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COVID-19's Impact on Agile Software Development

Investigating the impact of recommended or enforced remote work due to the COVID-19 pandemic, one year into the pandemic.

Master's thesis in Computer Science and Engineering

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Abstract

As a result of the COVID-19 pandemic, many agile practitioners had to transition into a remote work environment. Despite remote work not being a new concept for agile software practitioners, the forced or recommended nature of this remote work situation is new. This study investigates this new situation, as well as how agile practitioners have been affected in terms of ways of working. This study uses a mixed method approach consisting of two research phases, of which questionnaire and interview data was collected between February and April 2021. The quantitative and qualitative data were analyzed through Bayesian analysis and thematic analysis, respectively. The results show that feeling forced to work remotely has a significant impact on different aspects of agile software development (ASD), such as productivity and communication, and that industry practitioners' employment of agile development and ways of working have primarily been affected by the lack of social interaction and the shift to digital communication. In general, the aspects of ASD that have been the most affected is communication and social interactions. Technical work aspects have not experienced the same changes. The study also suggest that there will be a group maturing debt when teams do go back into office, as digital communication and the lack of psychological safety stand in the way for practitioners' ability to have sensitive discussions and progress as a team in a remote setting.

Keywords: Computer, science, computer science, engineering, project, thesis, agile software development, covid-19.

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Pernilla Ågren and Eli Knoph, Gothenburg, June 2021

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1
Introduction

At the end of 2019, it was reported that a new virus had emerged in China [1], and soon the whole world was faced with the consequences of what in March 2020 was officially declared by World Health Organization (WHO) to be the COVID-19 pandemic [2]. As the coronavirus spread across the world, more and more employees were asked to work from home as a measure to prevent and limit the spread. Tech giants such as Facebook, Google and Twitter soon reported that they encouraged their employees to work remotely [3] and only a couple of months after the outbreak, WHO advised organizations to promote remote work as a measure to both keep the business going and ensuring peoples' health [4].

At the time of writing, approximately one year after the virus being declared as a pandemic, the pandemic is still ongoing and people are still working from home. Working in a distributed manner, i.e remote, is not a new phenomenon within software development. Both distributed software development and global software development are areas well researched, and research has increased in this field over the past few years [5]. There are inherent challenges with remote work in and between software teams, and one reason why distributed teams fail is according to Shrivastava and Date that "they behave as if they are collocated and do not effectively address the additional communication burdens placed on them" [6, p. 13]. The importance of communication cannot be emphasized enough in this setting where communication and meetings cannot be performed as in a collocated environment [6].

However, despite distributed and global software development being a well researched field, there are two main differences between this research and previous research that in turn serve as a main motivation behind this study, namely 1) the involuntary and rapid shift to remote work, and 2) social restrictions. The quick and sudden involuntary shift from a collocated work environment to a distributed work environment changed the premise for distributed development, from being an opportunity and a choice to being a recommended or enforced policy. In addition, there are inherent limitations and implications to Agile Software Development (ASD) due to social restrictions. An agile principle, such as face-to-face communication [7] is not applicable to the current involuntary distributed agile development since most people are not allowed to meet or travel across sites anymore. Even if tools exist to be applied in a remote context, online collaboration tools are not equivalent to effective face-to-face communication and this will affect the future interaction of distributed agile teams [8].

The involuntary aspect and its effect on ASD in particular, has not been the focus of scientific papers released neither before nor during the pandemic. Instead, previous papers have focused on workers, such as developers' and software engineers' productivity and well-being, and report contradictory results. Some papers report that the pandemic seems to affect developers' productivity [9]-[10], whereas other papers report that it does not [11]. Some papers have found that well-being and productivity are correlated [12], whereas other report that they are not [13]. As mentioned, only a few papers (for example [14], [15] and [16]) have had the focus of industry practitioners in ASD in particular, where for instance, Marek, Wínska, and Dabrowski found that remote work during the pandemic does not seem to affect agile teams' productivity [15]. In other words, there is still a need for further investigation, which is supported by the fact that the journal *Empirical Software Engineering* has called for papers related to 'Software Engineering and COVID-19' [17] at the time of writing. In addition, since it is uncertain for how long the COVID-19 pandemic will require people to work remotely, it is not unreasonable that industry practitioners will continue to work this way in the future. Some companies are already considering a permanent shift from a collocated to a distributed work environment [18] and it might be that "The increased familiarity with online collaboration likely will increase future acceptance for virtual work" [8, pp. 312]. In fact, remote work polices existed already before the COVID-19 pandemic [19] and there are people who actually, even after the pandemic, do prefer this virtual way of working [8]. In other words, since the current situation differs from what is normal, and due to contradictory findings in previous research, it is important to investigate how ASD has been affected by the pandemic, and what techniques and practices industry practitioners apply to address the inherent challenges of involuntary distributed agile development during a global crisis.

In short, this study complements previous research and addresses how the involuntary shift to remote work and how social restrictions imposed by the COVID-19 pandemic have affected ASD, its practitioners and their ways of working. The study uses a mixed methods approach consisting of a quantitative and qualitative phase based on a questionnaire and interviews respectively.

The remainder of this thesis is organized as follows. Chapter 2 describes the background and related work. Chapter 3 describes the research method for this study and Chapter 4 presents the statistical analysis. Chapter 5 presents the results of the study whereas Chapter 6 discusses the results. Chapter 7 discusses threats to validity, and Chapter 8 presents the main conclusions of the study.

2
Background and Related Work

This section presents background on the COVID-19 pandemic and agile software development as well as an introduction to Bayesian statistics. It also presents related work regarding software engineering, agile development and the COVID-19 pandemic.

2.1 Background

This section presents some background on the COVID-19 pandemic and its affect on workers in general, but also on how agile development has facilitated the transition to remote work. Furthermore, this section presents an introduction to the values of agile development as well as an introduction to Bayesian analysis and ordinal regression models.

2.1.1 COVID-19

At the end of 2019, a new virus emerged in China [1] which later became known as the coronavirus. In March 2020, WHO declared the coronavirus as a pandemic [2], and as a precaution to limit the spread of the virus, social restrictions were enforced across the world. WHO advised companies to prepare their workplaces for the pandemic by, e.g, promote remote work [4]. Tech giants such as Facebook, Google, and Twitter were some of the first companies to apply remote working policies due to the virus [3]. Thereafter many employees started to work from home, and now, approximately one year after the outbreak, people are still working from home.

Since people have started to work from home, several news articles and reports try to capture and describe how people are adjusting to and experiencing remote work during the pandemic. A recurring theme is the expectation of future work to be more remote or a hybrid of remote and onsite work [20, 21, 22, 23] and the indication of a maintained or improved productivity [20, 22, 23]. There have also been reports and articles (for example [24, 25]) on how agile ways of working have facilitated work during the pandemic. Insights from McKinsey show that companies that had adopted agile ways of working before the pandemic outperformed those who had not [24]. Also, companies have been able to transform their operating models into more agile ones despite having employees working remote due to the pandemic [25]. Accelerated strategies' research in *The Future of Remote Work and Software Development* report that software development teams have felt more productive than

before the pandemic, and suggests that "the new normal is likely to be anything but normal" [26, p.3].

2.1.2 Agile Development

Agile development is a thoroughly researched topic [27]. It is a well-known and used methodology, originating from the software development field. As a result of trying to come up with better solutions for developing software, the Manifesto for Agile Software Development were developed in 2001 [28]. The Agile Alliance describes the term agile as "the ability to create and respond to change" [29]. As agile is not just a framework or a methodology but rather a mindset inspired by the Agile Manifesto's values and twelve principles [29], the ideas of agile development have spread to other fields as well, which explains the use of Agile Project Management.

The Agile Manifesto [28] highlights the following four values: "Individuals and interactions over processes and tools", "Working software over comprehensive documentation", "Customer collaboration over contract negotiation", and "Responding to change over following a plan". The manifesto was created in a time where most developers were collocated, and are therefore built on a premise that people work in the same physical workplace. One of the twelve principles states: "The most efficient and effective method of conveying information to and within a development team is face-to-face conversation" [7], which is not possible if people work remotely. However, this does not mean that agile development cannot succeed in a distributed environment where people work remotely. Evidence on agile principles' positive impact on quality and performance has been discussed before [6, 30], and as software development is becoming more global, multiple studies have been conducted with the focus on global software development (GSD), distributed software development (DSD), distributed agile software engineering (DASE) and geographically distributed agile development (GDAD) (see for example, [6, 30, 31, 32, 33]).

Communication challenges is a recurrent theme in distributed agile development. Some examples of challenges discussed in research concern, for example, network connection and video conferencing capabilities [33], and lack of communication tools [34]. Agile practices such as pair programming and continuous integration have also been discussed [35]. As it is easier to communicate if team members trust each other [34], distributed teams can have face-to-face meetings at the beginning of a project and then repeating such meetings throughout the project to establish trust and facilitate team bonding [33]. Dorairaj, Noble, and Malik suggest that team members who only communicate with a subset of all team members might be an indication of a lack of teamwork [34]. Rizvi, Bagheri, and Gasevic shed light on the fact that "much of the meaning, tone, and emotion" [33, p. 740] get lost in virtual meeting environments, making it more difficult to understand whether everyone has understood what has been discussed. Documentation, pair programming, training on agile principles, and distribution of work are all examples of challenges that geographically distributed teams may face [6].

Shrivastava and Date suggest that distributed teams might fail if "they behave as if they are collocated and do not effectively address the additional communication burdens placed on them" [6, p. 13]. They further suggest how it may be necessary to make changes in meeting formats and the way team members communicate [6]. For example, by increasing formal communication through weekly meetings and stand up meetings, it is possible to facilitate the process of the work, and by increasing informal communication through non-scheduled meetings it is possible to enable knowledge sharing and trust [34].

In a systematic literature review, Vallon et al. explored what agile practices that have been used in GSD during the period 1999-2016 [5]. The findings of the review show that Scrum and XP were the most prominent methods used. In the 14th annual state of agile report [36], based on a survey conducted between August and December 2020, Scrum was reported to be the most used method/framework, and SAFe the most used scaling framework, whereas XP was used by only 1% of the respondents. In addition, the top five agile techniques used were daily standup, retrospective, sprint/iteration planning, sprint/iteration review, and short iterations [36]. The report described that 81% of the respondents reported that their organizations have distributed agile teams, that is, that not all team members are working in the same physical location [36]. In May 2020, Digital.ai complemented the state of agile report with a survey focused on the COVID-19's impact on agile adoption [37]. Digital.ai revealed some of their findings in their press release, such as that "55 percent say their company plans to increase the use of Agile in the next 12-14 months" and that "33 percent say they increased or expanded Agile adoption in the last 90 days to help manage distributed teams" [37].

2.1.3 Bayesian Statistics

This study uses a Bayesian statistical approach using ordinal Bayesian regression models [38] for analysing quantitative data, where the dependent variable is referred to as an outcome or response variable and the independent variables referred to as predictors. In this study, the outcomes are based on Likert-item[1] data from a questionnaire, which means that the outcomes are of an ordered categorical type. For ordered categorical effects, the difference is not necessarily the same between all categories [38]. In other words, for a seven point Likert scale ranging from strongly disagree to strongly agree, where strongly disagree is 1, disagree 2, agree 6, and strongly agree 7, the difference between 1 and 2 is not necessarily equal to the difference between 6 and 7.

When using ordinal regression models, there are several classes of models to choose from [38]. A guideline on how to decide on which model to use is described in more detail in [38]. However, as a rule of thumb, the cumulative model is often a suitable choice for Likert-item data sets [38], as in the case of this study.

[1]For a Likert-item, as described by [38] "ordered verbal (or numerical) labels are used to obtain discrete responses about a continuous psychological variable.".

As described in [39], there are several advantages of using Bayesian statistics over frequentist statistics. It is possible to provide nuanced analyses, and to improve generality and predictive ability [39]. Bayesian statistics have the potential to provide more informative results than frequentist statistics since Bayesian statistics are based on probability distributions that are more informative than the single point estimates with approximate measures of uncertainty that are used in frequentist statistics [38, 39].

The basics of Bayesian statistics can be explained by the use of Bayes' theorem[2], conditional probability, and the notion of Bayesian inference, which basically means that Bayesian analysis is about describing the plausibility of different possibilities, given some known data and assumptions [40]. There are in particular three specific terms used in Bayesian analysis, namely: priors, likelihoods, and posteriors [39]. A reader who is further interested in how these terms are related to each other, and how the posterior distribution is calculated, is recommended to read the work of, for example, [38, 39, 40, 41]. Otherwise it is enough to know that a Bayesian analysis is an iterative process, and that the statistical models used in this study make it possible to conduct inferences about outcomes from a posterior distribution based on a combination of likelihoods, parameters, and priors [41]. As described by [40, p. 35] "priors are useful for constraining parameters to reasonable ranges, as well as for expressing any knowledge we have about the parameter, before any data are observed".

2.2 Related Work

Since the beginning of 2020 until April 2021, several papers related to the COVID-19 pandemic and software development or software developers have been released. Although related to the same area and conducted during the past year, their focus differ. For example, some papers focus on developers' well-being and productivity whereas other focus on start-ups and agile development.

One of the first extensively conducted papers was written by Ford et al. [11], a study based on a survey conducted between March and April 2020, investigating how the well-being and productivity of 3646 Microsoft employees have been affected by the remote work due to the pandemic. They found that there was no significant evidence that the workers' productivity has been substantially affected by the pandemic [11]. However, they do mention that workers' experience one to another is very different, what one sees as a benefit the other might see as a disadvantage. For example, some people like to work from home because of the freedom and therefore reported a higher productivity, whereas some missed the office and reported a lower productivity. The same dichotomous experience applies, for example, to factors related to well-being, ability to focus, work environment, and meetings. Another similar study also reported on software developers work environment, productivity and well-being

[2]Bayes' theorem "defines the logic of the posterior distribution" [40, p. 36]. As described by [40], the posterior probability is calculated as $Posterior = \frac{Likelihood \times Prior}{AverageLikelihood}$

[9]. With responses from 2225 people, collected between March and April 2020, and from many different domains all around the world they concluded, in contrast to [11], that the pandemic has had a negative impact on developer's productivity [9]. However, they do agree on the fact that different people need different types of support during these times, something also addressed in [10]. Ralph *et al.* [9, p. 4927] also concluded that "women, parents and people with disabilities may be disproportionately affected" during the pandemic. Similarly, in another study based on a survey conducted between April and May in 2020, with 233 respondents working in computer roles in Brazil, and with the aim to investigate the pandemic's impact on gender inequality, it is suggested that most of the organizational incentives adopted "to facilitate remote work during social isolation" were disproportionately benefiting men [42, p. 41]. Even though women and men report similar levels of interruptions, they experience different types of interruptions and effects on their well-being [42].

Another study released in October 2020 compared 139 developers' activity records before and after the COVID-19 pandemic [10]. The activity records stretch from January 2019 until March 2020 and measure developers' productivity. According to Bao et al. [10], larger projects and the type of projects are significant factors to why a developer might feel less productive now than before the pandemic.

Russo et al. conducted two surveys during, what they call, the first wave 20-26 April and during the second wave 4-10 May in 2020 [13]. The motive of their study was to understand what a normal day in a software engineer's work life looks like, and how and what activities that have an impact on their well-being and productivity. The surveys had about 200 participants, and they found that developers spend about the same time on activities at home as they did on-site. However, they also found that developers spend less time in meetings and breaks, and that there is no significant relation between well-being and productivity [13], contrary to what was found in [9]. In another paper, written by the same authors, they suggest that software engineers might have adapted to the situation over time and "that working from home was per se not a significant challenge for software engineers" [12, p. 2]. Also, they argue that their study shows that "on average, software engineers' well-being increased during the pandemic" [12, p. 36], and that well-being and productivity are correlated [12].

In a paper by NicCanna et al. [43], it is described how the management of a company's software development teams were experienced during the pandemic. In July 2020, they surveyed developers about their work location preference, and in January 2021 they conducted an evaluation survey about working from home. They found, among other things, that productivity increased immediately after the transition to remote work, and that the increased productivity seem to have been maintained.

Anselmo da Mota Silveira Neto et al. [44, p. 2] did a "a mining software repository study based on 100 GitHub projects developed in Java" between January 2019 and May 2020, which they complemented by surveying "279 software development professionals from 32 countries" [44, p. 3] to get a better understanding of "the impact of COVID-19 on daily activities and wellbeing" [44, p. 1]. 82% of their respondents

switched to remote work due to the pandemic. Their findings are similar to other studies, that the pandemic's impact is a spectrum and not a matter of just an increase or decrease in, for example, productivity.

One of the most recent papers at the point of writing is "'How Was Your Weekend?' Software Development Teams Working From Home During COVID-19" [45], in which Miller et al. explored how software developers at Microsoft in the United States have been affected by work from home (WFH) during the pandemic [45]. They investigated changes in teams' ability to meet milestones, team culture, support, communication, collaboration, social interactions, and what factors that are related to changes in team productivity. They conducted a qualitative and a quantitative survey with 2265 and 608 responses respectively, with data collection taking place in April and July 2020, and found that "software development teams working from home during the COVID-19 pandemic have experienced a radical shift in how they work together" [45, p. 11] and that social connection and communication are two of the most prominent challenges experienced [45]. Miller et al. suggest the quality of communication to be the challenge, and not a lack of communication [45]. A majority of the respondents reported "being less aware of colleagues' work" [45, p. 6], and similar to other studies, most of the respondents experienced little or no change in team productivity. However, reported productivity is a wide spectrum, with almost as many reporting an increase as decrease. Other findings in [45] are, for example, developers experiencing having more meetings, an increased empathy and understanding for each others' situation, the fostering of social interaction through social engagement meetings, and having personal check-ins to examine well-being and progress. They suggest that having personal check-ins to ask for each others' well-being and progress has gained more genuine interest during the pandemic, compared to before the pandemic [45].

Another recent paper focuses on a study on the remote onboarding experience (due to the pandemic) of 267 new software developer hires at Microsoft in the United States [46]. The study was based on a survey conducted in July 2020 and explored what challenges developers are facing and how they are getting along with their team members. In addition to the survey, they also conducted eight interviews to better understand the results from the survey. The paper presents three main interpretations of the results [46]. First, the developers faced many challenges, some unique to the special WFH situation and others that were not. Second, even though teams are having social events to connect with new hires, there are still some who report that they do not feel socially connected. Third, new hires want more manager meetings and overall interaction with their teams.

While none of the aforementioned papers primarily focused on agile development and how it has been affected by the pandemic, a few other papers did. An action study conducted between March and May 2020 [14], reported on the way a startup handled the remote work that came with the pandemic, and what agile practices and activities that were useful during such an uncertain time. To reduce uncertainties during the pandemic, it was found to be important to conduct socialization

events and guidelines, but also to establish knowledge sharing rounds and code development standards. A newer paper found, based on a survey with 120 responses conducted in early September 2020, that ASD teams' work was not significantly affected [15]. The teams transitioned to remote work without any major issues partly because many of the teams already used remote working tools before the pandemic. Respondents of the survey also stated that unnecessary meetings were reduced [15], similar to what was found in [13], and that productivity increased because of remote work. The study also found that teams that consisted of a mix of on-site members and distributed members improved their communication when everyone went remote [15]. A study conducted between April and May 2020 in Germany focused on managers and project management experts in agile development [16]. They found that "The sudden adoption of strong measures, also known as 'lockdown', had a significant impact on the nature of agile working." [16, p.10]. They mentioned that the transition to remote work went smoothly, and that practitioners now use online tools that they were reluctant to use before the pandemic. Also, they found that "work became more flexible with only a small loss in productivity" [16, p.10], which is in contrast to Marek, Wínska, and Dabrowski [15] who found an increase of productivity. Another study, also conducted in Germany, collected its data during August and September 2020, and observed three software development teams and their use of agile practices [47]. They found that in all three cases, pair programming, retrospectives and daily stand up meetings, among others, were used. They also found that daily, instead of weekly, stand up meetings, were conducted to increase synchronization in the team. Additionally, they found that pair programming is conducted in many different ways using different online tools.

In a conference paper from September 2020, Mancl and Fraser [8] summarize some of the main conclusions from the XP panel held at the International Conference on Agile Software Development in June 2020. "The panel discussed the impact of COVID-19 on knowledge workers, the acceleration of digital workplace transformation, and anticipated long term effects from the pandemic in the context of agile practices" [8, p. 309]. According to [8], "The primary conclusion of the panel was that tech workers will continue to work from home and use virtual collaboration technology for the foreseeable future" [8, p. 314], but the main conclusions from the panel are fourfold [8]. First, the COVID-19 pandemic has influenced industry practitioners' ways of working. Second, due to communication taking place online instead of face-to-face, it is more difficult to follow agile practices. Third, collaboration tools are not equivalent to face-to-face for all types of communication, in particular not for "performing high-bandwidth and informal interactions, such as brainstorming, white-boarding, side discussions, and hallway conversations" [8, pp. 310-311]. Fourth, it is a challenge to form new teams and to integrate new team members in a virtual work environment. Mancl and Fraser also mention that some people have felt more productive during the pandemic and that some would like to continue to work remotely in the future.

While not many scientific papers have been published regarding COVID-19 and ASD specifically, many nonscientific articles, blog posts and experience reports have been

written. One example is an article by Kude [48] from May 2020, where he discusses what remote work could mean when teams go back to being collocated. According to Kude, initial problems, such as access to databases, with going remote have been resolved, but there is a risk for both technical and social debt when going back to the office. An article by the Human Resources Certification Institute (HRCI) Team [49] from April 2020, emphasizes on establishing small and short increments and iterations during the COVID-19 pandemic while working online. An article written by Blueoptima [50] from February 2021, discusses what agile processes that can help remote teams. Among other things they emphasize on setting up regular meetings and working in small cross-functional teams to adapt faster to change [50], which is something also mentioned in an article written by Rehberg et al. in March 2020 [51]. In April 2020, Construx Software surveyed software professionals about their experiences of working from home due to the pandemic [52]. They summarized the results in a report, and state that, compared to before the pandemic, communication is much harder and misunderstanding are frequent [52]. However, they also report that team members seem to put in more effort into written communication, which has made communication more deliberate and clear.

Despite the existence of papers published related to the COVID-19 pandemic and software development, most papers have not had the focus of ASD in particular. However, there are some papers that do, such as [14], [15], [16] and [47], previously described above. The focus of previous work has been on developers', software engineers' or professionals' well-being and/or productivity, as in [9], [10], [11], [12], [13], and [42]. In contrast to these aforementioned studies, this paper investigates how specifically ASD have been affected by the COVID-19 pandemic. This implicates agile practitioners such as developers, software engineers, but also scrum masters, team leaders and managers etc.

Many of the previous studies have been conducted in the early stages of the pandemic from around March to the summer of 2020, such as [9], [14] and [44]. The first months of the COVID-19 pandemic might have been a time of confusion and uncertainties about and adjustments to the new situation, especially when working from home. The research methods used for data collection in this study, a questionnaire and interviews, were conducted between February and April 2021, which is approximately one year after the beginning of the pandemic. A lot of things can happen within one year, the sudden shock and adjustment period might have disappeared and left more unstructured processes regarding remote work behind. This may result in new insights regarding productivity, well-being, and impact on agile practitioners and ASD in the long term, and might differ from the insights from the early stages of the pandemic.

While other papers mention a "forced" aspect of the current working from home situation [52], also called “involuntary, remote work” [53, p. 607], or “Mandatory Remote Work” [42, 54], none has investigated what implications the feeling of involuntary and forced remote work has on industry practitioners, which is something we do in this study.

3
Method

This study aimed to investigate the COVID-19 pandemic's impact on ASD. The following research questions provided the focus for the investigation:

RQ1: *How has the COVID-19 pandemic impacted agile software development?*

RQ1.1: *Compared to before the pandemic, how has the way industry practitioners employ agile development and ways of working changed?*

RQ1.2: *How has industry practitioners been affected by recommended or enforced remote work?*

An overview of the process of this study is depicted in Figure 3.1, and each step is further described below. However, the main steps are as follows. First, a literature review was performed to get familiarized with the topic and to investigate what has been discussed in previous work. Thereafter, we designed and evaluated the questionnaire, and collected and analyzed the data. Based on the analysis, we decided on what results to investigate further, and designed and evaluated the interview protocol. We thereafter conducted semi-structured interviews and analyzed the qualitative data using thematic analysis. Finally, we integrated the quantitative and qualitative data, and analysed the results as a whole.

As the research questions were of both a quantitative and a qualitative nature, they could not be addressed by one research method alone. Therefore, an explanatory sequential mixed methods approach [55], using a questionnaire and semi-structured interviews, was chosen for this study. A descriptive quantitative approach, such as a questionnaire, cannot capture the reasoning behind the answers, whereas a qualitative approach, such as an interview, is insufficient to provide a general description of the situation. By combining these types of approaches we could achieve a better understanding of the COVID-19 pandemic's impact on ASD than what was possible if we only conducted either quantitative or qualitative research alone [55].

As the study followed an explanatory sequential design [55], it consisted of a quantitative phase - a questionnaire -, followed by a qualitative phase - interviews. The first phase provided the foundation for answering our research questions, enabling us to identify what factors were relevant to focus on in the qualitative phase, and in turn to fully answer the given research questions. By asking questions regarding industry practitioners' experience of the pandemic's impact on agile practices, and changes in productivity, communication, teamwork, and work environment, we collected quantitative data that enabled us to compare the impact on different factors

and to identify potential relations between factors and/or groups of practitioners. In [56], it is suggested that using surveys might be the best way to capture the relation between productivity and aspects such as satisfaction and well-being. As we investigated such aspects in this study, it was suitable to collect data using a questionnaire. In the second phase, after having analyzed the quantitative data, we conducted semi-structured interviews with industry practitioners to explore and explain the quantitative data in more depth.

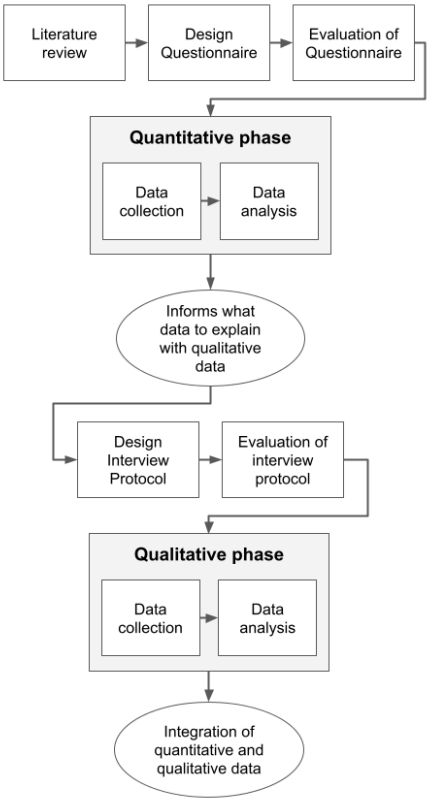

Figure 3.1: An overview of the steps of the explanatory sequential design of the mixed method study, with one quantitative phase followed by a qualitative phase.

3.1 Questionnaire

The quantitative phase in this mixed methods study consisted of a questionnaire. Benefits with a questionnaire are that they are time effective, easily administered, and provides an opportunity to collect data from a large sample of people from different parts of the world [57]. However, in a questionnaire there is no possibility to follow-up on and get an explanation for certain answers, hence why interviews also were conducted in this study. This questionnaire used in this study consisted of 28 questions regarding several aspects of ASD, as described in more detail in Section 3.1.1. The data collection period was between February and March 2021, as described further in Section 3.1.2, and resulted in a total of 96 responses that were

used in the Bayesian data analysis, as described in Section 3.1.3. More information about each step is presented in the sections below.

3.1.1 Questionnaire Design

We followed Kitchenham and Pfleeger's guidelines for personal opinion surveys [58] to design the questionnaire. These guidelines discuss six stages in survey-based research, namely: 1) setting the objectives, 2) designing, 3) developing and 4) evaluating the survey, 5) obtaining valid data and 6) analysing the data. In Figure 3.1, these stages are represented in the upper part of the Figure. Setting the objectives and developing the survey were left out from the figure to keep it simple, but were part of the process in question.

According to [58], it is important to assess whether a questionnaire is an appropriate method at the time of setting the objectives. Given the purpose of this study, a questionnaire was indeed a suitable approach since we could begin with a broad overview based on a diverse set of respondents, and thereafter follow up on details to get a better understanding of the COVID-19 pandemic's impact on agile software development. The quantitative data obtained were then used to inform what details to explore further in the qualitative phase.

The questionnaire was designed as a self-administered [58] cross-sectional [58] web-based questionnaire using QuestionPro's survey tool[1]. It was designed and developed with respect to different areas of interest, inspiration from previous research ([9], [11], [13]) and non-scientific literature ([36]), and a pre-study. A pre-study was conducted since it can be difficult to directly convert objectives to questions [58]. The pre-study consisted of three open-ended questions regarding agile development and the ongoing pandemic, and were sent out to five agile practitioners. The questions were directed to their own experiences and opinions regarding changes and perceptions because of the COVID-19 pandemic. The feedback obtained generated a few additional closed-ended questions but also justified having the open-ended questions we already had. As described by [58, p. 71] "There are advantages and disadvantages to each type of question", and open questions may be difficult to analyze but do not restrict respondents' answers since they can form their own answer instead of choosing from a predefined list.

Most of the questions in the questionnaire followed the same structure, and were introduced as "Compared to before the pandemic..." to capture the level of change experienced; for more details see Table A.1 in Appendix A. The questions were of four different types: closed-ended (select one option), Likert scales, ordinal scales, and open-ended (free-text), as seen in Figure 3.2. Questions of type 'select one option' had a pre-defined set of options. However, to avoid missing any potential alternatives and to avoid long lists of options, some questions (Q1, Q4, Q6, Q8, Q11) also had an 'Other' option [58]. In addition, as some questions might have not been applicable to all respondents, most questions also included the option 'Non applicable'

[1] `www.questionpro.com`

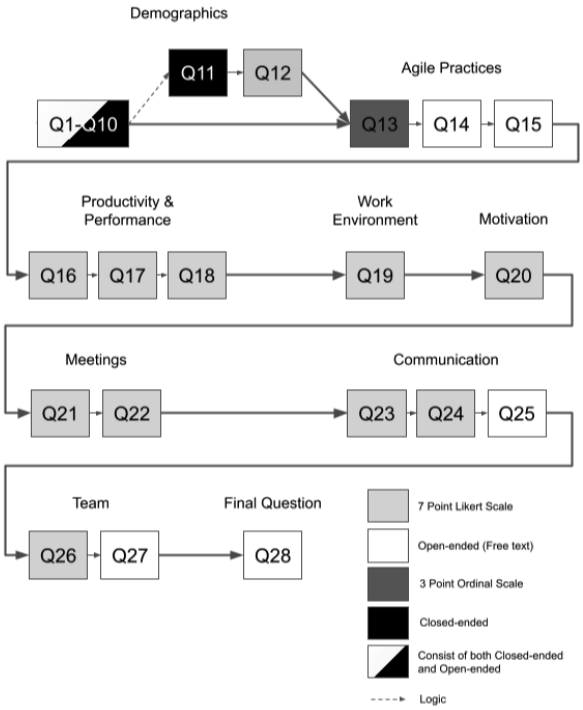

Figure 3.2: A figure of the question flow of the questionnaire. The demographic section consist of both questions that are closed-ended and open-ended. Some closed-ended questions also have an 'Other' option for respondents to add their own free text answer.

(N/A). By including such an option, respondents did not have to provide ambivalent answers [58], and we could distinguish skipped questions from non-applicable questions. Seven point Likert scales were used for all questions where applicable, except for Q13 for which a three point ordinal scale were used instead. Based on recommendations in [58], we labeled each point with a definition to enable a better understanding of its meaning, and used bold and underlined text for emphasis and instructions. The scales measured level of agreement, degree of change, and type of change. They were designed using standardized response formats to facilitate for the respondents and to minimize the time taken to complete the questionnaire [58].

The final version of the questionnaire [2] was divided into nine sections, covering 28 questions in total. Before starting the questionnaire, respondents were informed regarding the purpose of the study, participation, and our handling of the data. Participation was voluntary but withdrawal was not possible once started as the data were anonymous and confidential, hence incomplete answers were still collected. Each section of the questionnaire is described in the sections below, and an overview of what questions belonged to what section is depicted in Figure 3.2.

Demographics

[2]The questionnaire is available here: `https://doi.org/10.5281/zenodo.4506761`

The demographics section covered questions regarding, for example, domain (Q4), geographic location (Q5), role (Q6), and years of experience in agile software development (Q7). These questions provided an indication of the diversity of the sample. In addition, since the questionnaire included a section dedicated to team-related questions, the demographics section also included questions regarding team size (Q2) and whether the team constellation or employment had changed during the pandemic (Q3). It also covered to what extent the respondents had been working remote before (Q9) and during the pandemic (Q10). Those who had been working remote during the pandemic are asked to answer why they are working remote (Q11) and whether they feel forced to do so (Q12). Q11-Q12 were, in other words, included to capture how involuntary the shift was experienced. Respondents who had not been working remote did not see Q11-Q12.

Agile practices
A total of three questions regarding agile practices were included in the questionnaire with the purpose to investigate how deployment of agile practices had been affected by the pandemic. As "agile work practices are harder to perform" [8, p. 310] in the distributed agile environment caused by the pandemic, there was reason to include and investigate this area in the questionnaire. Q13 was a three points ordinal scale question covering how challenging 19 common agile practices are now, compared to before the pandemic. To further investigate ways of working (RQ1.1), two free-text/open questions regarding abandonment and/or adoption of practices (Q14), as well as practices' importance (Q15), were included. A list of the agile practices used in the questionnaire is depicted in Table 3.1, and a description of how they were selected is described below.

The development of the list of agile practices used in the questionnaire was initiated by a thorough research on most used agile practices in industry. Agile Alliance's list of 56 agile practices [59] and their definitions were used as a first reference point. Thereafter, Version One's 14th Annual State of Agile report's list on the most used agile practices and techniques of 2020 [36] was reviewed. We then read a systematic literature review from 2018, summarizing agile practices used in global software development during the period of 1999-2016 [5]. Finally, we cross-referenced practices in these three previously mentioned sources while considering the most used practices, and thereby created the final list of 19 agile practices as seen in Table 3.1.

As the list did not consist of all existing agile practices, Q14 enabled the respondents to add information on any practice, from the list or not, that they thought was extra valuable during the COVID-19 pandemic. The systematic literature review's list of practices [5] and Annual State of Agile's list of engineering techniques and practices [36] were not just merged together; some practices were grouped together, and some were excluded. 'Standup meeting' and 'Daily standup' were merged into 'Stand up meeting/ Daily Scrum'. 'Sprint' and 'Iteration' refer to a similar concept and were, therefore, defined as 'Sprint/Iteration' to cover as many methodologies as possible. 'Review' and 'Demo' were used interchangeably, and denoted as 'Review/Demo'. 'Planning Game' and 'Planning Poker/Team Estimation' were denoted as 'Planning

Table 3.1: The final list of the 19 agile practices used in the questionnaire.

1	Stand up meeting/ Daily Scrum
2	Sprint/Iteration
3	Sprint/Iteration planning
4	Sprint/Iteration review/demo
5	Retrospective
6	Continuous Integration
7	Pair Programming
8	Mob Programming
9	Coding Standards
10	Automated Testing
11	Test-driven development
12	Collective code ownership
13	Simple/incremental design
14	Planning Game (e.g Planning poker)
15	Refactoring
16	Onsite/proxy customer
17	Estimation Meeting
18	Backlog
19	Sustainable Pace

Game (e.g Planning Poker)' for simplicity and clarification. The reasons for using certain terms interchangeably were because of the similarity of the definitions by Agile Alliance, such as the definition for Daily Meeting, also known as Daily Scrum or Daily Stand-up [60].

Two practices were excluded: 'Face-to-Face Communication' and 'Common Work space'. Even though 'Face-to-face communication' was one of the most prominent used practices, according to [61], we excluded it from the list of practices as it is covered in the sections 'Communication' and 'Meetings' in the questionnaire. Similarly, as it already is covered by the demographic section, 'Common Work Space' was excluded as well.

Productivity & Performance
Q16-Q18 were closed-ended questions dealing with topics related to productivity and performance (RQ1.2). Q16 and Q18 measured level of change, whereas Q17 measured level of agreement. As described in Section 2.1.3, previous research show a dichotomous experience regarding industry practitioner's productivity when working from home due to the pandemic. Therefore, the questions covered aspects such as self-assessed productivity on both individual (Q16) and team level (Q17); perception of quality of work, availability, focus, distractions, and interruptions; customer satisfaction (Q17); and potential changes in time spent on certain activities (Q18).

Work Environment
There was one seven point likert scale question (Q19) in the questionnaire about

Work Environment. It handled topics such as the respondents' well-being, work/life balance, work environment etc. (see more specifically in Fig. 3.2). As mentioned in Section 2.1.3, there are varying findings on the aspects related to work environment, especially due to social restrictions and remote work. Changes in work environment (RQ1.2) and ways of working (RQ1.1) may have been affected.

Motivation
Q20 was a closed-ended question measuring level of change in motivation. Motivation is highlighted in the agile principle "Build projects around motivated individuals" [7], but is, to the best of our knowledge, not as prevalent as other factors in previous COVID-19 studies. It is likely that it may influence aspects of both RQ1.1 and RQ1.2, and is covered by statements in terms of pure motivation, feeling of being overwhelmed, ability to choose and focus on a given task, acknowledgement of work, and perception of having a meaningful work.

Meetings
Q21-Q22 were closed-ended questions concerning different aspects of meetings. Q21 measured type of change in terms of increase/decrease, whereas Q22 compared how often (frequency) specific meetings occur now compared to before the pandemic. As indicated in Section 2.1.3, varied findings have been reported concerning meetings in distributed environments. The questionnaire addressed industry practitioners' ways of working (RQ1.1) by taking several factors into account, such as quality, frequency, and length. As many practitioners work remotely, the questions also covered to what extent meetings are face-to-face, use video, and whether people made themselves heard. For a detailed list of factors and type of meetings included, please see the final questionnaire.

Communication
Q23-Q25 were all questions related to communication. The first two questions used seven point likert scales and the last one was an open question. These questions provided information about how industry practitioners' communication within teams and outside of teams has changed because of the pandemic (RQ1.2 and RQ1.1). As mentioned in 2.1.3, several studies described how communication is a main challenge in distributed software development [31], [6], [34], [62], [11].

Team
Q26 and Q27 consisted of one seven point likert scale question, and one open question, respectively. As previously mentioned in 2.1.3, agile teams are a central part of agile methodology, and due the current situation (the pandemic), there were reasons to believe that they might have been affected regarding internal communication and teamwork after social restrictions were introduced. Lack of effective informal communication and social interaction had been reported as some of the main challenges experienced by teams during the pandemic [11]. Therefore, the questionnaire included questions regarding, for example, team inclusion, team morale and transparency (RQ1.1).

3.1.2 Questionnaire Evaluation

Before implementing the questions into QuestionPro's survey tool, we reviewed all questions in several iterations, with focus on content, clarity and connection to our research questions. In one of the final iterations, we also consulted a software engineer to review the questionnaire regarding their clarity and wording. The feedback was that the questions were understandable and clear. After this pre-evaluation, we implemented all questions into the survey tool and initiated the pilot study described below.

As part of the pilot study, we collected feedback from three individuals - two agile practitioners and one software engineering student - regarding the clarity and content of the questionnaire. Before the reviewers opened the questionnaire, they were asked to think about the following aspects while answering the questions: if they understood all questions, if there was anything that they found unclear, what they thought about the different scales, if the length of the questionnaire and the time to complete the questionnaire were appropriate, and if there was anything that they missed or would like to add.

The feedback from the pilot study highlighted the need for a clarification of one question in particular (Q13), and adjustments were made according to the suggestions given. The time taken to complete the questionnaire was assessed to be fair, and the scales used were found appropriate. It was also suggested to increase the font size for subheadings and instructions, clarify whether the alternative "other" was of the free-text type for questions with many alternatives, and to highlight that the time referred to as "now" corresponds to "now, during the pandemic" (as seen in Q15). One reviewer voiced a wish for one additional open question. All of these aspects were taken into account and adjusted for in the final version of the questionnaire. In addition to responding to the given feedback, we also looked for inconsistencies among the reviewers' answers.

In short, the feedback from the pilot study resulted in a few clarifications of some questions and small changes of the alternatives in one question. One open question was added, but no questions were deleted.

3.1.3 Questionnaire Data Collection

The sampling techniques used for the questionnaire were convenience sampling [58], maximum variation sampling [63], and snowball sampling [58]. Convenience sampling is a non-random sampling [63] technique common in software engineering surveys that "involves obtaining responses from those people who are available and willing to take part" [58, p.86]. Maximum variation sampling is useful when not having a random sample, as was the case for this study, and the purpose of it is to achieve a wide variety of participants to get a better understanding of the topic in question [63]. "Snowball sampling involves asking people who have participated in a survey to nominate other people they believe would be willing to take part" [58, p.86].

The questionnaire was targeted to voluntary industry practitioners with different roles from different types of domains and size. As the purpose of this study was to investigate the pandemic's impact on agile software development, the targeted population was industry practitioners involved in agile software development, with the inclusion criteria [58] that they had been working both before and during the COVID-19 pandemic. Respondents who did not apply to this criteria were filtered out in the demographics section.

Data collection started on 10 February 2021, and finished on 15 March 2021. The questionnaire was distributed to industry collaboration networks and communities dedicated to agile software development on LinkedIn, Facebook and Reddit. Personal contacts with different roles and experience in industry were also contacted and asked to answer and distribute the questionnaire further within their organizations.

3.1.4 Questionnaire Data Analysis

This section describes the process of the data analysis of the questionnaire. It covers a description of the data cleaning, and the development and analysis of the statistical models.

3.1.4.1 Data Cleaning

In total, 155 people started the questionnaire of which 75 went through the whole questionnaire and submitted their answers, and 80 people started the questionnaire and dropped out before the end of the questionnaire, while some entries were completely empty. The cleaned data set consisted of responses from 96 respondents, but since we used partial answers for the analysis, the number of responses varied for each question.

The raw data from QuestionPro included columns such as IP addresses, timestamp, country code and question names, which were removed. Completely empty rows were also removed, that is, responses from respondents who only opened the questionnaire but did not respond, which resulted in a removal of 44 entries. Further, the ones who had only answered the demographic questions, were also removed, which resulted in a removal of 13 entries. Because the pandemic had been going on for more than a year (when the questionnaire was sent out), practitioners were required to have worked for at least one year, and due to the scope of the study, they had to follow agile methodologies. By using some of the demographic questions that served the purpose of filtering out responses not applicable to our study, we removed two entries that were not applicable. This partially cleaned data was uploaded temporarily to a private repository on GitHub.

3.1.4.2 Model Preparation

Out of a total of 111 questions (excluding open questions), 11 of the demographic questions were set as predictors (Q1-Q7, Q9-Q12), and the rest as outcomes. Question Q8 (Which development methodology do you mainly follow in your team/work now?) were removed from the data analysis since the data cleaning described in the previous section already has excluded practitioners who do not follow an agile methodology. In other words, the data set now only includes agile practitioners, which means that Q8 serves no use as a predictor. A summary of all predictors including their corresponding values and type is provided in Table 3.2.

Table 3.2: The ID indicates the coding in the analysis, predictor name indicates what the predictor is, value(s) indicates what values that can be used, and type is any of the following where $\mathbb{N}$ indicates a natural number, $\mathbb{O}$ indicates ordered (categorical) data, and $\mathbb{Z}$ indicates an integer for categorical data.

ID	**Predictor name**	**Value(s)**	**Type**
P_Q1_3C	Gender	female (1), male (2), other (3)	$\mathbb{Z}$
P_Q2_s	Team size	0,...,41	$\mathbb{N}$
P_Q3_5C	Team constellation	exactly same (1), mostly same (2), changed team but same employment (3), changed employment (4), not part of a team (5)	$\mathbb{Z}$
P_Q4_3C	Domain	IT (1), Embedded Technology (2), Others (3)	$\mathbb{Z}$
P_Q5_3C	Continent	Europe (1) , North America (2) , Asia (3)	$\mathbb{Z}$
P_Q6_3C	Role	Technical (1), Management (2), Agile (3)	$\mathbb{Z}$
P_Q7_s	Years of experience	0,...,30	$\mathbb{N}$
moP_Q9_1_5L	Remote work before	never remotely (1),..., never at office (5)	$\mathbb{O}$
moP_Q10_1_5L	Remote work now	never remotely (1),..., never at office (5)	$\mathbb{O}$
P_Q11_7C	Reason	Recommendation from company (1), government (2), company & government (3); Enforcement by company (4), government (5), company & government (6); My own choice (7)	$\mathbb{Z}$
moP_Q12_1_7L	Forced	strongly disagree (1),..., strongly agree (7)	$\mathbb{O}$

The analysis of the questionnaire data was done with Bayesian statistics in R[3]. To facilitate the analysis in R, we prepared the data set by re-coding outcome and predictor names and regroup certain categories.

[3]R is a language for statistical coding `https://www.r-project.org/about.html`

First step was to re-code all 'N/A' alternatives to 'N/A' in text, remove unnecessary blank spaces and re-code the question names to facilitate the analysis in R. All questions were re-coded based on their structure and type as we had both Likert scales, also called ordered categorical data, and categorical data. For example, Q16 is an ordered categorical question and became Q16_1_7L, because it is a question with a seven point Likert scale (1 to 7). Sub-questions in, for example, Q17, were named Q17_1_1_7L, Q17_2_1_7L and so on. Categorical questions were changed from, for example, Q3 to Q3_5C, based on how many categories they have.

We then investigated the responses to questions and noted the questions with alternatives that had few or no responses to regroup the categories to fewer ones, as described below. The final regrouping can be seen in Table 3.2.

Q1 ('gender'), had few responses in both category 3 ('Non-binary') and 4 ('Do not want to specify'), and none in 5 ('Other'). Therefore, we reduced the number of categories for Q1 from five to three. We kept 'Female' as 1, 'Male' as 2, but grouped 'Non-binary' and 'Do not want to specify' together into category number 3.

Q4 ('domain'), had 22 categories, out of which 19 had one or more answers. We decided to group them into three new categories, coded as: 1 for 'IT', 2 for 'Embedded Systems' and 3 for 'Others'. Domains primarily in IT were put in category number 1, and domains in embedded systems, but not primarily within IT were grouped into number 2, and the rest into category number 3.

Q5 ('continent'), had seven categories, but only answers in three of them. The new categories are coded as: 1 for 'Europe', 2 for 'North America', and 3 for 'Asia'.

Q6 ('role'), had 22 categories in total, in which only 15 had one or more responses. We grouped the categories into three new categories, coded as: 1 for 'Technical', 2 for 'Management' and 3 for 'Agile'. The ones with more technical roles, such as being a developer or software engineer, were put in category number 1, the ones with management roles, such as product manager or project leader were put in category 2 and the ones who primarily have agile roles, such as scrum master or product owner, in category 3. For more details regarding each question see more in Table A.1.

A complete case analysis was performed to avoid having to deal with missing data when building models. This means that if there is any data missing in a row, that row will be excluded from the analysis. In this case, this means that some of the entries in the data set used in this study were disregarded when running the models. We only analyzed the data for practitioners who had responded to all of the questions that were used as predictors. This means that respondents who never worked remotely during the pandemic - a total of four data entries -, and therefore did not answer Q11 and Q12, were excluded as a result of the complete case analysis.

3.1.4.3 Model design

In this section, the three main steps of building the model are described, namely: selection of likelihood, sensitivity analysis of prior and posterior, and diagnostics. The interpretation of the results are further described in Chapter 4. The statistical models were built and fitted using the brms (Bayesian regression models using 'Stan') package [38] in R. As described by [38], some of the advantages of using brms are that it can handle the three ordinal model classes cumulative, sequential, and adjacent-category, and that the use of a Bayesian framework provides more information than the frequentist approach. The final models were built on the form $O \sim p_1 + p_2 + ... + p_{12}$ where O represents an outcome and p_n represents a predictor. The predictors were, as previously described, all demographic questions Q1-Q12, excluding Q8. The predictors Q2 and Q7 were continuous variables, and were therefore standardized[4] to facilitate the sampling. The predictors Q9, Q10 and Q12 were ordered categorical predictors, and were therefore modeled with monoticity, which means that the variance between the different categories might differ [38]. By using a Dirichlet prior, we could express that we know that the variances might differ, but that we are skeptical of extreme differences.

All steps described below (except for comparing different likelihoods) on how to build a model for the outcome Q16 - self-assessed productivity - were applied for all of the 100 outcome variables. A model was also created for the predictor Q12, since Q12 not only could serve as an predictor, but also could be modelled as an outcome dependent on the rest of the predictors.

Selection of likelihood
To decide which likelihood to use for the model, a model comparison was performed. As all of the outcome variables were of an ordinal categorical type, there were at least three different types of models to choose among: cumulative, sequential, or adjacent-category [38]. The model comparison did not show any significant difference between the families, and we therefore settled on using the cumulative family since it is rooted in mathematical theory [64] and usually suitable for Likert-item data [38].

Prior predictive check
After choosing the cumulative family for the model, priors had to be set for all of the predictors before fitting the model and sampling from the priors.We performed a sensitivity analysis of our priors since we wanted the data to speak for itself, and the priors to affect the model as little as possible. This means that we experimented with different priors until we found fairly uniform priors and a good predictive power for our model [39]. The reason for choosing a fairly uniform prior is as described in [39, p.10], that "A weak unbiased prior is the most appropriate choice in most cases", and that "A uniform prior assumes that any possible value for a coefficient is as likely as any other" [39, p.10].

[4]Standardizing the predictors "means to first center the variable and then divide it by its standard deviation" [40, p. 111].

For most of the predictors, the priors were set to 'normal(0, 0.25)' [5], and for the ordered categorical (monotonic) predictors, the priors were set to 'dirichlet(2)'. As an illustration of the sensitivity analysis of the priors, that is, the prior predictive checks, see Figure 3.3. The figure shows how well the priors fared compared to the empirical data, which in this case was considered to be acceptable as the means (the black dots) were approximately at the same level and the uncertainties (the black lines) of each level were fairly uniform. The blue bars correspond to the observed data.

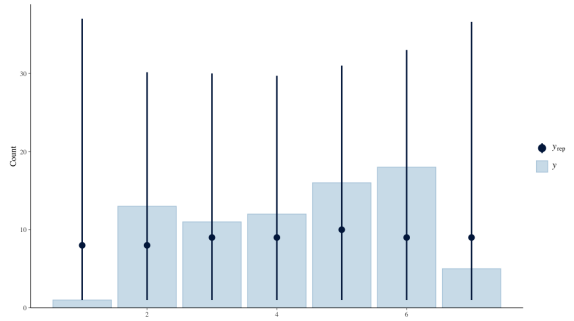

Figure 3.3: A Prior Predictive Check of the model with Q16 - self-assessed productivity - as outcome variable. Sampling only from priors.

Sample with data
After having fitted the model with a sample only from priors, we sampled from the observed data and checked for some of the model's diagnostics: divergence, energy, tree depth, effective sample size, and Rhat.

Diagnostics
Hamiltonian Monte Carlo was used for checking the diagnostics of the model. In this case, the diagnostics that were checked concerned divergence, energy, and tree depth. There should be no divergences as divergences can be an indication of that the posterior might be biased and the model therefore cannot be trusted [40]. A low energy value of the Bayesian fraction of missing information (BFMI) is also an indication of that the posterior can be biased [65], which is not desirable. In other words, E-BFMI should not indicate any pathological behavior. Also, for efficiency concerns, the tree depth should be kept as small as possible. For the model in question, the diagnostics looked good as none of the iterations ended with a divergence, and no warnings were reported for neither E-BFMI nor tree depth. In addition, convergence diagnostics in terms of effective sample size (ESS) [40] and Rhat [40], were also checked. ESS should not be below 0.1 and Rhat should not be above 1.01 [41]. Rhat should go towards 1.00, and if it exceeds 1.01, it is an indication of bias [41]. For the model for Q16, ESS=0.4055663 and Rhat=1.001462, which means that the diagnostics are fine.

[5] normal(0, 0.25) corresponds to a normal distribution with a mean of 0 and a standard deviation of 0.25

We also performed a visual inspection in terms of a "hairy caterpillar ocular test" [41, p.308], by looking at the trace plots to diagnose whether there was any malfunction in the posterior [40]. The estimated parameters should have a uniform looking hairy caterpillar with stationarity and good mixing [40], which they did, as seen in Figure 3.4. A hairy caterpillar is a sign of good mixing, and as mentioned by McElreath, "A well-mixing chain means that each successive sample within each parameter is not highly correlated with the sample before it" [40, p. 253].

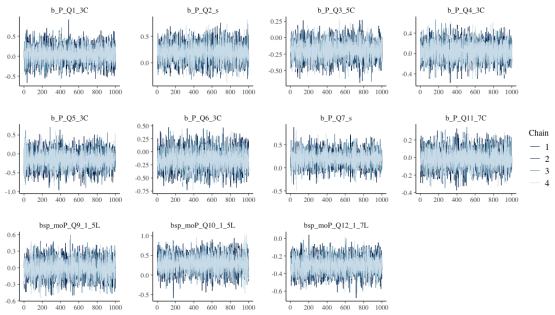

Figure 3.4: Trace plot of the parameters on the full model, with Q16 - self-assessed productivity - as the outcome variable.

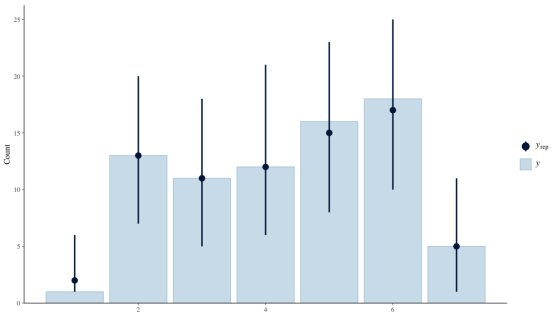

Figure 3.5: A Posterior Predictive Check of the model with Q16 - self-assessed productivity - as outcome variable. Sampling from observed data.

Posterior predictive check
Posterior predictive checks were done to see how well the model estimated the different levels in the model. In this case we have 7 levels, and as seen in Figure 3.5, the model estimated perfectly on four levels. The others were slightly above or below, but still acceptable.

3.2 Interviews

We conducted semi-structured interviews [66] with industry practitioners in April 2021. Semi-structured interviews were more appropriate than unstructured or fully structured interviews for the study in question since it enabled us to prepare questions in advance without having to follow a certain order as the conversation developed [66]. As described in [66], fully structured interviews are similar to questionnaires, and unstructured interviews based on questions of more general concerns. Given the research design for this study, an explanatory sequential design, we needed to focus on the result that was in need of further explanation. Therefore, by using semi-structured interviews, we could focus the discussion on the results we were interested but still allowing the interviewees to bring up additional aspects.

3.2.1 Interview Design

From the questionnaire data analysis, 29 outcome questions had statistically significant predictors. For detailed information about what a significant predictor is, see

Chapter 4. Out of those 29 questions, 23 had the same significant predictor, which was Q12 (see Table 3.2). Furthermore, there was at least one outcome with significant predictors in all questionnaire sections, as described in 3.1.1, which justified us asking about similar themes in the interviews as well. With significant predictors in mind, and by reviewing the responses to the open questions (Q14, Q15, Q25, Q27 and Q28, see Table 3.2) in the questionnaire and by considering our research questions, we created a first draft of an interview protocol, the final version can be seen in Section B.1 in Appendix B.

As the forced aspect seemed to be particularly important for the questionnaires responses, it was important for us to investigate why some feel forced, and why some do not feel forced to work remote. That is why we dedicated the first part of the interview protocol to questions regarding the transition to remote work, challenges, pros and cons regarding the situation. The other parts of the interview protocol were designed to get more explanations regarding aspects of RQ1.1 and RQ1.2, such as Communication and Teamwork.

3.2.2 Interview Evaluation

Before conducting the interviews we did a pilot study with the interview protocol with an industry practitioner. The pilot study was done to evaluate the quality and clarity of the questions, the length of the interview and what kind of results we can anticipate. The pilot was simulated as a real interview, and we found out that the first draft of questions we had were too many and would not keep the time frame, and that some questions were unclear and too hard to answer, hence did not generate any valuable answers. We acted upon the feedback and made changes to the questions accordingly.

3.2.3 Interview Data collection

We conducted seven semi-structured interviews in throughout all of April 2021. A summary of the interviewees is given in Table 3.3, and for details on each interviewee's work background, please see Section 3.2.3.1. The interviews lasted between 30-45 minutes, were held online over Zoom or Google Meet and we got permission from the interview subjects to record the audio. Two researchers were present at each interview, where one took notes and the other one asked the questions. The roles were switched before each new interview. The interviews were held in the language the interviewees were most comfortable with, which ended in that four of the interviews were held in Swedish, and the rest in English.

Two interviewees had filled in a registration for interest form regarding participating in interviews in this study, and were subsequently contacted and interviewed. Four were found through our personal contacts, while one were found through a dedicated agile forum. Before each interview, the interviewees were asked if they had filled out the questionnaire or not, of which four had filled it in and three had not, as seen in

Table 3.3.

Table 3.3: Interview subjects and a brief summary of their backgrounds regarding role, gender, if they have filled out the questionnaire, if they had changed team or employment since the beginning of the pandemic, and also in which country they work.

ID	Role	Gender	Filled out questionnaire	Changed team	Country
P1	Software Engineer	Male	Yes	Yes	Sweden
P2	Product Manager	Male	Yes	Yes	Sweden
P3	Software Developer Consultant	Male	No	No	Sweden
P4	Technical Agile Coach	Male	Yes	No	Sweden
P5	Software Developer Consultant	Female	Yes	Yes	Sweden
P6	Software Developer	Male	No	Yes	Sweden
P7	Software Developer	Male	No	Yes	England

3.2.3.1 Interview Subjects Background

This section describes the background regarding transition to remote work and work situation for the seven interview subjects.

P1
P1 is a Software Engineer working in Sweden who switched employment during the pandemic, but who worked about 100% on-site before the pandemic and 100% remote since the pandemic. Prior the pandemic, he was working as a consultant. In the beginning of summer 2020, he switched to his current employer. At his prior employment, he mainly worked alone in the office large parts of the time. His company and his office was rather small, and they could work from home if they wanted to even before the pandemic, therefore not much changed when Swedish authorities came with their remote work recommendations. Around April he started to work from home due to the pandemic. At his current employment, he joined a team where all team members had been a part of the same team during the beginning of the pandemic, but from around the same time as he joined the team, the team formation has changed about 50%. His current team started to work from home when it became a recommendation from Swedish authorities. One person in his team was still working in the office, but the others were primarily working from home. P1 had a team size of 5 and about 5 years of experience with agile software development.

P2
P2 was a Product Manager working in Sweden who switched employment in the later half of 2020. Before his current employment he worked as an agile coach. Since approximately one week after the recommendation to work from home came from the Swedish Authorities in March, he has worked 100% remotely and before the pandemic he worked approximately 10% remotely. His company at the time told everyone to go 100% remote from the start, and he experienced the transition

as fast. During the months that followed there were discussions about how many people should be allowed at the office and a possible transition to a hybrid model. P2 had met approximately 25% of his new colleagues face to face. P2 had worked with Scrum for 5 years, and in a smaller team with agile methods in over 15 years. P2 had a team size of 8.

P3
P3 is a Software Developer Consultant working in Sweden who started in his current team one month before they started to work remotely due to recommendations from Swedish authorities. The company said that the people who can, should work from home so that the ones who have to can work in the office. They did not need to specify why they did not want to go to the office. Before the pandemic he worked 100% in the office, and now he works 90% at home and 10% in office. From the beginning of the pandemic about half of P3's team members started to work from home and 1-2 people were in the office as there is work that need to be done in office, such as debugging hardware. Nowadays more people have volunteered to go to the office. P3 had about 2 years of experience with agile software development and had a team size of 6 people.

P4
P4 was an Technical Agile Coach working in Sweden in a consultancy firm with a flat hierarchy. P4 was working tightly with development teams. The decision to work from home came from the company itself where they discussed and reached a consensus where some can work in the office and some work from home, he experienced the transition as relatively sudden. However, as P4's firm delivers courses they have also had to adjust to clients' recommendations and guidelines whether to be onsite or online. Since then P4 has mainly worked remotely, but has also tried working a few days a week in the office, and the rest of the days at home. Before the pandemic P4 worked mostly on site. P4 has always been interested in agile ways of working.

P5
P5 is a Software Developer Consultant working in Sweden who started her current assignment approximately one month after the recommendation to work from home came from the Swedish Authorities, which she experienced as abrupt. The guidelines from the consultant firm was to follow the clients' recommendations regarding working from home or not. In the assignment she had during the transition to remote work, they could first choose themselves where to work, in office or not, but gradually they were recommended and enforced to work from home if they could. In the assignment she has now she can go to the office if she wants to. P5 works primarily from home and does not see any value in going to the office if her colleagues aren't there.

P6
P6 is a Software Developer working in Sweden who started his current employment some months into 2020. The transition to remote work came around the time when

the Swedish authorities recommended people who could, to work from home. He experienced the transition as filled with questions as they had not worked remotely before. Teams, including P6's team, could do their work from home so they did. If you wanted to work in office you would have to have a reason. P6 has never met his current team face to face. Before the transition to remote work P6 worked 100% onsite, and now he works 100% from home. He has only been to the office a few times to pick up work related things. P6 works some hours in the night and some on the day now.

P7
P7 is a Software Developer working in England who has been at his current company for several years. However, he switched teams within the company some months into 2020 but he knew his new team members from before. The transition to remote work came abruptly as the UK went into a lockdown in March 2020. The company told all of its employees the day after the announcement to work from home. Since then P7 has only been to the office once to pick things up and he has not seen his colleagues face to face in over a year. Some of P7's colleagues have been given permission to work in office because they cannot work from home, but this is rare. Before the lockdown P7 worked 100% onsite, and now he works 100% remotely.

3.2.4 Interview Data Analysis

We performed a thematic data analysis based on the six phases described in [67], that is, familiarizing yourself with your data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report.

As part of the first phase, familiarization with the data, we went through the notes from each interview and underlined the most interesting and important parts that we wanted to look into further. Thereafter we transcribed important parts, summarized each interview, and sent the summary of each interview to the respective interviewee for validation of our interpretation. Six out of seven interviewees responded with feedback. One interviewee provided feedback regarding one aspect that we had misunderstood, which we changed accordingly. The other five interviewees responded that they were fine with the summaries of the interviews.

The second phase of the analysis, generating initial codes, was performed manually using NVivo v.12[6], a qualitative data analysis software. We collaborated on the generation of initial codes for the first interview in order to get a similar feeling of how to code the data, but thereafter we coded the interviews separately. However, after finishing coding, we went through our codes together to make sure we agreed on the other one's codes. After having finished the initial coding and agreed on the codes, we merged all interview files and codes, and continued to the next phase of the analysis.

[6]NVivo is a qualitative data analysis software `https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/home`

The third phase of the analysis, searching for themes, was done by gathering all relevant codes into potential themes. For example, as seen in Figure 3.6, the quote in the upper left part of the figure was coded as "Pair Programming is easier to do remotely", and added to the sub-theme called Changes & Challenges of the higher-order theme called Agile Practices, since it described a change in how challenging an agile practice was experienced.

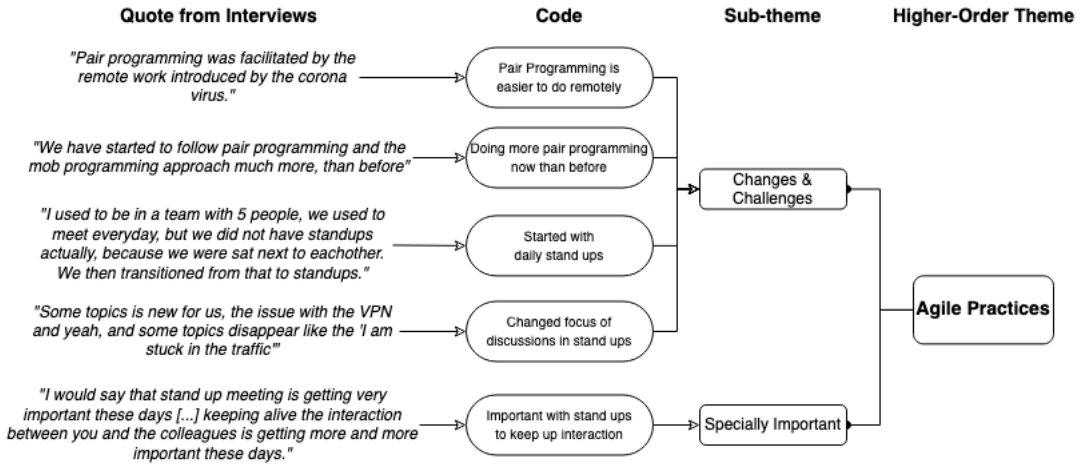

Figure 3.6: An example of how transcriptions from the interviews (the italic text to the left) were created into codes. Then they were grouped into sub-themes and then into higher-order themes in Agile Practices. This is only a selection of codes, most sub-themes had more than two codes.

During the fourth phase, reviewing themes, it became clear that some of the candidate themes were not really themes due to little or diverse data, as discussed in [67]. By reviewing all candidate themes and their respective data extracts and codes, we found that some extracts were not forming a coherent pattern and did not fit into the candidate themes. As a result, we reworked the themes by both renaming and merging some of the themes, as well as creating new ones.

In the fifth phase, defining and naming themes, we defined and refined all themes, and conducted a detailed analysis of each theme as well as identified its narrative. At this stage, we ended up with a total of eight higher-order themes, which are further described in Chapter 5.

Before moving on to the sixth phase, we conducted interviews until we reached a point of theoretical saturation. Already after six interviews we saw signs of saturation, but we conducted a seventh and last interview after which we reached saturation.

In the sixth and final phase, producing the report, we added the thematic map to the thesis and summarized the main results of the thematic analysis together with some examples of extracts that demonstrate the narrative of each theme.

3.3 Mixing Quantitative & Qualitative Results

As described in [55], there are several different ways to integrate quantitative and qualitative data when conducting a mixed method study. Not only is it possible to perform an integration at the time of the analysis, but it can also be done during the data collection by, for example, collecting both open-ended and closed-ended responses. For a mixed method study of a sequential explanatory design, initiated by a quantitative phase and followed by a qualitative phase, and where the intent of the qualitative phase is to help to explain the quantitative data with qualitative data, the integration refers to the explanation of the data [55].

In this study, there is an emphasis on the quantitative phase since the qualitative phase is used to support the interpretation and explanation of the quantitative data. Both significant and non-significant results from the Bayesian analysis were investigated before the interviews were conducted. By looking into the themes that emerged from the thematic analysis of the qualitative data, we found explanations for the quantitative data, both regarding significant results and descriptive statistics. Additionally, the answers to the open questions of the questionnaire served as an additional source of information that could be used to explain the quantitative data.

As the primary integration was done after the thematic analysis of the interviews, the report is structured in the way that we first describe the results from the Bayesian analysis in Chapter 4, and thereafter present the integration of the quantitative and qualitative data in Chapter 5, which is structured according to the themes that emerged from the thematic analysis. The implications of the integration is then further discussed in Chapter 6.

4
Analysis of Questionnaire

In this chapter, the Bayesian analysis of the questionnaire described in Chapter 3 is presented. With eleven demographic questions as predictors and the rest of the questions as outcomes, it was possible to determine whether any of the eleven predictors had a significant effect[1] on any of the 100 outcomes.

Significant effects are identified by either comparing the values of the lower and upper credible interval (CI)[2] values of population level effects, or by plotting probability densities, as seen in Figure 4.1, and Figure 4.5 in Section 4.1.7. An effect is significant negative if the CI values do not include zero, that is, both the lower and upper CI are negative or positive [39]. As an illustration on how to visually determine what effects that are significant, see Figure 4.1. The figure illustrates probability densities for each predictor of outcome Q16 (self-reported productivity). Similarly to the CI intervals, the density plots that do not cross zero represent a significant effect, one example of this is density plot Q12 in the bottom of Figure 4.1. By examining the same figure, it is also possible to identify potential tendencies of significance. Furthermore, the significant effects can be investigated in more detail by plotting conditional effects, as seen and described in more detail in Figure 4.2 and 4.3 in Section 4.1.1.

[1] A significant effect means that one can be confident that the predictor has an impact on the outcome or, in other words, that there is a difference between different values of each predictor.

[2] The CI reflects the uncertainty interval and is referred to as confidence intervals in frequentist statistics [39]

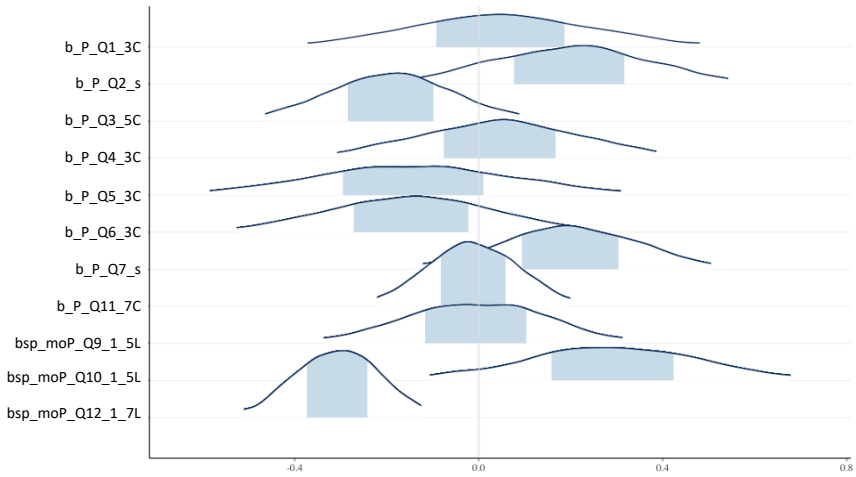

Figure 4.1: Posterior probability densities plotted on a logit scale for outcome Q16. The curves correspond to 95% probability and the shaded area corresponds to 50% of the probability. The only significant predictor was Q12, which is located at the bottom of the figure. Predictor Q2, Q7, and Q10 showed some tendencies toward positive significance, whereas Q3 and Q6 showed tendencies toward negative significance. Predictor Q1, Q4, Q11 and Q9 were clearly not significant.

4.1 Analysis

The Bayesian analysis resulted in a total of four significant predictors, and 31 significant effects for 29 different outcomes. The most common significant predictor is whether a practitioner[3] feels forced to work remotely, which was significant for 23 outcomes. The other three significant predictors are team constellation (significant for four outcomes), reason to work remotely (three outcomes) and role (one outcome). In this section, the predictors will be referred to using the abbreviations described in Table 4.1. For a thorough description of the significant effects and their tendencies, see Table C.1 in Appendix C.

Table 4.1: Abbreviations for the names of each significant predictor.

ID	Name	Abbreviation
Q12	Feeling forced to work remotely or not	Forced
Q11	Recommendation, enforcement or own choice to work remotely	Reason
Q6	Role you mainly work in	Role
Q3	Same team or changed team or employment	Team Constellation

Below the significant effects are presented in groups related to each section of the questionnaire, i.e. agile practices, productivity and performance, well-being and work environment, meetings, communication, and teamwork.

[3]In Chapter 4, practitioners refer to respondents of the questionnaire.

4.1.1 Agile practices

As seen in Table 4.2, stand up meeting/daily scrum, refactoring, and sustainable pace have forced as a significant *positive* predictor, while sprint/iteration, sprint-/iteration planning and sprint/iteration review/demo have Team Constellation as a significant *positive* predictor. This means that, for example, stand up meeting/daily scrum is experienced to be *more* challenging now than compared to before the pandemic, if the respondent *feels forced* to work remotely. Similarly, for someone who has *changed team or employment* since the beginning of the pandemic, a practice such as sprint/iteration is experienced to be *more* challenging now. These effects can be viewed in detail in Figure 4.2 and 4.3.

Table 4.2: Agile Practices - The following six outcomes have significant predictors regarding agile practices.

ID	Outcome	Significant Predictor	Direction
Q13_1	Stand up meeting/ Daily Scrum	Forced	Positive
Q13_2	Sprint/Iteration	Team Constellation	Positive
Q13_3	Sprint/Iteration planning	Team Constellation	Positive
Q13_4	Sprint/Iteration review/demo	Team Constellation	Positive
Q13_15	Refactoring	Forced	Positive
Q13_19	Sustainable Pace	Forced	Positive

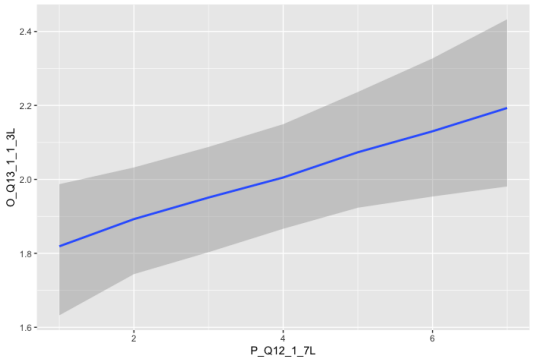

Figure 4.2: The graph illustrates how the predictor Forced (on x-axis) affects how challenging a stand up meeting/-daily scrum is experienced (on y-axis). On the y-axis, y<2 is *less challenging* and >2 is *more challenging*. On the x-axis, x<4 is *not feeling forced* and x>4 is *feeling forced*. In other words, the more forced a practitioner feels to work remotely, the more challenging is a stand up meeting/daily scrum experienced.

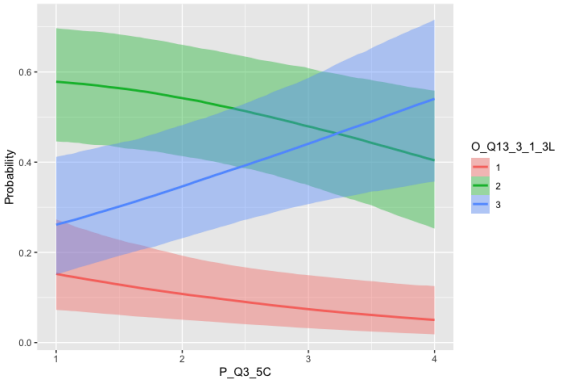

Figure 4.3: The graph illustrates how the predictor Team Constellation (on x-axis) affects the probability mass for how challenging sprint/iteration is experienced (on y-axis). The colors indicate the degree of challenge, where red is *more challenging*, green is *same as before*, and blue is *more challenging*. For example, the blue positive slope shows how the probability that a practitioner experiences sprint/iteration as more challenging increases as changes in team constellation increase.

4.1.2 Productivity & Performance

Significant effects for outcomes related to productivity and performance is summarized in Table 4.3. Productivity, focus, distractions, quality of own work, team productivity and quality of team's work have Forced as a significant *negative* predictor, and a significant *positive* predictor for time spent on administrative work. In addition, time spent on breaks has Reason as a significant *positive* predictor. This means, for example, that productivity is experienced to be *lower* now than compared to before the pandemic, if the respondent *feels forced* to work remotely. It also means that the time spent on breaks is *higher* now than compared to before the pandemic, if the respondent works remotely due to own choice rather than due to recommendation. A practitioner who *does not feel forced* to work remotely experiences *less* distractions now than before the pandemic, compared to a practitioner who does *feel forced* to work remotely.

Table 4.3: Productivity and Performance - The following outcomes had significant predictors regarding productivity aspects.

ID	Outcome	Significant Predictor	Direction
Q16_1	On an average work day now, I feel... (productivity)	Forced	Negative
Q17_1	I focus better on my job now...	Forced	Negative
Q17_2	I believe there are less distractions now...	Forced	Negative
Q17_4	I believe the work I produce now is of higher quality...	Forced	Negative
Q17_5	I believe my team is more productive now...	Forced	Negative
Q17_6	I believe the work my team produces is of higher quality now...	Forced	Negative
Q18_10	Time spent on administrative work	Forced	Positive
Q18_13	Time spent on breaks	Reason	Positive

4.1.3 Well-being & Work environment

Table 4.4 summarizes significant effects for outcomes related to well-being and work environment. Well-being, satisfaction of work environment, motivation and feeling of being appreciated, have Forced as a significant *negative* predictor. The feeling of being overwhelmed by work differs from other outcomes as it has two significant predictors instead of solely one. It has Forced as a significant *positive* predictor and Reason as a significant *negative*. This means, for example, that a practitioner feels *more overwhelmed* by work if he/she *feels forced* to work remotely, and *less overwhelmed* if the practitioner works remotely due to *own choice* rather than *recommendation*.

Table 4.4: Well Being - The following outcomes had significant predictors regarding productivity aspects.

ID	Outcome	Significant Predictor(s)	Direction
Q19_1	Well-being in general	Forced	Negative
Q19_4	Satisfaction of work environment	Forced	Negative
Q19_5	I feel appreciated	Forced	Negative
Q20_1	I am motivated to work	Forced	Negative
Q20_2	I am overwhelmed by work	Reason; Forced	Negative; Positive

4.1.4 Meetings

As seen in Table 4.5, meeting quality, extent to which meetings are face-to-face, brainstorming, and whether all people make themselves heard have Forced as a significant *negative* predictor. For meeting frequency, Forced is a significant *positive* predictor. Similar to the feeling of being overwhelmed by work, meeting quality also differs from other outcomes as it has two significant predictors; it has both Forced and Reason as significant *negative* predictors. This means, e.g, that meeting quality is experienced to be *lower* if a practitioner *feels forced* to work remotely and/or has *changed team or employment*. Also, as an example of a positive effect for Forced, meeting frequency is *higher* if a practitioner *feels forced* to work remotely.

Table 4.5: Meetings - The following outcomes had significant predictors regarding meeting aspects.

ID	Outcome	Significant Predictor(s)	Direction
Q21_1	Meeting Quality	Forced; Team Const.	Negative; Negative
Q21_2	Meeting Frequency	Forced	Positive
Q21_7	Extent to which meetings are face-to-face (in person)	Forced	Negative
Q22_3	Brainstorming	Forced	Negative
Q22_10	All people make themselves heard	Forced	Negative

4.1.5 Communication

Outcomes related to communication and their respective significant effects are shown in Table 4.6. Communication quality, and how often practitioners use written communication have Forced as a significant *negative* and *positive* predictor respectively. In addition, how often practitioners communicate in person has Role as a significant *positive* predictor whereas the extent to which respondents spend time on communication has Reason as a significant *negative* predictor. This means that, e.g, written communication is used *more often* and that communication quality is *lower* now than compared to before than pandemic, if the practitioner *feels forced* to work remotely. As seen to the right in Figure 4.4, all types of roles have experienced a decrease in how often they communicate in person, but a practitioner with a *non-technical* role experienced a *smaller decrease* than a practitioner with a *technical* role. Use of written communication has clearly increased for most practitioners, but practitioners who *feel forced* to work remotely has experienced a *larger increase* than those who *do not feel forced*. Furthermore, a practitioner spends *less* time on communication now, compared to before the pandemic, if working remotely due to own choice rather than due to recommendation, as seen to the left in Figure 4.4.

Table 4.6: Communication - The following outcomes had significant predictors regarding communication aspects.

ID	Outcome	Significant Predictor	Direction
Q23_2	I use written communication	Forced	Positive
Q23_3	I communicate in person	Role	Positive
Q24_1	Communication Quality	Forced	Negative
Q24_3	Time (I spend on communication)	Reason	Negative

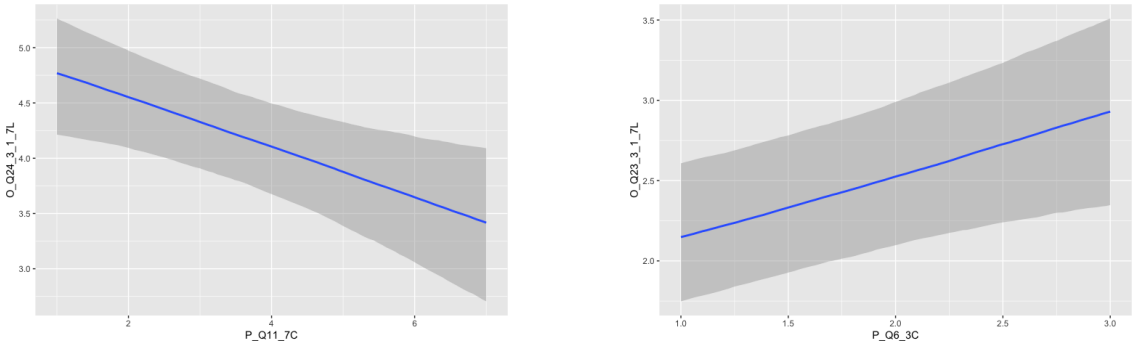

Figure 4.4: Conditional effects for the predictors Reason (Q11) and Role (Q6) for to what extent practitioners spend time on communication and how often they communicate in person, respectively. Predictors are plotted on the x-axis and outcomes on the y-axis. The effect in the graph to the left is condensed between *increased (5)* and *decreased (3)* of the outcome, whereas the effect in the graph to the right is condensed below *same as before (4)*. The latter means that practitioners clearly have experienced to communicate in person less often now.

4.1.6 Teamwork

As seen in table 4.7, team morale has Forced as a significant *negative* predictor. This means that the experienced team morale in a team has decreased compared to before the pandemic, if the practitioner feels forced to work remotely.

Table 4.7: Teamwork - The following outcomes had significant predictors regarding team aspects.

ID	Outcome	Significant Predictor	Direction
Q26_1	Team morale has..	Forced	Negative

4.1.7 Investigating forced as an outcome

Besides analysing Forced as a predictor, it was also analyzed as an outcome.

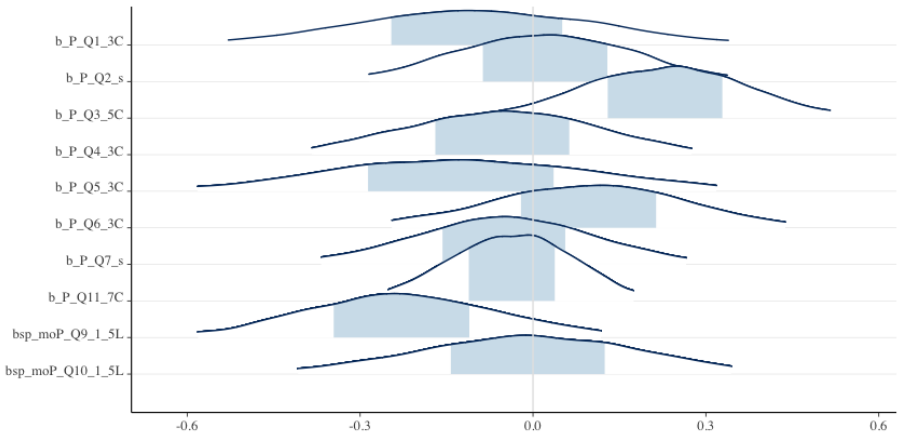

Figure 4.5: When analyzing Forced as an outcome, the extent to which a practitioner worked remotely or in office before the pandemic (Q9, second from bottom) and especially their Team Constellation (Q3, third from top) show strong tendencies to whether a practitioner feels forced or not.

From the model and its results, as seen in Figure 4.5, it is evident that to what extent a practitioner worked remotely or in office before the pandemic (Q9) and especially their Team Constellation (Q3) show strong tendencies to whether a practitioner feels forced or not, but it is not significant. For example, a practitioner who does not feel forced might be part of exactly the same team as before the pandemic.

5
Results

This chapter presents the results of the integration of the quantitative and qualitative data, as described in Section 3.3. First, demographics of the questionnaire respondents are presented. Then, COVID-19's impact on ASD is presented (RQ1). Next, COVID-19's impact on employment of ASD and ways of working are laid out (RQ1.1), followed by the impact of recommended or enforced remote work (RQ1.2). The results in Sections 5.2, 5.2.1, and 5.2.2 are structured according to the thematic map and the higher-order themes, as shown in Figure 5.5 in Section 5.2.

5.1 Demographics of Questionnaire

Of the respondents who completed the questionnaire, 70% were male, 27% female, and 3% were either non-binary or did not want to specify. Most of the respondents (94%) were located in Europe while the remaining 6% were located in North America (3%) and Asia (3%). When looking into the different domains of the respondents, 43% worked in IT (e.g. software technology), 28% in embedded systems (e.g. automotive), and 29% in other domains (e.g. entertainment/media). The majority of the respondents (54%) had a technical role (e.g. developer), 26% had a management role (e.g. development manager), and 20% had an agile role (e.g. scrum master). The respondents experience of agile software development ranged from zero to 30 years of experience (as shown in Figure 5.2) with an average of seven years of experience. The most common years of experience were five years (21% of the respondents).

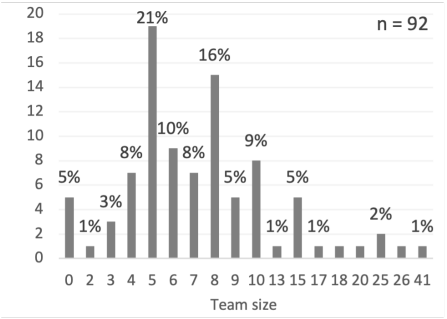

Figure 5.1: Team size. Values on the y-axis correspond to the frequency of respondents.

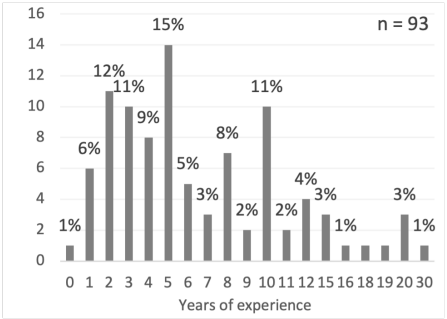

Figure 5.2: Years of experience in ASD. Values on the y-axis correspond to the frequency of respondents.

The reported team sizes ranged from zero to 41 (as shown in Figure 5.1), with an average team size of eight people. The most common team size was five (20% of the teams), followed by eight (16%), six (9%), and ten (8%). Five percent of the respondents reported that they did not belong to a team, that is, a team size of zero. Most of the respondents were either part of exactly the same team (36%) or mostly the same team (27%) as before the pandemic, while 15% had changed team during the pandemic but still employed at the same company, and 21% had changed employment.

Before the pandemic, about half (48%) of the respondents never worked remotely, 45% worked mainly in office but sometimes remotely, 2% split the time evenly between working in office and remote, 3% mainly worked remotely but sometimes in the office, and 2% only worked remotely. At the time of the questionnaire, i.e one year into the pandemic, a vast majority (78%) worked only remotely, while 17% mainly worked remotely, 4% only worked in the office, and 1% worked as much in the office as remotely. Among the respondents who worked remotely at the time of answering the questionnaire, 63% stated that the primary reason for working remotely was due to a recommendation from the company and/or government, 23% stated that the reason was due to an enforcement from the company and/or government, while 14% stated it as due to their own choice, as shown in Figure 5.3. The majority (52%) of the respondents stated that they do not feel forced to work remotely, 39% stated that they do feel forced, while the remaining 8% of the respondents were neutral, as illustrated in Figure 5.4.

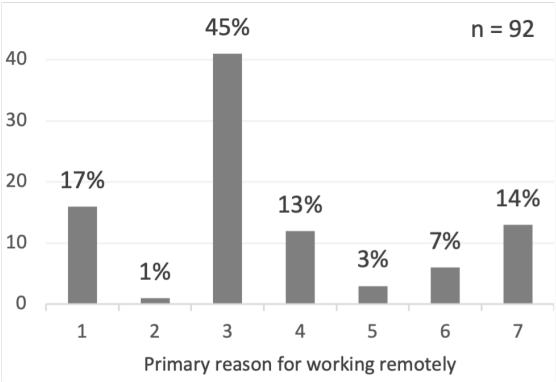

Figure 5.3: Primary reason for working remotely, where values 1-3 are due to recommendation from 1) company, 2) government, 3) company & government, and 4-6 due to enforcement by 4) company, 5) government, 6) company & government, and value 7 is own choice. Values on the y-axis correspond to the frequency of respondents.

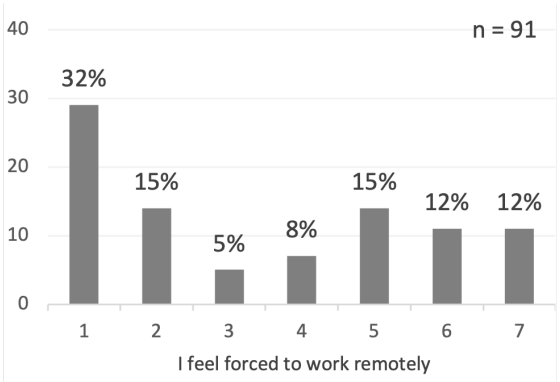

Figure 5.4: Whether feeling forced to work remotely. Where 1 is strongly disagree, 4 neither disagree nor agree, and 7 strongly agree. Values on the y-axis correspond to the frequency of respondents.

5.2 RQ1: COVID-19's impact on ASD

This section answers the first research question related to the COVID-19 pandemic's impact on ASD. The areas that have been affected in ASD due to the ongoing worldwide pandemic are: Agile Practices, Communication, Social Interactions, Teams, Tools & Technologies, Workplace, Personal Experience & Opinions, and Productivity & Performance (called higher-order themes), as illustrated in Figure 5.5. The higher-order themes are divided into two parts in Figure 5.5, where each part corresponds to a sub-question of the main research question, that is, how the COVID-19 pandemic has impacted ASD (RQ1). The five higher-order themes in the upper part of Figure 5.5 answer how industry practitioners employ ASD, and how their ways of working have changed, compared to before the pandemic (RQ1.1), and are described in Section 5.2.1. The three themes in the lower part, on the other hand, answer how industry practitioners have been affected by recommended or enforced remote work (RQ1.2), and are described in Section 5.2.2.

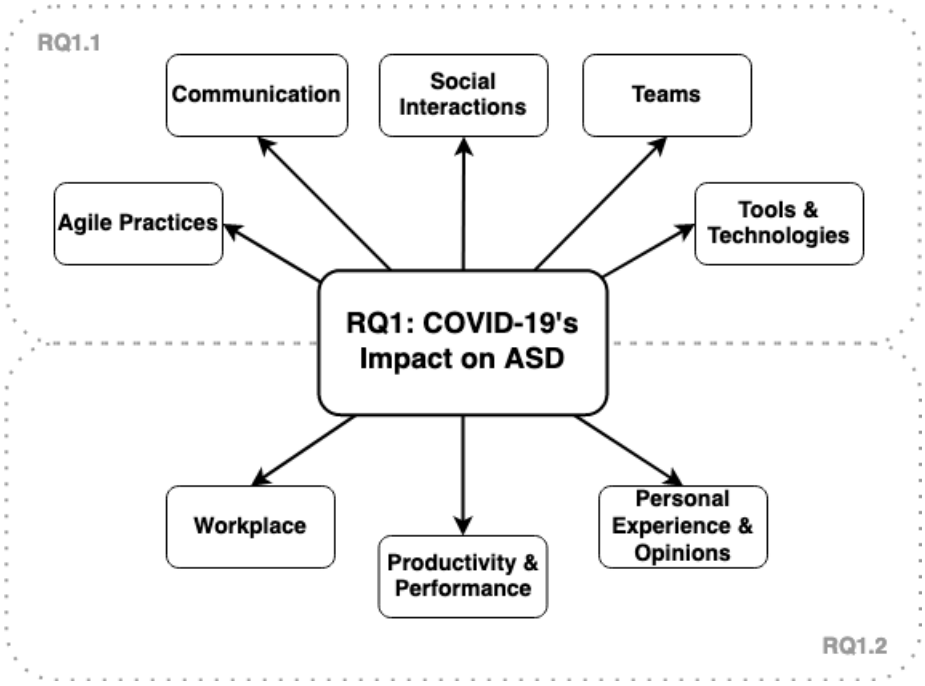

Figure 5.5: An overview of the themes that emerged from the thematic analysis of the mixed method. The central topic is how the COVID-19 pandemic has impacted Agile Software Development (ASD), which is addressed by a total of eight higher-order themes. The five higher-order themes on the top answer RQ1.1 and the three higher-order themes on the bottom answer RQ1.2.

5.2.1 RQ1.1: Employment of agile development and ways of working

This section covers the results of how industry practitioners[1] employ ASD, and how their ways of working have changed due to the pandemic (RQ1.1). The higher-order themes are presented in the following order: Agile Practices, Communication, Social Interactions, Teams, and Tools & Technologies. An overview of what is presented in relation to each theme is illustrated in Figure 5.6.

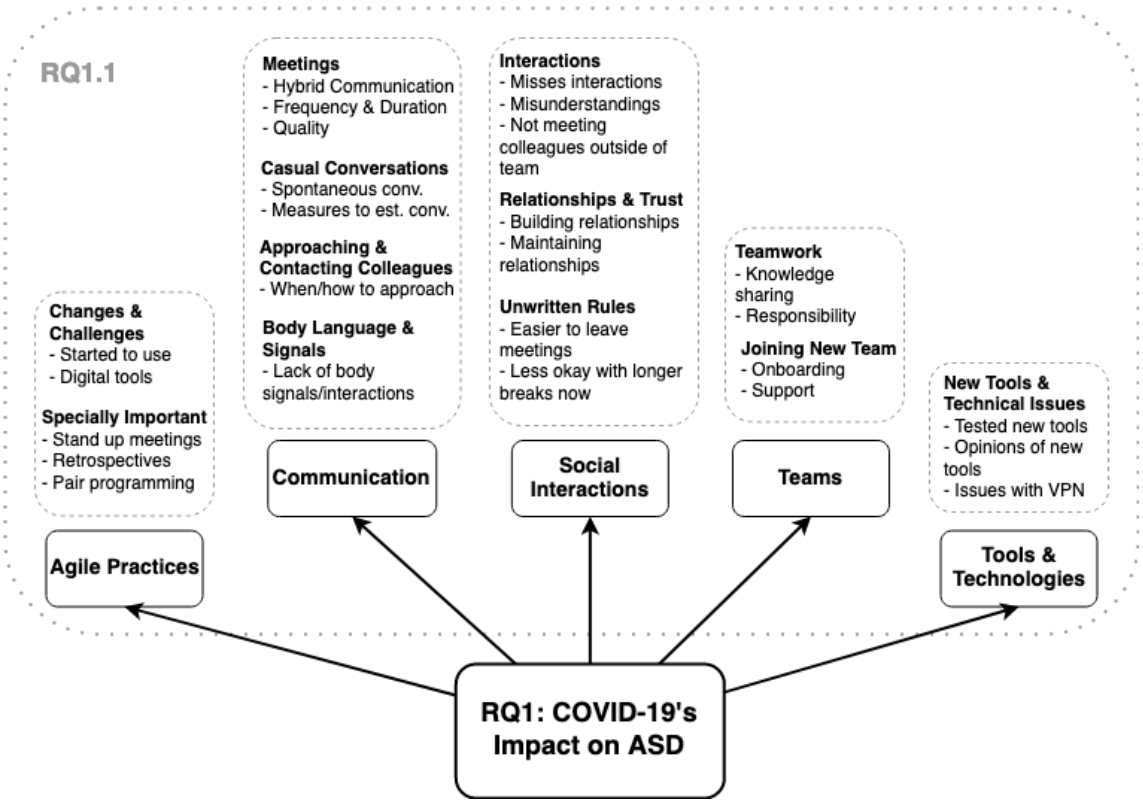

Figure 5.6: The Figure shows a detailed view of the higher-order themes that are connected to RQ1.1, and its content (the employment of ASD and ways of working). Illustrated is an overview of what topics that have been discussed in relation to each theme. For example, some practitioners described that they have started with certain agile practices during the pandemic, and how some agile practices have been either more or less challenging to perform, compared to before the pandemic. For a more abstract view of how RQ1.1 is related to RQ1 and RQ1.2, see Figure 5.5.

5.2.1.1 Agile Practices

Overall, in 14 out of 19 practices, a majority of the respondents experienced practices to be as challenging now as before the pandemic. In four out of 19 practices

[1]Practitioners refer to both interviewees, and respondents from the questionnaire, from both open and closed questions. Note that the following holds for the terminology used in the results section. A respondent refer to a respondent of the questionnaire, whereas an interviewee is either referred to by ID, for example, P1, or solely interviewee.

(Mob programming, pair programming, retrospective and planning game), a majority of the respondents reported a change in how challenging the practices were experienced. However for one practice (sprint/iteration planning), 50% of the respondents reported a change and 50% reported reported no change in how challenging the practice was perceived. A summary of how challenging each of the 19 practices were experienced is illustrated in Figure 5.7, sorted in a descending order of percentage of changes reported, with the highest percentage in the top left corner and the lowest percentage in the bottom right. The figure shows that practices of more social nature, such as mob programming and retrospective, indicated a higher percentage of changes than practices of more technical nature, such as continuous integration and test-driven development. The top three more challenging practices are mob programming, retrospective, and planning game, and the top three less challenging practices are pair programming, mob programming, and sprint/iteration review/demo. As also seen in Figure 5.7, the three agile practices that most respondents reported not using are mob programming, onsite/proxy customer, and planning game.

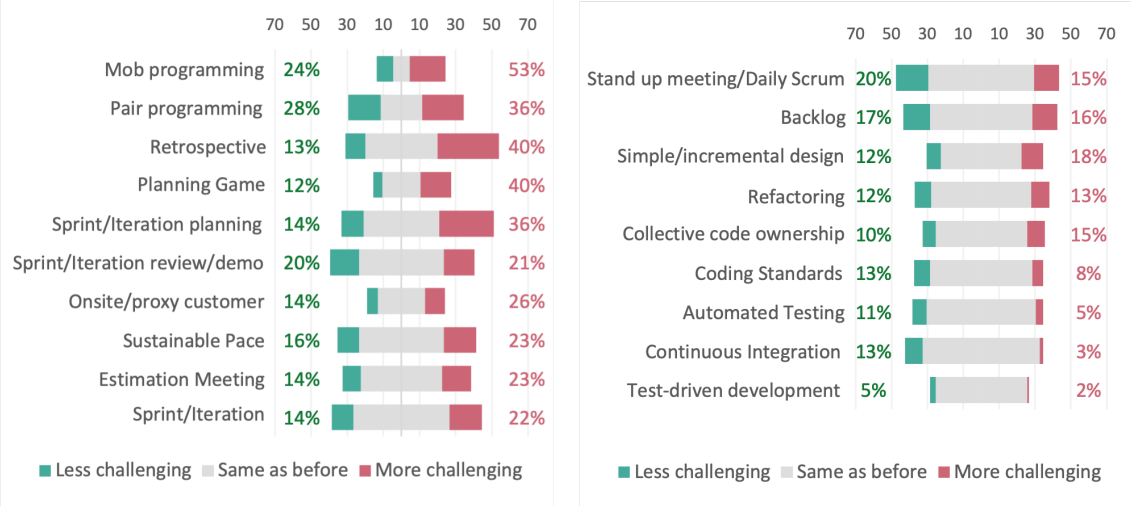

Figure 5.7: *Q13: How challenging do you find the following practices now, compared to before the pandemic?* All 19 agile practices sorted in a descending order of percentage of changes reported, with the highest percentage in the top left corner and the lowest percentage in the bottom right.

Changes & Challenges in Agile Practices

There are three practices in particular that have been mentioned regarding changes and challenges, both in the questionnaire and during interviews. The three practices that are of particular interest are: retrospectives, pair programming, and stand up meetings.

Regarding retrospectives, the questionnaire results show how they have become *more challenging* for many practitioners, as seen in the left part of Figure 5.7. Several interviewees have mentioned that the lack of body language and signals, and the fact that people talk over each other and do not open up during retrospectives, are

reasons that have contributed to why this practice is more challenging now than before the pandemic. Furthermore, as a result of the transition to remote work, several practitioners had to start using digital tools for retrospectives, which, for example, resulted in practitioners converting from physical post-it notes on a whiteboard to digital ones. A respondent mentioned that they started to use "*online tools for retrospective, to simulate physical meetings*". Several respondents mentioned that it is important to use video cameras during retrospectives to convey body language. A respondent stated that it is important that they "*always use video for body language, social interaction and human connection*". The content in retrospectives seems to have changed as well, as they do not only discuss ways of working, but also how people are doing and COVID-19 related aspects. One respondent mentioned that "*retro has always been important, but now it's a place to vent, talk about how we're doing and do some mental health support*".

Pair programming is one of the agile practices that differs the most from other practices, as there is not only a majority indicating a change, but there is also a relatively even distribution of respondents across the three different alternatives: less challenging, same as before, and more challenging. This means that almost as many respondents have experienced pair programming to be less challenging as those who have experienced it to be more challenging, as seen in the upper left part of Figure 5.7.

Based on the interviews, it is evident that several practitioners have started to or extended their use of pair programming. One interviewee even described that he has noticed how teams have started to use it more seriously during the pandemic. Pair programming seems to be done because of two reasons now; for knowledge sharing and to socialize. Regarding knowledge sharing, an interviewee mentioned that pair programming has been the rescue for new team members during the pandemic. Regarding social aspects, one respondent described that "*we are pair-programming a lot more now than before the pandemic. I guess this is because we don't see each other as much as before, so pair programming enables us to see and hear each other, and collaborate together on tasks, which are all aspects of team interactions that have taken a hit because of the pandemic.*". However, two interviewees expressed that they prefer doing pair programming in person. One of them stated that she does not believe that digital pair programming solutions have worked that well, and did not give any further explanation why.

The most used practice of the 19 practices listed in the questionnaire was stand up meeting/daily scrum, and the majority of the respondents believe it to be as challenging now as before the pandemic. Respondents reported that the frequency of stand ups is almost the same as before, but with a little change towards an increase. Among the interviewees, there were indications on both spectra. Several interviewees reported on adding more daily stand ups, e.g one more after lunch, because there has been a lack of natural syncing during the day. This was also confirmed by the respondents, of which one described that "*since spontaneous communication is a lot more difficult when working remotely we now have two standups per day.*"

The open questions also provided reasons why some practitioners have experienced longer stand ups. Some described how they are fine with it as there is less interaction and spontaneous conversations when working remotely, as illustrated by the following answer by a respondent "*daily Scrum meetings have become slightly longer but the team agrees this is OK because we don't see each other during the day like we did at the office.*" Similarly, another respondent described that they have longer daily scrums since "*you perceive less what the others are doing.*".

Specially Important Agile Practices
The experience and opinion of an agile practice is strongly dependent on a practitioner's personal experience. Although, a common theme that emerged is how some agile practices have been more important than others during the pandemic, especially daily stand ups, retrospectives, and pair programming. As the daily contact and interaction with colleagues have been strongly reduced during the pandemic, practitioners have used these practices to address the lack of interaction.

The daily stand up has been an important activity to keep the interaction alive. The stand up have not only been functioning as a way to update each other on work progress, but have also been a way to maintain the feeling of working in a team and to check in on how people are doing. Before the pandemic, people would still see each other outside of the daily stand ups, but when working remotely, the daily stand up is one of the few moments where they actually do see and talk to each other. As mentioned by a respondent "*daily standup is the most important. [...] And since attendance is mandatory people _actually_ communicate in a different way than they would without the standup. Moreover, the standup increases the feeling of being part of a team since there is always a little chit chat and joking around in those meetings.*"

Practitioners also described how retrospectives have become more important as it has been more difficult to communicate and pick up on how people are doing when not sitting next to each other. Several practitioners mentioned that retrospectives are particularly important now, compared to before the pandemic. One of the respondents explained that in the office, "*it was easier to pick up issues that people had but when everyone is remote, it is much harder to see if someone is not happy with something or not feeling well etc.*". Another respondent mentioned that it is particularly important as they do not "*sit together physically any more, which makes the retrospectives to be so much more important for the team to work as good as possible*". One interviewee also mentioned that retrospective is a specially important activity now during the pandemic, but that they use it too little. He mentioned that it does not need to be used only in big projects for big changes, but can also be used in smaller formats such as, for example, to ask what people thought about a meeting and so on.

Pair programming was also reported to be a specially important practice by multiple of the respondents and interviewees. Reasons given were, for example, social interaction, teamwork, knowledge sharing, and quality. One respondent described how daily meetings and pair programming are more important "*since the normal social*

interactions have been strongly reduced (i.e. not working in the same room anymore)". Another respondent described that distributed pair programming has been important for quality and that "*without this practice, quality suffers and it takes longer to deliver stories.*". One interviewee described how, knowledge sharing and socially wise, pair programming has been somewhat a rescue for new team members.

Key takeaways for Agile Practices:

- The more technical agile practices (e.g TDD, CI and coding standards) have not been experienced as more or less challenging now, compared to before the pandemic.
- The more social agile practices (mob/pair programming and retrospectives) have changed the most regarding being more or less challenging now, compared to before the pandemic.
- Stand up meetings, retrospectives and pair programming seem to be particularly important agile practices during the COVID-19 pandemic.

5.2.1.2 Communication

It is evident from the questionnaire results that practitioners communicate less often in person, as seen in Figure 5.8 and subsequently have less face-to-face communication, as seen in Figure 5.9. However, they use more written communication and digital communication now than before the pandemic, as seen in Figure 5.8. The challenges with digital communication are no face to face communication - meaning a decrease of body language and signals - but also hybrid communication. One respondent mentioned that when communicating digitally, it is hard "*to transmit the same amount of information via the different digital solutions, such as Skype, Teams, etc.*". Practitioners have also experienced challenges with hybrid communication, where some work in office and some at home, as it creates an uneven balance. Several interviewees have mentioned that hybrid communication does not work as well as when everyone is onsite or remote. A respondent mentioned that he/she "*personally think that remote teams works if all is working remotley*", he/she also added that a mix is not something that he/she feels has worked well.

Respondents seem to have less informal conversations but slightly more work related conversations, as seen in Figure 5.8, which also was confirmed by several interviewees. One interviewee mentioned that informal communication during lunches and in corridors have been reduced, which might result in things getting lost. Practitioners have also reported on that they communicate less with people outside of their own teams. One interviewee mentioned, for example, that he only talks to other people from other teams if he needs to work with them.

Having the transition to digital communication in mind, communication quality seems to have decreased since the beginning of the pandemic, whereas appreciation for communication has increased, as seen in Figure 5.9. As there have been inherent challenges with digital communication, several interviewees have mentioned that

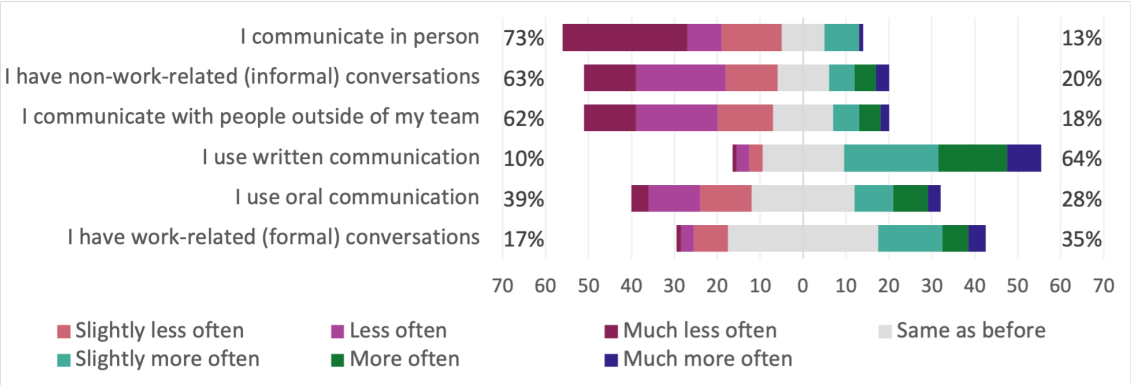

Figure 5.8: Q23: Compared to before the pandemic, how often do you do the following at work now? Sorted in ascending order of percentage of *same as before*.

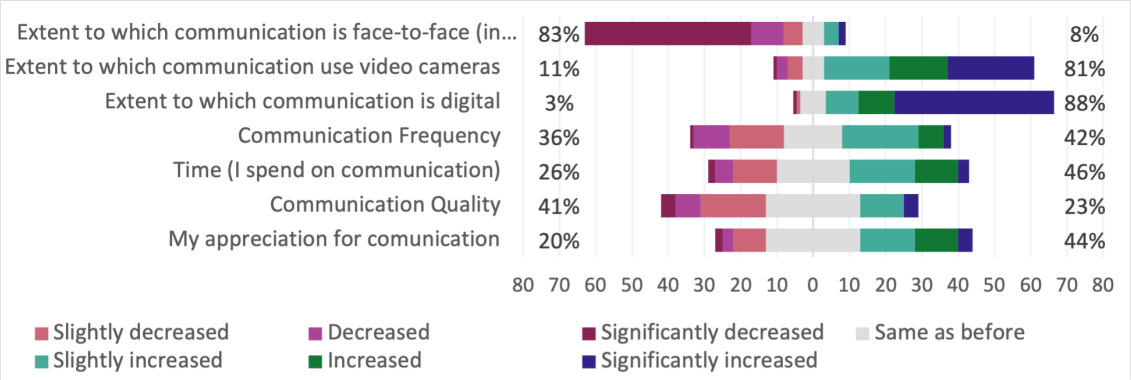

Figure 5.9: Q24: Compared to before the pandemic, how would you rate the following aspects regarding the communication you have now? Sorted in ascending order of percentage of *same as before*.

they miss their colleagues and other social aspects that they had when working in office, such as lunches and coffee breaks. However, a respondent mentioned that communication now "*has improved, being more concise, to the point and in overall warmer, but more of a human touch.*". A majority have experienced either increased or decreased communication frequency. As previously mentioned, there has been a decrease of spontaneous conversations but an increase of certain communication activities, such as stand ups, as mentioned in Section 5.2.1.1.

Meetings

Looking into the results from the questionnaire, it is evident that there have been changes to meetings due to the transition to remote work. Respondents have experienced a significant decrease of meetings that are face to face, and a significant increase of to what extent meetings are digital and use video cameras, as seen in Figure 5.10. A majority have experienced a change in meeting quality, where some believe it has increased and others that it has decreased. One respondent mentioned that "*meeting discipline (clear agenda, note taking, formal decisions) have improved tremendously.*". On the other hand, several interviewees mentioned that people often talk over each other or that they are too silent in digital meetings, which contributes

to a decreased quality.

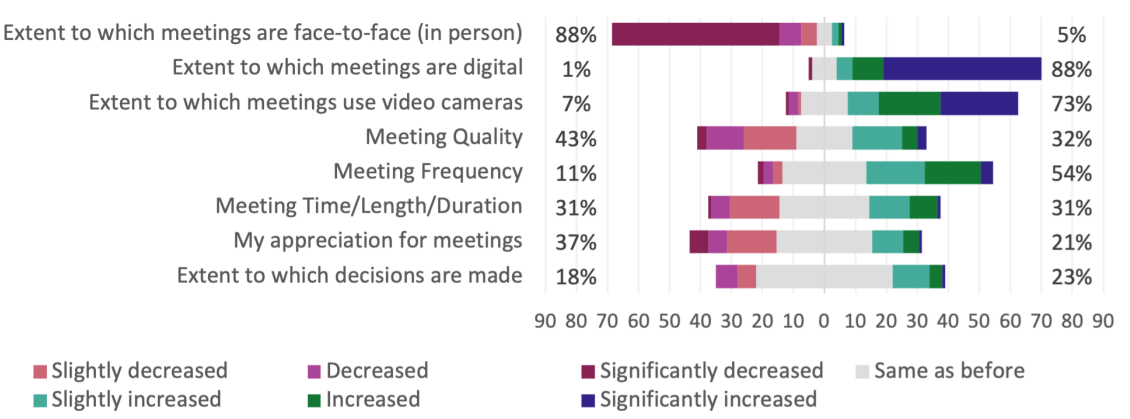

Figure 5.10: Q21: Compared to before the pandemic, how would you rate the following aspects regarding the meetings you have now? Sorted in ascending order of percentage of *same as before*.

A majority experience an increase of meetings, as seen in Figure 5.10. An increase of meetings in general is a result both confirmed and contradicted by the interviewees. Two interviewees expressed that their and other colleagues' schedules are packed, and that they experience "*back to back*" meetings because of the digital meeting structure. Respondents have also mentioned that they have "*meetings almost every day to ensure people are up to speed, less lonely etc*". In contrast, one interviewee believe that he attends fewer meetings now, compared to before the pandemic, which is something that he mentioned could be because he actively tries not to go into meetings now, but also that it is easier to leave them now.

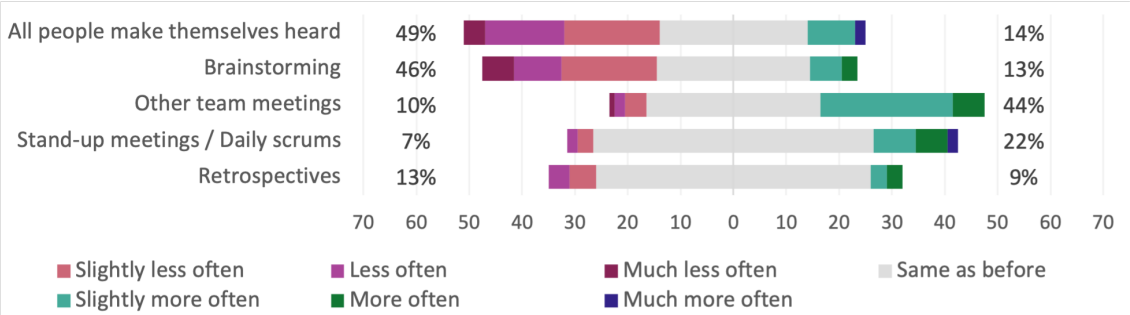

Figure 5.11: Q22: Compared to before the pandemic, how has the frequency of the following activities changed, now? Sorted in ascending order of percentage of *same as before*

There seems to be a decrease of brainstorming meetings, but an increase of other team meetings, as seen in Figure 5.11. Several respondents have mentioned that they have added extra stand up meetings or other types of meetings during the pandemic. A respondent mentioned that they "*started scheduling remote catch-ups with*

the team, to compensate for the lack of spontaneous coffee talks during the day.". There also seems to be a significant decrease in people who make themselves heard during meetings. Two interviewees expressed that they have experienced that some colleagues are very silent during meetings. One of them mentioned that digital meetings "*probably brings out the worst in people, allowing them to be more introverted*".

Casual Conversations
Both interviewees and respondents have mentioned a lack of spontaneous and casual conversations due to remote work. Casual conversations that used to be carried out in hallways, before meetings, and spontaneously as you saw other colleagues have been reduced. Two interviewees have mentioned that there have been less random conversations as you cannot glance or overhear what other people say or do in a remote setting because you do not sit physically close to one another anymore. One of them mentioned that "*you simply cannot turn around and ask someone easily*". Enabling these types of conversations seems to be much harder now, as a respondent mentioned; "*spontaneous communication is a lot more difficult when working remotely*". Regarding the content of informal conversations, one interviewee mentioned that conversations regarding other teams or about how people have behaved are something you could have during informal conversations, but these conversations are rarer now. Another respondent mentioned something similar, namely that "*all forms of non-work-related gossip is now gone*", which affects the respondent's social life.

P4, who works as an agile coach, mentioned a consequence of the lack of casual conversations. This have affected the work of some agile coaches who are more focused on organization and leadership, as much of their work is to talk to managers by the coffee machines to make changes. He mentioned that it is not as flexible to book a meeting for such informal conversations now.

As there has been a loss of these casual conversations, several practitioners have taken measures to reinforce similar types of conversations. Both respondents and interviewees have mentioned enforcing social activities, such as digital tea or coffee breaks[2], lunches, catch-ups and text channels. The reason for having, e.g, a digital coffee break is to enable informal conversations and to not talk about work. A respondent mentioned the importance of digital coffee breaks as a way to "*ensure staying close as a team*". These measures seem to be appreciated by most respondents and interviewees.

Another measure mentioned by the interviewees is the use of text channels, where people can post things - not necessarily - related to work. Two interviewees mentioned that people post random things and that conversations do spawn off, but one of them believes that it is just not the same as in a live setting. In contrast, one

[2]Both interviewees and respondents have also referred to "fika" when they have discussed coffee breaks. In Sweden, "fika" is somewhat a concept which is not only a coffee break, but a time to relax and socialize with friends or colleagues over, for example, a cup of coffee and something to eat, according to `https://sweden.se/culture-traditions/fika/`.

respondent described that "*conversations that just spin of in different direction isn't that common now.*" Another activity in which casual conversations might occur now is during pair or mob programming. Two interviewees mentioned that doing pair programming is a way to be social and work together when working remotely.

Body Language & Signals
As previously mentioned, respondents have experienced a significant decrease in how often they communicate in person and to what extent they communicate face to face, as seen in Figure 5.8, 5.9 and 5.10. A decrease of communicating face-to-face has subsequently lead to a lack of body language and signals. Throughout the interviews, the value of face to face communication regarding body language, signals, and facial expressions have become evident. Interviewees have mentioned that face to face conversations where you can read each other's body language and voice, are a lot easier, e.g when resolving design issues and other problems. Additionally, a respondent mentioned that "*at the office, it was easier to pick up issues that people had but when everyone is remote, it is much harder to see if someone is not happy with something or not feeling well etc.*".

Approaching & Contacting Colleagues
There have been changes to how practitioners communicate, and inherently how they approach and contact their colleagues. Personal preference and a lack of unwritten rules influence how practitioners approach their colleagues. Practitioners who used to approach colleagues by their desk now use written communication more or give them a call, and seem to be more reluctant to contact a colleague directly without thinking it through first.

One interviewee had the following reflection; before the pandemic, when she needed to ask someone about something, she would go to them physically in the office. Now, they use Slack as a communication tool and will therefore send a text message instead. She believes that many people experience sending text messages as easier than walking to someone in person. On the contrary, another interviewee and his team seem to be more open to calling each other directly, as he mentioned that if he needs to talk to his team members, he just calls them up. However, a general theme is that people are more reluctant to take contact now, than before. A respondent mentioned that "*there is a lot less rubber ducking and you don't ask people for help or about stuff before you have thought it through thoroughly. Both positives and negatives with that.*", while another respondent said that "*people think once more before disturbing and this helps with focusing on the given task and not being disturbed.*".

Key takeaways for Communication:
- Practitioners have significantly more digital communication now, compared to before the pandemic.
- Number of general meetings, and other team meetings have increased since the beginning of the pandemic, as much communication now is scheduled.
- Not being able to read body language, hybrid communication, people talking over each other, or being silent are factors that contribute to the decrease in meeting and communication quality.

5.2.1.3 Social Interactions

Despite that many practitioners have spent more time on communication now, compared to before the pandemic, they have less informal conversations. Additionally they also miss having social interactions with their colleagues. Most interactions have been replaced by digital social engagement activities such as digital coffee breaks or chats, which have been experienced mostly as good alternatives, but not necessarily substitutes to having them in person.

Interactions
Several interviewees expressed that they miss seeing their colleagues in person, and that they do not meet colleagues outside of their team to the same extent anymore. When working remotely, practitioners find it difficult to create substitutes for the situations where you meet other colleagues spontaneously. As a respondent mentioned, in an office it is easier "*to have a coffee if you bump into a colleague, remote requires more coordination to have the same kind of interaction.*". One interviewee mentioned that he only talks to other colleagues if he needs to work with them. Two interviewees explained that social activities such as a digital coffee break is especially important now, as it is the only time and space to meet other colleagues now, even though fewer people attend them now compared to before the pandemic.

In particular, practitioners seem to miss the social nature of being around other people and the spontaneous conversations it may induce. As one interviewee explained, he "*really miss the water cooler moments at work in particular, because you often bump in to each other in the kitchen and be like "I am working on this, how would you do it?" You get some really cool interactions with that*". An interviewee who has met his team a few times during the pandemic expressed that "*it was nice to see people in real life*", even though he is satisfied working remotely. Two interviewees described that they prefer to do pair programming in a physical setting and that they miss the physical interaction of doing it in person. They do not really know why they experience it to be different in a remote setting though, but one of them explained that "*it is pretty much the same, but not. Not as interactive maybe*".

Interaction with colleagues both within and outside of the own team, either physically or during a digital coffee break, is important to build relationships and to avoid

misunderstandings. Misunderstandings in online meetings and chats are examples of bad effects of digital communication as you cannot send a feeling in the same way as in real life, one interviewee described. He has experienced misunderstandings while chatting and learned that it is better to talk than to write. It is dangerous to only write and chat, he said. He also mentioned that he has never met his colleagues face to face, and that he sometimes does not understand why someone messages him in a certain way. Another interviewee expressed that it may be important that people know each other personally to not misunderstand, for example, jokes, but also in order to open up and to share things with each other. A respondent described that "*clear communication is very important, and keeping things organized in text form. I feel that extra care has to be taken when explaining things in text since you can't immediately catch misunderstandings.*"

Relationships & Trust

Almost a majority of the respondents reported a decrease in team morale, but for team inclusion and trust, there were almost as many reporting an increase as a decrease, compared to before the pandemic. Respondents' answers to the open questions revealed why some respondents even reported a better team morale, and was explained by the fact that everyone have been exposed to the same situation. Regarding relationships, it seems to be more difficult to create personal relationships when working remotely. However, as one interviewee described, it is not impossible, it may just take longer time to establish, and the number of people you create them with may be fewer. Practitioners have tried to build and maintain social relationships with their colleagues through the means of digital coffee breaks, games and physical meetups. Many practitioners argue that it is important to have such casual conversations where they do not talk about work, in order to maintain social interaction and to stay socially connected.

One interviewee mentioned how he thinks that there is less social visibility now and that more people knew him at his previous employment before the pandemic. If you want to network, get a promotion, or get another job, it could be useful to have such social visibility, he said. He also discussed how he thinks that it may be important that people know each other personally to open up and share things with each other, as well as to not misunderstand, for example, jokes. Similarly, another interviewee mentioned how his team previously had problems with people being silent during digital meetings, but now that is not a problem anymore. He believes that it potentially has been resolved due to the fact that people do know each other better now.

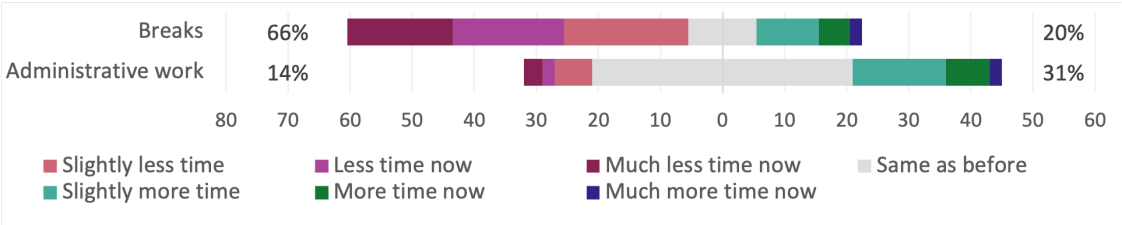

Figure 5.12: Q22: Compared to before the pandemic, how has the frequency of the following activities changed, now? Sorted in ascending order of percentage of *same as before.*

Unwritten Rules

When working remotely, practitioners are not necessarily expected to behave in the same way as they did in the office. On the one hand, it might be easier to deviate from the unwritten rules that existed in a physical setting. For example, it may be easier to drop out of irrelevant meetings when working remotely, compared to when working in the office. On the other hand, there might be some new unwritten rules to follow in a remote setting. For example, it may not be as easy to take a break by yourself when working remotely. Practitioners might feel expected to attend a coffee break in the office, but they do not necessarily feel expected to do so when working remotely.

As a result of being able to drop out of meetings now, one interviewee expressed how it is easier to handle meetings and to not attend irrelevant ones when working remotely. He compared to how it would be in a live setting: "*so, before if you were stuck into a physical meeting, you cannot just drop in 'oh, I am not actually interested in this' and then walk out, it would be more awkward you know.*". Another interviewee mentioned how she feels that it was more okay to take a 30 minutes coffee break in office when all colleagues were present than it is to take a 30 minutes coffee break alone at home, which can explain the significant decrease in breaks, as seen in Figure 5.12. Another interviewee described how all people do not join coffee breaks anymore. In office it was more of an expectation to join, but now when they are working remotely, it is an optional activity that is not necessary to join.

Key takeaways for Social Interactions:

- Practitioners miss seeing and meeting colleagues in person.
- There has been a significant decrease in practitioners seeing colleagues outside of their team.
- Practitioners have introduced, e.g digital coffee breaks to enable casual and informal communication.

5.2.1.4 Teams

Compared to before the pandemic, many respondents have experienced a decrease in team morale, knowledge sharing, and to what extent they know what their team members are working on, as seen in Figure 5.13. About half (49%) have experienced

an increase of misunderstandings, but regarding conflicts and disagreements, a majority did not report any increase or decrease. Regarding team inclusion and trust, the results are scattered.

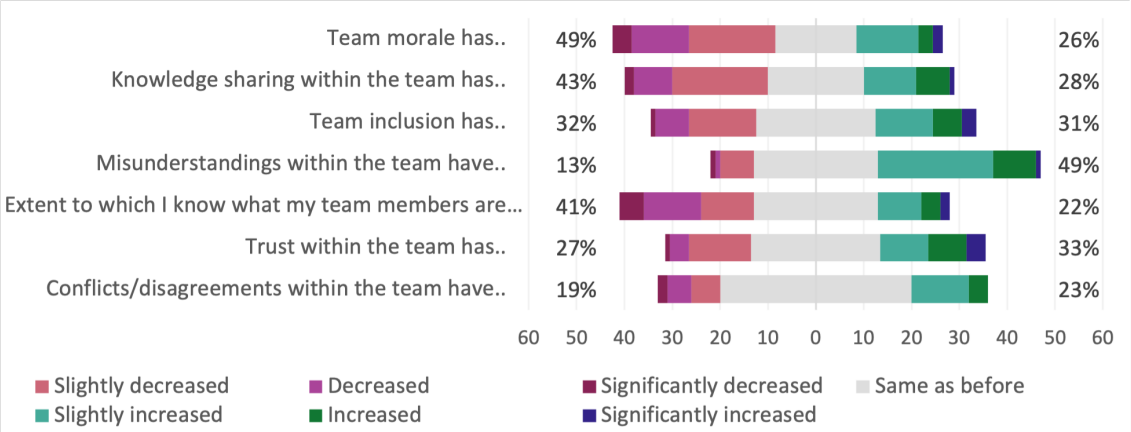

Figure 5.13: Q26: Compared to before the pandemic, how would you rate the following aspects regarding your team now? Sorted in ascending order of percentage of *same as before.*

Regarding knowledge sharing, many practitioners described that pair programming has been an effective approach. One interviewee explained that working in pairs from the beginning reduces the need for syncing as they already have went through things and figured out problems together. Other interviewees mentioned, for example, how some teams have started to use pair programming to create knowledge sharing and that it has been somewhat of a rescue for new team members.

One interviewee described how there is less need to be in office to work with hardware now compared to before the pandemic as one of his team members still goes to the office and therefore can take care of the work with the hardware. Another interviewee explained that his team also have work that needs to be done in office, but that they have a shared responsibility for doing such work. However, in the beginning of the pandemic, it was a bit unclear who was responsible for what. The team members who still worked in office ended up with higher workload than those who worked remotely, and got irritated on those who did not come to the office. Now there are more team members who voluntarily have started to work in office again, so it is not an issue anymore, he said.

Joining a New Team

Many practitioners have joined a new team during the pandemic; 35% of the respondents, and 71% of the interviewees. There are challenges when joining a new team during a pandemic; company feeling, getting to know colleagues, and avoiding misunderstandings are all part of what is challenging. Getting support from colleagues by, for example, being able to ask questions, especially when joining a new team while working remotely, is important to adapt to the situation.

Many of the interviewees joined a new team during the pandemic, but their experiences differ. Some had on-boarding onsite, others digitally, and some did not even have on-boarding activities. P1's on-boarding was mainly physical, not remotely, and he experienced it to be okay but not necessarily good. "*I am not a superfan of it, it was not necessarily good, so I do not know how worse it could be over the internet*", he said. P3 mentioned that they have not done any on-boarding for new team members, and gave no further explanation why. P7 said that he was given less tasks in the beginning and that there was a handover, but they did not have any particular events to get to know each other as they basically already knew each other from the beginning. In general the on-boarding was pretty lenient because it was during a pandemic, he described. He also mentioned that he has not met his replacement in the old team, but that they seem to be doing well.

P6, who joined a new company during the pandemic, expressed it to be super challenging to work from home in the beginning of the pandemic and that he prefers face-to-face communication since it is easier to interpret signals that way, compared to when working remotely. Similarly, a respondent raised how it is necessary to reduce the gap between new and old team members: "*people that is new at the company doesn't have the same team feeling that old members have. We have to work in that!*" From a manager perspective, P2 mentioned that he understands that it is a challenge for managers to build teams remotely, and that managers who are responsible for building teams have to think about "*how do I do that remotely?*".

Two interviewees explicitly discussed the importance of getting support from the company and colleagues when joining a new team and workplace. One of them described, for example, that in the beginning of a new employment you do not know the processes and you need to ask a lot of questions. At first he experienced it to be challenging to work from home and joining a new company during the pandemic, but now it is less challenging since his company and colleagues have helped him to adapt to the new situation. Another type of support is that an interviewee's company have expressed that people should take a day off if they are stressed, and according to the interviewee, people have taken this advice more seriously now compared to before the pandemic. The questionnaire results show on varying experiences regarding the support from the practitioner's company. Almost a majority of the respondents reported that they have as much support from their company now as they had before the pandemic, but for 21% it had decreased compared to 34% for which it had increased.

Key takeaways for Teams:

- Getting to know your team members to avoid misunderstandings is challenging for practitioners to do who joined a new team during the pandemic.
- Many practitioners have gotten support from their company regarding home office equipment and an increased understanding of mental health during the pandemic.

5.2.1.5 Tools & Technologies

The first half of year 2020 was a very technology intensive period, as an interviewee described it. Despite it being a necessary and somewhat forced decision to experiment with new tools, the usage has provided practitioners with insights of how it both can facilitate and hinder their work, and how it is possible to work remotely with agile development. Some tools were already in use prior the pandemic, such as issue tracking tools, but the use has become more serious during the pandemic. In the beginning of the pandemic, many experienced technical issues as the infrastructure was not in place to deal with everyone working remotely at once. However, most issues seem to have been resolved after a few weeks.

New Tools & Technical Issues
As a result of the transition to digital communication, many practitioners have tried new tools, and increased the extent to which they use video cameras and video conferencing tools. The experiences of these aspects vary, some are positive and others are negative. For example, a respondent described the value of some specific tools: "*digital whiteboards like Miro and Mural is really awesome and it would have been hard to cooperate and do what we do without them. They are really a life saver in our work.*" One of the interviewees described that they have replaced all physical course material with digital boards like Miro and Mural, and that it works well, even for keeping up the interaction. Similarly, some interviewees described that they have converted from physical post-it notes to digital tools. As one of them described, one positive aspect of using online tools instead of physical post-its is that everyone actually can see all the notes. However, digital tools do not always provide an equally positive experience. For example, people talking over each other, microphone problems, and people who tends to look at the presentation instead of the people despite using video cameras are all examples of issues with digital communication. One interviewee also described that it is more difficult to screen share something quickly than it is to draw something on a physical whiteboard.

Despite many experiencing technical issues with the infrastructure and internet connection during the beginning of the pandemic, most of the issues seem to have been resolved after a few weeks. One interviewee, however, described how they still experience problems with connection and VPN every day, and that these technical issues did not exist before the pandemic. Other mentioned issues with hardware that they needed to go into office to solve.

Key takeaways for Tools & Technologies:

- Most of the technologies and tools practitioners used before the pandemic, could still be used during the pandemic. Physical whiteboards and post-it notes, on the other hand, were replaced by digital tools.
- There were a lot of issues with infrastructure in the beginning of the pandemic, but the issues were resolved after a few weeks.

5.2.2 RQ1.2 Impact of recommended or enforced remote work

While it is evident that many things have been affected by the ongoing pandemic and social restrictions, certain areas have had more prominent impacts than others: Workplace, Personal Experience & Opinions, and Productivity & Performance. This section describes how practitioners have been affected by recommended and/or enforced remote work due to social restrictions (RQ1.2). The results show that recommended and/or enforced work have made practitioners change workplace, affected their behaviour and personality, and have had some effects on productivity and performance. An overview of what is presented in relation to each theme is illustrated in Figure 5.14.

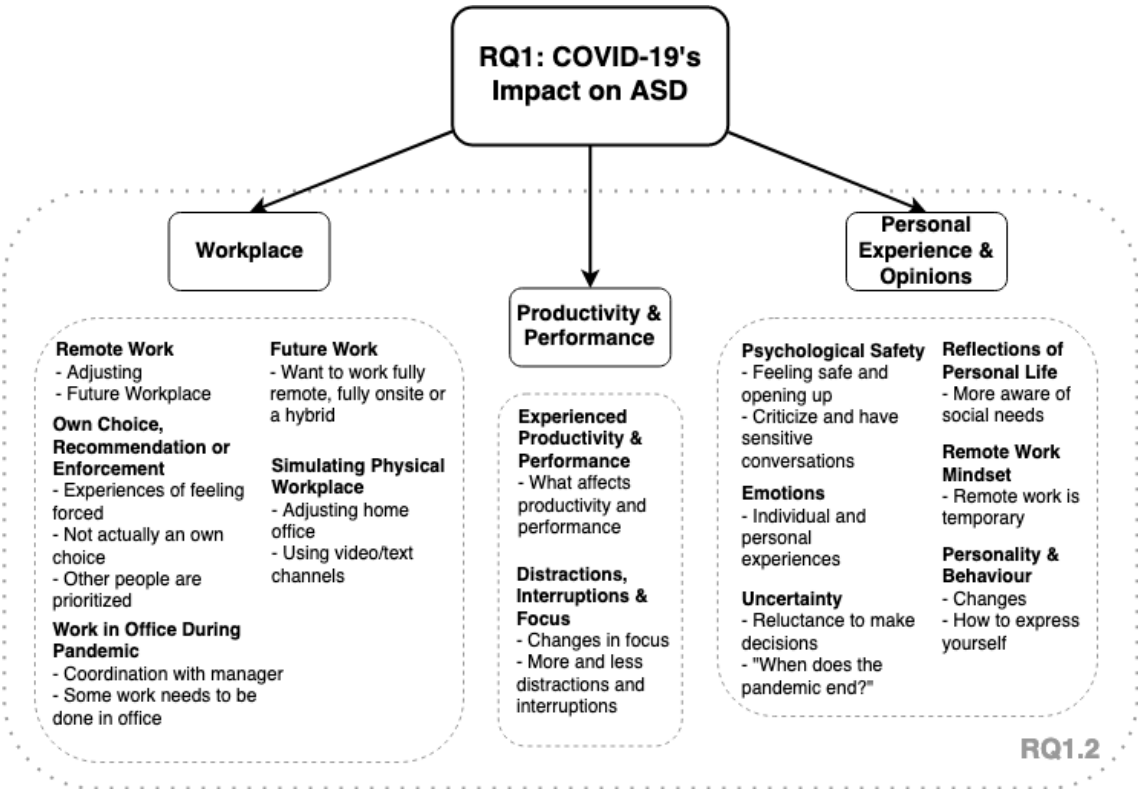

Figure 5.14: The Figure shows a detailed view of the three higher-order themes that are connected to RQ1.2, and its content (how practitioners have been affected by recommended and/or enforced remote work). Illustrated is an overview of what topics that have been discussed in relation to each theme. For example, regarding workplace, practitioners have adjusted to remote work and simulated a physical workplace by using video/text channels. For a more abstract view of how RQ1.2 is related to RQ1 and RQ1.1, see Figure 5.5. .

5.2.2.1 Workplace

It is evident that practitioners' workplace has been affected due to remote work. In this section, practitioners' adjustment to and attitudes towards remote work, and if it is their own choice or not, is presented and investigated.

Remote Work
Most practitioners had limited experience of working remotely prior to the pandemic and had to adjust to a completely new situation when they were asked to work remotely due to social restrictions. However, after one year of remote work, practitioners have realized that they are flexible and have gotten used to the situation. They have learned that everything cannot be done in the same way as in the office. Before the pandemic, the normal was to work in an office, but now the normal is to work from home.

Adjusting to remote work was a recurring theme during the interviews, as several interviewees explained how they have become more positive about remote work over time and that they have gotten used to the situation. One interviewee, for example, explained how remote work was a new experience for him, and that the biggest challenge was to adapt to the changes of not working in office anymore. However, by taking it step by step it went well, he said. Another interviewee expressed how he was impressed by how fast people have adapted to digital courses, and even though there was much focus on discussions on how to work remotely for a while, things have gone back to normal now.

Overall, practitioners have learned a lot by the fact that almost everyone are working remotely and that everyone have faced the same situation. One respondent described what has been communicated by both respondents and interviewees: "*we've learned a lot and especially if everyone is put up for the same challenges. Then it works a lot better since everyone needs to adapt, not just a few. [...] If some individuals are not keen on adapting and don't want to learn. Then it is really hard.*".

The questionnaire results do not reflect any direct attitudes towards remote work other than what is already mentioned in, for example, Section 5.2.1.2 - that it is more difficult to have spontaneous conversations than in an office and that you have to think more on how to communicate. However, the questionnaire results reveal that there is a mix of different opinions regarding the work environment as 38% of the respondents were less satisfied with their work environment whereas 31% were more satisfied. These results were also reflected by the interviewees, where some want to continue to work remotely, and others do not. One interviewee particularly expressed how he has reflected on how remote work all around the world due to the pandemic has been good for the environment as people now have been forced to learn that they do not need to fly to have a meeting. Similarly, one respondent shared the reflection that "*it will be easier to get understanding for working from home*" after the pandemic.

Among the most positive consequences of remote work that were communicated during the interviews are the benefits of not having to commute, and the perceived flexibility and freedom of working remotely. Almost all of the interviewees expressed how they have realized how much time they actually had lost due to commuting, before the pandemic. One interviewee described how this reduction even has influ-

enced their discussions as no one has to bring up that they, for example, are stuck in traffic during stand up meetings anymore. Besides the reduced need for commuting, several interviewees also highlighted how they have perceived having more flexibility and freedom when working remotely. They have, for example, realized that they basically can work from any place they want and that they can manage their time more easily when working remotely. The pandemic has provided them with the freedom to decide what to do and when. For example, one interviewee expressed the benefit of being able to exercise during lunch whereas another appreciated how he could work on a task at whatever time he wants. This flexibility is also reflected by the questionnaire results, which show that about half (45%) of the respondents reported an increase of work-life balance, whereas 28% reported a decrease.

Reflections regarding the differences between working onsite and at home have been raised by both respondents and interviewees. As one interviewee described, it has been a bit strange to work together without seeing each other in person, but it works. A respondent mentioned that when working in office, "*it's easier to have a coffee if you bump into a colleague, remote requires more coordination to have the same kind of interaction. On the other hand, using Teams is fairly lightweight, so to some extent, the outcome is the same.*" However, some practitioners are worried that not meeting each other in person will have negative consequences in the long run. The lack of interaction might affect peoples' feelings and personalities, as well as the ability to gain advantages of working as a team.

Own Choice, Recommendation or Enforcement to Work Remotely
As mentioned in Demographics of Questionnaire in Section 5.1, a majority of the respondents believe that they are working remotely due to a recommendation from company and/or government, about one out of four due to enforcement and the rest work remotely due to their own choice. All but one of the interviewees have been recommended to work from home, and now work from home the majority of the time. A majority of the both the respondents and the interviewees do not feel forced to work remotely, but 39% of the respondents do. The interviewees confirm the questionnaire results, but also explain more regarding their feelings and their experience of whether they feel forced or not. What is presented below are the circumstances and premises of the decision to work from home, as well as a couple of themes that emerged during the interviews regarding, for example, whose decision it was to work remote, feelings regarding the decisions, and their experiences.

About 39% of the respondents have experienced feeling forced to work remotely, which is fairly representative for the interviewees as well. P6 mentioned that he felt forced to work from home as there were no capabilities for them to work from home in the beginning. P2 also mentioned that the transition to remote work was in a somewhat forced direction. P1, on the other hand, said that "*if we were forced to do something, that would be to work from the office, and not the other way around*" as his manager encouraged him and his team to meet up in office once every two weeks, but they were still not forced, he said.

Several interviewees expressed that they do not feel forced to remotely. P4 argued that he cannot be forced to work remotely since he works in a company with a flat hierarchy, and that he was involved in discussions regarding who can work in the office and not. P1 mentioned that he has never felt forced to work from home and that forced is a very strong word. P3 mentioned that no one has been forced to work in the office, since you do not need a reason to work from home. He also said that it is important not to force people, especially the ones who either belong to a group at risk of serious illness themselves or who live with someone who does. Similarly, P5 said that she never felt forced to work from home or to work in office. P7 also mentioned that he does not feel forced, but in practice they were forced because of the lockdown.

One particular theme that emerged from the interviews was that there are examples of situations and decisions where it is not the individuals' own choice "per se", to work from home or in office. In some cases, they just follow the protocol and accept what their company suggests. Meeting up in the office once every two weeks was a suggestion from the manager, and according to P1, the team was fine with it. However, he emphasized that if you were not comfortable with it, the manager would not say anything. Several interviewees mentioned how they have been told to follow their clients' recommendations regarding working from home or not. P6 expressed that he is okay with whatever choice his company makes, "*if they ask me to work from home for the rest of my life, then I accept it.*"

Another common theme was that of prioritization, that is, putting other people first and respecting other peoples' personal feelings and needs regarding the uncertainties due to the virus. You cannot force people to work in office, especially not the ones at risk for serious illnesses because of the virus. Several interviewees explained that their companies had communicated that if you could work from home you should, so that the ones who have to, can work in the office. As in P6's case, some departments had to stay in office whereas others were asked to work remotely as they could do their work from home. P7 mentioned that some people have been allowed back in office, but that it is very rare and only if you had struggles working from home.

Work in Office During Pandemic

The questionnaire results show a significant increase in the number of people who now work from home the majority of the time. However, some still work as much remotely as in office, and some work the majority of the time in office. From the interviews, several themes regarding feelings and reasons for working in office during the pandemic became evident.

Several interviewees are still allowed to work in the office if they want to. Some have their own desk in the office, which they can go to whenever they like. However, as P5 expressed, there is no reason to work in office as all other colleagues are working from home.

Most of the interviewees mentioned that some work needs to be done in office. For

example, working in a department with certain services that need to be handled in office, troubleshooting hardware, or picking up work-related things, such as canvases and whiteboards, are all reasons to still be and work in office. As a respondent explained "*recently we've frequently had to have a local team member go physically to the office to re-start machines that failed on applying Windows updates.*" Some choose to work in office because they have a better looking background for video calls in office, as one interviewee explained, or that "*it is nice to have an empty office and great facilities on our hands*", as a respondent expressed it. P2 mentioned that managers had a rotating schedule for when they were present in the office.

One respondent described how they are doing less hardware testing as they are not working in the office anymore, which some of the interviewees also mentioned. However, in some cases, as for P1, the responsibility for working with the hardware can be taken care of by the ones who still go to the office, and therefore, all team members do not have to work that much with hardware in the office anymore.

Even though some of the interviewees are free to go into the office whenever, several interviewees also mentioned how they need to coordinate with a manager or have a specific reason before going to the office. As described, some work needs to be done in office, as when working with hardware, but another reason for going to the office could be that it is not possible to create a suitable work environment at home. P6 explained that they do not have any tool or process for this, but they coordinate with their manager and explain why they need to work in office.

As previously mentioned, P5 does not work in the office even though she is allowed to. She explained that "*I can go in to office if I want to, but there is no one there*", so there is no reason to do so. She has been in the office a few times during the pandemic, but she feels that she could just as likely work from home, as there is no one there. Similarly, when P6 went to the office, he believed the space to be empty and boring, and he does not think that it is a good idea to work in the office when everyone else are working from home. However, as P3 mentioned, some would rather work in office since there are elements of disturbance at home.

Future Work

It is evident that all interviewees have reflected about future work situations, especially for when the pandemic is over. The majority want to work in a hybrid model, if possible. However, one interviewee have to go back to the office when allowed, as it has been the plan all along.

P3 thinks it is great to work from home and said that five out of six of his team members want to continue to work 100% remotely in the future. Similarly, P6 mentioned that some colleagues are happy to work from home and want to continue doing so for the rest of their lives.

The majority of the interviewees have discussed working in a hybrid model in the future, where you work some days in office and some days at home. P4 said that

he would like to work in office at least two days a week, in the future, to get out of the apartment. Similarly, P5, P6, and P7 would also prefer to work in a hybrid model. P7 mentioned that if he could choose now, he would choose a hybrid, and P5 explained that if the whole team went to the office the same day, she would prefer the office. P1 mentioned a colleague who have been part of his team for the longest time and who misses the office and would like to go back to the office at least one day a week.

Even though the majority of the interviewees have mentioned that they would rather work in a hybrid model, there are a few exceptions, and some have colleagues or team members that feel differently. Some people think it is boring to work from home, one interviewee said, and others prefer to work in office as they might have family members who would disturb them at home. P5 explained that if a hybrid model is not possible in the future, she would choose to work in office full time. P7 will go back to the office since that has been the company's plan the whole time, but he would choose a hybrid if he could.

Several interviewees mentioned how there have been discussions regarding the future use of the office. One interviewee described how he thinks that offices will serve a more specific value in the future, rather than just be filled by a lot of empty desks. He particularly mentioned remaking certain rooms to workshop rooms, where teams can meet the days they all are in office. Similarly, P5 mentioned how there have been discussions regarding having some days a week being dedicated to certain teams. One interviewee also expressed how he expects there to be a greater mix and acceptance of remote work, in the future. "*actually, I could sit in a completely different place if I wanted to. [...] One does not need to sit in a big city anymore*", he explained.

Simulating Physical Workplace

Based on the interviews, the results show that several processes and tools, such as having core work hours or using open video and audio channels, are used to simulate a physical workplace.

Several interviewees described that they have been allowed to either buy or bring home some equipment from the office. One interviewee explained how he got tired of sitting at the same desk during both his free time and during work hours, so he created a dedicated home office, and have even started to rent an office space to which he goes to once a week. Having a dedicated workplace has been the key, he said. Some interviewees also mentioned that they have started to go out for walks and lunch during the day, just to leave their home for a while.

One way to simulate the feeling of a physical workplace that several interviewees have either heard of or tried themselves, is to have an open video call or voice chat that anyone can connect to during the day. This was also mentioned by a respondent who described it as a "team radio", "*an always on call that makes it feel somewhat like being at the office*". An informal channel where "*people can come and go as they*

please", and where other teams also can join in case they need help or if there is an urgent issue going on. However, for some, this simulated solution has not been used that much yet. Besides an open video call or voice chat, one interviewee also mentioned that they have tried Wonder.me to simulate a physical workplace.

Both the questionnaire and the interviews reveal how there have been changes to when practitioners contact each other. Things that were the norm before have had to take on new expressions. P5 mentioned that they tell each other when they start and end their work day to make it clear to know who are at work by, for example, writing 'Good morning'. She expects people to be available during that time, unless they have said that they will not. Similarly, P6 mentioned that they never contact each other after 4-5pm, to respect their private lives. Still, they inform each other in a Slack Channel when they are working or not.

As seen in Figure 5.9 in Section 5.2.1.2, a vast majority of the respondents have increased their use of video cameras for communication. As an answer to one of the open questions, some respondents explicitly stated that it is particularly important to use video during the pandemic. One interviewee explained how he and his team during the past weeks have have started to use video cameras to get more engagement during meetings. It has worked well, but sometimes you would rather look at the presentation than the people, he said. Another interviewee mentioned that they use video cameras in one-to-one meetings, but when they code they only use audio. It depends on the situation, he said.

Key takeaways for Workplace:

- The most appreciated aspect with remote work is the inherent flexibility and freedom, according to practitioners.
- Several practitioners have mentioned that they would prefer a hybrid model in the future, working some days at home and some in office.
- Practitioners have simulated a physical workplace by having an open video call or voice chat and establishing core work hours.

5.2.2.2 Personal Experience & Opinions

The interviews show that personal experiences and opinions regarding both work-related and social aspects have changed since the beginning of the pandemic. It seems that a lack of both psychological safety and spontaneous meetings have resulted in practitioners not opening up to or sharing as much with their colleagues as they did before the pandemic.

Psychological Safety

The interviewees explained how feelings regarding psychological safety in remote settings have become more important during the pandemic, even though a majority of the respondents have experienced, for example, the same amount of surveillance from their company and colleagues now, as before the pandemic. Based on the in-

terviews, it became clear that some people feel less safe in online meetings, and that without this psychological safety, some discussions will not be raised.

One of the interviewees expressed how he believes that it is dangerous to only write and chat. When you need to discuss critical things these days you should not do it via text, you should schedule an online meeting instead, he said. Although, another interviewee mentioned that they have put several things on hold during the pandemic, arguing that "*we can do that when we come back*", referring to working onsite. It is especially true regarding certain meetings and simple discussions that are safer to have in a physical location, that is, discussions where you could expect conflicts to arise and people to have more feelings. Similarly, another interviewee discussed how some people may be reluctant to write down certain things due to a fear of leaving digital traces in text, and that some people basically do not want to voice opinions about other colleagues and their behaviour in written and oral digital communication. The interviewee explained that such a discussion is a type of conversation that you would have during informal face-to-face communication, but also that it is important to have it since "*you might also understand if you have done something wrong yourself.*"

The questionnaire results show that all people do not make themselves heard as often now as compared to before the pandemic. The interviewees did not only confirm that they have experienced that some colleagues are very silent during meetings now, and that there is a lack of people opening up to other colleagues, they did also come up with suggestions for why this might be the case. According to P1, leaving digital traces and a lack of spontaneous meetings are two reasons why people do not open up via text or calls as much as they did before the pandemic. He also mentioned how important it is to know each other personally to avoid misunderstandings and to be able to open up and share things with each other. P7 provided another explanation, expressing that it might be due to the way meetings are conducted now, and that it "*probably brings out the worst in people, allowing them to be more introverted*".

Emotions

A majority of the respondents reported that they feel as appreciated as before the pandemic and that their work is as meaningful as before. However, P6 is quite sure that depression and emotional problems have increased during the pandemic, "*there is no doubt that the Corona has affected peoples' personalities and feelings*", he said. He also mentioned that he has been affected by the lack of interaction with people. P4 mentioned that it is harder to keep up the motivation when working from home, compared to when working in the office. He also said that he needs variation. P1 expressed that he does not like to work by himself, whereas P3 explained that he does not miss the social aspects from the office since he gets it from pair programming, meetings and active text channels.

Uncertainty

The interviewees described how the pandemic has been a time marked by uncertainties. Uncertainty regarding how to work remotely, an uncertainty that creates

a reluctance to make decisions, and an uncertainty of when the pandemic is over.

People would like to know when the pandemic will be over. One interviewee expressed that "*nobody expected that this pandemic to take this so long time*" and another interviewee wondered "*in a month or so, are people vaccinated by then, or will this go on for 5 years?*"

"*It is very hard to make any bigger decisions when there is so much uncertainty*", and since the beginning of the pandemic, the whole situation has been marked by it, one interviewee described. According to P4, the most difficult part of the transition to remote work was the uncertainties of whether their clients wanted to have their courses online or onsite. However, for some, as in P2's case, certain types of meetings and discussions were postponed insinuating that they would be resurrected when the pandemic has ended.

Reflections About Personal Life
Some of the interviewees have reflected on their personal life and needs. One of them mentioned how he is hopeful that we all are going towards a better world. He said "*this is like a breathing pause for the world in some way, to be able to think about what is important in life...*". Similarly, another interviewee expressed how he believes that more people are aware of their social needs now, and in general, he thinks that people take better care of themselves mentally now.

Remote Work Mindset
Several interviewees have expressed a mindset of that remote work is only temporary, and that they soon will be back in the office. Some held on to this belief for a long time, and have even put things on hold because of it. In P7's case, everyone have known that remote work is only temporary, since it has been the plan all along to go back to the office when allowed.

Personality & Behaviour
The interviews show that there has been a change in practitioners' behaviour and personalities. One interviewee explained how he has become less strict regarding daily stand ups and its content. Now he is more lenient with people not being on point when they explain what they have done and will do. Before the pandemic he would ask people to have sync discussions after the stand up, but now he allows people to be more verbose and have more discussions.

Regarding coffee breaks, one interviewee mentioned that people who used to turn up for the physical coffee breaks now do not join the digital coffee breaks. He likes digital coffee breaks, but he believes that people who do not show up might think that it is not as important anymore, because they have already been sitting in digital meetings with the same people all day long. "*Why talk to the same people again and again*", he said. However, he also noted that some people have to pick up their children at the same time as the coffee breaks are held. In contrast, one respondent described how they have "*forced Fika-Meetings to ensure staying close as a team.*"

The interviews show that people have reflected on how they prefer to communicate. Some express themselves better in text, whereas others prefer to talk. However, it is important that people are able to express themselves correctly to avoid misunderstandings. One interviewee mentioned that she expresses herself better via text, as long as there is not too much that you need to explain. In contrast, another one believes that he is "*100% better in expressing himself via talking*". He also mentioned that he has experienced misunderstandings when chatting with colleagues, and thus learned that it is better to talk. Some people cannot express themselves as effectively in written communication, and the type of communication can differ depending on the content. As one interviewee expressed, if it is of more technical character, he prefers to write, but if it is about a bug, he prefers to call.

As discussed, one interviewee expressed how he thinks that online meetings bring out the worst in people, allowing them to be more introverted. However, he also brought up that colleagues who - before the pandemic - used to be quiet and not hang around people, now try to join discussions more.

Two interviewees explicitly stated that their personality has changed since the beginning of the pandemic. P6 described himself to be a very extroverted person before the pandemic, but now due to the pandemic and the lack of communication with colleagues, his personality has changed towards being more introverted. He explained that you get more and more introverted, step by step, not within one week or one month but over time. He described that the interaction between people and society has been cut, and he believes that this is damaging to peoples' personalities. Contrary to P6, P7 described himself to be introverted one year ago, but now he has become more extroverted, but he is definitely not an extreme, he added.

Key takeaways for Personal Experience & Opinions:

- The feeling of leaving digital traces can make practitioners not open up or address critical situations when working remotely.
- Several practitioners have mentioned a change in behaviour and personality, due to the pandemic.
- It is obvious that the pandemic has affected practitioners feelings and emotions negatively.

5.2.2.3 Productivity & Performance

It is evident that there have been changes regarding productivity and performance. While the questionnaire results suggest a clear increase in productivity, the interviews reveal how productivity may fluctuate and that it depends on the situation. Although, most of the interviewees have experienced that their productivity either has increased or remained the same as before the pandemic. It is also evident that there has been a considerable decrease of interruptions and distractions.

Experienced Productivity & Performance
A majority (52%) of the respondents believe that their productivity on an average work day has increased since the beginning of the pandemic, as depicted in Figure 5.15. However, at the same time, approximately a third of the respondents believe that their productivity has decreased. As illustrated in Figure 5.16, the results are almost the same for team productivity as for self-reported productivity, but with a smaller increase, and a larger decrease.

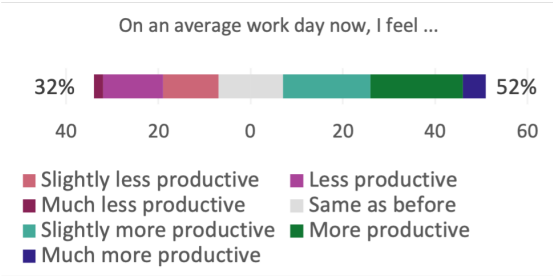

Figure 5.15: Self-reported productivity

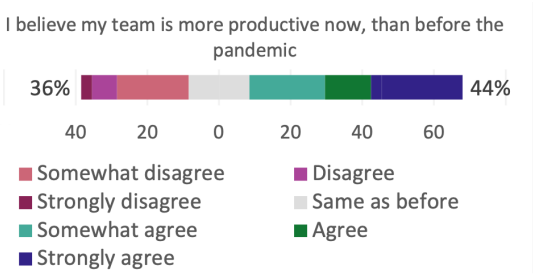

Figure 5.16: Team productivity

Several interviewees described how their productivity and performance have remained the same or increased, but for two of them, the productivity has been fluctuating. P7 said that he would like to believe that he can perform the same results as before the pandemic, but he does not have any evidence for it. However, regarding productivity, he mentioned that initially - in the beginning of the pandemic - he felt that he could do a lot and his productivity went up. Then it went downhill as he started to do his washing and other things. P6 believes that there are several things that affect his productivity. The weather, for example, is affecting his emotions and therefore - when the weather is bad - his productivity goes down. However, when P6 is happy with his personal life, his productivity increases. He particularly mentioned the lack of interactions with friends and family as something negative to his productivity.

Regarding whether the respondents' reported quality of work is higher now, the results are relatively evenly distributed across disagreement, agreement and same as before, as seen in Figure 5.17. One of the respondents described that there are several factors that contribute to general improvement: "*no time is wasted for commuting; number, length and frequency of meetings decreased, while their impact increased; [...] team members and the team as a whole increased its productivity and efficiency; sense of creativity, sense of independence, and thus our motivation also increased. All this results in improving our performance, work related satisfaction and quality of life.*" Another respondent was not as equally positive and stated that a "*remote team can work, even though I personally believe that working as team at an office is better for productivity.*"

Distractions, Interruptions & Focus
As depicted in Figure 5.17, a vast majority of the respondents have experienced less distractions and interruptions now, compared to before the pandemic. There

are only a few who believe that the level of distractions and interruptions have remained the same as before the pandemic. One interviewee explained that there are fewer interruptions and organic discussions now, as you cannot simply turn around and ask someone about something. However, another interviewee mentioned that some of the interruptions and distractions that disappeared have been replaced by new ones. She described that even though there are less distractions around her now, there are more distractions regarding, for example, Slack notifications, so "*it comes out even*", she expressed. Another interviewee explained that he is distracted by the weather and being alone, but mentioned also that some of his colleagues have other types of distractions at home, such as children.

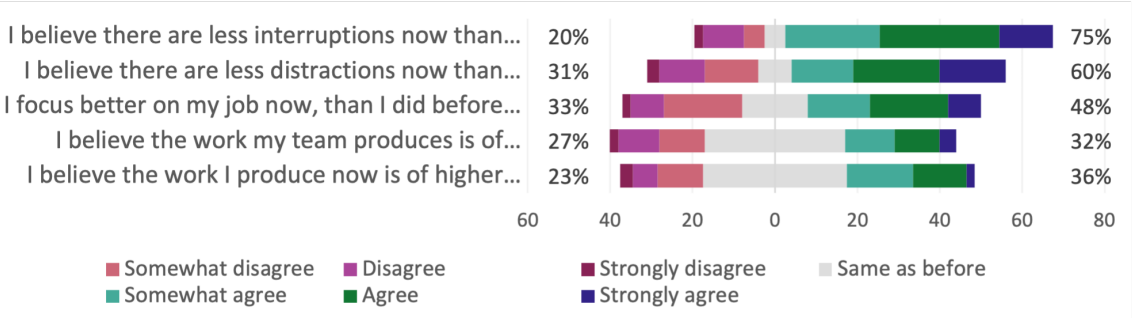

Figure 5.17: Q17: Please fill in to what extent you agree with the following statements (regarding Productivity & Performance). Sorted in ascending order of percentage of *same as before*.

The majority of the respondents believe that they have another focus on their job now, compared to before the pandemic. There are 48% who agree that they focus better on their job now, whereas 33% disagree. A majority also believe that they are expected to be as responsive and available, or more now, compared to before the pandemic. From the interviews it became clear that some have experienced a better focus. One interviewee mentioned that he can focus better at home, and another one described how it is easy to keep on working when working remotely as he does not have to leave work to go home. Before the pandemic, he would not always stay and fix an issue that he had at the end of the day, but now he can as he does not have to go home. Another interviewee expressed that even though he can sit at home and focus on a task alone, it might not be the best since he believes that he should work for the team and not himself.

One interviewee mentioned that one consequence of having a better focus when working from home might be that people work more individually now than before the pandemic. Similarly, one respondent mentioned that the team is"*much more personal focused now. It really takes hard steering to get the team to work as a team and not as individuals.*" Another respondent described that "*people think once more before disturbing and this helps with focusing on the given task and not being disturbed.*".

Key takeaways for Productivity & Performance:

- Practitioner's productivity seem to have increased, however there are also implications that it might fluctuate more now.
- In general, practitioners can focus better now due to decrease in interruptions and distractions. However, other distractions have been introduced instead.

6
Discussion

In this chapter the findings and the results of the study, divided into the research questions, will be discussed in more detail. Additionally, what implications the significant factors, as previously described in Chapter 4, have had on the results will also be discussed further.

6.1 RQ1: COVID-19's impact on ASD

As described in Chapter 5, there are several different areas of agile software development that have been affected by the COVID-19 pandemic. The areas that have been the most affected are related to social interactions and communication, whereas more technical aspects have been less affected. Based on the results, it is evident that technical agile practices such as test-driven development and continuous integration, and other aspects of a more individual character have been functioning well, even during the pandemic. Regarding aspects of more social nature, on the other hand, the results tell a different story. Practitioners have discussed how the lack of social interactions can result in negative consequences in relation to, for example, psychological safety, personalities, well-being and teamwork in general. This leads the discussion to the agile values and principles of the agile manifesto. To value "individuals and interactions over processes and tools" [28], have become more difficult now since there is a need to put more emphasis on processes and tools in a remote setting. Practitioners cannot communicate without relying on digital tools or setting up processes for how to communicate when they are not sitting next to each other or interacting with colleagues as much as before. Practitioners miss social interactions, especially the spontaneous ones, but interactions are seldom spontaneous in their current environment. Digital communication works, but is not the same as face-to-face communication.

Agile principles such as "build projects around motivated individuals"[28] and "give them the environment and support they need"[28], have become harder to follow and address because of the remote work during the pandemic, which is similar to the conclusion in [8]. As both the questionnaire and interviews show, practitioners have gotten technical support, but lacked the support for creating the informal environment they need. As discussed, practitioners find it important to have non-work-related conversations both within and outside of their own team, but as this study shows, this does not happen as often now as before the pandemic. Some feel inhibited by the virtual nature of communication, and experience that activities

of these kinds are more challenging now compared to before the pandemic. However, despite this, many practitioners do believe that remote work has worked better than expected, and realized that there are some positive aspects of remote work, such as not having to commute and the flexibility of managing their own time. The interviews show that there have been discussions regarding future work arrangements, where some people have expressed that they would like to work remotely at least some days a week, even after the pandemic. This is particularly interesting, considering the fact that many practitioners have commented on the lack of social interactions and believe that communication works best if all are onsite or all are remote, hybrid communication[1] is not preferred. What the long-term effects and implications of this will be, are yet to be shown. However, as described in more detail below, there is a risk that practitioners have been affected in a way that will make it somewhat challenging to go back to what previously was known as the normal, if even possible, and that it is important that these challenges are addressed and mitigated. Companies should expect a debt regarding team maturity and teamwork that needs to be taken action upon when teams once again are back onsite.

6.1.1 RQ1.1: Employment of agile development and ways of working

As a result of the transition from in person to digital communication, there has been a significant increase of meetings, as confirmed in [45] but contrary to [13] who reported on a decrease. Russo et al. focused on mainly technical roles, such as developers, and their study was conducted a few months into the pandemic [13]. This study, on the other hand, focused on more than just technical roles (agile coaches, product owners etc) and the study was conducted one year into the pandemic. These differences might explain the different results.

This study has shown on an increase of meetings, and one reason for this is that practitioners now schedule meetings for not only work-related topics, but also for topics such as catching up with colleagues and asking them how they are doing, which is also brought up by [47]. In a way, all communication, including what used to be brought up in spontaneous and casual conversations, have now turned into meetings. As a result, there has not only been an increase in frequency of meetings in general, but also an increase of back-to-back meetings, which in turn may result in more stressed and less motivated practitioners. This increase of meetings in combination with the challenges with the digital meeting structure, in for example, hybrid meetings, can also explain why there has been a decrease of appreciation for meetings now, compared to before the pandemic. Conversations during non scheduled activities with fewer attendees, e.g pair programming, seem to be seen as more spontaneous and casual but also easier to conduct than digital meetings. This could explain why appreciation for communication has increased, while appreciation for meetings has decreased.

[1] Hybrid communication is when a part of attendees of a meeting or a conversation are onsite, and the other part are remote.

Regarding hybrid communication, and in line with previous work [15, 8, 52], this study confirms the experience of hybrid meetings to be less effective or more challenging than all-remote or all-onsite meetings. Practitioners believe that communication works best if everyone are either onsite or remote, and not mixed. Hybrid communication is less effective since there is a gap between the people who are onsite and those who are remote, and many practitioners realized this first when everyone went remote. The ones who are onsite can easily talk to each other in a spontaneous way, whereas those who are remote have to rely on digital tools, and therefore have to approach and contact their colleagues in a more deliberate way. This unbalance creates a difference that not only can affect the relationships between team members, but may also result in that some information get lost along the way since everyone are not involved in the informal interactions that keep people up to date on, for example, what to discuss in an upcoming meeting or regarding who is working when and from where. However, despite this dislike of hybrid communication, many practitioners still want to work in a hybrid model in the future. This creates a challenge regarding future work arrangements and workplaces, since the challenges of hybrid communication will still be evident. How practitioners and their companies will handle this situation is yet to be seen. However, several practitioners have already begun discussing that certain days a week should be dedicated to certain teams, so that the whole team can meet in person at least some days a week. This suggests that they at least have started to reflect on how to work in a hybrid model where they can maintain social interactions and keep hybrid communication to a minimum, but still be able to reap some of the benefits of remote work.

From this study, the importance of having casual conversations has become very evident as practitioners have tried to address the difficulties in creating such conversations in a virtual environment by integrating them into some of their work practices instead. More specifically, this concern the three agile practices that were discussed the most in both interviews and answers to open questions of the questionnaire: stand up meetings, retrospectives, and pair programming. This study shows that these three agile practices have been particularly important during the pandemic, since it is in relation to these practices that casual conversations can occur more naturally now. Another study [16] found that only daily stand up meetings are used to fill this gap of casual conversations, and that only stand up meetings and retrospectives were found to be particularly important [16]. However, a majority of the respondents of the study had management positions [16], contrary to our study in which a majority had technical roles, which might explain why they did not come to the same conclusion as we did. For example, people with management positions might not do pair programming as much as, e.g. developers, and therefore not report such practices to be especially important.

This study's results show that practitioners now compensate for the lack of casual conversation by increasing the number of stand ups, extending the use of pair programming, and valuing retrospectives more now, than before the pandemic. For example, both non-work-related and work-related conversations that practitioners

had when they sat next to each other and worked in the office, are now manifested in the increased use of remote pair programming, to enable closer teamwork and knowledge sharing. Syncing conversations that usually existed in hallways, by the coffee machine, in the office kitchen, or before meetings, are now carried out during stand up meetings. The fact that practitioners do not see each other as often during the day now as before the pandemic, has been manifested in that there are both more and longer stand up meetings now. Retrospective aspects, such as reflections and continuous improvement have become more important than the retrospective meetings per se. These reflections have manifested itself in combination with other activities, e.g in the beginning of certain meetings where practitioners are asked about how they are doing and how their situation can be improved. Retrospectives have become a space to ask how people are feeling and doing during the pandemic, and the importance of this is confirmed in [45]. This study have also shown that pair programming is not only particularly important for teams and teamwork in a remote setting, but also for integrating new team members and facilitate knowledge sharing during a pandemic.

Regarding agile practices, [8] discussed that "agile work practices are harder to perform given the virtual nature of meetings and interactions", compared to before the pandemic. This study confirms that some practices in fact are more challenging to perform now, such as retrospectives and pair programming, but it also shows that some practices neither are more nor less challenging to perform now, such as continuous integration and automated testing. This study also shows that agile practices of more social nature have been experienced to be more challenging than those of a more technical nature, for example, that pair programming is more challenging than test-driven development. In general, online tools were already in use for several technical practices before the pandemic; for example, Jira was used for issue tracking before the pandemic, and is still in use. For pair/mob programming, on the other hand, there has been an increased usage of these activities, both among experienced and inexperienced users, for which the latter might had to deal with a learning curve. This might explain why pair/mob programming seems to be more challenging to perform now, especially since there has been a challenge in testing and using new online tools for digital pair programming. In practice, this means that technical practices were not as affected by the transition to remote work as social practices were, especially since these technical practices are not dependent on where the practitioners are located physically, compared to, for example, pair programming.

Contrary to other social practices discussed in this study, there were more respondents reporting the stand up meeting to be less challenging now than more challenging now, compared to before the pandemic. The reason seems to be that there is a difference between stand up meetings and general meetings, both regarding the structure and appreciation. Usually a stand up meeting is used for syncing between team members in a sequential way. Team members taking turns is also discussed in [8] as being more suitable in a virtual setting than in a physical one. The challenges of a digital meeting structure, such as people talking over each other or that some

are silent, might therefore not be as prominent in a virtual stand up meeting as in a virtual retrospective or general virtual meeting. This also explains why stand up meetings seem to be more appreciated than meetings in general.

6.1.2 RQ1.2: Impact of recommended or enforced remote work

This study is unique in the way that it investigates what impact a forced or recommended remote work situation has on agile software development and its practitioners. Other studies, such as [52, 42, 54], have mentioned the forced and/or mandatory situation, but not investigated the feelings of being forced to work remotely further. One of the main findings of this study is that whether a practitioner feels forced to work remotely or not, has an impact on many different aspects of agile software development, such as their well-being, productivity, communication, and experience of stand up meetings. Even though there is a considerable difference in *being* forced, and *feeling* forced to work remotely, practitioners do not seem to acknowledge the difference. For example, several practitioners have mentioned that they cannot feel forced to work remotely since they are not forced to do so, and that they, in practice, can work from wherever they want. However, despite that a majority of the practitioners have stated that they do not feel forced to work remotely, there is an underlying theme of putting the needs and wishes of other colleagues first, which might create a feeling of being forced to work remotely. Even though a practitioner would rather work in office, and are able to do so, he/she might feel a need to work from home anyway, as he/she believes that he/she is more capable to do so, compared to his/her colleagues. For example, other colleagues might be prioritized to work in office, since they cannot create an optimal work environment at home. At the same time, this study has shown on another way of feeling forced, in the opposite direction. Some practitioners have experienced feeling forced to go to the office, when they would rather be at home. Some practitioners who are not as worried of catching the COVID-19 virus compared to their colleagues, might feel forced to go into the office when there are, e.g. hardware issues that needs to be taken care of onsite. By acknowledging that there indeed is a difference between *being* and *feeling* forced to work remotely, this means that there might be more practitioners who feel forced to work remotely (or onsite), than expected. For example, the fact that practitioners who have expressed feeling forced to work remotely also have been the ones who were told to work remotely, and that practitioners who are free to go into office whenever have expressed that they do not feel forced, might be due to that practitioners believe that they have to be forced to in order to feel forced. However, as the results in Chapter 4 show, whether a practitioner feels forced to work remotely or not, does not depend on the primary reason for working from home, that is, whether it is a recommendation, enforcement or own choice. It rather seems to depend on the strong trend that people who switched teams or employment during the pandemic, and who have not met their new team members in real life, are more negative to the work situation, and therefore also might feel more forced to work remotely than others.

All in all, it is important to address these aspects of feeling forced to work remotely to minimize its effect on agile software development aspects, especially in similar circumstances in the future, as we have seen that this feeling affects many aspects negatively, such as productivity, communication, meeting quality, well-being etc. This finding is essential when considering future work arrangements. If a practitioner has the opportunity to choose where to work, he/she should be able to do so without taking other colleagues wishes and needs into consideration. On the other hand, if a practitioner cannot choose, he/she and his/her colleagues should be working under the same premise, that is, all in office or all remotely.

The findings of this study suggest that industry practitioners clearly have experienced a better productivity or at least not been affected negatively, which is in line with [43, 10, 11], but contradicting to [9]. However, as almost one out of three still reported a decrease, the study contributes to the fact that practitioners have dichotomous experiences of productivity, as discussed in [11]. Additionally, more unique to this study is the analysis of the relation between productivity and whether a practitioner feels forced to work remotely. Although, not necessarily surprising, one of the main findings of this study is that a practitioner who feels forced to work remotely experiences a lower productivity now, compared to before the pandemic, than a practitioner who does not feel forced.

In general, practitioners seem to be more reluctant to contact each other, which is also mentioned by [47]. If they do, they think through more on how they communicate. Positive aspects of thinking things through before contacting others are that practitioners do not disturb each other as often as before, and they also avoid misunderstandings by having more clear communication. Negative aspects, on the other hand, might be that immediate issues, both technical and social, do not get resolved directly, and might even be forgotten about as time goes on, as also mentioned in [48].

We were surprised that such a large amount of people had switched teams and/or employment during the COVID-19 pandemic. Despite not being the focus of this study, many aspects regarding the challenges of joining a new team or company during the pandemic became evident, which goes in line with what is said about virtual on-boarding by [48, 8]. Additionally, we have seen that knowing your colleagues, and especially having met them in real life, have a big impact on several aspects, such as opening up, avoiding misunderstandings, working better as a team in general, and being more content with your work situation. Making sure that newly joined team members are welcomed and get the social on-boarding that they need is crucial, especially since such a large amount of practitioners seem to have changed workplace or team this past year. If possible they should meet their colleagues, and especially team members, in person, as also discussed in [33]. Completely new teams formed during the pandemic do not seem to have the same issues, which could be due to that everyone has been exposed to the same challenge and/or developed a better understanding for each other's situation.

Another interesting aspect, which is also discussed in [47], is that conflicts and disagreements in teams do not seem to have substantially increased now, compared to before the pandemic. This is found to be interesting since a substantial number of practitioners actually have changed teams during the pandemic. The fact that conflicts and disagreements have not increased, can partly be explained by the fact that there is a reluctance to bringing up sensitive conversations digitally. It can also be explained by the fact that many practitioners believe that remote work is only temporary, and therefore put these conversations on hold until they are back in the office. Considering the challenges with digital communication, and the fact that many practitioners have changed teams during the pandemic, it would not have been surprising if conflicts and disagreements actually had increased. As first introduced by [68], a new group usually go through four phases - Forming, Storming, Norming and Performing - until they can perform at their very best. Storming is a phase where many conflicts within a group appear, and it is important to go through this phase in order to move on, and eventually perform as a group [68]. However, as this study does not show on any substantial increase of conflicts and disagreements, this can be a warning signal that many groups have not gone through all of these phases, which means that they have not matured enough to perform at their very best. Additionally, this could lead to that more conflicts and issues arise when the team do start to work together onsite again. To make room for and address a group maturing dept, as also suggested by [48], is of out most importance even now, but especially when teams do go back into the office.

7
Threats to Validity

One of the main advantages of conducting a mixed method study is the ability to address the validity concerns of one research method by another. To avoid potential threats that may arise as a result of using an explanatory sequential design, we have addressed the recommendations provided by [69]. Findings could be compromised and invalidated if all quantitative results have not been considered before deciding on what data to follow up on, and "by drawing on different samples for each phase of the study" [69]. We addressed these threats by not only looking into the significant results of the Bayesian analysis of the questionnaire, but also by looking at the non-significant results as well as the answers to the open questions before we designed the interview protocol. Also, as several of the interviewees had participated in the questionnaire, the sample of interviewees could be argued to be representative enough, given that convenience sampling was used for both phases of the study.

One threat to validity concerns the design of the questionnaire. A poor design might lead to a misunderstanding of the intent and content of the topic [70]. Regarding conclusion validity, it is not possible to exclude the possibility that the respondents misunderstood the questions [70]. These threats were minimized by conducting two iterations of pilot studies to reduce the room of misinterpretation of the questions [70]. Both iterations aimed to collect feedback regarding the clarity and content of the questions in the questionnaire. After each iteration, we took action upon the feedback and addressed the adjustments suggested.

As the majority of the questions of the questionnaire were of a seven point Likert-item format, it is possible that respondents did not notice minor changes in the scales, for example, changing the range from decrease/increase to less often/more often. To minimize this risk, our scales were always formatted in the same direction, that is, left as negative and right as positive. Additionally, we also included other types of questions besides the Likert-item questions, open-ended and closed-ended, to include variation and capture other ideas that the respondents might have had.

Another threat that may affect how respondents answer a questionnaire is that they answer based on a preconceived knowledge of what the study aims to conclude, if any potential hypotheses have been exposed [71]. In our case, when we promoted and distributed the questionnaire, we only provided general information about the aim of the study, that is, that we are investigating the COVID-19 pandemic's impact on agile software development. Based on the fact that this general information is neutral, potential hypotheses, such as that productivity might have decreased, are

not easy to deduce from the questionnaire or from the general information provided. In addition, questions in the questionnaire were phrased in neutral manner.

Both regarding the questionnaire and the interviews, there is a risk that practitioners may not share their opinions or answer truthfully, as discussed in [72], and thus making the results biased. To minimize this risk, we guaranteed complete anonymity and confidentiality to all participants of the study [73], that is, both to respondents of the questionnaire and to interviewees. Additionally, regarding the interviews, by having short interviews (all lasted between 30-45 minutes) in one work session, we have minimized a potential maturation threat [71].

When conducting interviews, there is a risk of collecting incorrect data, as discussed in [73], due to remembering things incorrectly or due to misunderstandings. We have minimized the risk of not remembering things correctly by recording the audio of all interviews so that we can go back and listen to what they actually said. Furthermore, we have minimized the risks of misunderstandings by sending out the summaries of the interviews to each interviewee respectively, for validation. We got feedback from six out of seven interviewees, and we adjusted the feedback accordingly.

There is also a threat to validity based on selection bias and convenience sampling. In our case, we have addressed this risk by collecting data from a diverse sample. For example, we have not only targeted practitioners from dedicated agile online forums, but also from our personal private network. This means that we have collected opinions of different practitioners with different backgrounds, which is confirmed by the data that reveal that there is indeed a diverse set of participants in our study. More specifically regarding the interviewees, we targeted a diverse sample of practitioners and interviewed at least one practitioner from each category of roles, regarding selection bias [73]. However, the final sample might not be representative for a global population of all agile software development practitioners, due to the fact that most of the respondents were from Europe, and all but one interviewee were from Sweden.

In general, to improve the reliability of the interviews, two researchers have been present during all interviews [73]. We followed an interview protocol to make sure that all relevant aspects were covered. Additionally, the researcher who took notes supported the interview lead by also asking questions when relevant.

8

Conclusion

The purpose of this study was to investigate how the COVID-19 pandemic has impacted agile software development and its practitioners, in terms of employment of agile development, ways of working, and the effect of recommended and enforced remote work due to social restrictions. The study used a mixed methods approach and an explanatory sequential design, and consisted of two research phases. First, using a questionnaire, we collected both open-ended and closed-ended responses from 96 industry practitioners, and analyzed the quantitative data using Bayesian analysis, which resulted in a total of four significant predictors, and 31 significant effects for 29 different outcomes. The most prominent significant predictor was whether a practitioner feels forced to work remotely, which was significant for, for example, productivity, well-being, meeting frequency, and communication quality. In the second phase, we followed up on the results by conducting semi-structured interviews with seven industry practitioners. Thereafter, data from both the questionnaire and the interviews were analyzed together in order to answer our research questions. The outcome of this study fulfills its purpose, contributing to a deeper understanding of how how agile software development and its practitioners have been affected by approximately one year of recommended and enforced remote work due to social restrictions, and the findings confirm that feeling forced to work remotely has a significant impact on practitioners and their ways of working

8.1 COVID-19's impact on ASD

The COVID-19 pandemic, and the recommended and enforced remote work that was imposed due to social restrictions, have impacted agile software development and its practitioners' employment of agile development and ways of working (RQ1). One of the main findings of this study is that the pandemic's impact on agile software development confirms the importance of the agile value "individuals and interactions over processes and tools" [28]. Technical processes and tools work as well in a remote setting as in physical one, but without physical social interactions, practitioners find it difficult to work together in an efficient way. However, despite the challenges experienced during the pandemic, several practitioners have become more positive towards remote work, and many would like to work in a hybrid model in the future. Although, as it has become evident that social interactions play a critical part in practitioners' work, and that many practitioners prefer all-onsite or all-remote regarding meetings, it is essential that agile practitioners consider what works best for

their teams regarding future work arrangements. Practitioners should consider how to reap both the benefits of remote work and the value of working closely together. In order to manage effective communication and meetings, and to maintain social relationships, all of the team members of a practitioner's team should work together in the office at the same time for such particular purposes, but work remotely when there is less need of social interaction to collaborate in an efficient way. However, it is important that the coordination is managed with care, since there is a risk that the benefits get reduced if practitioners loose their freedom and feel a need to putting the needs of others over themselves.

8.1.1 Employment of agile development and ways of working

Regarding practitioners' employment of agile development and ways of working (RQ1.1), the most prominent aspects concern three agile practices, in particular, and the adjustment to digital communication. Stand up meeting, retrospective, and pair programming have been three especially important agile practices during the pandemic, since practitioners have used these practices to address the lack of social interaction. Practitioners have missed the social nature of being around other people, and the stand up meeting has been one of the very few moments when they do see and talk to each other. The retrospective has served as time and place to discuss how they are doing, both professionally and mentally, and by doing pair programming, they have been able to both socialize and create knowledge sharing. Doing pair programming has even been suggested as being especially important for new team members. The transition to digital communication has resulted in a lower communication quality but also in that practitioners have reflected more on what and when to communicate and approach their colleagues, as some practitioners do not communicate and open up as easily in a remote setting as in the office. The remote work mindset in combination with less psychological safety and new team constellations during the pandemic, might lead to major consequences once back in office. As conflicts have not increased despite a substantial increase of misunderstandings, there is a risk that practitioners' teams have not matured during the pandemic and that the discussions that they have postponed will explode when they are back in office.

8.1.2 Impact of recommended or enforced remote work

The recommended and enforced remote work due to social restrictions have affected practitioners in many different ways (RQ1.2). However, it is not the reason per se that has had a major impact, but rather the aspect of feeling forced to work remotely. The findings of this study show that feeling forced to work remotely has had a significant impact on many different aspects of agile software development regarding, for example, productivity, well-being, communication, and meetings. A lower productivity, well-being, and communication quality, and a higher meeting frequency are all examples of significant effects for a practitioner who feels forced to work remotely.

8.2 Future Work

In the future, several aspects related to the results of this study would be interesting to investigate further.

Regarding teamwork, this study shows that different team members have experienced the transition differently and have different attitudes to remote work now, and in the future. It would be interesting to evaluate the different experiences of the individuals in a team during similar circumstances and investigate what factors that make their experiences differ. Similarly, this study shows that personality and behaviour of practitioners have changed since the beginning of the pandemic, and more research is needed regarding what different needs different personalities have regarding their workplace, both socially and physically.

One forthcoming situation for many practitioners is the return to an onsite work environment. Based on this study, we know that feeling forced to work remotely affects many aspects of agile software development. However, we have also seen that several practitioners actually feel forced to go to the office, during the pandemic. It would therefore be interesting to investigate practitioners' feelings regarding where they have to work when the COVID-19 pandemic and social restrictions are over, and if the forced feeling still has an impact on agile software development outside of this context.

Additionally, we have seen the challenges of joining a new team with social restrictions during the COVID-19 pandemic. It has become evident that there is a need for practitioners to have guidelines for how to build virtual teams effectively, both with and without social restrictions. More research regarding this and how to address the needs of psychological safety in order to give the practitioners the environment they need virtually, is needed. Especially since many practitioners will continue to work remotely even after social restrictions are gone, and potentially even in different parts of the world where weekly in person interactions still are not possible.

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A

Appendix 1

A.1 Questions in the Questionnaire

Table A.1: The list of all 28 questions used in the questionnaire.

Number	Question
Q1	To which gender identity do you identify the most?
Q2	What is your team size (including yourself)?
Q3	Are you a part of the same team now, as you were before the pandemic?
Q4	Which domain does your company primarily operate in?
Q5	Which continent are you personally located in when working, now?
Q6	What role do you mainly work in?
Q7	Roughly, how many years of experience with Agile Software Development do you have?
Q8	Which development methodology do you mainly follow in your team/work now?
Q9	Please choose the option that best described you before the pandemic.
Q10	Please choose the option that best describes you now.
Q11	What is the primary reason you are working remotely?
Q12	Please choose the option that best describes your perception for the following statement.
Q13	How challenging do you find the following practices now, compared to before the pandemic?
Q14	If there is a practice you do not take part in anymore or that you have started to use, due to the pandemic, please describe why.
Q15	Is there a practice/activity that you find particularly important for Agile Software Development now during the pandemic? Please describe what practice and why.
Q16	Please choose the option that best describes your perception of the following statement.
Q17	Please fill in to what extent you agree with the following statements.
Q18	Compared to before the pandemic, in general, how much time do you spend on the following activities now?
Q19	Compared to before the pandemic, how would you rate the following aspects regarding your well-being now?

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Table A.1 – continued from previous page

Number	Question
Q20	Compared to before the pandemic, to what extent would you rate the following statements now?
Q21	Compared to before the pandemic, how would you rate the following aspects regarding the meetings you have now?
Q22	Compared to before the pandemic, how has the frequency of the following activities changed, now?
Q23	Compared to before the pandemic, how often do you do the following at work now?
Q24	Compared to before the pandemic, how would you rate the following aspects regarding the communication you have now?
Q25	Anything you would like to add regarding your communication now during the pandemic?
Q26	Compared to before the pandemic, how would you rate the following aspects regarding your team now?
Q27	Anything you would like to add regarding you and your team now, considering the COVID-19 pandemic?
Q28	Is there anything else you would like to add regarding how the COVID-19 pandemic has affected agile software development, or that you would like to share?

B

Appendix 2

B.1 Interview Protocol

Forced way of working
1. How did you experience the transition to remote work?

2. How do you look at the situation now? Does it differ from your view at the beginning of the pandemic?

3. Are there any good things about your work situation now?

4. Are there some less good things about your work situation now?

Agile Practices
5. Are there any practices that you find less or more challenging now, compared to before the pandemic?

6. What practices did you abandon or started to use after the beginning of the pandemic?

7. Is there a practice or activity that is more important now than before the pandemic?

8. What agile practices do you use?

Communication & Meetings
9. If you consider the overall communication you have with your team, customers, etc. Have you experienced any changes in how you communicate?

10. Have you experienced any changes in how your meetings are done now compared to before the pandemic?

Productivity & Performance
11. Do you believe that your productivity has changed, because of the pandemic?

12. Have you been able to accomplish the same work results now as before the pandemic? Can you perform the same results?

Work environment
13. What has changed in your work environment, and what do you think about it?

Team
14. If you consider how your team works together now compared to before the pandemic, are there any differences in how you work as a team? How do you collaborate?

C
Appendix 3

C.1 Effects on Outcomes

Table C.1: The 29 outcomes with significant predictors and their tendencies.

Outcome	Significant Predictor(s)	Direction	Tendencies
Q13_1_1_3L	Q12	+	Q6(+) Q1(+)
Q13_2_1_3L	Q3	+	Q4(+) Q2(-) Q12(+)
Q13_3_1_3L	Q3	+	Q4(+) Q11(-) Q2(-)
Q13_4_1_3L	Q3	+	Q6(+) Q12(+)
Q13_15_1_3L	Q12	+	Q3(+)
Q13_19_1_3L	Q12	+	Q3(+)
Q16_1_7L	Q12	-	Q10(+) Q7(+) Q3(-) Q2(+)
Q17_1_1_7L	Q12	-	Q10(+) Q7(+) Q3(-) Q2(+) Q1(+)
Q17_2_1_7L	Q12	-	Q10(+) Q7(+)
Q17_4_1_7L	Q12	-	Q2(-) Q3(-) Q4(+) Q10(+)

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Table C.1 – continued from previous page

Outcome	Significant Predictor(s)	Direction	Tendencies
Q17_5_1_7L	Q12	-	Q10(+) Q7(+) Q3(-)
Q17_6_1_7L	Q12	-	Q11(-) Q3(-) Q2(-)
Q18_10_1_7L	Q12	+	Q6(+) Q2(+)
Q18_13_1_7L	Q11	+	Q3(+) Q12(-) Q9(+)
Q19_1_1_7L	Q12	-	Q10(+) Q7(+) Q4(-) Q3(-)
Q19_4_1_7L	Q12	-	Q10(+) Q7(+) Q6(-) Q3(-)
Q19_5_1_7L	Q12	-	Q11(+) Q5(-) Q1(+)
Q20_1_1_7L	Q12	-	Q11(-)
Q20_2_1_7L	Q11 Q12	- +	Q3(+)
Q21_1_1_7L	Q12 Q3	- -	Q4(+)
Q21_2_1_7L	Q12	+	Q1(-)
Q21_7_1_7L	Q12	-	Q10(-)
Q22_3_1_7L	Q12	-	Q7(+) Q4(-) Q2(-) Q1(+)
Q22_10_1_7L	Q12	-	Q6(-) Q3(-)
Q23_2_1_7L	Q12	+	Q9(-) Q7(-) Q1(-)
Q23_3_1_7L	Q6	+	Q12(-) Q7(+)
Q24_1_1_7L	Q12	-	Q6(-)

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Table C.1 – continued from previous page

Outcome	**Significant Predictor(s)**	**Direction**	**Tendencies**
Q24_3_1_7L	Q11	-	Q12(+) Q9(+)
Q26_1_1_7L	Q12	-	Q10(+) Q4(-) Q3(-)