ORIGINAL ARTICLE

Challenges to agile software project management practices in the context of the COVID-19 pandemic

Desafios às práticas ágeis de gestão de projetos de software no contexto da pandemia da COVID-19

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Abstract: The Agile approach is focused on individuals and customer satisfaction, based on the dynamic and streamlined work of a team that is capable of adapting, and adapting the project to changing scenarios and demands. However, amidst the COVID-19 pandemic, Agile teams accustomed to in-person communication have encountered the challenges of working from home. The main objective of this research is to analyze the challenges generated by the pandemic context, and the consequent social distance, for the development of software projects that use Agile approaches within a large state-owned company and identify the effect it had on the course and results of the projects. The research was qualitative in nature and had two exploratory diagnostic stages. The findings indicate that there were no negative impacts of relevance on project deliveries. On the one hand, results indicated losses in socialization, in spontaneous exchanges of knowledge, and in interaction among teams, as well as a demand for greater engagement of professionals. Additionally, limitations were revealed for more complex discussions and knowledge management. The study highlights solutions that were found and/or suggested for many challenges, contributing to the literature on best practices for the Agile approach, and is focused on the unprecedented context of the COVID-19 pandemic. Our findings can contribute to other companies with a similar profile that work with Agile projects, besides contributing to building a dialogue between the academic and business environments.

Keywords: Agile approach; Project management; Software development; COVID-19 Pandemic; Remote work.

Resumo: A abordagem ágil é focada nos indivíduos e na satisfação do cliente, fundamentada no trabalho dinâmico e simplificado de uma equipe capaz de se adaptar e adequar o projeto às mudanças de cenários e de demandas. Contudo, em meio à pandemia da COVID-19, equipes ágeis habituadas à comunicação face a face se depararam com a implantação do *home office*. O objetivo central desta pesquisa é analisar os desafios gerados pelo contexto de pandemia e do consequente distanciamento social para o desenvolvimento de projetos de *software* que aplicam as abordagens ágeis em uma empresa estatal de grande porte e os impactos identificados no decorrer e nos resultados dos projetos. A pesquisa teve cunho qualitativo e ocorreu a partir de duas etapas diagnósticas exploratórias. Os achados mostram que não houve impactos negativos de relevância nas entregas do projeto. Indicaram por um lado perdas na

socialização, nas trocas espontâneas de conhecimento e na interação entre equipes, assim como exigência de um maior engajamento dos profissionais. Além disso, foram reveladas limitações para discussões mais complexas e na gestão do conhecimento. O estudo aponta soluções encontradas e/ou sugeridas para alguns problemas, contribuindo para a literatura de melhores práticas para a abordagem ágil, com um recorte em um contexto inédito da pandemia da COVID-19 e pode contribuir para outras empresas com perfil similar que atuem com projetos com abordagem ágil, além de contribuir para a construção de diálogo entre os ambientes acadêmico e empresarial.

Palavras-chave: Abordagens ágeis; Gestão de projetos; Desenvolvimento de *Software*; Pandemia da COVID-19; *Home office*.

1 Introduction

When it comes to software project management, the search for productivity and fast and effective solutions is increasingly in evidence, placing dynamism and innovation as pillars for technological solutions. According to the Project Management Institute (PMI), the traditional measures of scope, time, and cost for a project are no longer sufficient in today's competitive environment (Project Management Institute, 2017). Planning needs to be dynamic, allowing for testing, user evaluations, and improvements throughout the process in order to contribute to the fast and effective solutions that the market demands, reducing the occurrences of failures and losses, as well as the waiting time for a final version of the product and all the cost tied to the deadline. According to the Pulse of the Profession report by PMI, Brazil loses an average of 133 million dollars for every one billion spent on projects, a value 14% higher than the world average – which alerts to the need to seek more effective solutions (Project Management Institute, 2020).

One solution in the face of the dynamic nature of the software development landscape came in the form of the Agile approach, which is capable of promoting communication with stakeholders throughout the development process while focusing on individuals rather than on tools and processes. Agile, as it is widely referred to, is a point-in-time iterative approach that encourages a rapid and flexible response to change by anticipating interactions throughout the development cycle (Gonçalves et al., 2020). The question is no longer how to stop change at the beginning of a project, but rather, how to best handle the inevitable changes throughout its life cycle, eliminating rework, reducing its cost, and maintaining quality (Highsmith & Cockburn, 2001).

Teams that work with high social interaction, such as those that adopt Agile approaches, as well as all workers in many different segments, experienced in the beginning of 2020 a moment of transformation. The COVID-19 pandemic took the world by surprise, forcing companies to rapidly change their ways of working, deal with an unplanned environment, and find solutions so as not to lose the productivity levels they had already achieved (Adhikari & Poudyal, 2021; Da Camara et al., 2020; De Smet et al., 2020; Kude, 2020).

Companies reacted quickly, focusing on the health and safety of their employees by adopting, as an initial step, the implementation of remote work while still unaware of how much could be done virtually. The various types of professional activities, previously performed in offices, were transferred to the workers' homes; including customer service, which was also transferred to the remote form, despite the many

uncertainties related to technology, the market, infrastructure, and socioeconomic challenges.

Imposed by the pandemic, remote work brought a series of changes to social interactions, delivery of activities, and communications. Notably, this new reality goes against two of the principles of the Agile Manifesto (Beck et al., 2001): number 4, which defines that "Business people and developers must work together daily throughout the project"; and number 6, which states that "The most efficient and effective method of conveying information to and within a development team is face-to-face conversation."

Given this situation, the following problem was raised: What were the challenges imposed by the pandemic and social distancing encountered by teams that use the Agile approach and its premises in the development of software projects in a Brazilian state-owned company?

The main objective of our study is to analyze the challenges imposed by the pandemic, and the consequent social distancing, regarding the development of software projects that apply Agile approaches and identify its effects on the course of projects.

The aforementioned main objective is broken down into two more specific objectives:

A) Identify the challenges encountered by the development teams of software projects developed with Agile approaches, in the face of the pandemic context, considering the assumptions intrinsic to the Agile approach, exploring the one that generated the greatest barrier or damage to the projects;

B) Investigate how software project management teams have adapted the application of Agile approaches when coping with the constraints imposed by the pandemic.

2 Theoretical background

Against a backdrop of threats and uncertainty brought on by the pandemic (De Smet et al., 2020), industrial digitization faced its greatest test. Due to the biggest economic and health crisis in recent history, companies across all sectors were forced to take extraordinary measures to protect their people and maintain operations (Agrawal et al., 2021). Considering, social distancing as one of several measures aimed at mitigating the pandemic, since the disease spreads mostly via physical contact (Anderson et al., 2020; Butt et al., 2021), several companies worldwide reduced the length of working days in offices or recommended and determined that their employees work remotely from home (Duffy, 2020; Schmidtner et al., 2021). Starting in March 2020, such restriction was implemented either by the local public administrators, by the guidelines issued by the WHO, or by personal motivation to preserve the health of professionals.

Teammates who used to sit side by side in the office environment were suddenly geographically dispersed, and companies had to deal with rapidly changing business operations to survive. While some professionals may be accustomed to working virtually and having team members located remotely, for many this situation was unusual and challenging (Daly, 2020). Thus, in addition to the more critical challenges related to social justice and family life, important questions were raised regarding office closures and whether working from home really works (Kude, 2020). Authors such as Baruch (2000), Bergamaschi et al., (2018), Da Camara et al., (2020), Gorbalenya et al., (2020), reported the difficulties related to the abrupt and unplanned adoption of remote work by employees who did not have this practice.

2.1 Constraints, adaptations, and challenges brought by the pandemic to project management

The world has never experienced a scenario such as the one brought on by the consequences of the coronavirus. The global effects of the pandemic evolved faster than the institutions' response plan, and its risks were underestimated by project managers, governments, industries, and everyone else (Ozguler, 2020; Zhykhor et al., 2021). For projects overall, security measures such as travel restrictions, social distancing, and quarantines resulted in delays and disruptions, affecting planning, timelines, and customer satisfaction (Da Camara et al., 2020).

Proper communication and collaboration, acceptance of digital culture in the workplace, maintaining an organized and responsive virtual environment, building trust and resilience among teams, and paying special attention to the treatment and safety of workers are some of the key areas to be prioritized to ensure better adaptability to the new norm during the pandemic and the migration to the remote work. Nunamaker et al. (2009) and Seerat et al. (2013), reinforced the significance of spontaneous and continuous communication for team performance. In addition, humility, empathy, conversations, and exchanges among team members, even if remotely, can aid in the transition and adoption of a new work culture (Adhikari & Poudyal, 2021; Seerat et al., 2013). Marodin et al., (2018) and Rad & Rad, (2021) further reinforce the importance of communication with the customer and their involvement in the process, especially during the product development phase.

Another important issue is the possible high turnover in project teams during a pandemic period. The risk of developing a deficient knowledge management within a high turnover scenario has been pointed out in the literature by different authors, such as Highsmith & Cockburn (2001), Boehm (2002), and Larson (2019), who understand the risks caused by minimizing documentation, leading to loss of project knowledge and data.

2.2 Pandemic and remote work context in software development project management through Agile approaches

The impacts of the constraints generated by the pandemic on companies and projects affected different aspects and demanded a series of adaptations and a lot of resilience, as discussed in the previous section. At first glance it is common to infer that the impact of working from home is less for software developers, since coding can be done anywhere and in a distributed way. However, for teams that follow an agile, human-centered approach to software development, the distance becomes a challenge regarding the development process itself, the social aspects between team members, and their interaction with the client (Butt et al., 2021; Kude, 2020).

Agile project management methods for software development were designed for a marketing scenario of constant changes in the demands of products and services, especially in IT (Date et al., 2016). To this end, it provides flexibility and predisposition for adaptations to the situational characteristics of a project and to uncertainties. The COVID-19 pandemic is an example of an event that caused a high level of uncertainty and is in itself an indication of the need for agility, according to Batra (2020).

In dynamic environments and in the face of rapidly changing demands, Agile is the software development method most capable of surviving and emerging successfully. The approach embraces change at any stage of the project with an eye toward customer satisfaction, employing practices of constant feedback on technical decisions, customer requirements, and management constraints (Anderson, 2003;

Beck et al., 2001; Butt et al., 2021; Conboy, 2009). Agility is, therefore, used as a way of dealing with external and internal changes, which are seen as unpredictable and uncertain (Ahimbisibwe et al., 2015), and companies that invest in such methods may fare better in a highly disruptive event, such as the pandemic (Batra, 2020).

Despite being a method suitable for unstable circumstances, a survey conducted with developers from different software companies that adopt the Agile approach identified the various problems they face in meeting development goals (Butt et al., 2021). The results pointed out that almost 81% of developers felt that the quality of Agile work for efficient software development was compromised due to the COVID-19 pandemic. Despite Agile playing a positive role in software development in the pandemic context, the values were not fully sustained in the view of the respondents, who pointed to the lack of coordination of teamwork and the impairment of collaboration among team members. Moreover, the survey pointed out low active participation of developers in Sprints and in discussions and parameter setting about the project, as well as low productivity during remote work, which had repercussions on delays in Sprint deliveries to the client and increased project time (Butt et al., 2021). In this sense, the study of Ralph et al. (2020) on the environment of software development project teams in remote work showed that they suffered a reduction in emotional well-being and productivity, a fact intensified by poor ergonomic conditions of improvised home offices, in addition to other factors related to the pandemic.

Based on the 12 principles of the Agile Manifesto, this research highlights the relevance of turning the focus on the reflexes of the pandemic and its restrictions on communication and interaction among the individuals involved in the project. This is due, at first, to the observation of two of these principles, which expressly refer to the importance of the team's performance and interaction face-to-face (Beck et al., 2001). They are: #4 – "Business people and developers must work together daily throughout the project"; #6 – "The most efficient and effective method of conveying information to and within a development team is face-to-face conversation."

Additionally, another principle refers to the importance of team motivation that reflects commitment and trust: #5 – "Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done."

Despite all the technical progress and adoption of immediate communication tools, remote work differs from the close collaboration in offices (Schmidtner et al., 2021), in which the exchange of experiences and opinions can occur in a direct, agile, and spontaneous way, since many social interactions happen between the lines (Kude, 2020). This challenge was reported in the research conducted by Kude (2020), in which an update of a component did not have its consequences perceived by the developer team, probably due to the circumstances of the crisis, which generated a loss of important data for the team. One interviewee explained that in normal times, during in-person work and without so many emotional interferences of a pandemic crisis, the change would not have been reported by a simple chat message but would have been discussed widely and its implications would have been analyzed by the team. Badiale (2020) reported that some aspects of human interactions were lost during strictly remote communication, and pointed out that online interaction can be misinterpreted due to the absence of the human aspect.

There are reports, however, of overcoming and achieving positive results in software development teams impacted by pandemic constraints. This was the conclusion of a study conducted by Da Camara et al. (2020) in a software startup based in Brazil. The team, which already habitually adopted the Scrum method, was able to adapt with

seemingly simple but well-structured measures for work performance. This series of actions favored the constant exchange of information and doubts among the team, which allowed the maintenance of social relationships and moments of relaxation – such as breaks for rounds of games – and promoted constant contact with customers (Da Camara et al., 2020). Neumann et al. (2021) reported that half of the respondents in a multiple case study scored an improvement in the efficiency of work done remotely. The studied teams adapted Agile practices, artifacts, and roles; conducted the necessary digitization of analog artifacts (Kanban boards); and applied the full use of software for communication during the pandemic (Neumann et al., 2021, Marek et al., 2021).

Managing uncertainty while adapting some Agile practices can be a determining factor in maintaining productivity during remote work in the pandemic (Da Camara et al., 2020). For Kude (2020), teams that worked based on architecture and software development processes, which balance stability and flexibility, and those that have developed solid teamwork structures and behaviors, successfully developing team psychology and high levels of shared understanding, are likely to have milder consequences in this restrictive phase.

The collaborative and iterative approach of Agile software development also extends to customers and end users, who are regularly involved in development activities throughout the project. However, if customer or end-user feedback is not functioning normally, the Agile development systematics and iteration can become impaired (Kude, 2020). This is depicted in the survey conducted by Butt et al. (2021), in which 77% of the interviewed developers reported that, with the suspension of in-person meetings, feedback was compromised due to the customer's reduced availability to schedule remote meetings, internet speed restrictions, and low availability of both parties to discuss the project, leaving most of the interaction restricted to exchanging e-mails or story cards, which goes against principle number 4 of the Agile Manifesto.

3 Methodology

The research in question is essentially based on interviews with members of the software project area in a state-owned company in Brazil (Alpha Company). Procedures and techniques of a qualitative nature were used, justified by its open nature, focusing particularly on the context of a reality (Godoy, 1995). The qualitative approach tends to explore issues in a deeper way, maintaining originality and breadth of findings and investigations (Parente & Federo, 2019; Yin, 2016)

It is worth clarifying that all the professionals who were interviewed worked on projects at the selected company, developed with an Agile approach, before the beginning of the pandemic scenario, which allowed the comparison of the experiences perceived in both contexts. This enabled the understanding of the real impacts generated by this change of scenario and working conditions, in the perception of the interviewees.

To achieve the proposed objectives, the research corresponds to a single case study, focusing specifically on the context of the reality of a Brazilian state-owned company. As for the means of investigation, we conducted a field research, with qualitative data collection procedures.

To meet the research objective, an organization that met the following criteria was sought: a) adopted Agile approaches in software project management for at least one year before the onset of the pandemic; b) easy access to professionals and capable of providing information on software projects developed with the Agile approach in the company.

The criterion described in item b) was met thanks to the fact that one of the researchers is a professional working for 6 years in the studied company, which facilitated the knowledge and contact with the teams that would participate in the field research.

To know the team characteristics and achieve the specific objectives listed in the first chapter of this research, primary data were collected via virtual interviews of employees from 5 teams that work with software projects developed with the Agile approach. All members of these teams were invited, who could eventually participate in more than one team, leaving a total of 12 interviewees. The data were collected between August and September 2021. In the table below are the periods of each project analyzed. Table 1 shows the composition of the teams from the five projects.

Table 1. Composition of the teams of the analyzed projects.

Project	Members	Beginning	End
1	2 Product owners	Jan/20	Sept/2021
	4 developers		
	1 scrum master		
2	1 Product owner	Apr/19	Dec/21
	4 developers		
	1 story designer		
	1 solution designer		
3	1 Product owner	Oct/2020	Dec/21
	4 developers		
	1 story designer		
	1 solution designer		
	1 Assistant PO		
4	1 Product owner	Apr/20	Jul/20
	5 developers		
	1 scrum master		
5	1 Product owner4 developers	Jun/21	in progress
	1 scrum master		
	1 solution designer		

Source: Prepared by the authors (2022).

The teams used elements of the Scrum method routine: PI (Increment Programming), Sprints, and Dailies. Other concepts of the Agile approach adopted in the development of the projects are: the non-definition of a deadline or project schedule, the focus on the delivery of value at the conclusion of the Sprint, the formatting of the teams without hierarchy and the model of the roles of the members (Product owner, scrum master, etc). Regarding software, all teams adopted the Jira software to manage the product backlog.

The research was developed in three stages, as shown in Figure 1. The first stage was diagnostic and was carried out by consulting the company's website and primary data made available by the company such as presentation materials, internal news, and videos. The second stage, also diagnostic, was carried out via semi-structured interviews using a semi-structured questionnaire, with employees from Alpha. The interview scripts were prepared with about 25 questions and are available for consultation with the authors. The questions were focused on the impacts and adaptations facing the adversities of the pandemic and were elaborated based on the content studied in the theoretical foundation and on the problematization, focusing on the study's main and specific objectives. Each interview

lasted an average of 60 minutes. The third and last stage was analytical and corresponded to the consolidation of the primary research data obtained from the diagnostic phases and the qualitative analysis of the referred content.
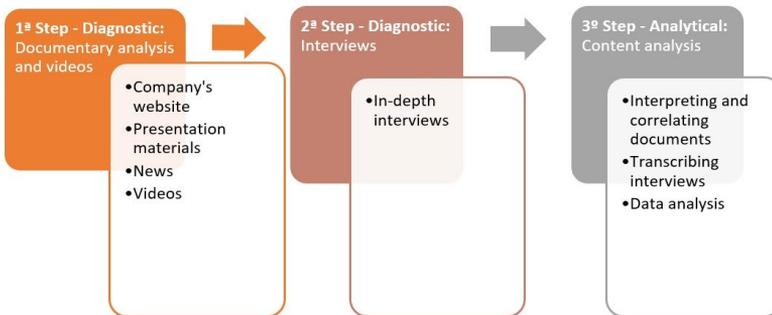
Figure 1. Research Methodology Steps Source: Prepared by the authors (2021).

For the primary data analysis, the content analysis technique was used, which, according to Bardin (2011), aims for a critical unraveling with an exploratory function that helps in the interpretation of the messages contained in communications and content. The author indicates that content analysis promotes better understanding of communications or speeches, enabling a look beyond or beside the main message. Nvivo software was used, which assisted in both "floating reading" and coding and categorizing the content (Piontkewicz et al., 2019). During the document exploration and analysis phase, the document and interview content was interpreted and coded by analogy via NVivo (Piontkewicz et al., 2019). Table 2 exemplifies the coding and categorization process.

Table 2. Examples of the coding and categorization process.

Encoding	Sub-coding
Traditional Project Ma na gement Methodology	Basic Concepts
	Cascade Model of Project Management
	Indication and contraindication for implementing the traditional model
Agile Approaches	Basic concepts of the approach and the Agile Manifesto; the obstacles and benefits of adoption
	Tools of the agile approach
	Team profile
	Agile approach in software development projects
The Covid-19 pandemic context	Introduction to the Covid-19 topic
	Constraints, adaptations, and challenges brought by the pandemic to Project Management
	Remote work concepts, advantages, and disadvantages
	Pandemic context and home office in the use of agile methodologies for software development project management
	Post pandemic Project management
Research methodology	
Findings from the study with the team of Agile projects in the context of the pandemic	

Source: Prepared by the authors (2022).

The final stage was the treatment of the results obtained (raw) and their interpretation, in order to make them meaningful and valid. At this stage occurs the moment of intuition, reflection, and critical analysis (Bardin, 2011). We identified, among the pandemic reflections reported by the respondents, aspects with the most positive or negative impact on the project development and on the relationship between developers or between developer and client, as well as the most recurrent impressions and opinions among the interviewees. These results are discussed in the next section.

4 Results and discussion

This chapter first presents the profile of the Alpha Company and the respondents who participated in the field research. Finally, we analyzed the acquired information to answer the problem and the specific objectives of the research.

4.1 Alpha company presentation

The object of study is a large Brazilian state-owned company, which has approximately 40,000 employees and presents an organizational chart that is functional and by business unit. The company, despite having a traditional organizational history and a bureaucratic profile inherent to state management, has in recent years, especially since 2015, been investing in innovation and agility.

The Agile project management approach has attracted the attention of Alpha's senior management as of 2019. Until then, the projects mostly adopted the traditional methodology, and occasionally in the sector of Information and Communication Technology (ICT) and in the newly created Digital Transformation (TD) area the agile approach was adopted in some projects. To this end, a pilot group was formed, identified as a startup with a perspective of one to three months of exclusive dedication. Thus, autonomy was granted to the Agile teams, allowing them to define the details of the process as they preferred, as long as they focused on the objective. On the other hand, those employees selected to make up the teams would remain hierarchically linked to their functional structure of origin and subordinated to their respective transactional leaders.

As occurred with most offices in Brazil and in most parts of the world, the Alpha Company implemented fully remote work for all its office employees in the second half of March 2020. This framework was maintained at least until October 2021, when employees were gradually reintegrated into the company's environments, even if only for a few days a week.

We identified a similarity and homogeneity in the profile of the interviewees and in view of this, a survey of basic demographic information of the sample was carried out (Table 3). Although we believe that younger professionals and those who share the home with less people present higher adaptability towards remote work, we decided not to go into this analysis due to the lack of variation in the sample.

Table 3. Profile of the sample.

Interviewee	Gender	Age	Training	Marital Status	Children at home	Residents in household
PO (Product Owner)1	M	39	History and Accounting	Married	1	3
PO2	F	34	Business Administration	Single	0	2
PO3	M	35	Electrical Engineering	Single	0	3
PO4	M	33	Production Engineering	Married	0	2
PO5	M	52	Petroleum engineering	Single	0	2
Developer 1	M	34	System Analysis	Married	0	2
Developer 2	M	32	System Analysis	Single	0	2
Developer 3	M	35	Administration	Married	0	2
Developer 4	M	37	Computer Engineering	Single	1	3
Developer 5	M	34	Computer Engineering	Married	0	2
Developer 6	F	40	Business Administration	Married	1	3
Developer 7	M	36	System Analysis	Married	0	2

Source: Prepared by the authors (2022). M = male, F = female.

4.2 Research results

We interviewed five Product Owners (POs) and seven developers who worked on five software projects with an Agile approach in Alpha's procurement area. In this session, they were referred to as PO1 to PO5 and Developer 1 to 7.

4.2.1 Response to Specific Objective A

Specific objective A is to identify the challenges encountered by the development teams of software projects conducted with an Agile approach, during the pandemic, considering the assumptions intrinsic to the Agile approach.

Under the aspects of the Agile approach, its values and principles (Beck et al., 2001), we noticed some challenges encountered by the researched teams due to the distance and remote working. Firstly, we can mention motivation, a principle of the Agile approach that plays an essential role alongside the principle of autonomy. The pandemic scenario brought a major impact on the well-being and mental health of the world population, it distanced people physically and brought limitations to social relations and integration among the teams, as reported by the interviewees. Remote communication also proved to be a relevant barrier to a work routine that requires many exchanges of information and ideas, daily meetings, and frequent and agile feedbacks. The Agile approach is one that replaces robust documentation to some extent with simplified, direct, and continuous communication between client and development team and tacit knowledge. Therefore, for a team used to dealing with small and large decisions in meetings and quick in-person conversations, having to fully migrate to remote communication was a challenge that demanded adaptations and resilience, especially regarding the dependence on technological resources and its losses, as will be addressed below.

One of the challenge mentioned in all of the interviews referred to communication and constant interaction between team members. All the interviewees reported that the biggest challenge caused by the pandemic and remote work was the absence of physical interaction and, consequently, discontinued communication.

The usual routine of an Agile team, before the pandemic, when members worked in the same space, was based on a daily interaction and constant exchange. The interviewee PO2 reported that the routine started with a daily meeting, which, according

to the agile approach, should not last more than 15 minutes and was held with the employees standing up, "precisely to generate that discomfort and avoid that the subjects were prolonged or ran away from the main issue," as reported by PO1.

After the meeting everyone dedicated themselves to their tasks of the day, working in a room that, also to collaborate with the interaction, was isolated from the open layout of the office. In that room the startup's teams worked, and during the whole day, the members exchanged information, contributing with each other, with freedom to consult each other, including the team members from other software projects also being conducted with the Agile approach.

With the onset of the pandemic and remote work, employees immediately experienced the following impacts on routine:

i) Technological dependence to communicate

For any communication, the employees depended entirely on the internet and equipment, such as cell phones or notebooks, provided by the company. As previously reported, in the first weeks, Alpha Company was still adapting to work remotely, so technical difficulties with equipment and access to the company's network were frequent, since before the pandemic a small portion of the employees – only the managerial positions – had the habit and authorization to work remotely. These technical limitations impacted on team interactions and access to useful systems.

As emphasized by PO1, this technical problem directly impaired the functioning of the software that was being developed by their team and was already being used by the general public. With this, the amount of users per day, which was around a few hundred users before the remote work, abruptly dropped to 10 or 20. This low frequency represented an important damage to the development of the project in that first month of the pandemic, since this is the most representative indicator to measure the usability of the product. "It was a very brutal drop and we took 10 steps back. In the first month we were very worried about keeping a system up because it would 'crash,' the databases would 'crash,' so it was a way of trying to survive," according to PO1. Inevitably, these issues caused delays to the project's development.

ii) Shortcomings in the home office environment

Most of the interviewees emphasized the challenges of working in a domestic environment, in a different condition from the standard remote work previously adopted by other companies, since in most homes all family members were at home, including the children, and the professional's focus could often be affected, as reported by PO1, who added to his work routine the coexistence with his son, who was in his first year of life, in early 2020. These reports coincide with the ponderations of Baruch (2000), Bergamaschi et al. (2018), Da Camara et al. (2020), and Gorbalenya et al. (2020), who point out the difficulties related to the abrupt and unplanned adherence to remote working by employees who did not have this practice.

An important obstacle mentioned, which the team needed to be overcome, was the physical adaptation of their homes, to transform them into a viable environment to work an average of 8 hours a day. Developer 2 reported that he had to purchase a desk, chair, and headphones suitable for a home office.

Similar to what is portrayed by the interviewees PO1 and developer 2, the study by Ralph et al. (2020) concluded that software development teams working from home

during the pandemic suffered a reduction in emotional well-being and productivity, which was increased by the poor ergonomic conditions of improvised home offices, in addition to other factors related to the pandemic.

Despite the relevance of the deficiencies in the home office environment, for 100% of the interviewees, the implementation of this system brought benefits in productivity. For developers 2 and 4, interruptions became more contained and it was possible to concentrate better at home on the activities being executed, considering the possibility of indicating the "busy" or "do not disturb" status in instant messaging applications and the more assertive and focused nature of virtual meetings. Such a characteristic of the remote work model was predicted by Kude (2020) and Butt et al. (2021), and was also identified in the results of the multiple case study by Neumann et al. (2021), in which 50% of the respondents scored an improvement in the efficiency of work done remotely.

iii) Impacts on spontaneous and ongoing communication

Without being able to work in the same environment, the direct and constant communication between team members was the first routine to be impacted, as mentioned by all the interviewees. It would not be possible to sit next to a colleague to answer a question pointed out on the monitor screen, or even to give an opinion about a theme that another member raised in a conversation in the workroom.

For PO3, whose project began in October 2020, that is, after the pandemic and the implementation of the exclusively remote work, there was the impression that the in-person routine favored a faster, more objective and simple communication, according to his following comment.

> *To discuss a project issue with the developer team, I need to schedule a meeting, prepare some power point slides to explain and discuss the topic with the team. If it were in person, I would get close to their workstation and we would talk immediately in a simpler way, without needing so much preparation* (PO3).

Such potential harms pointed out by the interviewees coincide with the theoretical approach, especially in the work of Nunamaker et al. (2009) and Seerat et al. (2013), who emphasize the importance of spontaneous and continuous communication.

iv) Loss in team involvement and synergy

Complementing the previous point, the lack of in-person interpersonal contact generated a loss in team involvement and synergy. According to PO3, during the remote work, the team in which he worked did not have the commitment, for example, to leave the camera open during conversations and meetings, and this limited, in his view, the interaction, since it limited the communication to a person's voice. Similarly, Badiale (2020) out in the results of their case study that 100% of the participants felt that some aspects of human interactions were lost with the strictly remote contact and written communication.

These perceptions reported by 50% of the interviewees at Alpha of the effect on the work routine are congruent with the literature, in that it reinforces the understanding that the dynamism and flexibility of the approach presented by the Agile Manifesto are supported by relationships and interactions of trust and constant exchange and collaboration (Beck et al., 2001). In this sense, the survey-type research by Butt et al. (2021) pointed out that for 80% of the interviewed developers there was a loss in the

team discussions, which had only some of the participants, who decided the parameters about the project.

Moreover, a message in the chat may be misinterpreted due to the absence of the human aspect, as reported by one of the participants in the study of Badiale (2020), as well as by one of the professionals from Alpha Company. An alternative to this problem – proposed by some of the interviewees from Alpha, also present in the study of Badiale (2020), is the promotion of small conversations among colleagues, on various topics, in order to increase team spirit and help the well-being, collaboration and, consequently, the efficiency of group work.

v) Impairment of interaction between projects

Besides the loss in the synergy within the groups, the interaction between the projects worsened with the physical distance, according to the PO2. There used to be fortnightly meetings between the projects in progress at the startup that, due to the remote working, were transferred to a remote model and had to be conducted alongside other non-Agile projects. From the interviewee's point of view, the in-person contact between the teams of different projects was better before the pandemic, since they worked in the same environment, and the meetings were only for the exchange of experiences between the software projects developed with the Agile approach.

The conclusion is that there was a concern from Alpha in maintaining the quality of communication between members of the same project, and in fact, they managed to minimize the damage of the distancing, but this effort did not occur regarding the continuous communication and sharing between the different software projects developed with an Agile approach, in progress. for PO2, this was a big loss, since "interpersonal development between projects brings many gains to them." The work of Kude (2020) in a French company illustrates the relevance of this challenge regarding the coordination between teams.

vi) Difficulties in coping with high turnover and new members joining the teams

Another challenge pointed out as relevant by PO1, PO2, and PO3 was in dealing with the high turnover of teams during the pandemic. The pandemic itself did not increase the turnover; however, if a high turnover of members naturally hinders the evolution of projects, the absence of daily contact of professionals and the dependence on technological resources further compromises the service delegations and team adaptations.

For PO3 the experience of replacing developers in the team also hindered the project's productivity.

> *The learning process for each new developer consumed a lot of time in the development of the project, because it required training, then if they made a lot of mistakes, I, as PO, had to test the story, identify errors frequently, leading to rework and, after a while, they could already be transferred, without me having any management either to contain the turnover or to request the replacement of the member* (PO3).

It is worth noting that, since the PO has no management role, it is not his job to manage the team and oversee the changes to it, but rather the PO has to manage the product.

As reported by PO1, the routine and the processes of a team of software projects developed with the Agile approach are not well structured as a sector that performs specific standardized activities, which makes the passage of service to new members more feasible. The replacement of members "becomes very difficult, because when a

person leaves he takes with him all the history, all the knowledge that he had and this is simply not replicable." As reported by two interviewees (PO1 and PO3), even if there is a recorded history, either a commented code in the system, which holds the history of the code itself, or the Kanban history recorded in a tool adopted for this purpose, passing this knowledge to new members is a challenge, it is necessary to "rewind everything" and "the learning curve is not worth it."

The risk of knowledge management deficiencies is pondered in the literature by different authors (Highsmith & Cockburn, 2001; Boehm, 2002; Larson, 2019), who understand the risks of minimizing documentation leading to loss of project knowledge and data, which could be mitigated with frequent interaction between team members (Highsmith & Cockburn, 2001).

vii) Impacts vary according to the stage of the project

Another important factor that can generate a greater or lesser impact of the pandemic on the project is the stage it is at. The initial phase of a project is marked by the brainstorming with the claimants, in which the PO is responsible for conducting several interviews with those who demanded the solution and those who will be the main users of the product (in this case, the software) to understand the process, macroprocesses, and related problems. In the vision of PO1, performing this phase remotely is quite challenging and can lead the project to failure.

The studies of Marodin et al. (2018) and Rad & Rad, (2021) reinforce the importance of customer involvement, especially during the product development phase, and clarify the concern of Alpha's PO1, since feedback should be at the core of the routine and, therefore, regular customer contact with project representatives is essential.

4.2.2 Response to Specific Objective B

Specific objective B is to verify how software project management teams have adapted the way they apply Agile approaches, in facing the constraints imposed by the pandemic.

As reported by PO1, there was no restructuring of the routine of the teams in the beginning of the pandemic. The adjustments occurred organically by the teams, due to the unprecedented nature of the experience.

With the start of the remote work, the teams continued to hold their daily meetings as they originally did, always at the beginning of the day. One of the changes was that the meetings stopped being in-person and standing up, and started happening through the communication app, only by voice (without using a camera). In addition, the retrospective meeting also became online, as well as the planner meeting, held before the beginning of each new sprint, to analyze the stories in the product backlog that would be prioritized. The planner meeting was already performed using the strategy of scoring the complexity level of each task in order to estimate the effort needed to accomplish each one of them by the developers, known as planning poker. Developer 4 and the PO3 explained that the routine continues to occur with a their own application program, in wich each participant shows the cell phone screen with his or her score, so that everyone can see it through the camera and the result is computed by the PO. Along the same lines, the multiple case study conducted in Germany found among several adjustments in agile practices, artifacts, and functions, the necessary digitization of analog artifacts (Kanban boards) and the full use of tools for communication and collaboration among team members (Neumann et al., 2021).

The literature emphasizes how important the use of communication software was in the implementation of remote work, whose use was intensified (Da Camara et al., 2020; Marek et al., 2021; Neumann et al, 2021; Schmidtner et al., 2021), mainly with the purpose of establishing a central and unique tool, aiming to concentrate all the information about the company's operation and help to know if the employee is available online or not (Da Camara et al., 2020). The same strategy was adopted at Alpha, which discouraged the use of WhatsApp, previously widely used by the teams, and demanded from employees the concentration of conversations via Microsoft application, licensed by the company for use in their mobile equipment, as reported by PO5.

To promote more interaction between the team members throughout the day, the interviewees PO2 and PO4 report that one solution found by the team was to stay connected in a meeting room, after the daily tasks, for the entire working hours. This way, the members felt more or less like in a workroom, knowing that they could open the microphone and make any comment, be it about the task they were performing or about amenities, or even raise a question, knowing that one or more colleagues on the other side of the screen could interact immediately, in a simple, natural and spontaneous way, as if they were side by side in the same office room. This would keep the ideals of simplicity and speed – that basis for the Agile approach – active.

Similar adaptations were identified by researchers Neumann et al. (2021) in the multiple case study, both regarding the format of the meetings (daily and retrospective), and the extension of the daily meeting period in which members remained connected, with the goal of promoting exchange within the team. Moreover, the estimation meeting that used to use the planning poker technique started to be held via communication applications.

The research of Schmidtner et al. (2021) pointed out the importance of maintaining the routine of daily meetings, even if in remote regime, being this one of the tools responsible for increasing the perception of agility by the group, since they have the power to fill the gap left by the absence of daily conversations with colleagues in the office.

A change made possible by the home office was the flexibility of the working hours. Initially, the teams' work schedule was adjusted with the intention of bypassing the most congested moments of the network, as reported by PO1. Once the company's technical limitation was solved, the developers found flexibility in the work day, extending beyond the standard hours when necessary, and working without interruptions from meetings and conversations via the application, as reported by Developers 2 and 5. Increased flexibility was also identified in Schmidtner et al. (2021) research, particularly for many employees with children who needed to change their work schedules to care for children at home.

One of the advantages of using Agile approaches in a context of instabilities such as the pandemic is the fact that there is no schedule or medium- or long-term planning. What exists is only the product backlog, whose prioritizations guide the team to what will be accomplished in the next sprint. That is, at the end of each week or two of work, the deliveries and new prioritizations are analyzed by the team, to meet new opportunities, since the backlog evolves according to the product development and the testing environment. Due to this model, the interviewees PO5 and Developer 6 clarified that in the change to a pandemic scenario, the limitations of the home office and adaptations in the team's work routine did not interfere in a broad schedule, but only in what had been planned for a week, and that with the new working conditions, it was soon adjusted to be viable in that new reality.

4.2.3 Summary of Responses to Specific A and B objectives and summary of contributions

In order to summarize the main results obtained in the study, we created Table 4, presented below.

Table 4. Summary of main results and contributions.

Challenge Found	Principle, value, or Agile practice affected	Main Reason	Solution found or suggestion
Motivational Aspects	Principle: *Build projects around motivated individuals. Give them the necessary environment and support and trust them to do the job.*	Lack of alignment of everyone on the project deliverables	Leadership must invest in the alignment of goals throughout the team and create an environment of spontaneous and respectful exchange, in order to value the performance of each one to promote autonomy and self-organization.
Remote Communication	Principle: *The most efficient and effective method of transmitting information to and between a development team is face-to-face conversation.*	Technological dependence, remote work deficiency, lack of spontaneity, loss of synergy	Training, invest in adapting remote work and in spontaneous and continuous communication. Promote small conversations to improve team spirit. Stay connected in a meeting room, after daily tasks (to simulate the spontaneity and exchanges common in a face-to-face work room). Make the workday more flexible.
Difficulty w/ high turnover and entrance of new team members	Indirectly related to the principles: *Build projects around motivated individuals. Give them the necessary environment and support and trust them to do the work. Business people and developers should work together daily for the entire project.*	Service delegations and team adjustments are compromised.	Reduce turnover, increase interaction among team members, and intensify retrospective meetings and explanatory meetings among the team, in order to integrate new members that have arrived during the course of the project.
Problems in the initial phase of projects	Principle: *Business people and developers should work together daily for the entire project.*	Uncertainties and lack of previous relationship, in a new team	Establish contact with the customer and perform integration dynamics with the team in order to improve the environment and motivation.
Less interaction among projects	N/A	The spontaneous and creative exchange ceases to happen, with other teams in the startup, whose diverse experiences can collaborate in the growth of the other teams and improvements in the processes and projects.	Resume scheduled team interactions with other Agile software development projects in the company.

Source: Prepared by the authors (2023).

5 Conclusions

The biggest challenge of the pandemic and the social distancing pointed out by the participants refers to the need to adapt to remote communication, exclusively dependent on online chat applications, in addition to the suspension of any in-person interaction. Once the initial technological barrier was overcome and the adaptations to

the domestic and work environments and routines were made, all the interviewees concluded that they had no overall loss in productivity, and most of them were satisfied with the remote work routine. It is important to point out that different people experience the pandemic – or any other time of crisis –in very different ways and that no standardized action seems beneficial for everyone. Therefore, mutual support and an individualized look is crucial, especially from the leadership, who must be attentive to these issues.

It is important to understand that, behind the success of the teams, there were barriers arising from an unplanned and urgent migration to remote working, which can be mitigated by a management prepared to support the teams and instruct on new adaptations that may be demanded in different scenarios. Thus, we believe that the knowledge generated here can support the leadership regarding the decisions of the company.

While the interviewees reported a reduction in interruptions and meeting time, these facts also affected socialization. If on the one hand the productivity of these moments is preserved, there are gaps in the relaxed moments, in the building and maintenance of social bonds, especially if this is considered a long-term reality. And the same loss can be concluded about the coffee break and the meeting in the elevator, in short, many opportunities for connections that the online routine does not naturally provide, either in the interactions within the teams, as between the different teams of the startup. Although conversations can be promoted through online tools, they are limited to specific topics, without the power to capture between the lines of an informal conversation, without giving opportunity for spontaneous exchange of opinions and experiences of each project, with the baggage of each professional.

Returning to the research question, the answers found in the Alpha Company lead to the understanding that the existence of the identified barriers does not make remote work unviable for project teams with an Agile approach to software development in the state company studied, nor does it harm the delivery of the product, even though there are reservations about the gaps and difficulties found, due to the restriction to in-person interaction. This conclusion confronts two of the principles of the agile approach, which considers as a requirement the interaction of team members face-to-face and in person, on a daily basis.

Our study did not provide objective data regarding the productivity and performance of the teams and projects. All the statements and conclusions were subjective, and this essentially qualitative character constitutes a limitation of the study. This is a single case study research that portrays the reality identified and reported by a group of professionals from Alpha Company, and thus cannot be generalized faithfully to the circumstances of other teams. This study did not find family to have had any influence on the interviewees' productivity, possibly because the sample was not very heterogeneous, with an average age of 35 years, sharing the residence with few people, and mostly without children. However, it is understood that this work can contribute as a reference to other teams and companies, with a similar profile to that of Alpha, or guide new more specific analyses. Future studies can expand the sample of project teams that use the Agile approach, such as via online survey applied in a large sample of Brazilian and/or international public companies, in an attempt to verify the behavior in different profiles of professionals or organizational culture. Another possible suggestion for research is to focus on the skills needed by the teams and the learning and gains that may have occurred. This research was conducted as a part of an ongoing project by the authors.

References

Adhikari, K., & Poudyal, L. (2021). Future of construction industry: COVID-19 and its implications on construction projects and risk management. *Review*, 2021040383. http://dx.doi.org/10.20944/preprints202104.0383.v1.

Agrawal, M., Dutta, S., Kelly, R., & Millán, I. (2021). *COVID-19: An inflection point for Industry 4.0*. McKinsey & Company. Retrieved in 2021, March 14, from https://www.mckinsey.com/business-functions/operations/our-insights/COVID-19-an-inflection-point-for-industry-40

Ahimbisibwe, A., Cavana, R. Y., & Daellenbach, U. (2015). A contingency fit model of critical success factors for software development projects: a comparison of agile and traditional plan-based methodologies. *Journal of Enterprise Information Management*, 28(1), 7-33. http://dx.doi.org/10.1108/JEIM-08-2013-0060.

Anderson, D. J. (2003). *Agile management for software engineering: Applying the theory of constraints for business results.* USA: Prentice Hall Professional.

Anderson, R. M., Heesterbeek, H., Klinkenberg, D., & Hollingsworth, T. D. (2020). How will country-based mitigation measures influence the course of the COVID-19 epidemic? *Lancet*, 395(10228), 931-934. http://dx.doi.org/10.1016/S0140-6736(20)30567-5. PMid:32164834.

Badiale, M. E. (2020). *The dynamics of communication in global virtual software development teams: a case study in the agile context during the Covid-19 pandemic* [Master's thesis]. Uppsala University, Uppsala. Retrieved in 2022, February 20, from http://www.diva-portal.org/smash/get/diva2:1444145/FULLTEXT01.pdf

Bardin, L. (2011). *Análise de conteúdo*. São Paulo: Edições 70.

Baruch, Y. (2000). Teleworking: benefits and pitfalls as perceived by professionals and managers. *New Technology, Work and Employment*, 15(1), 34-49. http://dx.doi.org/10.1111/1468-005X.00063.

Batra, D. (2020). The impact of the COVID-19 on organizational and information systems agility. *Information Systems Management*, 37(4), 361-365. https://doi.org/10.1080/10580530.2020.1821843.

Beck, K., Beedle, M., Van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., & Thomas, D. (2001). *Manifesto for agile software development*. Retrieved in 2022, February 2, from http://agilemanifesto.org/

Bergamaschi, A. B., Filha, W. R. N., & Andrade, A. R. (2018). Home office: solução para aumento de produtividade no INPI. *European Journal of Applied Business and Management*, 3(4), 30-45.

Boehm, B. (2002). Get ready for agile methods, with care. *Computer*, 35(1), 64-69. http://dx.doi.org/10.1109/2.976920.

Butt, S. A., Misra, S., Anjum, M. W., & Hassan, S. A. (2021, January). Agile project development issues during COVID-19. In *Conference of the International conference on lean and agile software development* (pp. 59-70). Cham: Springer. http://dx.doi.org/10.1007/978-3-030-67084-9_4.

Conboy, K. (2009). Agility from first principles: reconstructing the concept of agility in information systems development. *Information Systems Research*, 20(3), 329-354. http://dx.doi.org/10.1287/isre.1090.0236.

Da Camara, R., Marinho, M., Sampaio, S., & Cadete, S. (2020). How do agile software startups deal with uncertainties by covid-19 pandemic? *International Journal of Software Engineering & Applications (IJSEA)*, 11(4),15-34. https://doi.org/10.5121/ijsea.2020.11402.

Daly, E. (2020). *Virtual Project Management through COVID-19*. Retrieved in 2022, February 12, from https://www.grantthornton.ie/insights/blogs/virtual-project-management-through-COVID-19/

Date, R. N., Pinochet, L. H. C., Bueno, R. L. P., & Nemoto, M. C. M. O. (2016). Aplicação do método ágil SCRUM em uma fundação educacional do setor público. *Gestão e Projetos: GeP*, 7(2), 75-94. http://dx.doi.org/10.5585/gep.v7i2.437.

De Smet, A., Tegelberg, L., Theunissen, R., & Vogel, T. (2020). *Overcoming pandemic fatigue: How to reenergize organizations for the long run*. Atlanta: McKinsey Co. Retrieved in 2021, March 13, from https://www.mckinsey.com/business-functions/organization/our-insights/overcoming-pandemic-fatigue-how-to-reenergize-organizations-for-the-long-run

Duffy, C. (2020). *Big tech firms ramp up remote working orders to prevent coronavirus spread*. Retrieved in 2022, January 13, from https://www.cnn.com/2020/03/10/Tech/GoogleWork-from-Home-Coronavirus/Index.html

Godoy, A. S. (1995). Pesquisa qualitativa: tipos fundamentais. *Revista de Administração de Empresas*, 35, 20-29.

Gonçalves, L. C. C., de Oliveira, S. A. A., Pacheco, J. D. C. A., & Salume, P. K. (2020). Competências requeridas em equipes de projetos ágeis: um estudo de caso em uma Edtech. *Revista de Gestão e Projetos*, 11(3), 72-93. http://dx.doi.org/10.5585/gep.v11i3.18476.

Gorbalenya, A. E., Baker, S. C., Baric, R. S., de Groot, R. J., Drosten, C., Gulyaeva, A. A., & Ziebuhr, J. (2020). Severe acute respiratory syndrome-related coronavirus: The species and its viruses–a statement of the Coronavirus Study Group. *BioRxiv*, 1-15. https://doi.org/10.1101/2020.02.07.937862.

Highsmith, J., & Cockburn, A. (2001). Agile software development: the business of innovation. *Computer*, 34(9), 120-127. http://dx.doi.org/10.1109/2.947100.

Kude, T. (2020). *Agile software development teams during and after Covid-19*. Paris: ESSEC Business School.

Larson, D. (2019). A review and future direction of business analytics project delivery. *Aligning Business Strategies and Analytics*, 95-114. https://doi.org/10.1007/978-3-319-93299-6_7.

Marek, K., Wińska, E., & Dąbrowski, W. (2021). The state of agile software development teams during the Covid-19 pandemic. In *Proceedings of the International Conference on Lean and Agile Software Development* (pp. 24-39). Cham: Springer. http://dx.doi.org/10.1007/978-3-030-67084-9_2.

Marodin, G., Frank, A. G., Tortorella, G. L., & Netland, T. (2018). Lean product development and lean manufacturing: testing moderation effects. *International Journal of Production Economics*, 203, 301-310. http://dx.doi.org/10.1016/j.ijpe.2018.07.009.

Neumann, M., Bogdanov, Y., Lier, M., & Baumann, L. (2021). The Sars-Cov-2 pandemic and agile methodologies in software development: a multiple case study in Germany. In *Proceedings of the International Conference on Lean and Agile Software Development* (pp. 40-58). Cham: Springer. http://dx.doi.org/10.1007/978-3-030-67084-9_3.

Nunamaker, J. F., Jr., Reinig, B. A., & Briggs, R. O. (2009). Principles for effective virtual teamwork. *Communications of the ACM*, 52(4), 113-117. http://dx.doi.org/10.1145/1498765.1498797.

Ozguler, I. S. (2020). Insights report-project management after Covid-19. *PM World Journal*, IX, 1-20.

Parente, T. C., & Federo, R. (2019). Qualitative comparative analysis: justifying a neo-configurational approach in management research. *RAUSP Management Journal*, 54(4), 399-412. http://dx.doi.org/10.1108/RAUSP-05-2019-0089.

Piontkewicz, R., dos Santos Perin, E., Freitas, M. D. C. D., & Mendes, R., Jr. (2019). Contribuição do software Nvivo na avaliação de disciplina com conteúdo em ambiente virtual de aprendizagem. In *VIII Seminário Hispano-Brasileiro de Pesquisa em Informação, Documentação e Sociedade (8shb)*. São Paulo: USP.

Project Management Institute – PMI. (2017). *A guide to the project management body of knowledge (PMBOK® guide)*. USA: Project Management Institute.

Project Management Institute – PMI. (2020). *Pulse of the profession® 2020: Research highlights by region and industry*. USA: Project Management Institute. Retrieved in 2021, February 7, from https://www.pmi.org/learning/thought-leadership/pulse/pulse-of-the-profession-2020

Rad, D., & Rad, G. (2021). Going agile, a post-pandemic universal work paradigm - a theoretical narrative review. *Postmodern Openings*, 12(4), 337-388. https://doi.org/10.18662/po/12.4/380.

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., Milani Fard, A., & Alkadhi, R. (2020). Pandemic programming: how COVID-19 affects software developers and how their organizations can help. *Empirical Software Engineering*, 25(6), 4927-4961. http://dx.doi.org/10.1007/s10664-020-09875-y. PMid:32952438.

Schmidtner, M., Doering, C., & Timinger, H. (2021). Agile working during COVID-19 pandemic. *IEEE Engineering Management Review*, 49(2), 18-32. http://dx.doi.org/10.1109/EMR.2021.3069940.

Seerat, B., Samad, M., Abbas, M. (2013). Software project management in virtual teams. In *Proceedings of 2013 Science and Information Conference, SAI 2013* (pp. 139-143). New York: Institute of Electrical and Electronics Engineers (IEEE).

Yin, R. K. (2016). *Pesquisa qualitativa do início ao fim.* Porto Alegre: Penso Editora.

Zhykhor, O., Ryeznikov, V., Iafinovych, O., Pohribna, N., & Miedviedkova, N. (2021). Project management in universities under the global pandemic: a focus on finance. In *Conference on Integrated Computer Technologies in Mechanical Engineering–Synergetic Engineering* (pp. 667-679). Cham: Springer.

Authors contribution

Renata Bittencourt Mendonça dos Santos was responsible for designing, planning, performing data collection and writing and revising this study. Paulo Soares Figueiredo was responsible for designing, planning, writing and revising this study.Felipe Tumenas Marques was responsible for designing, planning, writing and revising this study.