Perception of Agile Teams About Home Office During the Covid-19

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Abstract: Due to the COVID-19 pandemic, there was a massive migration from working in the office to working from home (WFH) and the software development teams had to adapt to the new reality. This paper focused on how the agile teams dealt with the challenges of WFH and how this affected the software development process. To capture the perceptions of the agile teams, we carried out a survey that investigated the following aspects of WFH: work routine, collaboration, communication, productivity, transparency, challenges, and the software development process itself. The survey received 127 valid responses from agile team members and the results revealed that i) most of the members of agile teams considered the work continued as usual regardless of the place (office or remote); ii) 80% of members of agile teams mentioned an increase in productivity during WFH; iii) 85% of participants are using Scrum as management strategy; iv) communication between teams members during the remote working model was perceived as more effective; v) Microsoft Teams and Google Meets were the most used interactions tools by members of agile teams.

1 INTRODUCTION

In early 2020, with the global COVID-19 pandemic, software development teams were forced to migrate to working from home (WFH). On a global scale, the WFH radically changed the way of producing software and brought several challenges for project management and software development teams to carry on their duties (de Mendonça et al., 2020). Among the various challenges of working from home, agile teams faced other challenges such as communication, collaboration, transparency, and productivity (Ozkan et al., 2022).

According to the State of Agile Report (digital.ai, 2021), in 2021, 94% of companies surveyed use agile development methods, and 52% of respondents stated that agile methods are used in more than half of their teams. This report also indicates that remote workers have increased yearly, and those numbers increased dramatically during the pandemic. In addition, only 3% of workers plan to return to face-to-face work, and 96% of workers who started working remotely due to the pandemic want to continue working remotely.

Ozkan et al. (Ozkan et al., 2022) ratified that agile software development has generated interest due to the growing demands of various types of organizations. Furthermore, the State of Agile Report (digital.ai, 2021) added that "in response to the pandemic, organizations are accelerating the adoption of new processes, practices, and technologies to support changes to product and service delivery". Considering this context, several works were carried out to identify the personal and team impacts, changes in culture and productivity, and the advantages and disadvantages of WFH concerning agile teams (Marek et al., 2021; Neumann et al., 2021; Butt et al., 2021).

In this research, we investigate the perception of agile teams regarding WFH during the COVID-19 pandemic through a survey that approaches aspects related to productivity, interaction, transparency, collaboration, and communication of agile teams

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during WFH. These are considered the principles of agile methods, and investigating how they were used is essential to understand the agile process during WFH. In addition, we mapped the challenges and issues mentioned by agile teams, as well as possible solutions related to these principles suggested by them.

Our main findings reveal that: (i) for most agile teams, their productivity improved positively during the WFH; (ii) the interaction between Information and Communication Technology (ICT) and the business area improved with the WFH; and (iii) most agile teams stated that collaboration between members of agile software development teams has improved with the adoption of remote work with the majority of the agile teams pointing to the use of Microsoft Teams and Google Meets to carry out discussions on team activities.

2 RELATED WORKS

2.1 Agile Teams

Demir et al. (Demir et al., 2021) defined agile teams as the ability of a team to remain flexible in facing the inherent dynamism of a task, continually adjusting the team's behavior at the same time that develops new ones to adapt to unpredictable changes in the environment. In the context of our study, focusing on teams working with agile software development, we adapted this concept to "the ability of a team to remain flexible in facing the inherent dynamism of a task, adjusting the team's behavior continuously or developing new ones to adapt to unpredictable changes in the environment, working in the context of agile software development".

Agile methodologies provide a competitive and dynamic approach to development processes in software engineering. As a result, more and more software specification and development methods are being replaced by the principles and values announced in the Agile Manifesto (Beck et al., 2001). Thus, many methodologies and tools were developed to support agile software development since it became mainstream (Kropp et al., 2017)). This evolution of methods occurs to obtain faster results and add greater value to organizations, through a process in which the principles of collaboration, communication, interaction, and transparency are essential.

Calefato et al. (Calefato and Ebert, 2019) stated that "collaboration is strategic to distributed agile teams, and appropriate tool support is the only way

to do this efficiently". This led us to infer that during the pandemic, when all development was carried out through WFH, collaboration and the tools adopted to implement it became even more critical in this process. Alzoubi et al. (Alzoubi and Gill, 2021) stated that agile software development considers individuals and interaction the highest priority. According to Demir et al. (Demir et al., 2021) , interactions between team members are a dimension of team agility that is crucial for good performance in a dynamic task environment. According to these authors, the relationship between complex interactive team behaviors and team performance has been studied, considering different aspects such as communication, coordination, and trust.

Alzoubi et al. (Alzoubi and Gill, 2021) conducted a survey with 53 participants and identified the most common communication challenges: organizational factors, team configuration, human factors, and distance difference. In a previous work, Alzoubi et al. (Alzoubi et al., 2016), based on a systematic literature review of 799 papers, had already identified communication challenges of geographically distributed teams that develop software using agile practices.

Ciancarini et al. (Ciancarini et al., 2021) identified communication as a key challenge in agile teams. The authors conducted interview sessions with 30 IT practitioners from 20 companies and identified challenges such as the lack of a standard information model for requirements-related activities and the large number of customers leading to too diverse and controversial requirements. This finding allows us to infer that, regardless of the research, most authors recognize the importance of communication and interaction between agile teams.

In the context of transparency, Kautz et al. (Kautz et al., 2016) stated that the transparency of the process refers to one of the areas that distinguish agile methods from other development processes. Agile methods only work as intended if the entire process is, at all times, transparent, both in the sense of clarity and openness and visibility for all people involved, including leadership roles, developers, and stakeholders. The authors identified factors that can interfere with transparency, such as task status and overview, team collaboration, estimate credibility, estimation process, and customer involvement. Given this scenario, the principles that guide agile models need to be investigated, as it is essential to understand how agile teams adapted their work routines during the COVID-19 pandemic. Furthermore, the investigation must cover all the challenges and opportunities for improvement

identified in the context of the WFH.

2.2 Software Development and WFH

The practice of WFH already existed before the COVID-19 pandemic. According to Ozkan et al. (Ozkan et al., 2022), even before the pandemic, there were hybrid teams, where a part of the team members worked in the organization's office while another part in remote locations, such as their own home, universities or co-location offices. This is particularly true in software development with distributed teams, off-shore software, and global or geographically distributed teams. Due to the COVID-19 pandemic, many employees from the most varied types of organizations migrated from the face-to-face model to WFH. Often, this happened abruptly and forcedly, without planning, knowledge, or studies to guarantee a good product delivery or quality of life for team members. The massive volume of individuals in the WFH has generated many new research topics to explore.

Focusing on the physical and mental health of teams, Butler et al. (Butler and Jaffe, 2021) conducted a study with 435 Microsoft software engineers based on the first ten weeks of WFH. The authors identified that the most significant challenges were the high number of meetings, the feeling of work overload, and the maintenance of the mental and physical health of the teams. However, the authors concluded that the team could mitigate existing challenges in the WFH as long as they were known and addressed. The authors also identified the need to amplify feelings of gratitude in team members to improve mood and well-being during the pandemic period.

Uddin et al. (Uddin et al., 2022) analyzed the discussions in the devRant online forum during the first months of the COVID-19 pandemic. This forum enables discussions to be open and not linked to predefined research questionnaires. The authors grouped discussions into six categories: i) aspects related to the workplace; ii) personal and family well-being; iii) technical aspects; iv) preparation for confinement; v) financial concerns; vi) social and educational concerns. The authors identified that around 49 % of the discussions were negative and 26 % were positive. In addition, on the part of software developers, they found evidence of problems related to the lack of documentation for working remotely and the sense of loneliness during WFH.

Ralph et al. (Ralph et al., 2020b) conducted a survey with 2,225 respondents from 53 countries and identified that the pandemic harmed the well-being

of developers, also noting that productivity and well-being are closely related. The authors also identified that pandemic-related fear and home office ergonomics could affect well-being or productivity. In addition, they concluded that women, people with children, and people with disabilities could be disproportionately affected and that different types of support are needed according to people's profiles. Finally, the authors highlighted that the ergonomics of home offices must be improved to improve employee productivity.

In the context of productivity, Bao et al. (Bao et al., 2020) collected approximately four thousand records of 139 activities from developers of a Chinese organization during 138 working days. The authors identified that working from home impacts projects according to their characteristics, such as programming language, project type, duration, and size. Similarly, Miller et al. (Miller et al., 2021) collected 2,265 responses from developers of a large US organization, and identified the following challenges in WFH: reduced skill, interaction, increased meeting frequency, and decreased social interaction with outsiders. On the other hand, the benefits were: increased inclusion of all team members; increased empathy for other team members, including increased empathy for remote teammates prior to COVID-19; increased bonding in the team; and greater awareness of domestic challenges.

In Brazil, Jr. et al. (Jr. et al., 2020) investigated the impact of social isolation on the productivity of 413 software developers. Regarding productivity, 53.27% of developers stated that their productivity has increased due to less stress, less wasted time commuting to work, and fewer interruptions. As disadvantages of WFH, the developers mentioned the increase in demand because of the dismissal of some colleagues and fear of losing contracts, among others. The communication tools most used by developers were WhatsApp, Google Hangouts, Google Meet, Microsoft Teams, and Zoom.

Bezerra et al. (Bezerra et al., 2020) carried out a survey with 58 participants from Brazil and found that 74% of the participants considered that their productivity remained good or excellent during the WFH, and 84.5% felt motivated and had easy communication with their co-workers. The authors identified external disruption, adaptation to the environment, and emotional issues as the main factors influencing productivity. Castro et al. (Castro and Moreira, 2021) investigated the effects of COVID-19 in the context of existing social inequalities in Brazil and identified that remote work had a negative effect

and widened existing inequalities, i.e., WFH favored the richest, most educated, and formalized workers and imposed on other workers the need to choose between employment and income versus the risk of contagion.

Marek et al. (Marek et al., 2021) investigated the impact of COVID-19 pandemic on agile software development teams (ASDT) and what tools and metrics they used. The authors conducted a survey with 120 software engineers from several countries in Europe, Asia and the USA. The findings indicated that the work of the ASDTs was not significantly impacted by the pandemic, as most ASDTs had experience working remotely. Furthermore, the results indicated that the pandemic did not impact the product backlog or vision. Additionally, most ASDTs have not changed their definition of ready and release frequency, indicating that the pace and quality of work have not changed during the pandemic.

Neumann et al. (Neumann et al., 2021) examined the effects of the COVID-19 pandemic on agile software development in Germany. The authors carried out multiple case studies in 3 companies. The results showed that most teams did not decrease their productivity. Instead, the authors identified increased transparency of the process, working time is used more efficiently, and optimized integration of the product owner. Furthermore, according to the authors, communication became more objective and efficient, and there were some changes in the agile process, such as the daily stand-up meeting (Daily Scrum), which started to be carried out daily in the team to increase synchronization.

In Pakistan, in a survey that contradicts most of the findings of other surveys, Butt et al. (Butt et al., 2021) surveyed 250 developers from 10 software industries to determine the reasons for the failure of agile methodology during the COVID-19 pandemic. The authors identified a negative impact in 82% of companies, which reduced the influence of agile. According to the authors, there was a big drop in the productivity of agile teams compared to other teams that use another development methodology.

Bezerra et al. (Bezerra et al., 2021) investigated how software development teams in Brazil dealt with WFH after one year of pandemic. The research collected data from 67 development team participants and investigated aspects such as work routine, collaboration, communication, productivity, financial assistance, and the software development process. The authors identified that more than 56% of the participants had work overload and exceeded their working hours. However, more than 92% considered the team collaborative and 82% are

satisfied with the communication between team members. In terms of productivity, 59.7% stated that they had an improvement in productivity, and 75% are satisfied with their productivity. Santos et al. (de Souza Santos and Ralph, 2022) also investigated the impact of WFH on software development. The authors identified that WFH fundamentally altered coordination within software teams. According to the authors, poor coordination can lead to numerous problems, including misunderstandings, requests for help, lower job satisfaction among team members, and poorly defined tasks.

Mendonça et al. (de Mendonça et al., 2020) presented an experience report of a case study and conducted interviews with participants of a research and development project on the transition to WFH. The main changes identified were changes to the software scope, development procedures, communication with stakeholders, and project management. In addition, the authors concluded that there was no impact on team productivity. However, the team began working different working hours than before the pandemic. For example, a series of contributions were made during weekends, which allowed us to infer that the team works best during unusual working hours and without wasting time commuting.

3 STUDY SETTINGS

In order to define the research questions and objectives, we conducted an exploratory focus group with three ICT practitioners. All participants have more than 15 years of experience in agile software development. The objective of the focal group was to identify which principles related to agile methods we would research and which aspects were important during the WFH.

We also used, as a base, previous studies that investigated productivity and other aspects according to the perception of software development teams and worldwide during the WFH (Bezerra et al., 2020),(Jr. et al., 2020), (Ralph et al., 2020a) and the guidelines proposed by Molléri et al. (Molléri et al., 2020). Furthermore, we analyzed the main features related to agile models considering previous studies Agile Manifesto (Beck et al., 2001), Calefato et al. (Calefato and Ebert, 2019), Alzoubi et al. (Alzoubi and Gill, 2021), Ciancarini et al. (Ciancarini et al., 2021) and kautz et al. (Kautz et al., 2016).

In this way, some principles were identified (interaction, collaboration, communication) and some other aspects such as productivity and important tools

to be investigated in the context of agile models during the WFH. We investigated which tools were adopted by agile teams to carry out interaction, transparency (understanding what needs to be done and what is being done by teams), communication between teams, and collaboration. In addition, we investigated the impediments or problems faced in adopting the WFH and the challenges, solutions, and proposals to mitigate or improve the work process. Therefore, this research aims to investigate the perception of agile teams about working from home during the two years of the COVID-19 pandemic. For this, we conducted a survey study comprising the following research questions:

RQ.1: What is the perception of agile teams related to productivity, interaction, collaboration, and communication during working from home scenario?

RQ.2: What are the tools used by agile teams during working from home?

RQ.3: What are the challenges faced by agile teams during working from home and how were they solved or mitigated?

3.1 Survey Design

After the focus group and studies, the survey was then developed iteratively. The survey was divided into two parts, demographic questions, and questions related to work routines. The survey included traditional demographic variables (i.e., place of operation, age, level of training, experience, and functions performed) and questions related to the respondent's perception of productivity, communication, interaction, transparency, and collaboration. Survey also works with open and closed questions to improve construct validity. A construct is a concept that should not be measured directly. Open and closed constructs were used regarding the perception of communication, interaction, transparency, and productivity. On the other hand, the age, the level of training, and the experience are all measurable directly, so they were verified from the closed questions. Direct measures have inherent validity, but variables related to constructs should be more validated to ensure they measure the right properties (Ralph and Tempero, 2018). In total, the survey has 33 questions (17 closed questions and 16 open questions). All survey questions are available in our supplementary material (Canedo et al., 2022).

We validated the survey through a pilot with 4 ICT practitioners working in different software development teams. The survey questions were refined according to their feedback, and the answers were discarded from the data analysis. The survey initially presented to the participants the description of the research objectives, aiming to remove practitioners who did not meet the desired criteria, that is, practitioners who did not work in agile teams during the pandemic period. In addition, the survey contains a question trying to identify how the practitioner worked during the pandemic. Thus, ICT practitioners who reported not having WFH due to COVID-19 were also excluded from the research.

In data analysis, we performed Cronbach Alpha statistical analyses (Christmann and Aelst, 2006) to calculate reliability (i.e., the stability of the responses), correlating the responses given by the participants. Moreover, we performed the coding of open questions using Grounded Theory. According to Martin and Turney (Martin and Turney, 1986), Grounded Theory is a method's ability to fit with different types of researchers and provides a method that enables a researcher to adduce true meaning and understanding.

4 SURVEY RESULTS

The survey was conducted anonymously, and no personally identifiable information was collected. We shared the survey on mailing lists and IT social networks for recruiting participants. We sent the online survey to several ICT practitioners in our social networks and asked them to share it with members of their development teams. Before participating in the survey, participants read and accepted the consent form. The survey was distributed from January until March 2022. In addition, we invited several IT practitioners to participate in the survey via email. The survey was advertised as a general survey on ICT practitioners' perception of aspects of the WFH during the Covid 19 pandemic, considering agile teams.

We was answered by 132 practitioners who work in agile teams. The responses of 5 participants were excluded from the data analysis because they answered that they did not work from home. Therefore, we consider the answers of 127 practitioners. We initially asked questions related to the profile of the participants. The majority of the respondents of the survey were from Brazil, but we also had 3 responses from practitioners from Canada and Portugal. The survey responses can be seen in detail in our supplementary material (Canedo et al., 2022).

5% of the participants informed that they are under 21 years old. 16% are between 21 and 25

years old, 11% of participants are between 26 and 30 years old, 13% are between 31 and 35 years old, 16% are between 36 and 40 years old, 21% between 41 and 45 years old, 8% are between 46 and 50 years old, 6% are between 51 and 55 years old, 3% are between 56 and 60 years old. Only one participant reported being over 60 years old (1%), as shown in Figure 1. Regarding their educational level, 14% of participants are undergraduate students, 22% are graduates, 41% are master's students, 21% have a master's degree, 1% are Ph.D. students, and 2% have a Ph.D, as shown in Figure 2.
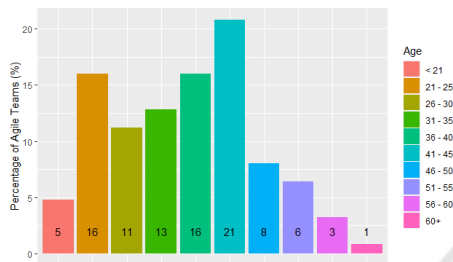

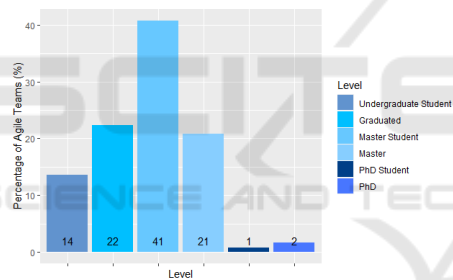Figure 1: Age of the respondents.

Figure 2: Educational level of the respondents.

15% of participants reported having between 1 and 3 years of experience in the ICT area, 15% have between 4 and 6 years, 10% between 7 and 10 years, 15% between 11 and 15 years, 15% between 16 and 20 years old, and 30% of the participants claimed to have more than 20 years of experience, as shown in Figure 3. Regarding the area of activity of the organization in which the participant acts or acted in a software development project, 6% agile teams stated that they work in companies of the state public administration, 30% work in the federal public administration, 47% work in private software development companies and 17% of the participants work in collaboration/research projects.

51% of the participants stated that they work or worked as a developer in the software projects they work on, 42% of them work as a project manager, 32% as a requirements analyst, 28% as a software engineer, 23% perform data modeling
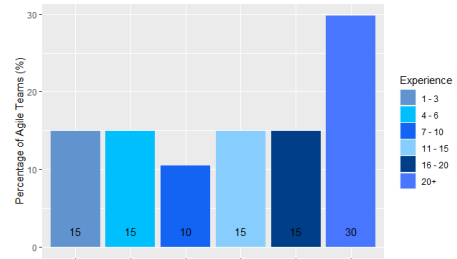

Figure 3: Working experience in years of the respondents.

activities, 14% work as a software tester, 10% as a designer (Interaction Designer, UX Designer), and 2% of them work as a specialist in human-computer interaction, as shown in Figure 4. In relation to
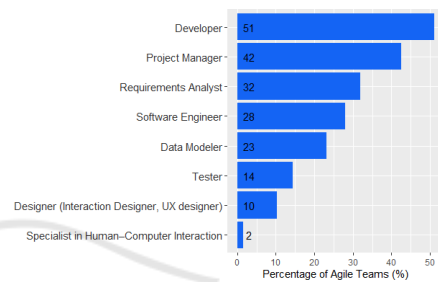

Figure 4: Role in the organization.

maintaining activities during the pandemic, 71% of the participants reported that their workplace was closed, but activities fully continued in remote mode; 28% of them reported that their workplace was partially closed, and activities fully continued in the hybrid modality (remote and face-to-face); 7% of participants reported that their workplace was closed, but activities partially continued in remote mode.

In relation to agile methodology, Scrum is the most widely used, 86% of the participants claimed to use it, 36% use Kanban, 14% use Scrumban, and 8% claimed to use XP. This finding is similar to other studies, in which Scrum was also the most widely used methodology by participants of the Surveys (digital.ai, 2021), (Canedo et al., 2021). In addition, we highlight that (Lase et al., 2022) conducted research to investigate the effectiveness of the use of Scrum in a distributed software development environment during the COVID-19 pandemic. The authors identified a number of success factors in the use of SCRUM and these factors may be contributing to the increased adoption of Scrum by Agile Teams.

4.1 RQ.1

According to 82% of participants, this pandemic imposed an adaptation in the way of working and WFH positively affected their productivity, 11%

stated that this adaptation did not affect productivity, and 6% of them stated that it negatively affected their productivity.

These findings confirm the findings of Oliveira et al. (Jr. et al., 2020) where 53.27% of developers said their productivity increased and Bezerra et al. (Bezerra et al., 2020) that identified that for 74% of the research participants, productivity remained good or excellent during the WFH. Ralph et al. (Ralph et al., 2020a) identified strong correlation between well-being and productivity. Among the reasons mentioned by the participants for having positively affected their productivity, we ratify the findings of Ralph et al. (Ralph et al., 2020a) regarding well-being and productivity and we also add aspects related to displacement, and behavioral aspects (focus, stress, motivation and information sharing) as variables that can also impact productivity during WFH.

Aspects Related to Displacement vs Productivity Increase:

"The traffic and the poor quality of public transportation impose such a great strain that only this fact has already given a great advantage to remote work".

"The lack of concerns, stress and loss of time with traffic contributed a lot to the well-being, and also to perform work activities outside the conventional schedule (8am to 6pm)."

"Now I arrive at work in the state 100% productive, before I had to slow down because of the shift to work and heavy traffic, which greatly increased the level of stress."

"[...] the time available for the work was longer and the breaks made during the activities were of better quality, thus allowing greater productivity".

Aspects Related to Well-being (Noise Free and Comfortability) vs Productivity Increase:

"...I can work quietly and with less pressure, delivering more."

"Being at home, comfortable and establishing one's own routine were differentiated factors to achieve better productivity".

"The remote working model allowed me to work in an environment that I feel more comfortable, allied to this model I also had my work schedule relaxed. .."

Aspects Related to Behavior (Focus, Stress, Motivation And Information Sharing) vs Productivity Increase:

"WFH allows more focus, avoids distractions and increases availability for the company. Higher quality of life. Work with less stress and greater productivity."

"Greater focus on work, fewer distraction problems. Use of remote communication tools. I believe that has greatly improved my contributions in software development, ... so the activities are performed perfectly!"

"The communication between the various areas of the organization has improved a lot, now it's easy to set up a meeting room with multiple teams sharing and solving the problem in real time. Before, I had to set up a meeting or make a phone call, explain the problem. Often it was necessary to go to the other team's room to try to solve some problem. .. Now we can focus on activities and suffer fewer interruptions during work, which leaves us more focused on activities."

Some aspects mentioned that negatively affected the productivity of agile teams were the higher demand, having to work after they were supposed and household tasks. We highlight some of these transcripts below:

"Lower queue control than previously happened in face-to-face, we now have more demand and more individual collection of plaintiffs who fail to realize that you are already busy."

"Displacement time was better spent with professional activities. However, demands and activities were also carried out during lunch hours and outside of working hours, as we lost track of time and worked much more hours."

"Conciliating domestic chores and caring for children have greatly affected my productivity."

"I needed to reinvent myself, and to live with my concentration problems that I didn't have or noticed at work. I learned to organize my hours and to separate hours of domestic work and hours of domestic work."

Considering the principles studied in this research, the following answers were identified:

Regarding the interaction between the ICT area and the business area has improved with the adoption of remote work, 66% of participants strongly agree and agree, 28% were neutral, and 6% disagree (Figure 5 (Q13)). Concerning transparency, 58% of the participants strongly agree and agree, 34% were neutral, and 8% disagree (Figure 5 (Q16)). That transparency (understanding what needs to be done, what is being done, etc.) improved with the adoption of WFH.

Regarding the collaboration, 65% of the participants strongly agree and agree, 26% were neutral, and 9% disagree (Figure 5 (Q19)). That collaboration among development team members improved with the adoption of remote work. 59% of the participants strongly agree and agree. Regarding the communication 26% were neutral, and 14% disagree (Figure 5 (Q22)). That communication between the team became more effective with the adoption of remote work. 75% of the participants strongly agree and agree, 19% were neutral. Regarding productivity 6% disagree (Figure 5 (Q25)) that their agile team became more productive with the adoption of remote work. 60% of the participants strongly agree and agree, 30% were neutral, and 10% disagree (Figure 5 (Q28)) that impediments or problems were solved more quickly with the adoption of WFH.

The survey also allowed us to calculate the reliability of the responses, that is, the stability of the practitioners' responses, correlating the responses given by the participants with respect to the previously mentioned constructs (team productivity, interaction, transparency, collaboration, and communication). The answers provided information on the reliability of a scale for Cronbach's Alpha (Christmann and Aelst, 2006). It is understood that the internal consistency of a questionnaire is greater the closer to 1 is the statistical value. That is, coefficients close to 0 are undesirable since they indicate a low association. The positive values in the correlation matrix indicate that all the items analyzed (productivity, interaction, transparency, collaboration and communication) are correlated. The general Cronbach's Alpha was 0.8499, which is higher than the common benchmark of 0.7 (Table 1). The dispersion matrix presented in Table 1 also shows that most items have a linear and positive relationship, as shown in Table 1.

Figure 5: Level of agreement regarding the positive impact of WFH on interactions, transparency, collaboration, communication, productivity and problem solving, respectively.

Table 1: Correlation matrix (Pearson's Correlation Test).

	Productivity	Interaction	Transparency	Collaboration
Interaction	0.395			
Transparency	0.487	0.626		
Collaboration	0.566	0.479	0.558	
Communication	0.528	0.442	0.532	0.705

Regarding the open questions, we performed their coding using Grounded Theory (de Souza Santos and Ralph, 2022). We coded the open-ended survey responses iteratively and inductively, where two of the paper authors tabulated all responses and then compared all findings in agreement sessions with all authors to refine them. To come to an agreement, this process was repeated three times until all responses were encoded and tabulated on a final set of findings and the representative codes for it. In total, we found 4 categories: Information Sharing, Behavioral Change, Tools, and Productivity.

In the category Information Sharing, we obtained communication, transparency, and interaction subcategories. The Behavioral Change category we classify in the subcategories communication, transparency, interaction, and collaboration. The Tools category was classified into the subcategories communication, transparency, interaction, and collaboration. Finally, the Productivity category has no subcategories. The complete view of our coding result can be seen in our supplementary material (Canedo et al., 2022).

Based on this analysis, it is possible to infer that most of the responses of the behavioral change demonstrate that the productivity and the characteristics of communication, transparency, interaction, and collaboration have improved. We can cite the following: learn to communicate faster; virtual meetings are punctual and better coordinated; dynamic and fast interactions; Product Owners began to communicate daily with agile staff; IT and business area learned to work together; stakeholders became more available and accessible and began to collaborate with the team. Regarding productivity, in addition to the perception of productivity having improved during the WFH, both individually and within the agile teams, some of the answers most mentioned by the respondents were: concentration at work, not being distracted, and manager of my own time.

This result allows us to infer another change in individual behavior influencing productivity. Moreover, the information during WFH was more shared due to the facilities offered by the communication tools used by the Agile Teams, as well as the increased frequency of Meetings.
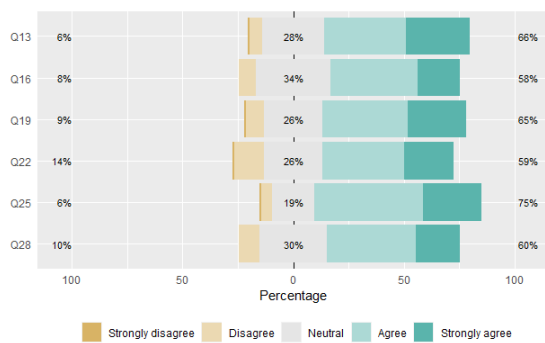
4.2 RQ.2

Concerning the tools used, it is possible to infer that they were probably an impacting factor in the increase of productivity, or even in the significant weighting of communication, transparency, interaction, and collaboration characteristics. The easiness of scheduling meetings, prevention of information loss, and monitoring tools were the most mentioned by agile teams. Below are some comments obtained in the survey regarding the impact of the tools adopted on productivity:

> *"At first it was a difficult process of adaptation. With the help of tools like Microsoft Teams, Slack, Bitbucket and Jira, we could maintain good productivity."*

> *"...The use of video calling tools brought teams closer together.*

Table 2 presents the tools most used by participants to interact with ICT and the business area and to carry out the activities with transparency. Microsoft Teams was the tool most used by agile teams to perform interactions between the ICT and business areas (mentioned by 43 participants) and to perform the activities with transparency (mentioned by 16 participants).

Table 2: Tools used by agile teams.

ICT and Business Interaction		Transparency	
Tools	Cited	Tools	Cited
Microsoft Teams	43	Microsoft Teams	16
Google Meets	14	Trello	8
Trello	7	Google Meets	6
Jira	5	Jira	5
Email	3	Kanban	4
Kanban	3	WhatsApp	3
Slack	3	Discord	3
WhatsApp	3	Redmine	2
Zoom	2	Slack	2
Discord	2	Git	2
Redmine	2	IdeaBoardz	1
Swagger	1	Skype	1
IdeaBoardz	1	Swagger	1
		Zoom	1

4.3 RQ.3

In the survey, we have asked Agile Teams whether their perception of working with age teams remotely was more challenging than working face-to-face and whether they encountered the same difficulties/challenges or others appeared. Most Agile Teams stated that the beginning of the WFH was more challenging, with respect to home and work routines, but over time they were adapting to

the WFH. Some practitioners mentioned difficulties or challenges, related to behavioral aspects, such as lack of eye contact with colleagues, lack of body language perception, lack of human contact, lack of interaction between team members, and lack of team motivation.

In addition, the Agile Teams recognize that the level of abstraction during remote work is lower than the traditional "in-company" model. On the other hand, teams presented more focus and discipline. Another challenge mentioned by Agile Teams was the interaction between tools and efficient communication. Some practitioners recognize that some people need personal coordination. Staff turnover and remotely integrating new professionals into the team were also mentioned as a challenge during the WFH. Some challenges mentioned by Agile Teams were:

Behavioral Aspects:

> *"WFH's challenges are different, not all people open the cameras, and we lose visual contact, perception of body language, the company has not bought other tools that help in the sharing of ideas in a playful way. Some teams had employees without access to corporate Teams, not being able to be in the same chat and so we lost this feeling of being sitting next to each other."*

> *"The main difficulty was dealing with members who did not show the minimum of discipline with remote work."*

> *"The main difficulties are dealing with professionals who use the freedom of the home office for procrastination and/or solving particular problems (go out to shop, go to the gym, travel, etc, even at office hours). There was also a problem in dealing with professionals who were very focused on work and did not look at messaging services, becoming inaccessible for several hours a day."*

> *"I believe it was more challenging due to the difficulties in maintaining efficient communication. Although productivity has improved, communication has worsened, as people are no closer. Each remains focused on their work without interacting with other team members."*

> *"Remotely it was more challenging with agile teams, because communication is essential, and we had a lot of difficulty in communication between teams and transparency of activities and projects between squads."*

Regarding the alternatives to mitigate the challenges and difficulties encountered during

the WFH, some practitioners suggested some solutions: larger interaction between the platforms and tools used; more frequent meetings and discussions; periodic reports; creation of routines; more accessible working protocols; greater amount of training; coaching, with closer monitoring of workers; compliance and commitment with meeting schedules; respect working hours. We quote below some of the solutions mentioned by respondents:

> " More frequent meetings and conversations, in addition to periodic reports and strict application of minimum service levels control indexes."

> "Offer practitioners frequent training, coaching, creation of backlog evolution indicators, training and mentoring with the team."

> "Carry out a closer follow-up with all team members, stimulating communication and debates between team members."

Survey participants mentioned other important considerations that were not addressed in the survey questions:

> "Regarding the health of members of the age teams, there were fewer departures during the pandemic."

> "Issues such as the costs of working from home and the cost of expenses, even partial, still need to be better addressed by companies. Also, the evaluation of results, performance and dedication of team members."

> "The diversity of profiles and some aspects of remote work require attention, especially aspects related to mental health."

> "The lack of empathy in understanding that people who are on the other side due to the pandemic may be experiencing motivation, family, or health problems, is a factor that needs to be discussed and mentioned by individuals. Understanding that remote work is not Home Office is an important point. Bringing light to these and other issues have brought gain to our Agile team."

> "The turnover in the ICT area was very high with the advent of the pandemic, which greatly hampered the work of agile teams that needed to devote more hours to meet their demands."

5 THREATS TO VALIDITY

The collection of survey data allows us to minimize the threats to internal validity, considering that the participants were selected randomly and the researcher did not interact with the participants, so there was no influence from him on the results. Moreover, the survey has a description and questions to identify the practitioners who meet the desired criteria, i. e., working in agile teams during the pandemic period and having WFH due to COVID-19. Thus, ICT practitioners who did not meet the desired criteria were excluded from the research. Finally, to ensure the conclusion's validity, we consider that the sample size allows us to draw interesting conclusions.

Within the scope of external validity, we consider that the instrument used to collect data from the survey provided an ideal means and allowed us to collect a representative sample even though most agile teams are from Brazil. In this context, further studies will be conducted, particularly in other countries, to generalize the results. Finally, the realization of the Focus group and a pilot survey with 4 ICT practitioners working in different software development teams allowed us to validate the questions asked in the survey.

6 CONCLUSIONS

This research aimed to identify the perception of Agile Teams regarding productivity, interaction, collaboration, and communication during Working from Home (WFH). In addition, we investigated which tools were used by Agile Teams, which challenges were faced during WFH and how they were solved or mitigated. We identified that, for most participants, an adaptation in the way of working was necessary and that productivity was positively affected. The interaction between the Information and Communication Technology ICT and business areas has improved. Transparency (understanding what needs to be done and what is being done), collaboration, and communication have also improved. According to the participants, the obstacles or problems were solved with greater agility.

We identified several other tools also used in smaller numbers during COVID-19. Monitoring tools were also widely cited, allowing greater control of who is doing what. In addition, we identified that most respondents work with Scrum. Concerning the challenges and actions undertaken to solve or mitigate them, we have identified a series of behavioral changes that have enforced the positive perception of the participants regarding productivity, collaboration, transparency, communication, and interaction. These are: the increasing frequency

of meetings; the ease of scheduling meetings and the better coordination; dynamism and speed of virtual meetings. In addition, there was an increase in the collaboration and communication of the team members and the perception of the need to integrate the work.

In future works, we suggest continuing the research in other contexts, aiming to ratify these findings. For example, we suggest monitoring the agile teams returning the face-to-face activities to verify whether these changes were only temporary or permanent and whether they would modify the way they work. Another interesting research would be to verify if the positive findings of this paper are related to the age group of the participants since 48% of the participants are under 35 years old, and some works have already identified that the group's age can influence the results of WFH.

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REFERENCES

Alzoubi, Y. I. and Gill, A. (2021). The critical communication challenges between geographically distributed agile development teams: Empirical findings. *IEEE Trans. Prof. Commun.*, 64(4):322–337.

Alzoubi, Y. I., Gill, A. Q., and Al-Ani, A. (2016). Empirical studies of geographically distributed agile development communication challenges: A systematic review. *Inf. Manag.*, 53(1):22–37.

Bao, L., Li, T., Xia, X., Zhu, K., Li, H., and Yang, X. (2020). How does working from home affect developer productivity? - A case study of baidu during COVID-19 pandemic. *CoRR*, abs/2005.13167.

Beck, K., Beedle, M., van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Highsmith, J., Hunt, A., Jeffries, R., Kern, J., Marick, B., Martin, R. C., Schwaber, K., and Thomas, J. S. D. (2001). The agile manifesto.

Bezerra, C. I. M., Coutinho, E. F., and Araujo, A. (2021). How do brazilian software development teams deal with working from home after a year of the COVID-19 pandemic? In Vasconcellos, C. D., Roggia, K. G., Collere, V., and Bousfield, P., editors, *SBES '21: 35th Brazilian Symposium on Software Engineering, Joinville, Santa Catarina, Brazil, 27 September 2021 - 1 October 2021*, pages 368–377. ACM.

Bezerra, C. I. M., de Souza Filho, J. C., Coutinho, E. F., Gama, A., Ferreira, A. L., de Andrade, G. L., and Feitosa, C. E. (2020). How human and organizational factors influence software teams productivity in COVID-19 pandemic: A brazilian survey. In Cavalcante, E., Dantas, F., and Batista, T., editors, *SBES '20: 34th Brazilian Symposium on Software Engineering, Natal, Brazil, October 19-23, 2020*, pages 606–615. ACM.

Butler, J. L. and Jaffe, S. (2021). Challenges and gratitude: A diary study of software engineers working from home during covid-19 pandemic. In *43rd IEEE/ACM International Conference on Software Engineering: Software Engineering in Practice, ICSE (SEIP) 2021, Madrid, Spain, May 25-28, 2021*, pages 362–363. IEEE.

Butt, S. A., Misra, S., Anjum, M. W., and Hassan, S. A. (2021). Agile project development issues during COVID-19. In Przybylek, A., Miler, J., Poth, A., and Riel, A., editors, *Lean and Agile Software Development - 5th International Conference, LASD 2021, Virtual Event, January 23, 2021, Proceedings*, volume 408 of *Lecture Notes in Business Information Processing*, pages 59–70. Springer.

Calefato, F. and Ebert, C. (2019). Agile collaboration for distributed teams [software technology]. *IEEE Softw.*, 36(1):72–78.

Canedo, E. D., Calazans, A. T. S., Cerqueira, A. J., Costa, P. H. T., and Masson, E. T. S. (2021). Agile teams' perception in privacy requirements elicitation: Lgpd's compliance in brazil. In *RE*, pages 58–69. IEEE.

Canedo, E. D., Calazans, A. T. S., Silva, G. R. S., Brito, I. S., and Masson, E. T. S. (2022). Supplementary Material for Perception of Agile Teams About Home Office During the COVID-19 Pandemic.

Castro, N. R. and Moreira, G. C. (2021). Who worked from home in brazil? inequalities highlighted by the pandemic. *Nova econ.*, 31(3):833–859.

Christmann, A. and Aelst, S. V. (2006). Robust estimation of cronbach's alpha. In Sciencedirect, editor, *Journal of Multivariate Analysis*, pages 1660–1674. Elsevier.

Ciancarini, P., Ergasheva, S., Gizzatullina, I., Ivanov, V., Masyagin, S., and Succi, G. (2021). Empirical research on customer communication challenges in the companies adopting agile practices. In Filipe, J., Smialek, M., Brodsky, A., and Hammoudi, S., editors, *Proceedings of the 23rd International Conference on Enterprise Information Systems, ICEIS 2021, Online Streaming, April 26-28, 2021, Volume 2*, pages 139–150. SCITEPRESS.

de Mendonça, W. L. M., Costa, P. H. T., Cançado, E. C. R., Lima, F., Canedo, E. D., Bonifácio, R., and Amaral, L. H. V. (2020). From dusk till dawn: Reflections on the impact of COVID-19 on the development practices of a r&d project. In Cavalcante, E., Dantas, F., and Batista, T., editors, *SBES '20: 34th Brazilian Symposium on Software Engineering, Natal, Brazil, October 19-23, 2020*, pages 596–605. ACM.

de Souza Santos, R. E. and Ralph, P. (2022). A grounded theory of coordination in remote-first and hybrid software teams. *CoRR*, abs/2202.10445.

Demir, M., Canan, M., and Cohen, M. C. (2021). Modeling team interaction and interactive decision-

making in agile human-machine teams. In *2nd IEEE International Conference on Human-Machine Systems, ICHMS 2021, Magdeburg, Germany, September 8-10, 2021*, pages 1–6. IEEE.

digital.ai (2021). 15th state of agile report. *digital.ai*.

Jr., E. O., Leal, G. C. L., Valente, M. T., Morandini, M., Prikladnicki, R., Pompermaier, L. B., Chanin, R., Caldeira, C. M., Machado, L., and de Souza, C. (2020). Surveying the impacts of COVID-19 on the perceived productivity of brazilian software developers. In Cavalcante, E., Dantas, F., and Batista, T., editors, *SBES '20: 34th Brazilian Symposium on Software Engineering, Natal, Brazil, October 19-23, 2020*, pages 586–595. ACM.

Kautz, K., Johansen, T. H., and Uldahl, A. (2016). The perceived impact of the agile development and project management method scrum on process transparency in information systems development. In Goluchowski, J., Pankowska, M., Barry, C., Lang, M., Linger, H., and Schneider, C., editors, *Information Systems Development: Complexity in Information Systems Development - Proceedings of the 25th International Conference on Information Systems Development, ISD 2016, Katowice, Poland, August 24-26, 2016*. University of Economics in Katowice / Association for Information Systems.

Kropp, M., Anslow, C., Mateescu, M., Burkhard, R., Vischi, D., and Zahn, C. G. (2017). Enhancing agile team collaboration through the use of large digital multi-touch cardwalls. In Baumeister, H., Lichter, H., and Riebisch, M., editors, *Agile Processes in Software Engineering and Extreme Programming - 18th International Conference, XP 2017, Cologne, Germany, May 22-26, 2017, Proceedings*, volume 283 of *Lecture Notes in Business Information Processing*, pages 119–134. Springer.

Lase, K. J. D., Ferdiana, R., and Santosa, P. I. (2022). Optimizing scrum's effectiveness in distributed software development environment during the pandemic era: A systematic literature review. pages 181–185. IEEE.

Marek, K., Winska, E., and Dabrowski, W. (2021). The state of agile software development teams during the covid-19 pandemic. In Przybylek, A., Miler, J., Poth, A., and Riel, A., editors, *Lean and Agile Software Development - 5th International Conference, LASD 2021, Virtual Event, January 23, 2021, Proceedings*, volume 408 of *Lecture Notes in Business Information Processing*, pages 24–39. Springer.

Martin, P. Y. and Turney, B. A. (1986). Grounded theory and organizational research. *The Journal of Applied Behavioral Science.*, 22(2):141–157.

Miller, C., Rodeghero, P., Storey, M. D., Ford, D., and Zimmermann, T. (2021). "how was your weekend?" software development teams working from home during COVID-19. In *43rd IEEE/ACM International Conference on Software Engineering, ICSE 2021, Madrid, Spain, 22-30 May 2021*, pages 624–636. IEEE.

Molléri, J. S., Petersen, K., and Mendes, E. (2020). An empirically evaluated checklist for surveys in software engineering. *Inf. Softw. Technol.*, 119.

Neumann, M., Bogdanov, Y., Lier, M., and Baumann, L. (2021). The sars-cov-2 pandemic and agile methodologies in software development: A multiple case study in germany. In Przybylek, A., Miler, J., Poth, A., and Riel, A., editors, *Lean and Agile Software Development - 5th International Conference, LASD 2021, Virtual Event, January 23, 2021, Proceedings*, volume 408 of *Lecture Notes in Business Information Processing*, pages 40–58. Springer.

Ozkan, N., Erdil, O., and Gök, M. S. (2022). Agile teams working from home during the covid-19 pandemic: A literature review on new advantages and challenges. In Przybylek, A., Jarzebowicz, A., Lukovic, I., and Ng, Y. Y., editors, *Lean and Agile Software Development - 6th International Conference, LASD 2022, Virtual Event, January 22, 2022, Proceedings*, volume 438 of *Lecture Notes in Business Information Processing*, pages 38–60. Springer.

Ralph, P., Baltes, S., Adisaputri, G., Torkar, R., Kovalenko, V., Kalinowski, M., Novielli, N., Yoo, S., Devroey, X., Tan, X., Zhou, M., Turhan, B., Hoda, R., Hata, H., Robles, G., Fard, A. M., and Alkadhi, R. (2020a). Pandemic programming. *Empir. Softw. Eng.*, 25(6):4927–4961.

Ralph, P., Baltes, S., Adisaputri, G., Torkar, R., Kovalenko, V., Kalinowski, M., Novielli, N., Yoo, S., Devroey, X., Tan, X., Zhou, M., Turhan, B., Hoda, R., Hata, H., Robles, G., Fard, A. M., and Alkadhi, R. (2020b). Pandemic programming: How COVID-19 affects software developers and how their organizations can help. *CoRR*, abs/2005.01127.

Ralph, P. and Tempero, E. D. (2018). Construct validity in software engineering research and software metrics. In Rainer, A., MacDonell, S. G., and Keung, J. W., editors, *Proceedings of the 22nd International Conference on Evaluation and Assessment in Software Engineering, EASE2018, Christchurch, New Zealand, June 28-29, 2018*, pages 13–23. ACM.

Uddin, G., Alam, O., and Serebrenik, A. (2022). A qualitative study of developers' discussions of their problems and joys during the early covid-19 months. In Link, S., editor, *Empir Software Eng*, volume 27 (117), pages 1–52. Springer Link.