Agile Teams Working from Home During the Covid-19 Pandemic: A Literature Review on New Advantages and Challenges

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Abstract. Whilst co-location is the common and preferred kind and key standard for self-organizing agile teams, this option is not always possible for some organizations that have to lead to the distribution of teams and/or individuals in one or another form, especially because of Sars-Cov-2 pandemic (Covid-19) today. The pandemic has forced a shift to virtual working for many organizations, which makes it necessary to investigate its possible effects on the self-organizing agile teams. In this manner, this study aims to investigate emergent challenges and advantages arising from working at home for self-organizing agile teams where every team member works from home with the impact of the Covid-19 pandemic by systemically reviewing the literature. Finally, all the findings, derived from the literature, were discussed from coordination, collaboration and communication, agile practices, agility, emotions and feelings, leadership, productivity, and quality aspects. The results demonstrate that along with some specific challenges for the agile teams during the pandemic, there are several advantages of working at home for them.

Keywords: Agile · Scrum · Software development · Sars-Cov-2 pandemic · Covid-19 · Advantages · Disadvantages · Challenges · WFH · Working from home

1 Introduction

Agile software development (ASD) has generated interest due to the increasing demands from varying kinds of organizations [1]. It highlights the importance of a people-oriented approach to software development [2]. Flourished by the proper people-oriented approaches, well-functioning teams that are advised to work collocated are acknowledged as a key success factor for ASD [3]. Co-location allows frequent in-person contacts, builds trust quickly, simplifies problem solving, encourages instant communication, and enables fast-paced decision-making [4].

From the standpoint of locational distances, whilst co-location is the common and key standard for self-organizing agile teams [5, 6], this option is not always possible for

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some organizations that have to lead to the distribution of teams and/or individuals in one or another form. At this point, the distribution comes in three main veins: geographically distributed teams, dispersed individuals in a particular team, and hybrid teams [6]. In hybrid teams, a part of team members works from office and the rest of them from home. Mostly seen in the off-shoring and global software development forms, geographically distributed teams are common for many years [8]. While the teams are split into different geographic locations, individuals in the sub-teams are usually co-located. The geographically distributed software development is mainly in relation to the global software development where software development projects are implemented with international cooperation [7]. The individually dispersed teams differently address the case where each individual in the team is located in different places so each individual is on his own [6]. While geographically distributed teams are fully distributed in multiple geographic locations, times or organizations, in the case of individually dispersed individuals, a particular team's individuals are distributed across multiple locations, such as homes in the pandemic. Geographically distributed, hybrid and individually dispersed teams differ in terms of challenges they have. Since the basic work unit in agile software organizations is the team rather than the individual [36], preserving the nature of the team from distance (e.g. homes) confronts us as a new challenge for the individually dispersed teams.

The case of individually dispersed teams has become common nowadays for many organizations, especially because of Sars-Cov-2 pandemic (Covid-19) and the shift to virtual working from homes. This working model has brought several challenges and complexity for agile teams [9] who have a heavy focus on in person interactions [10]. Moreover, Comella-Dorda et al. [12] claim that agile teams, earlier confirmed to be effective with remote working, can be inefficient when working fully remotely. Therefore, it becomes necessary to investigate this new form's possible effects on the self-organizing agile teams to give them insights in particular for this pandemic period and in general for the future. From this unique model of working, important lessons can be learned about both software development and agile software development. While some challenges related to co-located and distributed remote teams have been explored in prior literature, the context of individually dispersed agile teams has a unique nature exhibiting new challenges [7, 13] and little is known about challenges resulting from and experienced by the self-organizing teams working from home [14].

In this manner, this study aims to investigate the emergent key concerns arising from individually dispersed self-organizing agile teams working from home within the context of Covid-19 pandemic by using Systematic Literature Review (SLR). In this regard, we identified one of the Research Questions 1 (RQ1) as below. Apart from identifying the challenges, it would be interesting whether working from home enhances some of agile teams' abilities. For this purpose, this aspect is looked at in the RQ2.

RQ1: What new challenges have agile team members working from home faced during the pandemic?
RQ2: What kind of new advantages do agile team members working from home have during the pandemic?

The remaining of this paper is organized as follows: Sect. 2 summarizes the applied research method in this study. Section 3 delivers related works. Section 4 presents the results based on the applied method. Section 5 discusses the results and Sect. 6 states the limitations of the study and directions for future works.

2 Research Method

The aim of this study is to review the status of current challenges and advantages for the self-organizing agile teams working from home, in particular by concentrating on studies providing any kind of comparisons between the pre- and pandemic era. This study has been undertaken based on the SLR guideline proposed by Kitchenham et al. [15], with some deviations from its original protocol. As one of the deviations, we did not purposely apply any quality assessment to the papers identified since the topic is relatively new and the literature naturally has a scarce of resources. In this case, publications with a high-quality level and those with a relatively low level of quality were included and evaluated together. We have decided on this way in order to make the scope as wide as possible for this subject that has a lack of resources, at the expense of compromising the quality of our study in terms of the included papers.

Having a lack of resources on this subject also shaped our selection of the libraries to conduct the review. The initial searches were done in Scopus, IEEE, and ACM Digital Library with the search strings elaborated below. Then, it is realized that the results obtained from them are not sufficient to go further as seen in Table 1 at #4, 5 and 6 yielding 5, 0 and 0 related results respectively. One of the reasons for this may be that the literature on this subject is not very extensive yet. Then, we considered including Google Scholar that covers more resources such as master theses that can be helpful for our study, but, not transformed into a peer-reviewed publication yet. Then, we decided to use Google Scholar as the main library for further searches since it already indexes well-known digital libraries and more and, thus, provides the most extensive source for such a new topic. Even so, a cross-checking was conducted with the five results from Scopus as it is another extensive source of academic papers to cross-check our search results coverage in Google Scholar. It was seen that all results are covered by Google Scholar searches. When it comes to the year range and publication types, all the searches included the peer-reviewed and supervised resources for the years of 2020 and afterwards.

In designing the search strings, we aimed to reach a comprehensive and also reasonable list to investigate the result set by using not a single but multiple search string. Regarding the structural body of the search strings, we identified and merged two substrings representing the two parts in our scope. Our scope includes the keywords specific to our target domain (software development) and those representing the pandemic side of the strings.

To identify the appropriate and effective keywords for both sides of the strings, the search process was operated iteratively. In the first iteration, to determine the appropriate keywords, a preliminary search was conducted in Google Scholar with the word including "agility" (#1 in Table 1). 46 results were examined both in terms of the effectiveness of the search key and relatedness of the results. We realized that most of the studies

including the "agility" word in their titles belong to other domains (such as health, logistics, strategic agility, and marketing agility) and we found that all of them are out of our scope by applying our standard paper selection method described in our study. Then, we decided to exclude the "agility" keyword from our further searches to narrow the results down to the relevant scope. For the part representing the Agile domain, "("agile teams" OR "agile team")" in full text search and "(scrum OR agile OR XP OR Kanban)" in title search in Google Scholar were formed. The side representing the pandemic part was formed as "(covid OR sars OR pandemic OR corona OR coronavirus OR lockdown OR outbreak)" after some pilot iterative searches are done in Google Scholar. Regarding the working from home, the "home" keyword was a good candidate to include in this string yet this adding brought many irrelevant results, which renders the manual review almost unreasonable.

Regarding the search locations, we anticipated and were largely satisfied with the effectiveness of searching in the titles after realizing that almost all results returning from #2 search in Google Scholar include the keywords we identified in their titles; that is the corresponding authors locate the relevant terms (agile or the specific agile method name and the pandemic specific word(s) in their paper titles). Moreover, we realized that all results from the Scopus search were covered by our former search in Google Scholar, #3. After all, Table 1 summarizes the reviews conducted with the aforementioned keywords.

Based on the scope and context of our study, for the selection of the papers, the following propositions of inclusion criteria (IC) and exclusion criteria (EC) were specified and applied to the search process.

IC1: Papers investigating effects of the pandemic on the agile software development.
IC2: Papers on working from home rather than the conventional global software development or hybrid teams.
IC3: Peer-reviewed and supervised academic works including conference, workshop, proceedings, journal papers, thesis, etc.
EC1: Papers not available in English.
EC2: Papers published in non-peer-reviewed or non-supervised academic sources such as web pages and books.
EC3: Papers not accessible by the authors.
EC4: Papers investigating effects of being agile to cope with issues specific to the pandemic.
EC5: Papers investigating effects of the pandemic on the software development in general without any explicit relation to the agile software development.

After defining the keywords, libraries, IC, and EC, the full searches were conducted by the first author between 13.09 and 16.09.2021 to identify the relevant studies by applying the detailed inclusion and exclusion criteria to the papers. In this process, total number of 1004 of works were obtained from the search results as seen in Table 1. After removing the duplicate records, the list included 964 distinct records. All papers were examined through their titles and, where necessary, abstracts in order to identify whether they are in our scope. If even the abstracts were not sufficient to decide to include or exclude the papers, then, a scanning through the full texts of the papers was done for those that were further included or excluded. 883 papers were investigated only through

their titles, 37 of the them through their titles and abstracts and 44 of them through their titles, abstracts and full texts.

Excluded 9 studies are within the scope of our study, but they were ignored, as they are not peer-reviewed (yet) coming from Google Scholar, in relevant EC2. The exclusion was applied for 2 papers regarding EC3 because the papers' full texts were not accessible by the authors. We applied EC1 to specify the papers not available in English either by filtering via the relevant features of libraries allowing eliminating non-English studies forehand or via the manual investigations. 12 papers were manually excluded as they have an abstract in English but have a non-English full text. EC4 and EC5 are about the content details of the papers, then, they were applied during the meta-data or the full text investigation stages, yielding 925 papers' exclusion. After all, 16 distinct studies were identified as relevant and listed in Table 2 in the order of identification time. In the further examinations of all identified studies, the relevant contents were extracted from the studies and grouped under some main customized items by the first author based on their contents. This grouping was elaborated further in this study.

Table 1. Search details

#	Library	Place	Search string	Number of results	Number of relevant results
1	*Google Scholar	Title	(agility) AND (covid OR sars OR pandemic OR corona OR coronavirus OR outbreak OR lockdown)	46	0
2	Google Scholar	Full text	("agile teams" OR "agile team") AND (covid OR sars OR pandemic OR corona OR coronavirus OR outbreak OR lockdown)	791	14
3	*Google Scholar	Title	(scrum OR agile OR XP OR Kanban) AND (covid OR sars OR pandemic OR corona OR coronavirus OR outbreak OR lockdown)	91	14
4	Scopus	Meta-data	(agile AND software AND (covid OR sars OR pandemic OR corona OR coronavirus OR lockdown OR outbreak))	55	5
5	IEEE Xplore	Meta-data		16	0
6	ACM	Meta-data		5	0
Total				1004 (964 in distinct)	33 (16 in distinct)

*Google Scholar does not provide searching in metadata except specific to title

3 Related Works

Several studies and SLRs are available for the software development during the pandemic. For instance, Nolan et al. [16] covered the learning from working at home during the pandemic in their SLR. Several other studies such as Rehberg, et al. [17] discuss the advantages of applying agile approaches to better deal with issues in the pandemic. As mentioned before, these two types of scope were ignored in our study; our study rather focuses on the effects of the pandemic on agile teams rather than the effects of the pandemic on the software development in general or on agile capabilities to deal with pandemic specific issues.

When it comes to our scope, there are several studies identified as relevant as listed in Table 2; yet none of them is an SLR study like ours. Since these studies have already been included in our study with details, it was not preferred to mention them in detail in this section. Our list includes only the academic literature, however, we encountered some grey literature as related works, such as [12] and [13]. In the study [12], the authors provide their ideas about how to ensure that agile teams are effective where Covid-19 has forced them to work remotely. Study [13] gives personal ideas about the challenges of agile software development from home along with the practical examples and what will probably happen to agile software development teams when the crisis is over.

The included studies and excluded grey literature analyze the pandemic through challenges, new practices, tools, and possible solutions in the agile teams' context. Our study differs from the existing literature in some aspects. Firstly, it reviews and combines other studies' findings and as far as we know, it is the first in this regard. Secondly, it also differentiates and compares working from home and normal work, which has not been clearly expressed in other studies.

4 Results

As seen in Table 2, five of the studies are published in a conference proceeding. Four papers out of these five papers were presented in one of the leading Agile conferences, LASD (International Conference on Lean and Agile Software Development). A considerable number of the remaining papers, nine of them, are master theses, indicating a positive reflection of academia to the subject. The remaining two papers are journal articles. When we look at the geographical distribution, we see that Northern and Central Europe surface. In terms of the time distribution, it is seen that the times near the end of the university semesters are dominant.

Table 2. Results from the literature review

Paper code	Reference	Type	Method	Date (of Publication)	Country conducted
P1	[18]	Conference	Survey with 250+ people	January 2021	Pakistan
P2	[19]	Journal	Survey with 171 people	June 2021	Germany

(*continued*)

Table 2. (*continued*)

Paper code	Reference	Type	Method	Date (of Publication)	Country conducted
P3	[20]	Conference	Panel	September 2020	–
P4	[21]	Master thesis	Survey with 17 people + 2 semi-structured interviews	June 2020	Sweden
P5	[22]	Journal	Action research	July 2020	Brazil
P6	[23]	Master thesis	Interview with 8 people	May 2021	Finland
P7	[24]	Master thesis	Survey with 96 people + 7 semi-structured interviews	June 2021	Sweden
P8	[25]	Master thesis	Interview with 13 participants	May 2021	Sweden
P9	[9]	Conference paper	Case study - one team	January 2021	Ireland
P10	[26]	Master thesis	Multinational company case study with interview of 10 people	June 2020	Switzerland, France, Romania
P11	[27]	Master thesis	Survey with 114 people	June 2021	Canada, Estonia, India, Ireland, United States of America
P12	[28]	Master Thesis	Survey with 67 people + A census study with 105 employees	February 2021	Finland
P13	[29]	Master thesis	Interview with 9 people	May 2021	Iceland
P14	[30]	Master thesis	Interview with 19 people	July 2021	Belgium
P15	[7]	Conference	Case studies	January 2021	Germany
P16	[31]	Conference	Survey with 120 people	January 2021	Poland

Topics of challenges and advantages of the agile teams during the pandemic that were extracted from the identified studies were classified by the first author based on the aspects as seen in Table 3. Coordination, Collaboration, and Communication aspects among the distributed individuals were obvious enough to point out in the contents of the papers. Productivity and Quality items have also taken their place as one of the compelling topics of the pandemic period. In some papers, it was also discussed how agile practices were affected and performed during the pandemic period. Apart from the practices, some agile values and principles about transparency, flexibility, and self-organization were included by some identified works. Even though the Leadership, Coherence, and Feeling of the team members are relevant to agile values and principles, we handled them separately since they have a considerably high number of items. At the end of all these, as a result, changes in Agility degree in the organizations have also been the subject of research.

Along with these dimension items, the table presents the information about how many times each item was addressed by which study. Accordingly, it is seen that the most intensively discussed dimension is about Coordination, Collaboration, and Communication (it accounts for more than one-third of all items). It is noted that in this dimension, there are challenges and a considerable number of advantages as well. The second place is about the findings on the effects of working from home on Agile Practices. The table shows that working from home produces the most disadvantage at Leadership and Coherence aspects. The item with a relatively high advantage is about the increase in Agility. Apart from the dimensions, the study P8 numerically contributes at most to the all list.

Table 3. Number of advantages and challenges per each paper

Aspects	Effect	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	Total	Total by aspect
Coordination, collaboration and communication	Negative	2		2	2	3	1	11	9	3	2	2	1	3	3	2		46	70
	Positive			2				2	8		1	1	2	2	2	3	1	24	
Agile practice	Negative			1		1	2	2	3	3				1	1	1		15	25
	Positive							2						3	1	2	2	10	
Feeling	Negative	1		1		1		5	3	2		2	2	2	1			20	24
	Positive								1				1		1		1	4	
Productivity	Negative	5	1	1	1			1			2		1	1				13	22
	Positive				2			1				1		3		1	1	9	
Leadership	Negative			1			1	1	5				1		1	1		11	12
	Positive								1									1	
Agility	Negative	1																1	9
	Positive		2					1	1		1		1			2		8	
Coherence	Negative						1	2				2	2		1	1		9	9
	Positive																	0	

(*continued*)

Table 3. (*continued*)

Aspects	Effect	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	Total	Total by aspect
Quality	Negative																	0	1
	Positive																1	1	
Total	Negative	9	1	6	3	5	5	22	20	8	4	6	7	7	7	5		115	-
	Positive		2	2	2			6	11		2	2	4	8	4	8	6	57	-
	Grand total	9	3	8	5	5	5	28	31	8	6	8	11	15	11	13	6	172	-

Tables 4 and 5 illustrate the disadvantage and advantage of the content items extracted from the papers, mapped for each paper and grouped by each identified aspect. In this table, under each content item, it is seen which studies include the content items and by how many studies each item was included. The top item about challenges shows that in spite of the technological advancements, lack of face-to-face communication is a clear challenge that conflicts directly with one of the agile principles; "the most efficient and effective method of conveying information to and within a development team is face-to-face conversation". In a similar vein, integration, coordination and involvement of stakeholders, forming effective new teams and onboarding staff become more difficult in remote working from homes because of more difficult, less or slower communication capabilities the teams have. This leads to decrease of productivity especially because of fewer interactions with others. Among other items, building work-life balance surfaces as one of the most mentioned issues of the agile teams.

Table 4. Map of disadvantage of items per each paper

Negative content item	Frequency	Citing paper(s)
Coordination, collaboration and communication		
Lack of face-to-face communications to experience the social aspect	9	P1, P3, P5, P7, P9, P10, P12, P13, P15
More difficult, less and slower communication	6	P6, P7, P8, P10, P13, P14
Integration, coordination, and involvement of stakeholders are more difficult	5	P1, P8, P9, P13, P15
Lack of constant communication	3	P4, P7, P8
Misunderstandings in communications	3	P5, P7, P8
Plethora of interruption	3	P7, P8, P9
Less spontaneous informal communication among team members	2	P7, P11
Making voice heard	2	P7, P8

(*continued*)

Table 4. (*continued*)

Negative content item	Frequency	Citing paper(s)
A need for communicating more with fewer abilities, increased number of meetings and less effective meetings	2	P8, P14
Dealing with problems on their own instead of doing together	1	P8
Unable to cheer up each other when mentally down	1	P11
Suffering from interpersonal friction	1	P3
Trouble with expressing themselves	1	P4
Establishment of tools to support working	1	P5
Lack of visibility	1	P8
A distance created with the transversal roles such as the Product Owner or Scrum Master	1	P14
Easier to deviate from unwritten rules	1	P7
A reluctance to bring up sensitive conversations digitally	1	P7
A fear of leaving digital traces when writing down certain things	1	P7
A decrease in knowing the extent of the team members' working	1	P7
Productivity		
Productivity decreased because of fewer interactions with others, low working hours of developers or no work pressure on them	6	P1, P2, P4, P7, P10, P12
Teams suffered from interpersonal friction are exacerbated	1	P3
Motivation and efficiency affected negatively	1	P10
Delay in the project delivery time	1	P1
Not applied sprint meetings	1	P1
Stress and emotional and mental instability affecting productivity	1	P1
Work pressure and home life leading to a conflict and resulting in less productive teams	1	P1

(*continued*)

Table 4. (*continued*)

Negative content item	Frequency	Citing paper(s)
Decreased productivity [with no specified reason]	1	P13
Agile practice		
Agile work practices getting harder to perform due to the virtuality of meetings and interactions	2	P3, P7
Hardship in knowledge management	2	P5, P7
Challenge of establishing a new way of working with digital tools	2	P8, P15
Cyclical Agile nature of the team moved to pure execution and mechanical version of Scrum	2	P6, P9
Higher reliance on documentation, tools, processes, and more structured work	1	P6
Scrum meetings taking much unnecessary time	1	P8
No longer “touch” hardware products	1	P8
Difficult to stay within tighter time-box	1	P9
For sprint planning, engagement remaining for a shorter period of time	1	P9
Increased number of meetings	1	P14
Meetings can continue longer without being decided beforehand	1	P13
Feeling		
Damaged work-life balance	5	P3, P9, P11, P12, P14
Loneliness and feeling forgotten	3	P8, P12, P13
Decreased motivation	2	P7, P8
Decrease in team morale	2	P7, P13
Fatigue	2	P7, P9
Decreased ergonomics and comfort	1	P5
Easiness of disturbance	1	P8
Not using skills to full extend	1	P11
Less ambition and work satisfaction	1	P1
Decrease in breaks	1	P7
Changes on feelings and personalities like being more introverted at long term	1	P7

(*continued*)

Table 4. (*continued*)

Negative content item	Frequency	Citing paper(s)
Agility		
Less effective agility	1	P1
Leadership		
Forming effective new teams and onboarding staff	5	P3, P6, P8, P12, P15
Having trouble with keeping track of people and how they feel	3	P7, P8, P14
The leadership affected since the workload increased	1	P8
Mental breakdowns	1	P8
Increased workload since the team's wellbeing getting worse	1	P8
Coherence		
Integrating new employees	3	P6, P7, P14
Affinity, togetherness	2	P12, P15
Team spirit	1	P11
Less communication resulted in more conflicts and less trust	1	P11
Feeling of disconnected	1	P12
More difficulties in creating personal relationships	1	P7

In terms of advantages, increased efficiency of meetings, fewer interruptions and increased productivity and flexibility are prominent.

Table 5. Map of advantage items to each paper

Positive content item	Number of frequency	Citing paper(s)
Coordination, collaboration and communication		
Fewer interruptions and more status updates with the present status in the communication tools	5	P3, P7, P8, P10, P15
Saved time from commuting	3	P7, P8, P12,
Meetings start on time and run more efficiently and more effectively	3	P3, P13, P14
Increased frequency of communication	2	P11, P16

(*continued*)

Table 5. (*continued*)

Positive content item	Number of frequency	Citing paper(s)
More factual and precise, objective and efficient communication and collaboration	2	P13, P15
Easier communication	1	P8
Increased and faster interaction with customers	1	P8
Ability to speak naturally in front of a big group of people	1	P8
Became good at respecting who is talking	1	P8
Follow-up communication; written communication within teams is stored and visible	1	P8
The documentation clearer and more structured	1	P8
Employees preferring virtual communication and cooperation	1	P12
Able to do several things at the same time for less interesting meetings	1	P14
Teams forced to adopt more state-of-the-art communication practices	1	P15
Productivity		
Increased productivity [with no specified reason]	4	P7, P13, P15, P16
Productivity improved due to less distractions from coworkers	2	P4, P13
Improved speed of achieving work goals	1	P11
Productivity improved due to the reduced amount of tension the employees feel	1	P4
A longer workday from home	1	P13
Agile Practice		
Saved time for Scrum meetings	3	P13, P14, P16
Scrum meetings getting more goal-oriented, factual, and more efficient	3	P7, P13, P15
Agile approach becoming more transparent	2	P7, P15
Increased accountability	1	P16
Easier time planning for sprints	1	P13
Feeling		
A better “we” feeling by connecting different geographical locations	1	P8
Improved work-life balance	1	P12

(*continued*)

Table 5. (*continued*)

Positive content item	Number of frequency	Citing paper(s)
Trust and flexibility in the company	1	P14
Increased accountability	1	P16
Agility		
Increase in flexibility	4	P2, P7, P10, P12
Increase in perceived agility	2	P2, P8
Better self-organization	1	P15
Increased transparency	1	P15
Leadership		
Leaders better at realizing if someone has something to do	1	P8
Quality		
More automation	1	P16

5 Discussion

Unlike co-located or distributed teams, being distributed on an individual basis rather than on a team basis opens door to new challenges. Since the basic work unit in agile software organizations is the team rather than the individual [36], preserving the nature of the team during working from distance (e.g. homes) confronts us as a new challenge for dispersed teams. In addition to these challenges, it has been seen that the items on the right of the agile manifesto, whose contribution to agility has not been investigated sufficiently by the agile communities until this catastrophic change brought by the pandemic, can also support agility when the circumstances demand it. In history, such catastrophic changes are few, even fewer in the information technology era, and can be considered as the first instance in the age of agile software development. From a wider perspective, such changes provide lessons not only for the pandemic but also for the post-pandemic time. In this sense, in the following, the implications for this review study are presented.

5.1 Implications for Agile Practitioners

Among the challenges of working remotely from home, we have seen that the communication dimension has a considerable place during the pandemic as it was before the pandemic. Communication, which plays a key role in many issues, is prominent especially in the context of Agile. Korkala [32] highlights the project failures in agile teams because of the poor communication that can be also the root cause of other problems within the teams. Within this scope, individuals' ability to express themselves, understand each other correctly, coach people, communicate without loss of emotions and feelings, conflict resolutions, and a desire for having intensive human contact can be counted. It is expected that the first challenge faced by teams accustomed to close working with high interactions is about communication and its related aspects.

Even though many tools support the interactions efficiently, they are still not as effective as a face-to-face conversation [20]. Non-verbal communication carries a lot more information like facial expressions, gestures, posture, proximity, tone of voice, pitch, etc. in comparison to verbal communication [33]. However, a big part of non-verbal communication is lost in the virtual teams' processes [34], like happened across the (members of) teams. During the working from home, without adequate capabilities that the traditional face-to-face teams have, contact is prone to be harder, kept at a minimum and more formal. Along with these shortcomings, working from home may also open the door to other problems such as a quality decrease in software products. As Agile requires intensive coordination, collaboration, and a coordination-based approach extending to the broad parties including clients and end-users, the regular and continuous involvement of them in the cycles in the development activities can have problems. The lack of communication within team members may also lead to misunderstandings that deteriorate the team's coherence. Because of the lack of sensing, the social fabric of the team may be in danger, making communication more difficult, less and slower.

Agile teams prefer constant and spontaneous communication and make voices heard to facilitate an agile and transparent way for their information to flow across and inside the teams. These abilities decrease during the pandemic since to convey the information in the (even increased number of) meetings or online during the pandemic seems ineffective to provide these abilities. As a side effect of these decreased abilities, agile teams lose the feel of togetherness, and start to behave introvertedly and individually. There are several instances of that such as, dealing with problems on their own, being unable to cheer up each other, suffering from interpersonal friction, having trouble with expressing themselves, having a distance occurred with the transversal roles, deviations from unwritten rules, and decreases in knowing the extent of the team members' working.

During the pandemic, after dealing with the challenges of the establishment of digital tools to support working and finding state-of-the-art communication practices, agile teams need less effort to communicate. For instance, they can save time from commuting to come together, ignore irrelevant subjects easily, and present their status in the communication tools. This easiness in communication brings increased frequency and equality of communication and collaboration. Online meetings can start on time and run more efficiently and more effectively and support more factual and precise, objective and efficient communication and collaboration of group members and customers. With digitalization, the documentation becomes clearer and more structured.

Some issues for coordination, collaboration, and communication have both positive and negative sides. For instance, the form of interruptions only changes in the manner of interrupting during the pandemic; having interruptions physically at the office turns into digital interruptions during the pandemic. While digital tools and documentation are effective for having a corporate memory, they are not preferred for discussing sensitive issues by some agile teams because of the fear of leaving digital traces.

In a similar vein, the productivity aspect has positive and negative effects during the pandemic. Productivity decreases because of ignored and not applied agile practices, fewer interactions, less direct contact of people, less motivation, more interpersonal friction and more stress and emotional and mental instability emerged in home-life during

the pandemic. Meanwhile, we see positive reflections of improvements in communication dimensions, including fewer distractions and commuting effort, and improved speed of information, on productivity. The number of studies stating that productivity increases during the pandemic without providing a clear reason is also noteworthy.

Agile work practices get harder to perform during the pandemic due to the virtuality of meetings and interactions. It is possible to say that relatively more abstract phenomena like knowledge management, engagement, and the spirit of agility are also negatively affected by the pandemic. Agile teams are prone to pose a pure mechanical execution under the constraints of the pandemic, laying more on the doing rather than being (agile), on documentation, tools, processes, and more structured work. The state of being ineffective under this condition is tried to compensated with having more meeting durations, taking much unnecessary time, and posing difficulties to stay within time-boxes.

On the other hand, Agile practices benefit from the pandemic conditions in terms of especially efficiency and effectiveness aspects. Agile teams save time from the (unnecessary parts of) rituals and focus on the main issues in the meetings by getting more goal-oriented, factual, efficient, and transparent. In this case, it is possible to say that Agile practices are under a conflicting influence during the pandemic.

Study [12] suggests modifying Scrum ceremonies as appropriate rather than sticking to a guide. They also stress the need for a different approach of processes [due to the decrease in ability in tacit knowledge] to produce a so-called single source of truth as the memory of the teams and organizations. In parallel to this suggestion, the teams should come with some out-of-box set-up for Scrum to meet the challenges of implementing Scrum specific activities during working from home. The teams also are expected to recalibrate their agile processes in their remote environments. Adaptation of Agile work practices, which is encountered as one of the challenges during the pandemic period, can be considered in this context. Although some studies state that implementations of these practices still exist as usual [31], there are cases of changes in the way these practices are performed by the agile teams [12]. These deviations may lead to inconsistent work practices observed in the agile teams.

A similar recalibration is required to strike a work-life balance for the individuals, especially after the intense involvement of life dynamics into every possible moment of working hours during the pandemic. In general, well-being and emotions of agile teams working at home have been negatively affected by the conditions of working from home, especially in terms of work-life balance with the new blurred boundaries of the business and life, feeling loneliness, decreased motivation and morale and more fatigue. Qualitatively speaking, all these effects regarding the Feeling aspect are strong enough to have severe negative impacts on teams in the long run. For the later stages of the pandemic or any form of working from home, the long-term impacts of these deep-seated effects on the Feelings of the teams should be thoroughly investigated. Besides, during working from home, with the possibilities of digitalization, agile teams in different geographical locations experience a better feeling of connectivity. In general, there are some studies assert that the teams can have an improved work-life balance and increased accountability.

For the Agility aspect, there are conflicting results of the studies. The majority of the results state positive impacts on agility as a result of increased flexibility, self-organization, and transparency. There are more negative effects than positive effects regarding leadership during the pandemic as it requires intensive communication with people, especially with newcomers. Like negative effects on the individuals in the agile teams, we see a similar case for the coherence within the individuals and their relationships. This situation can be attributed to the weakening of invisible ties across the individuals during working from home. Like the Feeling aspect of the individuals, the issues about the Coherence aspect can have unexpected and severe damages on the teams in the long run.

The more usage of digitalization, documentation, tools, and processes, play more crucial roles during the pandemic. In our work results, it is clearly seen that digitalization, documentation, and tools provide many benefits and directly affect the flexibility and agility of the teams. These artifacts stand on the right side, which is the less preferred side of the Agile Manifesto, can open a door for us to reconsider discovering more balanced ways with the right side. Even though the Agile Manifesto suggests to value individuals and interactions over processes and tools, we have seen how processes and especially tools support agility to be sustainable and interactions in a more efficient, faster, convenient, and, in other words, agile way. As stated by the study [7] "business people and developers [can] work together daily throughout the project" with the support of the digitalization tools.

It was stated by some studies that digitalization, compared to physical boards, enhances visual capabilities, and facilitates feedback channels and clarifications, resulting in more factual and precise, objective and efficient communication and collaboration, increased transparency and involvements of partners. Making meetings more goal-oriented, factual, and more efficient in this way raises doubt on the correctness of the following principle of the manifesto; "the most *efficient* and effective method of conveying information to and within a development team is face-to-face conversation". In the same vein, more documentation is needed in remote working to foster organizational memory. The fact that the pandemic has emphasized the need of having a proper enterprise memory, which is also valid in the form of close working, can be considered as a belated awareness of the Agile committee.

Within the online environment, the "frequent" meetings resulting from rituals of Scrum can be more casual and easier for the teams. As a reflection of this enhanced capability, it can become easier to establish closer contact with business units while the frequent meetings could be more difficult in an office environment hardly supporting these capabilities. Moreover, the extra exhaustion resulting from being in the office, combined with the high efforts for the frequent meetings of Scrum, appears as an additional challenge.

There may appear a loss of energy and motivation during working from home resulting in a decrease in the team's coherence. Easy and asynchronous communication causes more interruptions during working at home. Asynchronous and easily initiated digital communication in the pandemic may lead teams to more multitasking and distractions and less opportunity for focus. Especially in review and retrospective meetings of Scrum, which require intense human contacts [38], the online environments in this regard can

reduce the impact on people compared to physical environments. However, the business units can involve more in the meetings with the support of the convenience of digital platforms.

A decrease in the "real" contact and connection capabilities within teams and team members during the pandemic may put a distance within people and, thus, may threaten trust in remote work. In this regard, a possible decrease in the capabilities of improvements, leadership, team cohesion and feeling of isolation, loneliness, low motivation, and disconnectedness are relevant. In the case of virtually working individuals, Sen [37] states that in communication, when body language, subtle tones, and facial gestures are not added to the spoken word, misinterpretations and misunderstandings and individual interpretations may create situations where each team member unknowingly "does his/her own thing" rather than following the team's agenda. That study adds the lack of relationship and trust, isolation, loneliness, and the feeling of disconnectedness that may erode energy and lessen commitment to the team. It is important to underline that it is possible for teams experiencing isolation, loneliness, and disconnectedness because of specialist culture, and cross-functionality after a while in the pandemic. Similarly, for the teams with high autonomy but low maturity or living in their early stages, control and balance issues may take part in organizations' management agenda.

Mancl and Fraser [20] foresee that many people appreciate working at home. Our study also exhibits several advantages and also several challenges of working at home. In particular, for the challenges, there can also be some other issues for the teams that have not raised in pandemic yet. In addition, the expectation that the pandemic will be temporary may have kept some organizations away from some long-term actions. After all, all these identified and further challenges may imply that self-organizing teams in Agile should re-invent some code of life that can be naturally very complex for the formation of remote working in the pandemic.

The results relating to the Coordination, Collaboration and Communication, Feeling, Productivity, Leadership, Coherence, and Quality aspects might also help non-agile teams with their working from home, since many aspects are transferable also to traditional processes. Putting Productivity and Quality aside since these two are more about the generic results, rest of these common themes emerged in agile teams experienced as deeper issues compared with the classical software development teams. The unique characteristic of agile teams in software development requires to deal with these encountered challenges to maintain a sustainable agile culture, as they need these capabilities more than the traditional teams. Additionally, in contexts where there is a problem about team cohesion within agile team members and/or agile teams, having estrangement from the central authority and different perceptions of authority by the teams may be a more possible and crucial problem compared to classical teams, because of the agile teams' self-organizing characteristics. In self-organizing agile teams, rather than applying a centralized decision structure, the structure of decentralized decision is applied where team members make independent decisions. It may make interactive decision-making process through dispersed team members problematic that may cause different perceptions of authority by the teams.

Geographically distributed and individually dispersed teams share common issues around virtually working. Like geographically distributed teams, individually dispersed

teams operate in virtual environments leading to concerning virtual communication and collaboration [7], lack of face-to-face direct, synchronous and non-verbal communication, difficulties in building and maintaining trust, different perceptions of authority, lack of mechanisms for creating shared understanding, misunderstandings, inconsistent work practices, reduced cooperation and coordination, and control, knowledge management and leadership challenges that need to be overcome [35, 37]. Like in individually dispersed teams, the absence of togetherness and team cohesion, accompanied by common view of goals, and feeling of isolation, loneliness, low motivation and disconnectedness are also issues of the geographically distributed teams [35, 37]. Differently, study [35] reports the specialist culture problem for geographically distributed teams that has not been encountered in the studies for individually dispersed teams, yet.

5.2 Implications for Researchers

The research community is paying great attention to issues related to self-organizing teams in software development [35]. As a result, we have seen that considerable effort has been paid to identify the problems faced by co-located agile teams. There are also secondary studies that combine primary studies on this subject. It is possible to say that the subject is beyond the identification of the problems, rather at the stage of handling the issues of the teams working co-located. A similar result can be obtained for the teams that work in a classically distributed way. The relative saturation of the publications in these two fields is remarkable.

Although it is known that some cases exist for traditional teams, we have come across rare cases of agile teams working as individually dispersed teams before the pandemic, which is not surprising because of the agile teams' inclination to and need for working in co-location. When we look at the pandemic period, we can say that some earlier studies have just started to emerge. Specifically speaking, considering the year 2020 and 2021, publications at the LASD (International Conference on Lean and Agile Software Development) conference, which is specific to the field of Agile and the venue including the most papers in this scope, are remarkable in the number of the academic publications on this subject.

Co-location for agile teams allows frequent in-person contact, encourages instant communication, quickly builds trust, simplifies problem solving, and enables fast-paced decision-making [12]. Therefore, by considering the benefits gained from (co-located) agile teams, working from home in the pandemic that should come with a considerable shift in multiple facets needs further studies. Alternatively, the need for studies that will guide practitioners about the hybrid model, which includes the advantages of both working types, is increasing.

Although it is possible to say that the belief that the pandemic will not last long is prevalent, examining the effect of such a catastrophic change on agile teams will provide useful insights. It is a suggestion to academy to focus more on agile teams during the pandemic period. In this regard, our scope of the literature review was extended with so called grey literature, a non-peer-reviewed but supervised academic theses. Considering the relatively long durations of the publishing processes, it would be appropriate to say that this preference to expand the sources studied to find a sufficient number of papers strengthens our study conducted at this particular time. In addition, the fact that all of

the studies from this particular branch are empirical studies has reduced our worry about their reliability.

6 Conclusion, Limitations and Future Work

This paper presents a systematic literature review to evaluate the effects of the Covid-19 pandemic on the agile software development teams. Two research questions were proposed: what new challenges the team members have faced and which advantages have occurred. Our study focuses on a timely new topic relevant for today and provides further insights into the post-pandemic time. It focuses on an important topic which is likely to play a greater role in the future after the pandemic. This topic has practical relevance since it affects most of the teams that had to change their way of working during the pandemic. Team members' distribution was already relevant and not sufficiently researched ahead of the pandemic, and also in the post-pandemic time, many teams are likely to keep a more flexible and remote way of working.

The study reveals that working from home during the pandemic poses some challenges and advantages. The challenges stress the importance of face-to-face communication that is vital especially for the agile teams. The newly learned advantages imply that we can lead to revising the understanding and value of the underestimated classical artifacts such as (digital) tools to communicate not effectively but efficiently and processes to connect dispersed members.

Our study contains all the hereditary limits and threats to the validity of a review study. Thus, the procedures used in our study have limitations in several ways. Only a single researcher extracted the data from the studies and this poses a threat to reliability. Also, we may have missed some relevant studies, as we did not include all possible variations of keywords since it is not practically possible to cover them all. In addition, we did not include all possible libraries. In particular, we may have missed the studies published in not-peer-reviewed sources. To mitigate the risk of this issue, we have used not an equivalent but multiple search string to cover a more comprehensive area. In addition, we have searched in the most appropriate databases such as Scopus and Google Scholar, in terms of their coverages.

For the quality of the selected papers, due to the relatively low number of relevant studies, we did not want to set a threshold value as it reduces the number of studies any further. Therefore, it may become an issue when including studies that were not very systematic. For instance, even though the data in some particular studies are insufficient, we included them. However, we have seen that the studies of low quality with insufficient data have a minor part of the whole. Some papers such as P1, P5, P6, and P9 seem to focus on negative aspects and P16 seem to focus on advantages. However, we are not sure if the involved people were asked neutrally about their work in these studies. Therefore, the studies may include a bias in this regard and this bias inherently transfers to our work.

We have not seen a study among the existing works that makes a review on this subject. This study aims to fill this gap, for now. We are planning to repeat this study in the future to reach more better results. As a possible avenue for further studies, we plan to conduct a quantitative study to investigate the difference between on-site and

working from home challenges. Working from home during the pandemic is not equals to dispersedly remote working during "normal times". Similar research can be conducted for dispersedly remote working during normal times and hybrid working (partially on-site and partially dispersedly working). The challenges specific to the pandemic imply that organizations should address issues and accordingly provide more flexible work environments for working at home, and that can be a subject for further studies in this area. Some adequate agile responses to such extreme crises can be located from technology startups, providing another further study for researchers to transfer those abilities to conventional organizations.

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