at each meeting (Cooper & Fürst, 2020; Cooper & Sommer, 2018a; Edwards et al.,2019). This is emphasized by an investigation presented in (Cooper & Fürst, 2020) that shows only 45% of manufacturing companies using agile development do frequent prototyping.

However, it is still argued that the demo meetings serve an important purpose, as they allow frequent feedback on the work carried out from stakeholders external for the project. Also, the demo meetings set continuous deadlines for work to be done, leading to the achievement of project milestones (Edwards et al., 2019). Various solutions for achieving the desired purpose of demo meetings are presented in the literature. Edwards et al. observed that demo meetings could demonstrate completed work; it can be market analysis, visual description of identified personas results from a user-study, and more (Edwards et al., 2019). Cooper and Sommer suggest that Agile fits best in the technical stages where the product is developed and tested. They argue that the focus on producing a prototype suits the technical stages. However, the same study also observed teams' tendency to demoing other deliverables than a prototype (Cooper & Sommer, 2018a). Cooper and Fürst present the opportunity of executing longer sprints in the development and testing stages, from 8-12 weeks, instead of 3-4 weeks. The long sprint cycles allow the team to develop a tangible prototype to be developed and presented to both management and customers (Cooper & Fürst, 2020).

Retrospective meetings are not discussed much in the literature. However, it is found that it is a part of the Scrum process, also when used in physical NPD, as it is presented as an element in the case studies (Cooper & Fürst, 2020; Cooper & Sommer, 2018a; Edwards et al., 2019). Cooper and Fürst comment that the retrospective serves the same purpose as presented in software agile (Cooper & Fürst, 2020).

3.2.3 Artifacts

The product and sprint backlog are mentioned as elements that are used in physical NPD in the same way as in software development (Cooper & Sommer, 2018a; Edwards et al., 2019; Sommer et al., 2014, 2015). Most of the literature does not discuss the impact of this. However, Edwards et al. note that the product backlog loses its flexibility in hardware development, as it is difficult to add features later in the development process. Instead, the backlog has the characteristics of a project backlog, listing the activities and tasks to be done (Edwards et al., 2019).

The artifact referred to as *increment* leads back to the discussion of demo meetings. It can be discussed whether demoable increments must be a product prototype or if any work can be presented at demo-meetings.

At this point, the use of all Scrum elements in physical NPD has been discussed. In the following, the effect of co-location is explored.

3.2.4 Co-location in Agile NPD

In traditional agile, it is a condition that the team should be co-located (Cooper & Fürst, 2020; Sommer et al., 2014). This corresponds with the 6th principle from the agile manifesto:

The most efficient method of communication is a face-to-face conversation

(Beck et al., 2001)

When looking at research within using agile in physical NPD, the perceived importance of team co-location varies. In a comparative study investigating the governance model of five case companies practicing Agile and/or Stage-Gate, Sommer et al. state the following:

"Each active Scrum team must have a dedicated project room, where they are physically located throughout the development process" (Sommer et al., 2014)

This indicates that co-location is a pre-condition for NPD teams going agile. However, in the study, all five companies were using project rooms, making a comparison of co-located vs. non-collated teams impossible. The argumentation for the importance of co-location is:

- Enhanced process visibility through displayed tools and plans
- Knowledge sharing within team and stakeholder

Again, the study does not investigate other alternatives for achieving these advantages.

In the study from 2018, Cooper and Sommer state that the team is ideally co-located to facilitate communication and increase productivity (Cooper & Sommer, 2018b). This is mentioned in the background for the study, however, without a source supporting the statement. In the study, only one of six cases was mentioned to use collocation, and this company was not stated to have better benefits than the remaining companies. This could imply that co-location is not as crucial for success with agile practices in NPD as indicated by Sommer et al. (Sommer et al., 2014).

Edwards et al. briefly discuss this point. In this study, none of the three test companies implemented co-location. Like the study done by Sommer et al., this makes it impossible to compare the results with, in this case, teams that did co-locate. However, it is relevant to note that none of the companies in the study reported a need for frequent discussion of development issues that required team members to be in the same room. Edwards et al. propose that the reason for the teams not needing co-location could be that team members in physical NPD projects have very distinct competencies and thus did not use each other to resolve technical problems (Edwards et al., 2019). In one of the case-companies, co-location was used for development tasks that affected multiple areas, for instance, interface changes or design changes affecting several components. This implies that co-location makes sense in specific situations.

In a case study of HP's product development process made by MacCormack et al., co-location is also only applied in some situations. Here it is proposed that physical colocation is only used in the "emergent" phase of projects, which refers to the early startup phase where the initial product description is made. For general development and maturing stages of the product development process, as well as development processes for products with low complexity and uncertainty, co-location is not mentioned (MacCormack et al., 2012). In relation to this, Cooper and Fürst state that the Agile Stage-Gate approach is only used for "larger projects that are more ambiguous and poorly defined, with higher uncertainty" (Cooper & Fürst, 2020).

3.3 Remote and Agile

Despite co-location being a central standard for agile teams, distribution of team members has been a reality for many teams for years (Sharp et al., 2016), and research has shown that the use of agile methods can help reduce partially the issues related to the distances in a distributed environment (Lous et al., 2018)

One relevant study investigating remote agile development prior to the COVID-19 lockdown was identified (Lous et al., 2018). Two studies have been made in connection with the lockdown, both reports published by large consultancies (Conrella-Dorada et al., 2020; Rehberg et al., 2020). All the included research concerns software development.

3.3.1 Ceremonies

It is stated in the report released by the Boston Consulting Group that it is important to prioritize agile ceremonies when working remotely and keep a regular rhythm of meetings, as these are a great tool to enhance transparency for both teams and related managers (Rehberg et al., 2020). This report does not include references and only refers to an internal analysis by BCG, making it likely that the report is based on subjective reflections and experience, leading it to be a less valid source. The study published by the consultancy McKinsey & Co. states that modifications of ceremonies should be considered (Conrella-Dorada et al., 2020). The proposed modifications have no reference to data or other literature but are found relevant to consider and are presented below

- Extend daily Scrums from 15 to 30 minutes and block the second half for problem-solving to accommodate the tendency of remote teams initiating problem-solving on stand-ups, as they cannot coordinate naturally afterward
- Break longer meetings down into two separate sessions to ensure engagement
- Establish an agreement on preparation work ensuring a well-structured meeting
- Ensure access and familiarity with virtual tools, ex. virtual whiteboards and documentation tools
- Ensure that sub-groups or individuals refine tasks before sprint-planning
- Ensure engagement through video meetings and visual presentations of progress
- Use anonymous digital tools for retrospectives
- In the retrospective meeting, team members should be allowed to choose between video or audio interaction

Another essential modification for distributed teams is revealed by the qualitative case study of the company Debitoor (Lous et al., 2018). Lous et al. conclude that it is crucial for distributed teams that ceremonies are fully remote. Hence if a part of the team is co-located, these team members should still attend ceremonies from individual computers and headsets. In addition, they propose that screen sharing either of the virtual whiteboard or deliverables is a central tool to ensure engagement during the ceremonies and meetings.

The retrospective meeting is mentioned as crucial for a remote team in two articles (Conrella-Dorada et al., 2020; Lous et al., 2018). The retrospective meetings allow continuous improvements of the remote work process, ex—new tools or new facilitation ideas (Lous et al., 2018).

Lous et al. identified one significant change related to ceremonies in their case-study – sprint planning meetings were removed from the process and replaced with a grooming process executed by the Product Owner, who had meetings with specialists to refine sprint tasks before sprint start

(Lous et al., 2018). This solution worked well for the examined case-company, which contradicts the previous discussion where planning meetings are found to ensure a common understanding of tasks and goals. However, the study only included a single case, and the article does not elaborate on how the refinement process was shared with the remaining team members.

One essential point is noted in the McKinsey report: the importance of "a single truth." When teams are co-located, conversations are organic, and it is easy to align continuously. When being remote, it is crucial that this alignment happens during meetings, ensuring that all participants have the same understanding. This can be done through documentation and/or clear agreements where all involved parties actively respond depending on the situation (Conrella-Dorada et al., 2020). In addition, it is suggested to consider adding ceremonies if needed; an example given is a new ceremony aligning the remote team with organizational objectives to ensure the feeling of purpose in relation to the work (Conrella-Dorada et al., 2020)

3.3.2 Artifacts

It is suggested that virtual whiteboards or programs with similar functions are used to create both sprint backlogs and KanBan/Scrum Boards (Conrella-Dorada et al., 2020; Lous et al., 2018; Rehberg et al., 2020). In the study published by BCG, it is emphasized that rigid prioritization of backlog tasks is required to ensure that team members are aligned continuously on what to work on (Rehberg et al., 2020). It is vital that these artifacts are continually refined and discussed in the team.

In the study done by Lous et al., it is observed that the team uses visual slide decks to present their daily progress in increments to make it easier to understand and more engaging for fellow team members (Lous et al., 2018)

3.3.3 Roles

The role of the project leader is put in focus in all four articles. The BCG report states that the leader should keep a significant focus on concrete output and goals, ensuring a shared vision in the team. In addition, it is identified to be crucial that the leader seems visible to remote workers, and it is suggested in the article that leaders put placeholders in their calendars to display the periods in which they are available to remote team members (Rehberg et al., 2020).

The report also points out that the leader should take the initiative to build a remote team culture. For example, they should share photos or give a tour in the home office to make the team feel closer and build trust (Rehberg et al., 2020).

The issue of building trust is also discussed in the article by Lous et al.. First of all, the report states that trust can be created by the organization fully trusting the development team, giving them empowerment – which is also highlighted in agile. The next level of trust, between developer and leader, is created by the leader initiating one-to-one conversation with team members, discussing both professional and private issues if needed, and ensuring wellbeing and satisfaction for each team member. The frequency could vary between once each week to every third week, depending on the need for that conversation type (Lous et al., 2018). Trust in the team was found to improve with the absence of micromanagement (feeling of being trusted) (Lous et al., 2018)

Only the McKinsey report brings up the role of the Scrum Master. Besides the traditional responsibilities known from agile, the report focuses on the Scrum Master as responsible for

growing a remote culture. This is done by establishing virtual collaboration rules and resolving potential problems for teams or individuals.

It is found important that the development team is trusted and empowered to do the development work. The development team is also found to have a great responsibility to engage in remote activities (meetings, channels, and more) (Conrella-Dorada et al., 2020; Rehberg et al., 2020). For ad hoc problem-solving, team members must have media to reach out for help; here, the instant chat is recommended (Conrella-Dorada et al., 2020; Lous et al., 2018; Rehberg et al., 2020), as it can be used for the same purpose as poking someone on the shoulder.

The Product Owner is not discussed to have any responsibilities differing from the traditional agile role.

*

This was the final topic in the systematic literature review, ending the rigor cycle of this research process. The following chapter will present the relevance cycle, including the primary data and analysis of these.

4 INTERVIEWS: RELEVANCE CYCLE

The relevance cycle is based on interviews that were conducted and analyzed. The seven interviews were transcribed, leading to 93 pages of transcription (See appendix A – external from this document). In this section, the collected data will be investigated; this is done by first displaying the results and second presenting the analysis.

4.1 RESULTS

Immediate results are presented in the following. This includes identified coding categories, general background information for interviewees, and coding distribution.

Identified Codes

As described in the method section, the transcribed interviews were first coded using a deductive approach. The applied categories are seen in table 4.1.

Table 4-1: Overview of Initial Code Categories

Practices	Implications of practices	Other
Ceremonies	Positive implications for performance	Establishing trust
Roles	Negative implications for performance	Customer involvement
Artifacts	Positive implications for wellbeing	General communication
Project execution (other)	Negative implications for wellbeing	Agile values/principles
		Improvement initiatives

The categories "my questions" and a unique category for each interview were made, only for practical reasons to make the analysis of the codes easier; thus, these categories are not included in the following. Besides, a code for background information was applied.

Background information

The relevant background characteristics are seen in table 4.2. All interviewees were involved in new product development projects and followed the Scrum method.

Table 4-2: Background Information

	POSITION + COMPANY	INDUSTRY	TEAM DISTRIBUTION (BEFORE LOCKDOWN)	AGILE EXPERIENCE IN ORGANIZATION
I1	Agile coach, A	Software	Co-located	Medium (fully implemented, still in learning phase)
I2	Project Leader, B	Software	Distributed in two locations • Denmark • Ukraine	High (implemented +10 years ago)
I3	Project Leader, B	Software	Distributed in three locations • Denmark • Ukraine • Macedonia	High (implemented +10 years ago)
I4	Agile coach/ Scrum master, A	Hardware	Distributed in two locations • Sweden (main part) • Italy (smaller part)	Medium (fully implemented, still in learning phase)

I5	Unit Director, B	Software	Distributed in three locations • Denmark • Ukraine • Macedonia	High (implemented +10 years ago)
I6	Project Leader, C	Hardware	Distributed in four locations • Denmark (core team) • Poland (procurement • China (production) • France (Product Manager)	Low (First agile project)
I7	Project Leader, C	Hardware	Distributed in three locations • Denmark (main team) • Poland (mechanic developers) • Macedonia (app development for product)	Low (First agile project)

Code Distribution

By applying the 13 coding categories to the interview data, 562 individual codings were placed. The distribution of codes is seen in figure 4.1, where the number of codings within each code category is shown. The number of codings is divided into the software and hardware interviews to see if any significant differences in how much each topic was discussed.

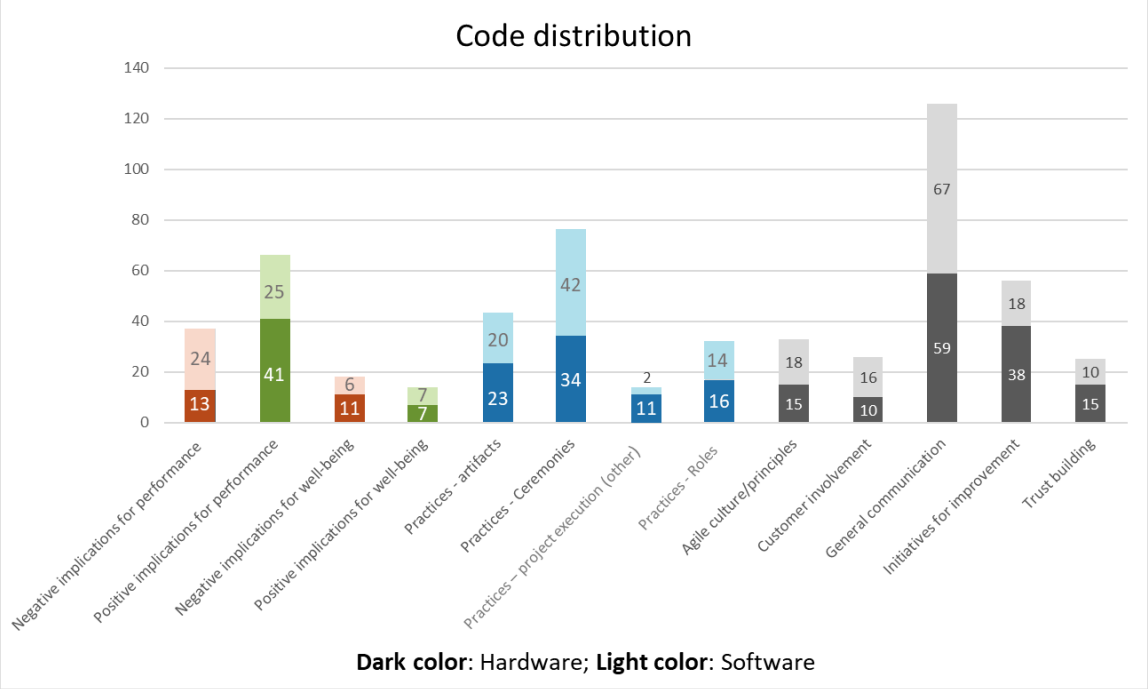


Figure 4.1: Code Distribution

The topic of *general communication* is the most mentioned topic. Within the implication categories, the subject of performance was the most commented topic, mostly discussing positive implications. Looking at agile practices, the *ceremonies* is the most discussed category, and *roles* is the least discussed topic. *Other project execution practices* were mentioned a lot, which was expected, as the interviews focused on agile.

It can be seen that people within software commented most on the negative implications on performance, whereas the hardware people mentioned negative implications on wellbeing most. It

is also seen that hardware interviewees discussed other project execution practices significantly more than software. This makes sense as the hardware interviewees were newer to agile practices. Also, agile for hardware is known to integrate traditional execution methods into the agile practices, as previously discussed.

It should be noted that there are three interviews in the hardware category and one more (four) in the software category, leading to an expectation of more codes in the latter. However, the hardware interviewees were mainly interviewed last, making the interviewer more comfortable with the interview guide and more aware of qualified follow-up questions due to new knowledge obtained in the first interviews. In addition, the software interviewees are in general more advanced in agile practices, leading them to put a more significant focus on the consequences and effects of the lockdown. Thus, the code distribution should only be used to gain a general overview of the interviews' discussed topics and not to draw conclusions.

4.2 Interview Analysis

The focus of the interview analysis will be three-fold.

- Deviations from the traditional Scrum method (due to remote or physical NPD practices)
- Remote communication practices
- Perceived effects and consequences of remote agile practices

As stated in the method section, the initial codes were refined during the analysis process. This resulted in 53 sub-categories that revealed important topics addressed across the interviews. An overview of the refined code categories can be seen in appendix 6a. Also, images of the visual overview created to identify the sub-codes are seen in appendix 6b.

The analysis is structured in three main themes with underlying sub-topics, as shown in figure 4.2.

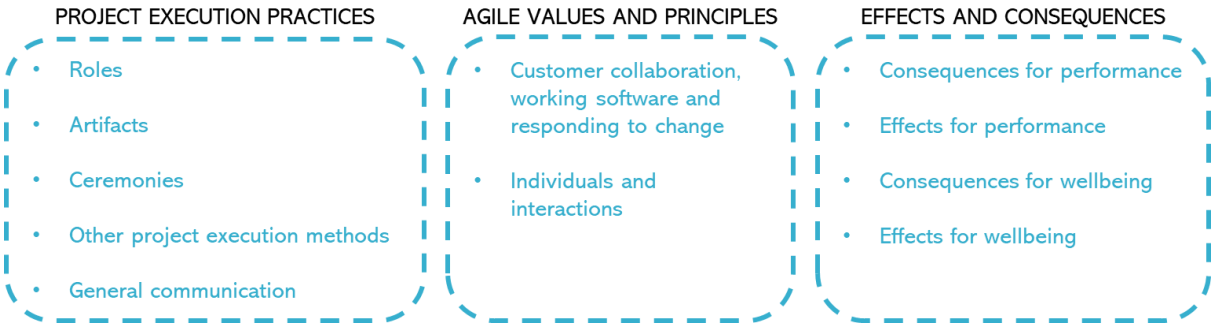


Figure 4.2: Analysis Structure Overview

4.3 Project Execution Practices

In general, the shift to being fully remote did not lead to significant changes in how the Scrum process was executed (besides the digitalization of artifacts and communication). Several interviewees commented that being remote did not interfere with the agile project execution at all.

"We can still keep the roles, we can still keep the events, and we can still keep the artifacts. We can still stick to the values, we can always go back to the values, and that would work either if it is remote or in real life" – Interview 4.

Only one interviewee expressed great general frustration towards the shift to remote agile practices. However, when specifying these, most issues referred back to technical problems that interrupted the process significantly.

Agile practices included the execution of sprints and all appurtenant ceremonies (sprint planning, daily stand-up, sprint demo, and retrospective). Scrum Board, Backlog, and working with demoable increments were also used by teams of all interviewees, along with a focus on customer involvement. Looking at the roles, all interviewees worked with cross-functional development teams. The Scrum Master and Product Owner roles were not widely discussed; however, Project Leaders and/or Steering Committees were mentioned in several interviews.

4.3.1 Roles

Roles were not discussed much in the interviews. However, some relevant points were mentioned.

Scrum Master and Product Owner

The responsibilities of both the Scrum Master and Product Owner seemed to be fulfilled in the setup of all interviewees. However, the role distribution differed a bit from traditional Scrum.

Product Owner: The role of the Product Owner was not widely discussed. In relation to the role responsibilities, no issues concerning prioritization or product value were mentioned, implicating that the Product Owner function was fulfilled in all cases.

It was clear that in cases with project leaders, this role functioned as communication between the business and development team. Also, steering committees and sponsor meetings were mentioned in two of three hardware cases. At these meetings, the project progress is discussed, and management can comment on the project. The committee was also invited to demo meetings, giving the opportunity to comment on business value and prioritization.

Scrum Master: Only one case mentioned the Scrum Master role specifically. It seemed that the responsibility from the role was given either to a general team member or the project leader.

Project Leader

In companies B and C (five out of seven cases), the role of a project leader was mentioned. The project leader role was not widely discussed. However, it was clear that the responsibilities were similar to a traditional project leader, being in charge of facilitating and communicating project progress (taking Scrum Master role responsibility), coordinating resources with line managers, and ensuring good collaboration within the team.

The latter point is relevant to focus on when discussing a remote setting, as it can be challenging to observe the collaboration. When asked about the subject, it was stated that communication is key.

> *"You have to communicate often with your team, and you must facilitate that the team talk on a daily basis, it is crucial both for the mental health of the team members, but also to ensure a constant focus on the goal."* – Interview 3

Development Team

The development team was in all cases a cross-functional team. It was found that dedication, allocation, and distribution of team members, differed from traditional agile.

Dedication: Not all team members had the same level of dedication. In general, the team members were more dedicated in the software cases were three interviewees worked with 100% dedicated teams and one with 70+%. In the hardware development teams, the dedication was more fragmented, and some team members had as low as 20% dedication (one day pr. Week).

Despite only being 20% dedicated and participating in just one stand-up each week, it was stated that it added value to the project that the less dedicated members were present in ceremonies and did not cause confusion. It was also said that it does not make sense to dedicate some functionalities more than 20% as it would not bring additional value due to limited tasks within some areas (this was present in the hardware cases)

However, it was mentioned by two interviewees that team members working on a large number of various projects besides the main project should be avoided. This is very harmful for the team members' dedication to the project, as it becomes too difficult to focus on the project even in the hours that should be used working on the main project.

From this, it can be derived that it is crucial to fence the resources to the extent that these are used in the project. This means that if a team member works one day each week on the project, this day must be dedicated to the project without disturbances.

Allocation: When team members have a different level of dedication to the project, it is impossible to have total allocation (team members working on the project at the same time). However, it was mentioned by several interviewees that when working remotely, people must be allocated as much as possible when they work on the project.

"I actually think that it is very important that the team is allocated when working remote, as you already have very little contact when you do not sit in the same office, so if you work on different stuff on top of that, I believe it would be difficult to keep track of what people do" – interview 2

In addition, if a team member only works one day each week on the project, there must be a daily stand-up with the entire team that day. In this way, the tasks and progress can be synchronized and coordinated between all team members at least one time each week.

From this, it can be derived that planning for the highest allocation possible is an essential aspect of remote agile practices.

Distribution: In six out of the seven cases, the interviewee worked with distributed teams even before lockdown having team members in various geographic locations. It was clearly stated that having all team members work remotely improved the collaboration between locations significantly. A significant factor for this was that all were suddenly working under the same conditions when accessing information and communicating with other team members.

From the interviews, it is clear that an agile team's definition to be a fully dedicated and co-located team is challenged by the conditions of physical product development and increasingly distributed teams. However, this does not seem to interfere with the opportunity to gain value from agile methodologies if resources are fenced to their dedication and information is sufficiently accessible to all.

4.3.2 Ceremonies

In general, all ceremonies were executed in the same way as if they had been off-line. It is also important to note that several of the interviewees had distributed key team members before lockdown and, thus, did all ceremonies remotely. This included the three interviewees from company B.

As no significant changes were made to the format of the ceremonies, it is not relevant to dive into the content of each ceremony. Instead, it is interesting to zoom in on identified themes that either deviated from traditional Scrum practices or related to working remotely.

Structure and Facilitation of Ceremonies

The ceremonies were executed using MS Teams or Zoom. For planning and stand-up, the teams accessed digital backlogs and Scrum boards. For sprint demo, PowerPoint, videos, shared screens of virtual boards, and images of technical drawings or other deliverables were used.

One effect of remote execution of ceremonies was an increased level of structure, as only one person can speak, and only one slide or presentation object can be showed at the time. This made the discussion in the ceremonies more structured/disciplined.

"I think it provides some more discipline… …Participants are much more likely to let people finish when they talk before they ask questions, and it gives a more steady and constructive talk. Before you would stand in a room and then someone would suddenly see something on a wall and start to talk about a completely different subject." – interview 6

This structure was pointed out to make the ceremonies more efficient. However, it was also noted that it could lead to a loss in value, as some of the side-discussions of regular ceremonies can lead to important discoveries. This was a point underlined by one of the interviewees.

"When it comes to the ceremonies, you lose a lot of value [being remote]. Maybe people do not think about the reason with the post-its being small and moving things on a board, thinking "crap we are late" or "we are working on the wrong features." A lot of that is lost" – Interview 1

To ensure getting the maximum value from the ceremonies, it is essential to adjust the facilitation to a remote setting. Highlighted advice discussed in the interviews are:

Everyone talks: Several interviewees pointed out that it is crucial for the facilitator to ensure that all participants have the chance to speak, to ensure that no opinions or relevant knowledge are left out as a consequence of not being able to break in or use body language to signal having a comment.

Documentation: One advantage of the remote execution of ceremonies is the ability to record. Several interviewees mentioned that they recorded their demo meetings, both to document (instead of using resources on writing a summary) but also to easily share with interested people across the organization or stakeholders, who could not be present.

One interviewee mentioned that recording was used to limit the number of participants to deal with capacity issues on remote meeting platforms.

Importance of Goals

One element that was stressed to be vital when working remotely by several interviewees was the use of goals. Team members cannot be confirmed on their purpose through small talk in the office, making a clear goal that their work can be connected to crucial.

"When people sit alone, then everyone has a lot of focus on the specific assignment you do. And you know, what is the purpose of this actually? It can quickly seem pointless to do the small things" – interview 2

This is an element that is found to be considered more critical when working remotely than when being co-located.

Mixing physical presence with remote participation

One relevant discussion was the effects of a mixed constellation, meaning that some participants were co-located, and some were remote. This was experienced by four out of the seven interviewees. Out of these four cases, one had good experiences with the setting.

"Sometimes it is difficult for people not being in the room to follow the discussions in the room, so you need to be aware of that and ensure that everyone talks – also the remote participants. However, when you have practiced it a little, it works quite well." – interview 7

However, the three others did not have a positive attitude towards this. They emphasized that all participants should be online, as a mixed setting excludes people not physically present.

Based on this, it is implied that a mixed setting is not a good idea. However, it could be relevant to investigate the practices of the one interviewee who had a positive experience further to see if there is a general way to make it work.

Frequency and Importance of Daily Stand-Up

The daily stand-up meetings were present in all cases. Five of the seven cases had the Stand-up each day (all software and one hardware), and two cases (hardware) had it every second day, stating that having it each day would be too much, as some tasks take more than a day, and team members are not entirely dedicated.

Frequent communication was stated to be essential when working remotely by all interviewees and was seen as one of the significant advantages of using agile practices in a remote setting.

"Daily stand-up is crucial. It becomes the key to ensure that everyone is on board and that they have something to do, and if not they will speak up and find out what to do, or if someone is stuck" – interview 7

Knowledge Sharing in Sprint Demo Meetings

The sprint demo meetings were executed as in traditional Scrum. The team meets with stakeholders to present their work and get feedback. One stakeholder explicitly mentioned in hardware was line managers with resources in the project, who needed to be updated on project progress.

In addition to updating and validating the work with external stakeholders, the sprint demo was also an important tool to share detailed knowledge within the team. As not all team members had work related to each other and thus did not have full insight into all work and how it related to the

project, it was necessary to connect the tasks continuously. Thus, the demo meetings had an essential purpose within the teams as well.

An opportunity that arises from remote demo meetings is to invite entire units or maybe the entire organization to listen in or record and share the demo-meeting across the organization.

This enables people who might not have an actual stake in the project but are professionally interested in it to gain insights. Thus, it opens a possibility to facilitate increased knowledge sharing and potentially organizational learning.

Sprint Planning and Retrospective

The Sprint planning and Retrospective meetings were executed without other adjustments than the remote execution.

The sprint planning meetings were seen as an essential part of making remote practices work. It helped keep a manageable scope avoiding that individuals went too far down a deviating path, forgetting the purpose when sitting alone.

Also, the breakdown of tasks done in sprint planning helped gain essential insights into the various members' work and the connection between tasks. If the team was co-located, this coordination could be done by small talking in the office. However, this is more difficult to facilitate when working remotely, making the sprint planning meeting highly valuable.

The clear definition of tasks was also seen as a crucial aspect for the individual team member to ensure that everyone is sure of the scope of the work they are carrying out.

"It [task break down] is more important… …I think it is related to the number of interactions that the team has. I mean interpersonal interaction. Assumptions are the mother of all fuck-ups, and people assume a lot more when they do not meet and discuss stuff" – Interview 1

The retrospective was found to be essential for the teams to improve and adjust the process of running remote and agile practices. Also, it was mentioned that the retrospective meetings provided an important space for discussing frustrations. Sharing frustration can be difficult when working from home, as there are mainly formal communication and no coffee-machine chats and small-talk.

4.3.3 Artifacts

Looking at the artifacts, no significant changes were discovered related to the use of these. However, the digitalization of the artifacts opened meaningful discussions regarding remote work.

Backlog and Scrum Board

The product backlog and Scrum Board were used in all cases. The tools used for these artifacts were Jira (only software cases), MS Teams using the task function, and the digital whiteboard tool Miro. Three of four software cases already used digital artifacts as their core-team was distributed even before the COVID-19 lockdown.

The digitalization of these led to two relevant points related to the shift from physical to digital.

The use of post-its: When tools are digitalized, it is not possible to use traditional post-its. Three interviewees commented that this decreases because of the following two points.

- Loss of the 'good feeling' released by physically moving a task – one interviewee stated that it does not give the same kick or get people to open discussions when the post-its are just moved on a virtual board.

- Too much text due to no limit for the amount of text on a digital post-it. One interviewee experienced longer planning sessions due to people writing more detailed and longer descriptions on the virtual post-its than paper post-its.

Enhancing transparency: Digitalization of the tools is found to improve the transparency as all team members, and stakeholders can access updated artifacts at all times in all locations. This was mentioned by five of seven interviewees.

In general, people were positive towards virtual artifacts and found them to function very well. All cases from company B already used virtual artifacts before lockdown to enable the work across locations. It was stated that their process would never work with physical posters that needed to be updated separately. Two cases that used physical artifacts before lockdown said that they would never go back to off-line artifacts, even when people get back to the office.

"I will hold on to the Miro boards that we have, instead of having physical posters again – we should you do that? Here everyone has access to it no matter where you are, so I do not think that I will ever have physical posters on the walls again because we can do exactly the same here, and it leads to the external parties being involved in a completely different way." – Interview 6

In addition, one interviewee mentioned the use of a virtual project parking lot, where team members could dump thoughts that could then be discussed later. This was seen as a great initiative for storing and sharing thoughts in the team continuously without having to disturb through direct contact. This parking lot was created in the same virtual space as the Scrum Board and backlog.

Increments

One of the hardware cases explained an interesting approach to working with increments in physical remote product development. Each time a design, flow, or another element of the solution (which can be considered an increment) was completed, it was uploaded to their shared Miro Board.

"We just take a picture of our design or solution and post it in here, then you can dump images, and the ones who have comments can just add them around it" – interview 7

This made it possible for all team members to continuously comment on the increment, creating a very dynamic and transparent process instead of keeping work off-line and presenting it to the demo meeting. This was also applied to process-related increments (understood as work executed as a part of the process but not related to the product) such as risk analysis and communication plans.

4.4 Other Project Execution Methods

Despite the interviews focusing on agile practices and the Scrum method, some essential elements within non-agile project execution were mentioned.

Milestone Planning

Milestone planning is not a part of agile practices. However, several cases mentioned that they still use milestone planning as a part of their agile project execution. Milestone plans were used to provide an overview to the management and coordinate project elements.

"We plan for shorter cycles but still has our milestone plan and a steering committee who have expectations regarding when the milestones are met" – Interview 6

In the two cases in company C, the milestone plans were an element adopted from the company's former project management practices, which were still used in other projects.

One interviewee mentioned that the combination of traditional milestones and short-term planning caused some confusion. However, it was stated that the confusion became smaller during the process, and it was the first agile project for all team members. Thus, it is unknown whether the confusion was caused by the combination or as a consequence of changing the ways of working.

Design Freeze

Agile promotes the principle of "welcoming changing requirements even late in development." However, there is a critical point of no return referred to as Design Freeze in physical product development. Here it is decided to lock a product element, for example, an electronic component or mechanical design. This is necessary as hardware manufacturing demands the construction of (often expensive) machinery to the production. Once the machinery is defined and ordered, it is costly to make changes to the design requirements.

"It is important for us to get the mechanical design and say – now we will not make any more changes to this so that we can order some tools for the production" – Interview 7

However, it was mentioned by hardware interviewees that it was crucial to test requirement assumptions and prototypes with customers or the sales organization, ensuring that the product was validated sufficiently, and allowing changes, before design freeze.

Project Kick-off

In addition to the agile ceremonies, two of the hardware cases mentioned using a project kick-off event. This was mentioned as an important event to ensure a good process. Multiple purposes of the kick-off were mentioned, (1) professional coordination between product elements, (2) overall planning, and (3) Socializing to create good relations and team collaboration. The latter was found challenging to do in a remote setting.

"I think it has been difficult for us and others to make good project kick-offs. Because it should both be some professional discussion, some planning, and a social aspect, to start up the project and make sure that the team has a strong bond, and I think the last part is missing" – Interview 6

In addition, the three cases from company B mentioned that they would always gather the distributed team and be physically co-located at project start-up to boost collaboration. This was found to be a loss when working remotely.

4.5 General Communication

Besides considerations regarding agile ceremonies, artifacts, and roles, it is crucial to focus on general communication in the NPD process, as this is changed to be fully remote.

Communication platforms were used for:

- Video calls (MS Teams as the most used)
- Regular phone calls
- Instant messaging (Slack and MS Teams as the most used)
- Document management (MS Teams as the most used)
- Sharing of process management (Miro as the most used)
- Sharing of increments (Confluence the most used in software Miro most used in hardware)

In the following, identified essential aspects concerning general communication are presented.

4.5.1 Improving collaboration between distributed teams

The shift to being fully remote had one consistent advantage. The team members and/or stakeholders not located in HQ were suddenly much more included.

One significant catalyst for this is that all communication was remote, eliminating the difference in communication richness between team members sitting outside of HQ and HQ members.

"I really understand that people sitting outside HQ sometimes have had a feeling of being left out or that you do not know what is going on. Because some things just take place at the office. So it has been a benefit that everyone is equally enlightened concerning the project" – interview 5

This is mentioned and underlined by five of seven interviewees (without being directly asked). Also, cases used to having the core team co-located stated that the collaboration had improved significantly with the team members or stakeholders stationed in other locations due to everyone being remote. This implies that inclusion is an important learning gained during the lockdown.

4.5.2 Challenges related to remote communication practices

The shift to fully remote communication was not without challenges, which were also highlighted in the interviews.

Communication Barriers

A challenge that was consistent throughout the interviews is communication barriers.

"It has been a lot scarier for them; instead of just tapping each other on the shoulder, they have to grip the phone to resolve the little things." – interview 4

This impacted both the quantity of communication and the quality of communication.

Quantity of communication: It was clear that the general amount of communication was lower than when all or some team members were co-located. This causes that a minor issue that a fellow team member could have easily solved can put a task on hold until the next Scrum meeting, adding more development time.

"I often see that there are subjects where I hear about it the next day at a stand-up, where someone has been fighting half a day with an issue, where we would normally discuss and resolve it in the lunch break or at a small talk" – interview 2

Another point was the lack of responsiveness when initiating contact, sending a message, and not getting an immediate response. This can lead to delay of project tasks if people are dependent on

answers or information. In a co-located setting, someone would not ignore a tap on the shoulder, and it is easy to see who is available and who is not.

The lack of responsiveness was also identified as a problem during synchronous communication as a video call lowering the quality of conversations.

"Sometimes, people are not very responsive. You can ask a question to a meeting with 20 people and nobody answers" – interview 1

This underlines that it is essential that people who should participate actively in meetings are interested in each other's work or the meeting purpose.

The size of the barrier preventing people from initiating communication was different from person to person. Some people had no problem at all messaging or calling others, while some did not initiate contact unless a meeting was scheduled, making all their communication formal.

In addition, it was mentioned by all interviewees that it had, in general, become easier for people to initiate contact during the remote period, indicating that the barrier is decreasing over time and with experience.

"At the beginning, there was definitely a barrier, but as soon as you learn that you can just call over Teams or write a chat message to ask if someone knows the answer to a question or if someone is available to help, it is easier. But it is a change, and you have to get used to it… … now it happens all the time" – interview 7

Quality of communication: Another challenge related to remote communication challenges is the quality of the communication. The lack of body language and a more formal approach to communication was a challenge. It increases the risk of misunderstandings and makes it more challenging to explain complex messages.

The formal nature of all communication also made it more challenging to communicate topics not directly on the agenda, leading to a loss in general knowledge sharing between team members and other colleagues.

"I am most worried about people losing context because you need to compensate for the coffee-chats and the chat across the table in the office you sit in. You know "what was the thing with this? And what should we do with that?" – interview 5

Requirements for physical presence

It was evident in the interviews that a setting where all communication is remote the entire time is not favorable. This is based on two main elements.

Trust building: Creating and maintaining relations in a remote setting is a significant challenge.

Especially when building new relationships, this is very difficult. This was present with new employees working in the team, customer collaboration with new customers (or new people at the same customer organizations), and new partners (ex. outsourcing). Mentioned consequences of this were increased misunderstandings and increased communication barriers, leading to decreased communication.

"Normally we would have traveled to them, or they would have come to us, and then you had been introduced and established personal relations… …Get to know each other personally, and then it is ten times easier to contact each other afterward, when you know each other, and we simply miss that" – interview 7

The teams where all team members and stakeholders knew each other well before lockdown did not experience challenges with trust. This indicates that when trust has been established, it remains for long periods. However, it was mentioned that a physical get-together approximately each quartal improves collaboration.

"Typically I would ensure to have face to face meeting from time to time, it makes it much easier to collaborate afterward when being remote" – interview 2

Delivering complex information: Another discussed challenge is providing highly complex information.

"Our app-developers in Macedonia… …they have not worked with this kind of products before, so here it has been challenging to do everything online, I would really prefer if we could visit them, so they could be introduced to the products and see and feel them while explaining how it is used. Doing that virtually just takes more time" – interview 7

This was also mentioned in relation to highly complex tasks such as setting up production lines, where it is required for the specialist to travel to the production site, as they can not explain to others how to do it.

On the basis of this, it is seen as crucial and worth the investment of time and travel cost to have physical co-location when establishing new relations and every three to four months to maintain relations. Physical presence is also needed if complex and crucial subjects should be communicated to minimize misunderstanding and increase efficiency.

4.5.3 Social Interaction

A problematic practice to execute when being remote is social activities. All interviewees were found to have implemented or engaged in social activities that were initiated due to the isolation brought by the lockdown. This included virtual Friday bars, virtual coffee break meetings, virtual team breakfast, and lunch breaks.

Some interviewees believed the events to be critical, especially for extroverted people who gain a lot of energy from social interactions.

"We have half an hour remote coffee every day for each team, and it is totally optional if you use it. What I can say is that for one of the teams, it has been almost life necessary for them to have this." – interview 4

However, it was also mentioned that some people found it stressful to have the social interactions scheduled in their calendar, despite being voluntary. It was also clear that it could not provide the same value as face-to-face chats at the coffee machine and team building.

4.5.4 Advice and Best Practices

The following are concrete advice and/or best practices mentioned by the interviewees.

Adjust facilitation approach: Remote meetings do not function as co-located meetings, and the facilitation approach must be adapted, as described under the facilitation of ceremonies.

Put on the camera: It was a clear message from all interviewees that it is crucial that participants in video conferences all turned on and used their cameras.

"When people do not put on their video, that makes you wonder – could I just put a blanket on myself if I had been in a conference room? Because then I cannot see how you are feeling and I cannot see if you are even there, are you present?" – interview 4

Agree on platform and structure across an organization: It is essential to have universal communication practices within an organization, making it easy for people to work across units and projects. Otherwise, it can cause great confusion and misunderstandings delaying processes.

"It is a lot easier for everybody if you have just one tool per category. I mean, I do not know how many invitations in my calendar have both Teams and WebEx in them, and we never pick the same. Annoying, you lose minutes here and there of many, so it actually costs a lot of money" – interview 1

Ensure to make room for continuous sharing and discussion of problems: The retrospective meetings give an essential space for discussing the work process. However, it is also essential to continuously discuss minor issues that could be easily adjusted, as these can quickly grow to a more significant problem if not discussed. A person would typically mention these by the water-cooler or in the team room in a co-located setting. However, it is more difficult to mention these things in a remote setting if they are not put on an agenda, as it seems unnecessary to initiate contact over a small problem.

"The other side of the coin is that you do not have access to just quickly talk with someone when you have an issue – it becomes very official if you write or call someone." – interview 2

Thus, it is vital to establish a culture that allows people to share problems and frustrations and openly talk about these to ensure that issues do not expand if they can be solved.

Use instant messaging: Instant messaging was mentioned to be a valuable tool. There should be a good culture for using instant messaging to ask questions in the plenum, get clarification, or check if someone is available. An instant message can always be followed up with a phone or video call.

Ensure discipline: Discipline is mentioned to be crucial when doing remote meetings, and there should be a focus on agreeing on expectations to discipline when communicating:

"Then there is discipline – show up to the meetings, you are very dependent on this, as you cannot just go get people and say "hey the meeting is now" so discipline is important in this context" – interview 6

Several interviewees stated that meeting discipline was significantly improved during the remote period, meaning that people logged in on time and had improved the level of preparation for meetings.

At this point, project execution practices and general communication have been discussed. In the following, an analysis of the presence and use of agile values and principles are presented.

4.6 Agile Values and Principles

All interviewees were able to execute agile practices while being remote. However, it is relevant to investigate whether the remote conditions and/or physical product development changes the ability to follow the agile values and principles.

The values and principles were not a direct focus point in the interviews; however, it was discovered that these were still expressed from the interview analysis.

4.6.1 Customer Collaboration, Working Software, and Responding to Change

There was a focus on customer collaboration and validation in all seven cases, highlighting the agile value "Customer Collaboration over Contract Negotiation."

"We have a lot of interaction with our customer base early in the development process… … I do not think working remotely has any impact on that" – interview 2

However, working with physical products makes it impossible to deliver and test *working software* (1st and 3rd 7th principle). Instead, the focus was on early and continuous customer validation in the hardware cases. One of the cases explained how they started a project with a number of assumptions regarding product requirements. These were tested and discussed with customers as fast as possible.

Later in development, the testing of prototypes (made using 3D printing and other rapid methods) was executed. Due to the lockdown, this could not be done located with the customer. Instead, the prototypes were sent to the customer, and the tests were done remotely using digital tools.

Some issues with remote customer collaboration were discussed, (1) lack of trust in the customer relationship if it is the first time meeting the customer.

"I think it means a lot that you have trust in each other and know how each other think in some way, and that happens when you visit the customers. Typically we go out and eat together and use two or three days, so that is a lot of hours compared to sitting in a meeting… … so I believe it is pretty effective to meet face to face first and get to know each other, and then stick to remote meetings afterward" – interview 2

(2) More preparation is needed as it is impossible just to take over and show how to use the product or draw on a board, (3) Loss of small talk leads to less discussion and possibly loss of essential points that the customer does not share.

However, the remote setting also had advantages as (1) time, and resources were not used on traveling, (2) ability to record and share customer feedback.

This discussion overlaps with the value "working software over comprehensive documentation." Working software could be replaced with "demoable increments," as the software is not the main element in physical NPD. It is seen that it is impossible to get rid of comprehensive documentation when working with physical product development, as regulations require documentation. Thus, this should be seen as a part of the product and not non-value-adding work.

Another critical discussion is identifying customer representatives. It was mentioned by several that the sales organization was seen as representing the customer. Thus, these were invited to demo meetings providing customer feedback.

The continuous customer feedback allows that requirements are changed and tuned, and it was clear that even the hardware cases allowed changes if required, following the value "responding to change over following a plan."

"We still run into problems as we did before, where we suddenly discover something unexpected. But now we have the freedom to say "then we focus on this in the next sprint" instead of having a plan but then get disturbed and suddenly do other stuff because we need to fix some problem" – interview 6

This corresponds with the second principle that states to welcome changing requirements. However, the principle also states that this should be done even late in development. Here physical product development is challenged, as it is in no way favorable to welcome change after design freeze. Thus, it can be discussed if the "development" should be perceived as completed at design freeze or if the principle should be rephrased to fit physical development conditions.

4.6.2 Individuals & Interactions

Looking at the remaining value, "individuals and interactions over processes and tools," the remote setting has some impact.

First of all, the medium for interaction is changed. It is impossible to talk face-to-face, which is the most efficient and effective way to convey information according to the agile manifesto (6th principle). Instead, messages, phone calls, and video meetings must be used. However, as discussed, this has both advantages and disadvantages, making it difficult to conclude whether this sixths principle is true. However, trust must be established to make remote communication work, which is very difficult without meeting face-to-face.

Another principle is that business people and developers must work together daily (4th principle). It was clear that the project leaders were an essential link between business and developers and could be seen as the business representative. However, as stated, some people were not dedicated to work on the project every day, and developers in physical development often have tasks that do not progress daily, making daily collaboration unnecessary. However, it is vital to link the developers' work with a greater value and purpose – providing a goal.

It is also stated that the project should be built around motivated individuals who should have the environment and support they need (5th principle). Here a critical perspective is identified – all interviewees mentioned that most developers prefer working isolated to eliminate disruptions and increase focus. Thus, the environment needed for some developers is *non-collocated*. Fulfilling this principle will thus go against the importance of co-location in agile.

The 8th principle states that the development should be sustainable, leading to a constant development pace. In physical NPD, this is challenged, as there are interdependencies and development tasks that lead to natural breaks in the development process or restructuring of the project set-up.

"We have been very fast in the process, so we have just made a retrospective for it, and here we have restructured the project and changed the sprint lengths for some teams" – interview 7

The last principle that can be discussed based on the interviews is the 12th principle that states that the team should meet regularly to reflect on how to become more effective and adjust their behavior accordingly. As mentioned, all cases used retrospectives, fulfilling this principle remotely. A

relevant comment is that some of the teams used the retrospectives to tune their digital behavior, making the shift to remote easier.

4.7 Effects and Consequences

In general, the interviewees mentioned that the work experience during the lockdown had positive effects, both due to a high level of learnings within digital behavior and the work process.

"It has forced us to become even better online because suddenly we were all remote, and I think we have had a positive experience… …it has been a catalyst for the learning process of working from a distance" – interview 6

All interviewees agreed that using agile practices had a positive impact on the situation. Key factors of this were mentioned to be.

- Clear structure in communication
- Visual overview of tasks and process
- Daily communication
- Transparency in the process

It was mentioned that using agile practices was a factor that enabled remote work to succeed. Several of the interviewees pointed out that agile had led to a maintained performance. They believed that using traditional product development practices would have led to a decreased performance when shifting to remote work.

"I believe that if we had worked with a traditional waterfall-model…. …then there would have been a larger risk for a decrease in performance" – interview 3

However, the sudden shift to working completely remote led to both positive effects and negative consequences these are seen on table 4.3 and discussed in the following. A summary of the analysis is seen on table 4.4.

Table 4-3: Overview of Effects and Consequences of Remote Agile Practices

Effects **Performance**	Consequences **Performance**	Effects **Well-being**	Consequences **Well-being**
Increase in productivity	Delay in process	More free-time	Blurred line between work and free-time
Better coordination	Increased cost	Better work environment	Decrease in motivation
Increased motivation	Decreased productivity	Frequent communication	Decrease in mood
Increased focus		Increased well-being	Decreased well-being
Decreased risk of social loafing			
Improved ability to respond to change			

4.7.1 Negative Consequences on Performance

Three main points were identified within the category of consequences on performance. All of these are related to working remotely.

Technical issues leading to delays in the process and increased cost

As previously mentioned especially one of the interviewees experienced consequences of having technical issues when being remote.

"We experienced issues with Teams and WEBEX, and stuff not working. Capacity issues, complete break-down of the work systems" – interview 1

The challenge was partly mitigated using different technical solutions; however, it was a continuous challenge. It affected the possibility of getting work done and lowered the quality of meetings. Ultimately, this led to postponing work, meaning that it slowed down and delayed the development process. Also, it resulted in much time lost for the team and stakeholders, waiting in meetings for the technology to work, which is costly as it increases idle time.

However, as only one interviewee had a significant challenge, technical issues are seen as a treatable problem eliminating the subsequent consequences.

Loss of communication leading to misunderstandings, decreased productivity, and delays

Another critical factor is that communication loss leads to delays in development work due to decreased productivity and misunderstandings.

A decrease in productivity: Several interviewees mention that as a result of not being co-located, a team member "cannot just tap a colleague on the shoulder and ask for help." Besides, it is not possible to observe colleagues and react if they appear to be frustrated. This results in people getting stuck with relatively simple issues.

"They get stuck. And they do not know whom to ask because they do not know the organization. They are stuck with small things that a colleague sitting in the same room could easily and quickly have solved" – interview 7

The lack of responsiveness also leads to the situation that people dependent on an answer are left with no response and cannot move on with the work creating idle time.

An increased level of misunderstandings: It is more challenging to deliver complex information via remote communication, as previously discussed.

"I have seen a lot of misunderstandings when you write together, and you think that you agree on something, but it turns out that you understood two different things" – interview 2

In addition, it is mentioned that remote meetings can lead to a worse dialogue. Some people talk too much and are difficult to stop, and some do not respond. Due to a lack of responsiveness in meetings it is unknown whether people received and understood the information or looked at something else and did not receive the message. This leads to misunderstandings.

Working isolated leading to decreased motivation and productivity

Motivation was also a factor mentioned by several interviewees. Here it was clear that people struggled to maintain the same level of productivity when working from home. Two sub-tendencies are found within this topic.

People who work better in the office: All interviewees mentioned that a group of people just works better when they are in the office.

"There are some people for whom it does not work well [to be home], and that was some of the people who might have a difficult time to work concentrated in the first place" – interview 5

A point touched in the above quote was found to be highly relevant. People who struggled with their performance before the lock-down, in general, had decreased performance when working from home. At the same time, people who generally have a high-performance increase the performance further when working from home. Several interviewees mentioned this.

People affected by the long period of isolation: The other factor mentioned affected more people and was seen as a direct result of the continuous isolation brought by COVID-19 restrictions.

"After sitting for a couple of months at home, I missed some other input, professional input… …so after a couple of months it was easier to be distracted" – interview 3

Several interviewees mentioned that the motivation decreased after a long time sitting at home, not meeting with colleagues, and getting other input.

From this, it can be derived that long-term consistent physical isolation from the organization and colleagues does not fit the majority of employees. To maintain motivation, most people need to change the scenery from time to time and meet with other colleagues (it is not mentioned that this needs to be team members specifically).

4.7.2 Positive Effects on Performance

Zooming in on the positive effects on performance, three points were identified, revealing six effects, both related to remote working and related to the use of agile methods.

Working from Home leading an Increase in productivity

An apparent positive effect of working from home is an increase in productivity due to the elimination of disturbance from others and the opportunity to create a unique work environment.

This was mentioned by all interviewees and is seen as a key benefit of working remotely, explicitly working from home. The software cases extensively highlighted this and said that it significantly improved the productivity of many developers. However, it was also underlined by the hardware cases.

"Some engineers are somehow introverts, so I believe that they sort of got a free space, and many have actually felt a relieve that they finally can sit down and complete work, instead of being disturbed by people walking by in the office" – interview 6

Another point mentioned by several interviewees was that the elimination of commute time led to increased work hours. Especially for team members living in rural areas far from the office or in countries with bad infrastructure, working from home increased their productive time and performance.

"I would say that it [agile] has contributed to that we have been able to maintain the same performance, and the fact that people have not had any commute time, and that you have had the time to go into depth with tasks, has led to higher performance" – interview 2

Frequent communication leading better coordination and increase motivation

Another positive effect is related to the stand-ups. This agile ceremony enabled frequent coordination. Therefore, people knew what to work on every day, minimizing the amount of idle time between project-related tasks. Thus, the risk of social loafing was decreased significantly, as team members are faced with sharing the completed work, diminishing the ability to hide when working from home, thus increasing motivation to get work done.

Sprints, task break down, and visual overview of the process leading to an increased focus

Finally, the sprint element was mentioned to increase performance as it helped the team focus on the most urgent tasks.

In addition, the task break-down and visual overview provide a common understanding of what is being made and what is not, decreasing misunderstandings.

"I definitely believe it has [agile practices have helped improve performance]. Because it has provided the structure to get our tasks defined and clarify what we will do until the next sprint and maybe even the next meeting" – interview 6

This also allowed an improved ability to respond to unforeseen challenges than before, as described in under the values.

4.7.3 Negative Consequences on Wellbeing

When asked about the consequences for wellbeing, the interviewees discussed two main points leading to three consequences, all related to remote working. It was also mentioned that few employees were noticed to experience a significant general decrease in wellbeing because of the remote conditions.

"Then there are the others who live of their social contacts and get energy from interacting with people. It has really been tough for them it has really been hard" – interview 6

This implies that some people are affected significantly more than others. The two following points were mentioned as general challenges for wellbeing.

Working from home makes the line between work and free time blurred

It was difficult for people to draw a clear line between when they were working and when they were not working. This was mentioned to have a negative effect on wellbeing.

"Multiple team members mentioned that work and free-time blend in with each other. You go to eat, but then the PC is there, and the work is exciting so you can work a bit more… …and you are not finished with your work, but you will never be completely finished" – interview 7

It was mentioned that the issue had been discussed within the team, which had been positive as people could share their thoughts. It was discussed that a good idea was to have a clear structure to make a line between work and free time and leave unfinished work for the next day.

One interviewee pointed out that this issue is person-dependent.

"I am very disciplined myself when the clock strikes four, I stop, unless something critical occurs… …My wife are very different, I almost have to drag her away from the computer some times. So I believe it is very individual, how easy this is" – interview 6

This indicates that some people need more help to define clear frames for their workdays when working from home than others.

Long term isolation leads to a decrease in mood and motivation

Another point mentioned when discussing wellbeing is the issue of physical isolation from colleagues.

"There is a lot of employees who miss the colleagues, and really wants to get in and sit with them to have this loose dialogue over the computer and have the social aspect with the colleagues" – interview 7

It was mentioned that extroverts were affected most by this issue, resulting in some team members having a challenging time sitting at home. Several interviewees stated that it was the minority who felt this was a crucial issue; however, most interviewees had intermediate lock-down breaks where the colleagues could come in a limited number of days each week, which relieved the consequence for many.

At this point, long-term isolation has been mentioned as a factor decreasing both performance and wellbeing, implying that this is a harmful condition causing various consequences.

4.7.4 Positive Effects on Wellbeing

Looking at the positive effects experienced by the interviewees, three subjects were identified. In addition, it was mentioned that some people experience a general increase in wellbeing when working from home.

More free time

One point mentioned is the increase in free time due to the elimination of commute time. In addition, working from home allowed parents to accommodate children being home from school, avoiding family conflicts. This enabled people to spend more time with family, which interviewees considered being positive for the wellbeing.

"It has provided an opportunity to get the family life working for many. You know, made it possible to complete your work and be on the job even while having kids at home, etc." – interview 7

Better work environment

Another point is that each person can create their own work environment. Several interviewees mentioned this to improve the work environment for some, as this enabled opportunities as listening to loud music. This was considered to be especially important for introverted individuals. These persons could suddenly create a more comfortable zone without social pressure and disturbances.

"The introverts are finally flowering. It goes back to their safe space, and they are communicating like never before because they are doing it in writing, and they are speaking up in a totally different way, which they have never done before because now they are safe – their environment is safe" – interview 4

This creates a clear link between good wellbeing and improved performance – when a person feels safe and has a good work environment, he/she is more likely to be active and engage in the process.

Frequent communication

Finally, it was mentioned to positively impact team members' wellbeing to engage in frequent communication with others.

> *"Agile has really shown its strength because you talk daily. You have your daily meetings, and then you can work with something, having peace to do this, maybe you have a go-home meeting or status. So, most people are in contact with the work multiple times a day"* – interview 7

When discussing this, several interviewees referred to the stand-ups as a great tool to keep team members engaged and check in on each other while working remotely.

*

A summary of the analysis of these are seen on table 4.4, which ends the analysis of the primary data included in this study. In the following chapter, the developed artifact is presented.

Table 4-4: Overview of Challenges and Benefits Analysis in Primary Research

Challenge/Benefit	Triggers	Effects/Consequenses
Technical issues	• Capacity issues on platforms • Lack of consistency in platform use	• Process delays • Increased cost
Loss of communication	• Not possible to observe colleagues • Communication barrier • Worse dialogue in remote meetings • Lack of responsiveness	• Misunderstandings • Delays • Decreased productivity
Working isolated	• Individual preferences • Long-term isolation	• Decreased productivity • Decreased motivation
Working from home	• Individual preferences • Elimination of disturbances • Better work environment for some	• Increase in productivity
Frequent communication	• Daily communication when working on project	• Better coordination • Decreased risk of social loafing • Increased motivation
Task overview	• Break down of task • Visual process overview	• Increased focus • Improved ability to respond to changes
General decrease in well-being	• Individual preferences	
Blurred line between home and work	• No separation of work and home space	• Decreased well-being
Isolation	• Long-term isolation	• Decrease in mood • Decrease in motivation
More free-time	• Working from home	• Increased well-being
Better work environment	• Working from home • Individual workspace	• Elimination of social pressure • Introverts get a comfort zone
Frequent communication	• Daily communication when working on project • Planned ceremonies	• Increased engagement • Possibility to check-in

5 THE REMOTE AGILE FRAMEWORK: DESIGN CYCLE

The practitioner interviews revealed that agile functioned very well in a remote setting, and the experiences with the process were mainly positive. Thus, the RAF is based on the traditional Scrum framework, with additions of elements identified in the interviews to improve remote conditions and enable agile in physical NPD. The completed RAF is shown in figure 5.1. In the following, descriptions of the elements that differ from the traditional Scrum process are presented.

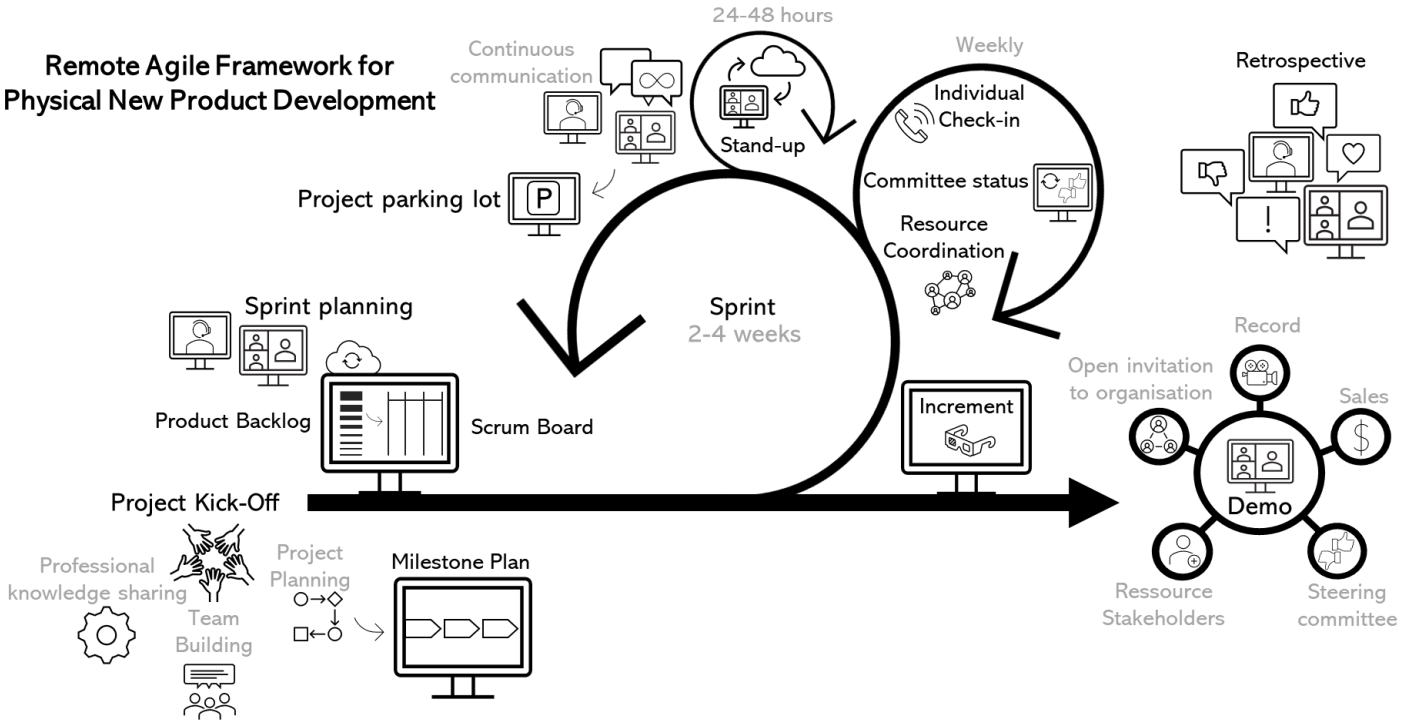


Figure 5.1: The Remote Agile Framework

The RAF's general conditions provide complete mobility for the team members, enabling employees to work from home and working in geographically distributed teams. It is recommended that everyone have the opportunity to work from home to optimize both the performance and team members' wellbeing. However, team members should have access to an office with colleagues or other professionals when needed. This does not have to be project team members, as the purpose is to change the scenery, socialize, and not suffer long-term isolation.

5.1 ROLES

The roles differ from the traditional Scrum. In the RAF, the defined roles are Team, Project Leader, and Steering Committee. These are described in the following.

5.1.1 Team

The development team should still be cross-functional and work closely together throughout the project and be limited in size following the Scrum guide (Schwaber & Sutherland, 2011). Core team members should be dedicated at least three days each week (60%). This allows the team to have bi-daily stand-up meetings three times each week, enabling frequent communication. The team can be supplemented by

specialists or other resources that have a lower level of dedication and participate in ceremonies when they have relevant inputs or are dependent on the output.

The development team should work allocated, meaning that they work on the project on the same days within the same approximate timeframe to ensure coordination and general communication between team members.

The development team can be fully distributed, and team members can work from any location unless their work requires special facilities or equipment.

5.1.2 Project Leader

The project leader is responsible for facilitating all ceremonies, taking responsibilities from the Scrum master role. This ensures that the ceremonies are facilitated and that the project leaders are close to their team members. Connected to this, the project leader is responsible for people management, ensuring that all team members are engaged and feel positive about their role in the project.

The project leader is also responsible for the overall project plan and communication of this to relevant stakeholders including the steering committee. The project leader oversees ensuring resources for the project and continuously coordinating these resources with line managers or relevant stakeholders.

5.1.3 Steering Committee

The steering committee is a role found in traditional project management. It consists of people from management who continuously evaluate development projects and determine whether further investments can be made. In larger organizations, more committees can be present, and smaller companies can have only one consisting of top management. This depends on the organizational structure.

The steering committee (or a representative) should participate in the demo meetings to be updated on project progress and provide relevant feedback on prioritizing project tasks, taking some responsibility from the traditional Product Owner role to create transparency from the project and up and vice versa.

5.2 ARTIFACTS

The following artifacts are used as described in the traditional Scrum process. They should be fully digital, and all relevant stakeholders should have continuous access to fully updated versions.

- **Scrum Board**
- **Product Backlog**

Three artifacts from the RAF differ from the Scrum process, increment, milestone plan, and project parking lot.

5.2.1 Increment

The increment artifact differentiates from traditional Scrum where a functional product piece is required. In the RAF an increment is considered a project-required deliverable or an element enabling product validation. The increment most be in a form that can be communicated to relevant stakeholders such as management, customers, or internal sales organization.

Examples are:

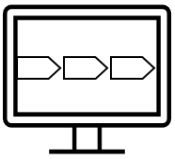
Product validation elements:

- List of product requirements
- Customer study design
- Component prototype
- Design drawing

Project required deliverable:

- Risk analysis
- Business case
- Required documentation

5.2.2 Milestone Plan



The project must have a high-level plan with a target timeline for significant deliverables, which the team works towards during the sprints. This also create an overall purpose and intermediate goals. The milestone plan should correspond with the type of plans used for non-agile projects within the organization, to enable integration of the projects using the RAF.

The milestone plan should consider resource planning and needed dedication for team members in the project phases to enable high level coordination with resource owners (ex. line managers).

The project leader is responsible for prioritizing tasks according to the plan and negotiating the plan with the steering committee and resource owners across the organization if changes are required to increase product success.

5.2.3 Project Parking Lot

The project parking lot is an artifact dedicated to being a place where team members can dump thoughts related to the project, which would usually be discussed at the coffee machine, but are not relevant to discuss immediately in ceremonies. Thus, it is a way for continuous asynchronous knowledge sharing. The parking lot is a space on a virtual whiteboard, and thoughts should be documented on digital post-its.

5.3 CEREMONIES

Looking at the ceremonies, these should all be executed 100% remotely, meaning that all participants are logged in from separate devices, and the information is shared in a digital space during the meetings.

A general point that is recommended to be considered is to invite participants 15-30 minutes before a ceremony starts to socialize with colleagues sitting in distributed locations. However, it should be clearly communicated that this is not mandatory, and it should not interrupt the general flow of the actual ceremony.

The following agile ceremonies are executed as described in the traditional Scrum while being remote. Only minor adjustments should be made, which is commented below.

- **Sprint**
- **Sprint Planning**
- **Stand-up**
  With the adjustment that it can be with 48-hour intervals if the team is less dedicated.
- **Demo**
  With the adjustment that the meeting should be recorded as documentation and can be shared across the organization.
- **Retrospective**

Four additional ceremonies are implemented in the RAF. These are described in the following.

5.3.1 Project Kick-Off

The project kick-off is the only physical co-located event in the framework. It is seen as a crucial element for team collaboration.

The event should take a minimum of two days to execute, and the main participants are the project leader and the development team.

The purpose of the project kick-off is three-fold, as discussed in the interview analysis:

1. **Planning**: The overall milestone plan is created and refined with input from all functions. A representative from the steering committee can be present for this. The project plan should include a focus on periods where project dependences interfere with the agile practices (ex. waiting for test results, waiting for equipment, or holiday periods); in these periods, the process can be paused to optimize resource utilization.
   Also, the team is presented to the overall project goal.
2. **Coordination**: The team is introduced to the ways of working, expected behavior, for example, which working hours are expected, and general communication practices. It is important to consider that it is not necessarily the richest media that are most appropriate for all communication. Instant chat and channels can be a powerful tool. All process templates are introduced to ensure that all team members know how to manage these.
   Each function should introduce an overall plan for their specific work, the level of complexity and risk, and any interdependencies with other functions' work.
   Finally, customer involvement should be discussed, and initial planning for this should be executed.
3. **Team building**: The team should focus on creating personal bonds and good relations to improve collaboration throughout the project.
   The team can also discuss potential remote social activities, such as Friday Beers, virtual coffee-breaks, or individual cake baking at milestone celebrations.

The project leader is responsible for the project kick-off; however, it is essential to gather inputs from the team members, steering committee, and other relevant stakeholders, to be prepared for each activity's content.

5.3.2 Individual Check-in

The individual check-in is a weekly event performed by the project leader. At least one time each week, the project leader should contact each team member to ask about the team members' wellbeing.

Questions could be:

- How are you doing?
- Do you enjoy your work tasks?
- Do you like the way of working?
- Is there anything we could do to improve your current situation?

The check-in symbol is a phone, to symbolize as it can be done in a flexible setting, i.e., a virtual walk-and-talk. However, it can also be done over videocall or face-to-face if the project leader is located with one or multiple team members.

5.3.3 Committee Status

The committee status meeting is a weekly meeting where the steering committee or a representative gets an update on the project progress and potential challenges from the project leader. It can be seen as a weekly stand-up and should not take more than 15 minutes.

It has the purpose to increase transparency by ensuring the exchange comments, which would typically be discussed in an informal setting (ex. talking by the coffee machine).

5.3.4 Resource Coordination

Resource coordination is a weekly event performed by the project leader. The project leader should weekly practice and confirm resource planning with team members and resource owners (ex. line managers), with the purpose of continuously ensuring resources for the project.

This was the last element of the RAF completing the framework. In the following, a presentation of agile values and principles fitted to the conditions of the RAF is presented.

5.4 Values and Principles

To accommodate the RAF, the agile values and principles have been adapted to fit the context of remote physical NPD projects to make it easier for the teams to understand and use these. The following values and principles are based on the understanding developed through the process of doing this project. It should be seen as a theoretical reflection, contributing to the research society with a new perspective.

5.4.1 Values

Looking at the values, only one was found not to fit the context, indicated with an arrow.

*Individuals and interactions **over** tools and processes*

*Customer collaboration **over** contract negotiation*

→ *Requirements testing and product validation **over** comprehensive documentation*

*Responding to change **over** following a plan*

5.4.2 Principles

Seven of the 12 principles were changed to fit the context, again, indicated with an arrow.

(1)→ Our highest priority is to satisfy the customer through early and continuous product validation.

(2)→ Welcome changing requirements even late in the development cycle. Design Freeze should not be made before all features have been tested and validated.

(3)→ Deliver demoable increments from a couple of weeks to a couple of months with a preference to the shorter time scale.

(4)→Businesspeople must work closely with developers and ensure that there is a clear goal linking technical tasks to the project purpose.

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

(6)→ Agile processes promote dedicated development. The sponsors should ensure that the team has the required resources to maintain constant progress.

(7)→ The level of product validation is the primary measure of progress.

(8) → The most efficient and effective method to build trust within a development team and stakeholder relations is face-to-face communication.

(9) Continuous attention to technical excellence and good design enhances agility.

(10) Simplicity–the art of maximizing the amount of work not done–is essential.

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

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

5.5 Connecting the RAF to Previous Research

The development of the RAF was based on the practical experiences and recommendations from the interviewed practitioners. However, it can also be connected to the findings in previous research discovered in the systematic literature review. The relations between the RAF developed in this project and the findings from previous research are presented in the following to provide an overview of the connections between the two research elements.

First, it is identified which triggers related to remote challenges and benefits identified in the systematic review are implied to be treated by the RAF elements. This is presented in table 5.1. Subsequently, the connections between the RAF and agile in physical NPD, as well as remote agile practices, are presented.

Table 5-1: Connection between Triggers and RAF Elements

Benefit/Challenge	Trigger	Treated by
Increased quality of communication	Documentation of information and communication	Scrum board, product backlog, project parking-lot, increment, recording of meetings
	Continuous sharing of information	Stand-up, Demo-meetings, committee status
	High responsiveness	Stand-up, team allocation, project kick-off
Decreased quality of communication	Lack of verbal communication	Stand-up, project kick-off, retrospective
	Lack of responsiveness	Stand-up, team allocation, project kick-off, retrospective
	Lack of informal communication	Project kick-off, Stand-ups
	Technological issues	Project kick-off, retrospective
Increased productivity	Flexible workhours	N/A
	Distraction free environment	Working remote
	Increased concentration	Working remote
	Elimination of social pressure	Working remote
Decreased productivity	Distractions from home environment	N/A
	Decreased concentration	Stand-up, task break-down
	Lack of informal communication	Project kick-off, Stand-ups
	Individual preferences for separation of work and home	N/A
Increased recruitment pool	Ability to distance manage	Working remote
Lack of performance monitoring practices	Remote workers cannot be observed	Individual check-in, daily stand-up, demo meetings
	Some employees are micro-managed	Individual check-in, daily stand-up, demo meetings
Decreased stress-level	More free-time	Working remote
	Flexible workhours	N/A
Increased stress-level	Blurred line between work and home	Project kick-off, individual check-in, stand-up, retrospective
	Lack of support	Individual check-in, stand-up
	Unclear or too high expectations	individual check-in, sprint planning, stand-up
Increased quality of remote worker relationships	Good quality of communication technology	Project kick-off
	Focus on updating supervisor continuously	Stand-up, Demo-meeting, Scrum board, Individual check-in
	Focus from supervisor to reach out to remote workers frequently	Individual check-in
Decreased quality of remote worker relationships	Decreased amount of interactions	Stand-up, individual check-in
	Lack of informal communication	Project kick-off, Stand-ups
	Out of sight	Stand-up, Demo meetings
	No previous collaboration	Project kick-off
Increased job-satisfaction	Increase in work-life quality	Working remote
	Introvert personalities can be alone	Working remote

It is clearly implied that using the RAF will improve both the performance and wellbeing of remote workers as it treats most identified triggers within all identified challenges and benefits. Table 5.1 shows that the RAF does not treat the following triggers: Distractions from the home environment, Individual preferences for separation of work and home, and flexible work hours. Therefore, there is a risk for decreased productivity and missing the benefits of increased productivity and decreased stress-level, as these are related to the untreated triggers. This can lead to decreased performance and prevent an increase in performance and wellbeing related to remote work.

It should be noted that the relations are only implications based on the RAF elements' expected functionalities. The effects of using the RAF on the various challenges and benefits should be investigated in practice to draw further conclusions.

Looking at the relation to previous research within agile in physical NPD, the RAF includes identified adjustments including: Implementation of project leader, decrease in requirements for allocation and frequency of stand-ups, a focus on continuous commitment and planning of resources, and a broader understanding of what an increment is. A milestone plan is also implemented, which is used to integrate the agile project with the organization's governance model. In literature, it was found that the Stage-Gate process was the most used method for this purpose. The RAF only has one co-located event supporting the findings by Edwards et al. that co-location is not essential in physical NPD but neglects the findings by Sommer et al. that argue co-location be a must for agile in physical NPD.

Finally, the previous literature on remote agile practices stated to ensure familiarity with virtual templates and establish agreements of preparation for meetings across the team which is a part of the project kick-off. Also, the project leader's significant responsibility to ensure a remote culture and people management highlighted in the literature (Conrella-Dorada et al., 2020; Lous et al., 2018; Rehberg et al., 2020) is expressed through additional ceremonies and giving the project leader the functions of a traditional Scrum master. Finally, the recommendation running ceremonies fully remote if one must participate remotely as stated by Lous et al. (Lous et al., 2018) was also identified in the primary research in this study, leading that this is implemented in the RAF.

It is seen that there are clear connections between the artifact developed based on data from this study and previous research. Thus, the developed RAF can be supported by both the systematic review and the practitioner interview, finalizing and connecting the three phases of the research design: Rigor cycle, relevance cycle, and design cycle.

*

Connecting the RAF to previous research was the final topic within the RAF presentation ending the design cycle. In the following chapter, a discussion of the research outcome is presented.

6 DISCUSSION

In the following, the results of this research are discussed. The discussion will include a presentation of identified dilemmas, implications for theory and practice, and finally limitations in this research study and relevant future research within this field.

6.1 DILEMMAS IN REMOTE AGILE PHYSICAL NPD

Four dilemmas have been identified during this project. The dilemmas are seen as observations of situations where it is believed that the optimal choice differs from context to context, and thus it is difficult to state what the right decision is. The dilemmas are briefly described in the following and are seen as essential aspects. However, they will not be investigated further in this project.

Allocation versus flexible work hours

As stated, it is recommended in the RAF developed in this project that the team should be allocated as much as possible. However, it compromises the highlighted trigger: Flexible work hours, for the benefits, decreased stress-level and increased productivity found in the literature (Gajendran & Harrison, 2007; Grant et al., 2013; Kurland & Bailey, 1999). Thus, the requirement for the allocation of team members is a dilemma that should be examined. It can also be considered if it is more favorable to provide the benefits of flexible hours when dealing with physical NPD as it is suggested by literature that the differences in competencies within the team decreases the need for constant communication and collaboration (Edwards et al., 2019)

Underperforming remote workers

Giving employees the authority to determine whether they will work from home or be at the office corresponds with agile principles of practicing self-management. However, it was stated in the interviews that some people decrease performance when they are not in the office. A dilemma arises if these team members experience an increase in wellbeing when working from home and prefer this despite their decreased performance, creating a sort of social loafing. Should the leader set a limit for the amount of time these people can work from home, thus differentiating between team members, potentially creating the challenge of resistance from these workers who cannot perform while working from home, as mentioned in the literature (Grant et al., 2013)? Neither literature nor interviews directly highlight this dilemma, but it is seen as a potential challenge that could arise with the practices proposed in the RAF.

Governance in agile for physical NPD

In the literature, it is clear that Agile Stage-Gate is the preferred method to use when implementing agile practices in physical NPD. The Stage-Gate element introduces a portfolio management layer, as the model is used to compare various projects in the development pipeline (Cooper, 1990; Cooper & Sommer, 2018a). However, in the study by Edwards et al., the practice of comparing projects was not used; instead, only the progress of the agile project was discussed (Edwards et al., 2019). This indicates that the need for projects to be completely comparable at given parameters is not required. In addition, no interviewees mentioned the use of the Stage-Gate model, implying that agile can be implemented in manufacturing companies without the Stage-Gate element.

Given agile NPD projects' uncertain nature, it may make sense to create traditional project milestone plans. This leads to a more agile deliverable structure, as milestone deliverables can be tailored to the project, but it removes portfolio management qualities from the Stage-Gate model.

Using Agile in General Remote Projects

In the literature, it was stated that agile methods are not used for all types of projects. As there is a need for high dedication, agile projects are observed to be reserved for prioritized projects that have a high degree of uncertainty, while less complex and uncertain projects can follow a traditional product development process (Cooper & Fürst, 2020; MacCormack et al., 2012). However, as agile practices are found to improve both performance and wellbeing in remote teams, it can be discussed whether some agile practices should be incorporated in all projects where the team works remotely. It is not known whether the practices will have the same effects on projects with lower dedication or maybe even projects outside NPD, but it is found to be a relevant consideration if it is worth implementing agile practices in order to optimize remote practices, although the project type does not suit the agile requirements.

6.2 IMPLICATIONS

To sum up key findings from a practical and theoretical perspective, implications derived from this project are identified and presented in the following.

6.2.1 Practical Implications

The practical implications are findings that people who work with practices investigated in this report. The implications target the role of a project leader or middle manager who has a large responsibility in the potential digitalization of product development processes.

Employees react differently on working from home

Previous research on the effect of remote work on performance and wellbeing shows contradicting, and it is difficult to conclude whether working remotely brings more challenges or benefits. This study implies that a significant factor for the uneven results is the individual difference in preferences. This leads to the implication that a leader and organization must be aware of these differences and provide adaptive management approaches. Some people need more guidance and clear frames for their work hours when sitting at home; others thrive with self-management and more flexible hours, and some do not thrive when working from home at all. Leaders and managers should take the initiative to discuss these preferences with each individual and dedicate time to ensure that all employees have a good work structure.

It seems that a hybrid setting, allowing people to be at an office with colleagues when they feel like it, mitigates most remote work challenges. It is important to note that it does not have to be an office with the team members; it can be other colleagues as it is the social factor and the change of scenery that are vital.

If one active participant is online, everyone should be

A concrete, practical implication is that communication is an either-or element when having a distributed group. It is seen as a crucial finding that all active participants (meaning people who both listen and speak or are critically dependent on the shared information) should either be co-located or digital. A mixed setting makes the communication uneven, as it is more difficult for the online participants to break in or listen to sub-conversations.

Time spent on learning digital tools and behavior is time well spent

This study implies that a best practice when shifting to remote practices is to ensure that all involved parties know how to navigate in and use the digital tools that replace general communication and information sharing. It is also crucial to agree on a structure around these tools (which ones do we use and how) to avoid confusion and misunderstandings. This includes general remote behavior, where teams and organizations should highlight expectations and help each other to fulfill this behavior and refine it when learnings are discovered. These practices and behaviors should be on an organizational level to enable flexibility between teams and units.

Project Leaders have a great responsibility related to remote work practices

The research process has made it clear that the project leader has a significant and crucial responsibility when using remote practices and that the leadership practices differ from traditional practices, as workers cannot be observed or approached face-to-face. Besides, the facilitation of meetings must be adjusted to the remote setting. Thus, it is considered necessary that the project leader gets sufficient training that the organization should offer. If it is not possible to provide qualified training, the expectations for the project leader's performance should be adjusted. It is recommended that the organization collect and share learnings continuously to improve remote leadership capabilities.

6.2.2 Theoretical Implications

The theoretical implications are findings that can be relevant for the research society working within related subjects. As this study is highly explorative, the findings should be used as inspiration for further research or maybe revisiting previous research with a new perspective.

Agile practices improve remote conditions

It was discovered in the literature study that much research investigates the impact of working remotely and suggests good practices to improve both performance and wellbeing. However, little focus has been put on concrete frameworks and methods to make working remotely work. This creates a landscape of independent practices that only target fragments of the challenges each. It can be challenging to navigate and identify a set of practices that complement each other.

This study revealed that the agile methodology Scrum is a defined set of practices that have helped to minimize challenges and realize benefits both within performance and wellbeing.

Remote conditions do not prevent agile practices to work

Co-location is seen as a crucial element of working agile. However, this study implies that the development team's co-location is not nearly as important as concluded by previous research. This creates a relevant opportunity for the research society not to make it a pre-condition for an agile team to be co-located.

An interesting reflection is that the agile principle stating to give team members the best work environment and trusting them to get the work done is prevented when forcing team members to be co-located, as some people have the best work environment home.

This creates a larger research pool for testing the effects of agile methodologies in various industries, as it removes the rigid constraint of co-location. This is increasingly important as organizations tend to be more distributed geographically, and working from home practices are increasingly desired and used.

Adaption of Agile values and principles may increase value for physical NPD teams

The agile values and principles are seen as fundamental building blocks for much research within the field. However, these are defined explicitly for software development teams. Despite this, the values and principles are referred to in research on agile practices in physical product development. With an increase in physical product development teams who apply agile methods, an interesting question to ask is, "should the values and principles be changed?". This study implies that the values and principles can be adapted to fit the conditions of both working with physical product development and remove the constrain of working co-located. This is believed to make it easier for teams within this area to understand and apply agile practices and agile values and principles.

6.3 LIMITATIONS

This research project has initiated research work in a new cross-field between agile in physical NPD and remote work. It has shown exciting results that lay the ground for further research to validate the implications and investigate related topics. However, this study has limitations that should be discussed.

6.3.1 Limitations for the systematic literature review

First, the review in total analyzed 20 articles; this is a fragment of the collective literature found on the subjects, enabling the risk of excluding essential perspectives. In the review-part focusing on remote work, the two research areas, performance, and wellbeing were included in the inclusion criteria and the search strings. This excluded literature that could be relevant but does not link its findings directly to the areas, thus, introducing the risk of missing essential data.

Second, the identified literature within agile NPD only contained qualitative studies. This is not necessarily a weakness when doing explorative studies, as qualitative insights provide a deeper insight into behavior dynamics and relations. However, it is argued by some that quantitative studies have higher validity when making conclusions rather than implications (Onwuegbuzie & Leech, 2007). Also, the authors Robert G. Cooper and Anita Friis Sommer recur on multiple articles. The case companies can also be suspected to be the same in multiple articles as industry descriptions recur or fit disclosed companies; thus, the number of case samples can be smaller.

6.3.2 Limitations for the semi-structured interviews

First, there has not been collected any data from ordinary team members – only team leaders. Leaders risk to have a different perspective on the situation and what general employees actually need (Brower, 2021). If this is the case, there is a risk of the interviewees having provided a twisted perspective, as they also shared perceived views on team members' situations. Leaders can also be believed to be people with better personal skills and experience (given their higher rank). This potentially provides them with better resilience towards difficult situations such as the lockdown and changed conditions – providing them with a more positive view of the situation.

Second, the data collection has been made during a pandemic leading to working from home was a forced condition. Thus, the implementation was abrupt, most likely eliminating much of the resistance towards working from home, as it was legislation.

The pandemic has also forced people to limit their social life beyond work, resulting in a more significant degree of isolation. This created an increase in general loneliness, depression, and anxiety for some, due to the severe circumstances (UNRIC, 2020). Also, many have been faced

with the stress of having children at home. These are all examples of factors that have influenced this data collection, which will hopefully not be present in the future. Thus, there is a risk that the results will change significantly in a time with no pandemic.

Third, the last limitation considered is personal bias, also discussed in the method section. Looking at the primary data collection, a semi-structured approach was used, leading to the author asking in-depth questions using prior knowledge to target relevant subjects. This enabled the inclusion of biases obtained prior to the research project. However, the opportunity to utilize this knowledge to get more qualified data is valued more than the risk of biases harming the data's validity is feared.

6.4 Future Research

Looking at relevant further research led by this study, three main opportunities were identified.

Pilot test of the RAF: A case study measuring the impact on performance and wellbeing of implementing the RAF in a remote physical NPD team. The research should include (1) creating and defining artifact templates and communication channels and training in using these, (2) continuous evaluation of the practices and if/how they adapt within the team, (3) potential coaching of the project leader and team members, and (4) evaluating project results by comparing data on the teams' traditional project practices and RAF practices.

As an addition to this, it is seen as an exciting opportunity for the research society to investigate whether the second set of values and principles help physical NPD teams to harvest increased benefits from agile.

Extended literature study on remote work: As mentioned, the systematic literature review revealed a very distributed landscape of implications from working remotely. It is found to be an interesting subject. It would be relevant to make a more extensive research study to increase the amount of included literature and differentiate between the various remote work types to investigate potential differences in results.

Comparative studies: Finally, it could be highly relevant to make a research project trying to map whether there are differences in performance and wellbeing between:

1. An agile physical NPD team working from home and/or distributed **and** a co-located agile physical NPD team

2. A remote agile physical NPD team **and** a remote traditional physical NPD team

This could give more profound insights into whether remote conditions positively impact an agile team in physical NPD and if agile practices positively impact a remote team in physical NPD, which could validate the implications derived from this study.

*

The identified topics for future research were the final element of the discussion that finalizes this research project. In the following chapter, the conclusion is presented, summarizing the research process and the answers to the five research questions.

7 CONCLUSION

The purpose of this study was to create a Remote Agile Framework (RAF) for physical New Product Development (NPD) teams, based on knowledge gained from both secondary and primary data, to investigate the opportunity of improving performance and psychological wellbeing in remote teams. This was done by answering five research questions through a Design Science Research-inspired research design. Five research questions were answered throughout this report.

The first two research questions were investigated through a systematic literature review.

RQ 1: *Based on previous research, what are the main challenges and benefits of remote work related to performance and psychological wellbeing, and what are the triggers and consequences/effects of these?*

Six main benefits and five main challenges related to remote work were uncovered. By analyzing each of these, the triggers that have been identified to lead to the benefits and challenges and expected effects or consequences from these were investigated and mapped. This covered an identified gap in the literature on remote work. One main point was that differences in individual preferences for remote employees can affect both performance and wellbeing in both a positive and negative direction. This is important as it can explain why the literature on the subject show contradicting results.

RQ 2: *Based on previous research, what changes should be made to the Scrum practices to fit physical NPD projects, and what is the effect of co-location in agile NPD?*

The most highlighted changes to the Scrum process when adapting it to physical NPD are, lower dedication of teams, and a broader understanding of what can be reviewed at demo meetings including other project deliverables and not just product prototypes. In addition, it was discussed that teams kept the project leader role when going agile. It was found that the co-location of team members is both argued to be crucial and non-important. One mentioned possibility was that co-location can be used in specific situations but is not required continuously.

The third and fourth research questions were examined using data collected through seven semi-structured interviews with project leaders and coaches who have been working with agile teams during the COVID-19 lock-down in 2020.

RQ 3: *What are the experiences with using agile practices in a remote setting for NPD projects, and what are the best practices recommended by current practitioners?*

Agile practices can be used in a remote setting in both software development and physical NPD. It was found to be important that the team had good communication practices and helped each other break down the barriers of calling each other. Besides, everyone knew how to operate the digital artifacts and update them continuously. The project leader had a great responsibility for ensuring frequent contact with team members and adjusting facilitation methods to fit remote meetings.

RQ 4: *What are the experienced effects and/or consequences on a teams' performance and psychological wellbeing when executing a remote agile NPD process?*

The interviewees stated that remote agile practices had mainly brought positive experiences; these include, improved collaboration with geographically distributed team members, improved

productivity lead by fewer disturbances, transparent task distribution, and better work environment for especially introverted team members, improving both performance and psychological wellbeing. However, a number of challenges also occurred, including, lack of motivation, decreased productivity, and feelings of isolation. All negative consequences were related to remote practices and long-term isolation. It was confirmed that employees' reactions to remote working varied with individual preferences. Agile was found to have a significant positive effect on both the performance and wellbeing of remote team members.

The fifth research question was answered by presenting the RAF developed using the knowledge gained through the analysis of the primary data collected.

RQ5: *What is a qualified project execution framework for remote physical NPD projects based on analysis of practical experiences with remote agile NPD practices during the lockdown in 2020?*

The developed RAF includes all the Scrum-process elements executed in a remote setting, as all of these were found valuable. In addition to the existing elements, four ceremonies are added to the framework. Three of these, weekly check-ins, resource coordination, and steering committee status, have the purpose of ensuring both good wellbeing and an effective process fitting into a manufacturing company structure. The fourth project kick-off is the only co-located ceremony where the team should meet to plan, coordinate, and build relations, which is crucial in ensuring project success. It is the project leader who is responsible for driving the project, and this role takes both leadership and Scrum master responsibilities. The Product Owner function is carried out through a collaboration between the project leader and a project steering committee. In addition to the RAF, this study made a ground for updating the existing agile values and principles to fit remote and physical NPD processes.

Looking at remote agile practices for physical NPD, some dilemmas can be identified and discussed. One of these is the choice between providing complete flexibility in workhours improving productivity or allocation of team members required to maintain good communication. Also, the autonomy to work from home for team members whose performance is decreased when not in the office should be considered. Finally, the integration of agile projects in manufacturing organizations, which are often more rigid, and only benefit from using agile in the most complex and uncertain projects, can be discussed. Here the organization can consider using either milestone plans proposed in the RAF or Agile Stage-Gate proposed by previous literature. The requirements for an agile project to be both uncertain, highly prioritized, and complex can be discussed to change when working with distributed teams or work from home practices, as agile practices can be a tool to improve remote collaboration, enhancing performance even in projects with lower uncertainties and prioritization.

In connection to this study, several limitations are relevant to consider, including, limited inclusion of literature, a limited interviewee pool, COVID-19 related concerns interfering with data, and finally, presence of personal bias.

This study has shown promising results, creating an exciting ground for future research within the field. It implies a new era for agile teamwork, breaking with the literature claiming that co-location is crucial for agile NPD teams.

It is possible to succeed with remote agile teams in physical NPD.

8 REFERENCES

Alliance, S. (2020). *Scrum Foundations ELearning Transcript* (pp. 1–19).

Ays, J., Dölle, C., & Schuh, G. (2019). Constitutive Features of Agile and Plan-Driven Processes in Hybrid Product Development. *Advances in Production Research*, 477–486. https://doi.org/10.1007/978-3-030-03451-1

Beck, K., Beedle, M., Bennekum, A. van, 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., & Thomas, D. (2001). *Agile Manifesto*. https://www.agilealliance.org/agile101/the-agile-manifesto/

Bentley, T. A., Teo, S. T. T., McLeod, L., Tan, F., Bosua, R., & Gloet, M. (2016). The role of organisational support in teleworker wellbeing: A socio-technical systems approach. *Applied Ergonomics*, *52*, 207–215. https://doi.org/10.1016/j.apergo.2015.07.019

Brower, T. (2021, January). What People Want: What Leaders Get Wrong And How To Be More Right. *Forbes*. https://www.forbes.com/sites/tracybrower/2021/01/24/what-people-want-what-leaders-get-wrong-and-how-to-be-more-right/?sh=5dc047587ac4

Christensen, C. M., & Rytter, R. (2018). Focus on benefits in agile transformations. *Implement Consulting Group*, 1–8.

Conrella-Dorada, S., Grag, K., Thareja, S., & Vasquez-McAll, B. (2020). Revisiting agile teams after an abrupt shift to remote. *Organization Practice McKinsey&Company*, *April*. https://www.mckinsey.com/business-functions/organization/our-insights/revisiting-agile-teams-after-an-abrupt-shift-to-remote#

Cooper, R. G. (1990). Stage-Gate Systems: A New Tool for Managing New Products. *Business Horizon*, *May-June*.

Cooper, R. G. (2014). What's next? After stage-gate. *Research Technology Management*, *57*(1), 20–31. https://doi.org/10.5437/08956308X5606963

Cooper, R. G. (2017). *Winning at New Products*.

Cooper, R. G., & Fürst, P. (2020). Agile Development for Manufacturers : The Emergent Gating Model. *Innovation Management*.

Cooper, R. G., & Sommer, A. F. (2018a). Agile–Stage-Gate for Manufacturers: Changing the Way New Products Are DevelopedIntegrating Agile project management methods into a Stage-Gate system offers both opportunities and challenges. *Research Technology Management*, *61*(2), 17–26. https://doi.org/10.1080/08956308.2018.1421380

Cooper, R. G., & Sommer, A. F. (2018b). Agile–Stage-Gate for Manufacturers: Changing the Way New Products Are DevelopedIntegrating Agile project management methods into a Stage-Gate system offers both opportunities and challenges. *Research Technology Management*, *61*(2), 17–26. https://doi.org/10.1080/08956308.2018.1421380

Digital.ai. (2019). 14th annual State of Agile report. *Journal of Chemical Information and Modeling*, *53*(9), 1689–1699. https://doi.org/10.1017/CBO9781107415324.004

Dresch, A., Lacerda, D. P., & Antunes, J. A. V. (2015a). Chapter 7: Systematic Literature

Review. In *Design Science Research: A Method for Science and Technology Advancement* (pp. 129–158). https://doi.org/10.1007/978-3-319-07374-3

Dresch, A., Lacerda, D. P., & Antunes, J. A. V. (2015b). Design science research: A method for science and technology advancement. In *Design Science Research: A Method for Science and Technology Advancement* (pp. 67–102). https://doi.org/10.1007/978-3-319-07374-3

Edwards, K., Cooper, R. G., Vedsmand, T., & Nardelli, G. (2019). Evaluating the agile-stage-gate hybrid model: Experiences from three SME manufacturing firms. *International Journal of Innovation and Technology Management*, *16*(8). https://doi.org/10.1142/S0219877019500482

Friis Sommer, A., Hedegaard, C., Dukovska-Popovska, I., & Steger-Jensen, K. (2015). *Improved Product Development Performance through Agile / Stage-Gate Hybrids*. *February*, 34–45. https://doi.org/10.5437/08956308X5801236

Gajendran, R. S., & Harrison, D. A. (2007). The Good, the Bad, and the Unknown About Telecommuting: Meta-Analysis of Psychological Mediators and Individual Consequences. *Journal of Applied Psychology*, *92*(6), 1524–1541. https://doi.org/10.1037/0021-9010.92.6.1524

George, T. (2020, December 9). *Hermeneutics* . Stanford Encyclopedia of Philosophy. https://plato.stanford.edu/entries/hermeneutics/

Grant, C. A., Wallace, L. M., & Spurgeon, P. C. (2013). An exploration of the psychological factors affecting remote e-worker's job effectiveness, well-being and work-life balance. *Employee Relations*, *35*(5), 527–546. https://doi.org/10.1108/ER-08-2012-0059

Hayes, J. (2018). *The Theory and Practice of Change Management* (Fifth Edit). Palgrave.

Hazzan, O., & Dubinsky, Y. (2014). *Agile Anywhere - Essays on Agile Projects and Beyond*. Springer.

Johri, A. (2015). Supporting global virtual work through blogs and micro-blogging. *Proceedings of the Annual Hawaii International Conference on System Sciences*, *2015-March*, 422–431. https://doi.org/10.1109/HICSS.2015.58

Kurland, N. B., & Bailey, D. E. (1999). When workers are here, there, and everywhere: A discussion of the advantages and challenges of telework. *Organizational Dynamics*, *28*, 53–68.

Kvale, S., & Brinkmann, S. (2014). *Interview: Det kvalitative forskningsinterview som håndværk* (3.). Hans Reitzels Forlag.

Lattemann, C., Siemon, D., Dorawa, D., & Redlich, B. (2017). *Digitization of the design thinking process solving problems with geographically dispersed teams*. *10288 LNCS*, 71–88. https://doi.org/10.1007/978-3-319-58634-2_6

Lous, P., Tell, P., Bo Michelsen, C., Dittrich, Y., & Ebdrup Debitoor, A. (2018). From Scrum to Agile: a Journey to Tackle the Challenges of Distributed Development in an Agile Team. *Icssp*, *18*, 10. https://doi.org/10.1145/3202710.3203149

MacCormack, A., Crandall, W., Henderson, P., & Toft, P. (2012). Do you need a new product-development strategy? *Research Technology Management*, *55*(1), 34–43. https://doi.org/10.5437/08956308X5501014

March, S. T., & Storey, V. C. (2008). Design Science in the Information Systems Discipline: An Introduction to the Special Issue on Design Science Research. *ACM Transactions on Computer-Human Interaction*, *13*(3), 725–730. https://doi.org/10.1145/1183456.1183457

Olson, J. S., & Olson, G. M. (2014). How to make distance work: Work. *Interactions*, *21*(2), 28–35. https://doi.org/10.1145/2567788

Onwuegbuzie, A. J., & Leech, N. L. (2007). *Validity and Qualitative Research : An Oxymoron ?* 233–249. https://doi.org/10.1007/s11135-006-9000-3

Péréa, C., & von Zedtwitz, M. (2018). Organic vs. mechanistic coordination in distributed New Product Development (NPD) teams. *Journal of Engineering and Technology Management - JET-M*, *49*(May), 4–21. https://doi.org/10.1016/j.jengtecman.2018.04.005

Pikkarainen, M., & Passoja, U. (2005). An approach for assessing suitability of Agile solutions: A case study. *Lecture Notes in Computer Science*, *3556*, 171–179. https://doi.org/10.1007/11499053_20

Poulsen, S., & Ipsen, C. (2017). In times of change: How distance managers can ensure employees' wellbeing and organizational performance. *Safety Science*, *100*, 37–45. https://doi.org/10.1016/j.ssci.2017.05.002

Rebentisch, E., Conforto, E. C., Schuh, G., Riesener, M., Kantelberg, J., Amaral, D. C., & Januszek, S. (2018). Agility factors and their impact on product development performance. *Proceedings of International Design Conference, DESIGN*, *1*, 893–904. https://doi.org/10.21278/idc.2018.0236

Rehberg, B. B., Danoesastro, M., Kaul, S., & Stutts, L. (2020). How to Remain Remotely Agile Through Covid-19. *BCG*, 1–9.

Rigby, D. K., Berez, S., Caimi, G., & Noble, A. (2011). Agile Innovation. *California Management Review*, *53*(2), 6–27. https://doi.org/10.1525/cmr.2011.53.2.6

Schiller, S. Z., & Mandviwalla, M. (2007). Virtual Team Research. *Small Group Research*, *38*(1), 12–59. https://doi.org/10.1177/1046496406297035

Schwaber, K., & Sutherland, J. (2011). *The Scrum guide*. *2*(July), 17. https://doi.org/10.1053/j.jrn.2009.08.012

Sharp, H., Barroca, L., Deshpande, A., Gregory, P., & Taylor, K. (2016). *Remote Working in an Agile Team*. 1–15. http://agileresearchnetwork.org/wp-content/uploads/2016/09/Remoteworkingwhitepaper.pdf

Sommer, A. F., Dukovska-Popovska, I., & Steger-Jensen, K. (2014). Agile Product Development Governance - On Governing the Emerging Scrum/Stage-Gate Hybrids. *IFIP Advances in Information and Communication Technology*, *438*(PART 1), 184–191. https://doi.org/10.1007/978-3-662-44739-0_23

Sommer, A. F., Hedegaard, C., Dukovska-Popovska, I., & Steger-Jensen, K. (2015). Improved product development performance through agile/stage-gate hybrids: The next-generation stage-gate process? *Research Technology Management*, *58*(1), 34–44. https://doi.org/10.5437/08956308X5801236

Staglin, G. (2020). When Home Becomes the Workplace: Mental Health and Remote Work. *Forbes*, 17–20.

Suzuno, M. (2019). *Top 2019 talent trends: The remote and distributed… | Greenhouse*. https://www.greenhouse.io/blog/top-2019-talent-trends-the-remote-and-distributed-workforce

Therkildsen, C. S. N., & Industri, D. (2020, April 2). Flere arbejder hjemme. *Tv2Lorry*. https://www.tv2lorry.dk/region-hovedstaden/joggingbukser-og-morgenhaar-her-arbejder-flest-hjemmefra

Turner, D. W. (2010). Qualitative Interview Design: A Practical Guide for Novice Investigators. *The Qualitative Report*, *15*(3), 7. http://www.nova.edu/ssss/QR/QR15-3/qid.pdf

University, G. (2020). *Systematic Literature Reviews for Education*. https://libraryguides.griffith.edu.au/c.php?g=451351&p=3333115

UNRIC. (2020, May 15). Covid-19: Stor stigning i angst og depressionssymptomer. *FN's Regionale Informationskontor for Vesteurope (UNRIC)*. https://unric.org/da/covid-19-angst-og-depression-stiger/

Wang, W., Albert, L., & Sun, Q. (2020). Employee isolation and telecommuter organizational commitment. *Employee Relations*, *42*(3), 609–625. https://doi.org/10.1108/ER-06-2019-0246

Weimann, P., Hinz, C., Scott, E., & Pollock, M. (2010). Changing the communication culture of distributed teams in a world where communication is neither perfect nor complete. *Electronic Journal Information Systems Evaluation*, *13*(2), 187–196.

9 APPENDIX

APPENDIX 1: Search strings per topic

Remote work and psychological wellbeing: ("remote work" OR "distance work" OR "WFH" OR "work from home" OR "telework") AND employee AND psychological wellbeing OR challenges ← (included due to identification of "challenge" related to psychology)

Scientific Hits: 100, **Included after manual review: 6**

Remote work and performance: (performance OR efficiency OR effectiveness) AND ("remote work" OR "work from home" OR "distance work" OR "telework") AND (team OR individual OR organi*ation) AND (project OR "product development")

Scientific Hits: 64, **Included after manual review: 4**

Agile practices in physical NPD and performance: "Agile" AND "practices" AND ("NPD" OR "New product development" OR "product development") NOT "software" NOT "IT" AND "psychological wellbeing" NOT "physical" NOT "healthcare" AND ("Project performance" OR "project" AND ("performance" OR "efficiency" OR "effectiveness"))

Scientific Hits: 96, **Included after manual review: 6**

Agile and Remote practices: "Agile" AND ("remote work" OR "work from home" OR "distance work" OR "telework")

Scientific Hits: 7, Popular Hits: 6, **Included after manual review: 3**

Agile and psychological wellbeing: "psychological wellbeing" AND "agile" NOT "healthcare" NOT "physical"

Scientific Hits: 5, Popular Hits: 1, **Included after manual review: 0**

It was discovered that no appropriate literature could be found on the subject of agile practices and psychological wellbeing. The lack of literature indicates either a gap in the existing research or that this field has not been relevant to research up to this point.

Additional literature: One article was added after the search process to the subject of agile NPD. This article was published during the research period and identified and shared by the project supervisor. This leads to a total of 20 articles identified and included in the systematic literature review. An overview of these articles divided into subjects is found in appendix 2.

APPENDIX 2: Included literature

Theme	No.	Reference
Remote work and Psychological Wellbeing	1	Employee isolation and telecommuter organizational commitment (Wang et al., 2020)
	2	In times of change: How distance managers can ensure employees' wellbeing and organizational performance (Poulsen & Ipsen, 2017)
	3	The role of organizational support in teleworker wellbeing: A socio-technical systems approach (Bentley et al., 2016)
	4	The Advantages and Challenges of Working Here, There, Anywhere, and Anytime (Kurland & Bailey, 1999)
	5	The Good, the Bad, and the Unknown About Telecommuting: Meta-Analysis of Psychological Mediators and Individual Consequences (Gajendran & Harrison, 2007)
	6	An exploration of the psychological factors affecting remote e-worker's job effectiveness, wellbeing, and work-life balance (Grant et al., 2013)
Remote work and Performance	7	How to Make Distance Work: Work (Olson & Olson, 2014)
	8	Supporting Global Virtual Work through Blogs and Micro-Blogging (Johri, 2015)
	9	Digitization of the Design Thinking Process Solving Problems with Geographically Dispersed Teams (Lattemann et al., 2017)
	10	Changing the Communication Culture of Distributed Teams in a World Where Communication is Neither Perfect nor Complete (Weimann et al., 2010)
Agile practices in physical NPD	11	Agile Stage-Gate for Manufactures (Cooper & Sommer, 2018a)
	12	Agile Development for Manufactures: The Emergent Gating Model (Cooper & Fürst, 2020)
	13	What's Next – After Stage-Gate (Cooper, 2014)
	14	Agile Product Development Governance – On Governing the Emerging Scrum/Stage-Gate Hybrids (Sommer et al., 2014)
	15	Evaluating the Agile-Stage-Gate Hybrid Model: Experiences From Three SME Manufacturing Firms (Edwards et al., 2019)
	16	Do You Need a New Product-Development Strategy? (MacCormack et al., 2012)
	17	Improved Product Development Performance through Agile/Stage-Gate Hybrids: The Next-Generation Stage-Gate Process? (Sommer et al., 2015)
Agile and Remote	18	Revisiting agile teams after an abrupt shift to remote (Conrella-Dorada et al., 2020)
	19	From Scrum to Agile: a Journey to Tackle the Challenges of Distributed Development in an Agile Team (Lous et al., 2018)
	20	How to Remain Remotely Agile Through Covid-19 (Rehberg et al., 2020)

APPENDIX 3: Interview Guide

SETTING THE STAGE

- **Welcome & project background**
- **Purpose and focus of this interview**
- **Can I record?**

BACKGROUND

- **Tell me a little bit about yourself and your role related to NPD projects**
- **How were your conditions during the lockdown? (how much of your time did you work remote? did your assignments change?)**
- **Do you have any remote work in connection to development projects when corona is not interfering with the workflow?**

PRACTICAL EXPERIENCE

- **Tell me about your remote practices in relation to the development project(s)**
- Ex.
    - How do/did you plan?
    - Do/did you use sprints?
    - How do/did you coordinate within the team?
    - Do/did you use a product backlog for task management?
    - Do/did you use a Scrum Board to track progress?
    - Which virtual tools do/did you use?
    - How do/did you manage informal communication?
    - Did you have any product demonstrations to users or stakeholders outside the team?
    - Did your team discuss the work process and how to make improvements to this?

EFFECTS ON WELLBEING

- **Thinking back on this remote period – what do you think was the biggest benefit(s) related to the *wellbeing* of you and the development team?**
    - **Do you think that the use of agile practices enables this benefit? Why – why not?**
    - **Do/did you/your team take any concrete actions to enable/maintain this benefit?**
- Did you experience less stress during the remote period?

- **Thinking back on this remote period – what do you think was the biggest challenge(s) related to the *wellbeing* of you and the development team?**
    - **Do you think that the use of agile practices causes this challenge?**
    - **Do/did you/your team take any concrete actions to prevent/mitigate this challenge?**
- Do/did you experience any challenges related to trust within the team or with your leader/manager?

- Do/did you experience any challenges related to psychological isolation?

EFFECTS ON PERFORMANCE

- **Thinking back on this remote period – what do you think was the biggest benefit(s) related to your and the development team's *performance*?**
  - **Do you think that the use of agile practices enables this benefit?**
  - **Do/did you/your team take any concrete actions to enable/maintain this benefit?**
- Have you experienced an increase in productivity during the remote period?

- **Thinking back on this remote period – what do you think was the biggest challenge(s) related to your and the development team's *performance*?**
  - **Do you think that the use of agile practices causes this challenge?**
  - **Do/did you/your team take any concrete actions to prevent/mitigate this challenge?**
- Have you experienced decreased productivity in the remote period?
- Have you experienced a tendency for "free-riding" during the remote period?

REFLECTIONS

- **Do you think that agile practices support good wellbeing and performance for NPD teams working remotely?**
- **Do you think agile practices should be adjusted when used remotely (compared to co-located teamwork)?**

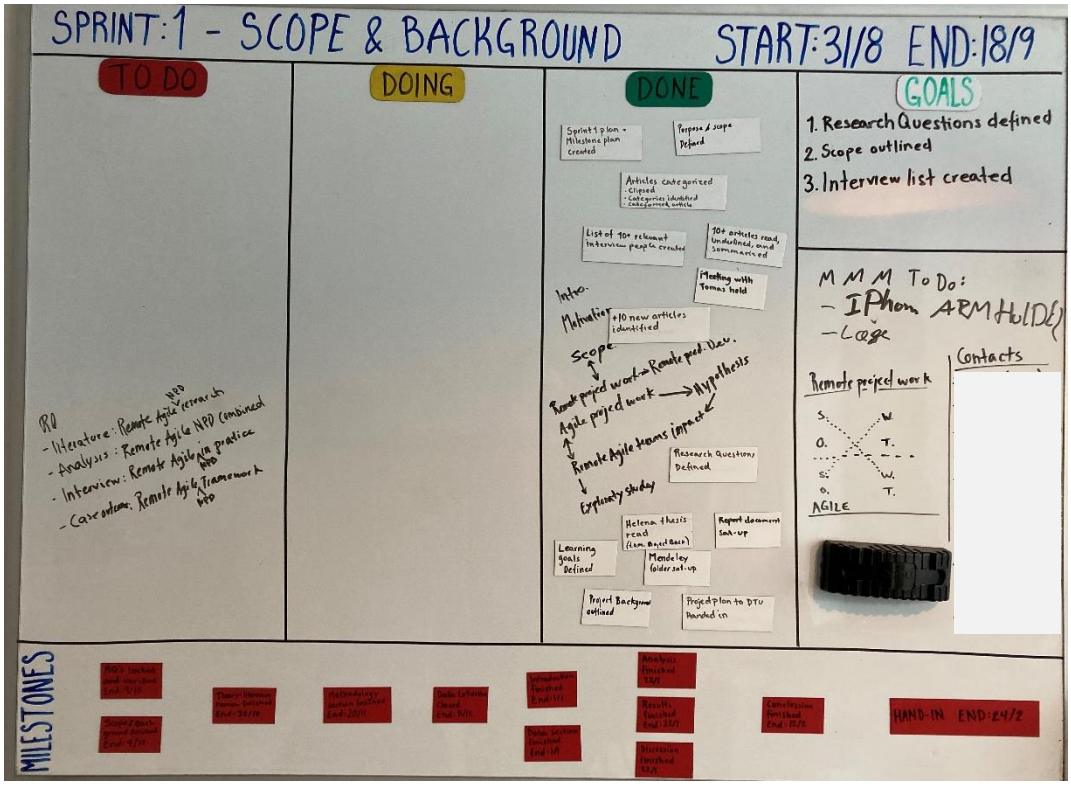
RECOMMENDATIONS

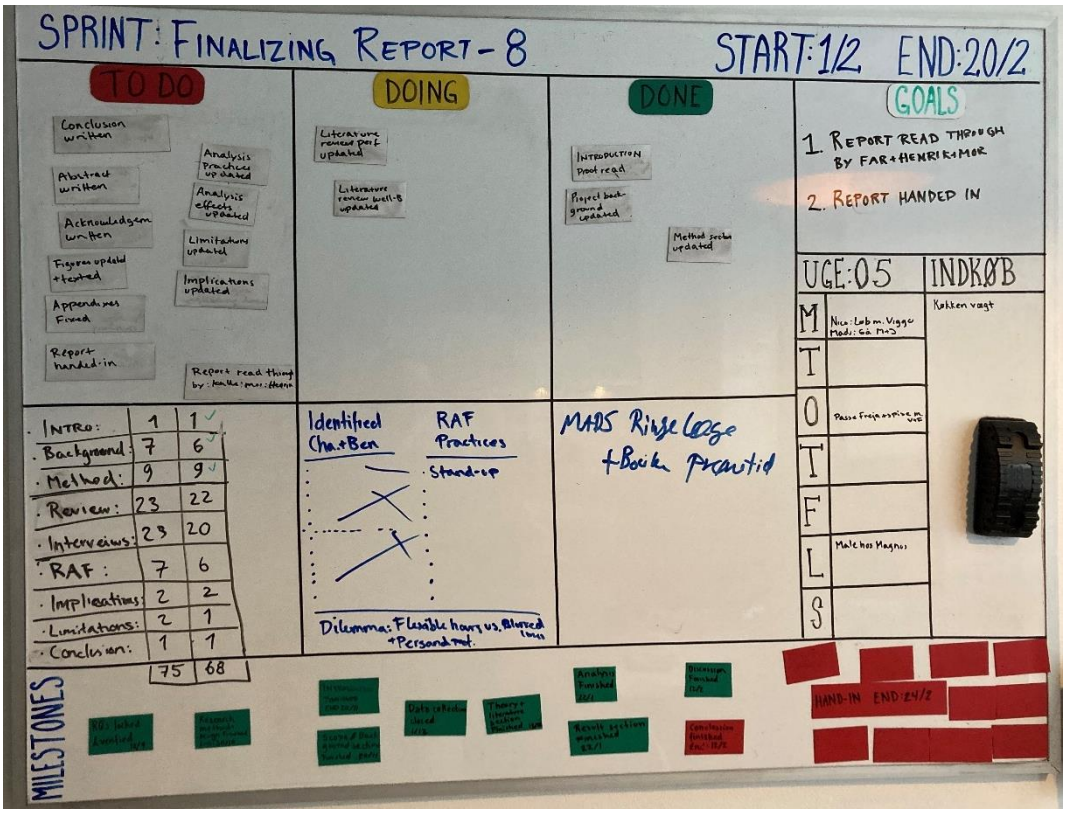
- **Based on your experiences, what are your top recommendations for other NPD teams and managers who want to use agile practices when working remotely?**

CLOSING REMARKS

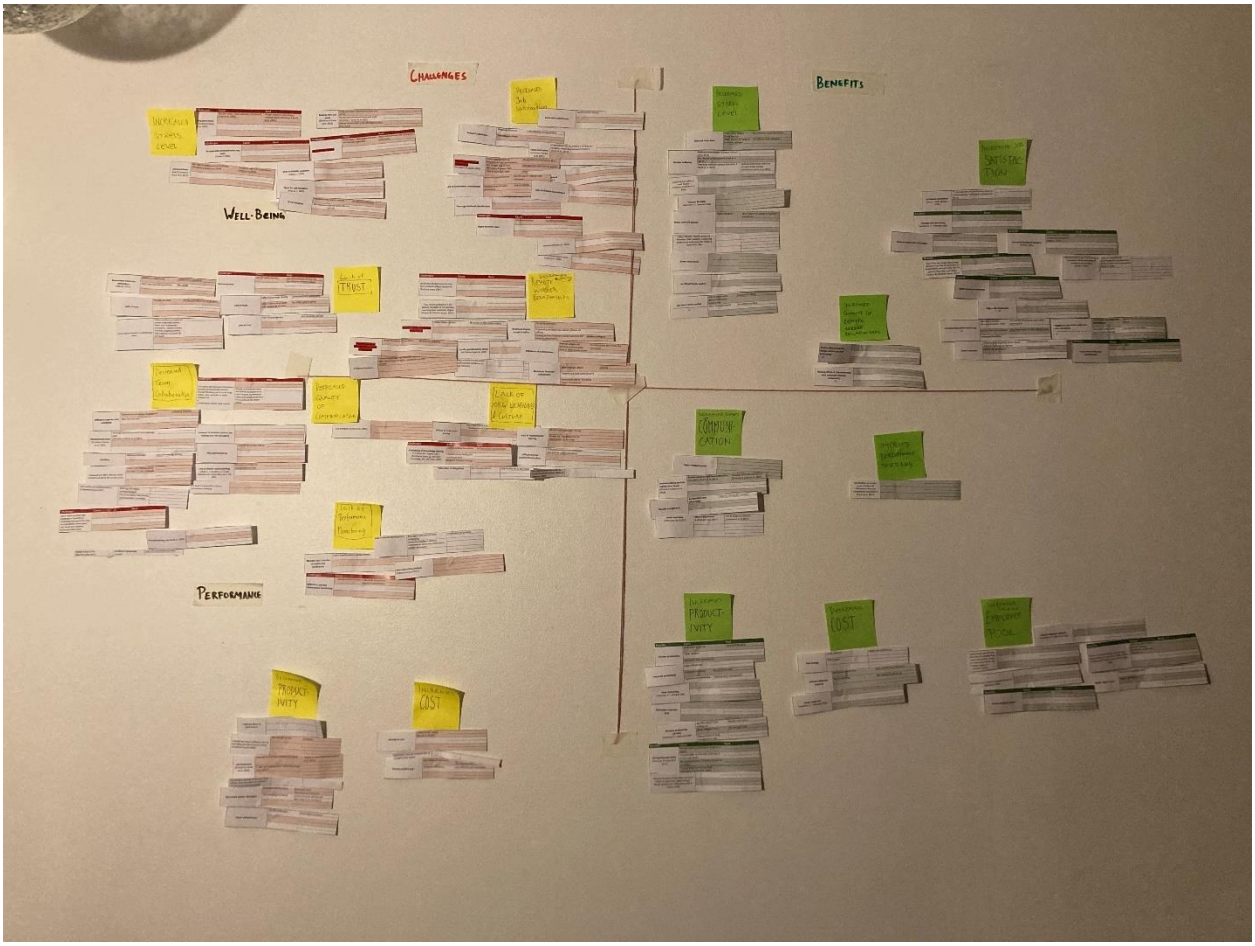
- **Do you have any final comments, not mentioned yet, that you find important for this topic?**

APPENDIX 4: Examples Scrum board for research process (first sprint and last sprint)





APPENDIX 5: Challenge and Benefit mapping in remote work literature



APPENDIX 6a: Sub-codes

Category	Main code	Sub-code
Practices	Ceremonies	General
		Issues
		Advice
		Sprint
		Retrospective
		Demo meeting
		Daily Stand-Up
		Sprint Planning
	Artifacts	Scrum Board
		Increments
		Backlog
		General
	Roles	Scrum Master
		Development Team
		Project Leader
		Stakeholders
	Project Execution (other)	Milestone planning
		Design Freeze
		General
		Other
Agile values and principles	Agile Values	Empowerment
		Iterations
		Minimum Viable Product
		Responding to Change
		Retrospective
		Customer Lock Down
		Positive Experiences with Customer involvement
		Issues with customer involvement
		Customer Relationships
Trust		Physical presence
		New relations
		Dialogue
Implications	Positive implications on performance	General
		Increased focus
		Elimination of disruption
		Increased work hours
		Increased quality of communication
		Better work environment
	Negative implications on performance	Decreased quality of communication
		Technical issues
		Decreased focus
	Positive implication on wellbeing	More free-time
		Better work environment
		Introvert people have safe-space

	Negative implications on wellbeing	Blur between work time and free-time
		Decreased quality of work environment
		Isolation
General Communication		Best practices
		Challenges
		General
		Social
		Physical presence
		Platforms

APPENDIX 6b: Visual overview of sub-code process