Impact of remote work on Portuguese software professionals during the COVID-19 pandemic

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Abstract. *Although remote work was already possible and used in some contexts, the COVID-19 pandemic made it normal and, in some situations, even mandatory. This was the case in Portugal and in particular in its software industry. Given this abrupt change in how we work, it became pressing to investigate the impacts of this profound change to remote work, so that we can cope with the potential negative consequences (professional, personal, etc.). Thus, the goal of this work is to study the impact of the referred change to remote work, due to the COVID-19 pandemic, on software professionals in Portugal.*

To achieve this goal, a survey was prepared and distributed via email, LinkedIn, and Instagram. In total, 176 valid answers were collected from software professionals working in Portugal from 38 different companies. After the performed statistical analysis on the targeted population and focusing on the 10 elaborated research questions, two major findings can be concluded with certainty: (i) having worked in a remote regime before the pandemic period has a strong relationship with a higher frequency of use of teleconference tools after this period, and (ii) participants who do not feel safe about coming back to a fully on-site regime are more likely to prefer a fully remote regime than the ones who feel safe, while the latter group is more likely to prefer a hybrid regime.

1. Introduction

Remote work is a type of flexible working arrangement that allows an employee to work from a remote location outside of the corporate offices. This concept dates back to the '70s when many countries worried about their oil and the impact that home-work commuting had on their reservoirs. In that same decade, Jack Nilles, a NASA engineer, laid the foundation for modern remote work when he invented the term "telecommuting" (Hill and Fellows, 2014).

In this century, remote work was somewhat used, often through a Wi-Fi equipped laptop or tablet or even a smartphone, to work from home, public libraries, coffee shops, or other places. The COVID-19 pandemic led multiple world leaders to decide to lockdown their population for several months. Even after that measure was eased, and since

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many restrictions were still mandatory (and, in some cases, still are), some companies decided to continue to embrace remote work.

Thus, this study intends to analyze and understand the impact that the change to remote work, due to the COVID-19 pandemic, caused to software professionals.

The literature is rich in discussing this same problem. For example, some authors focused their effort on understanding the impact on productivity (Bao et al., 2022; Bezerra et al., 2020; Guler et al., 2021; Russo et al., 2021b; Šmite et al., 2022), while others studied the impact of remote work on employees' family members (Chinnaiah and Smt.Chythra, 2021; Ford et al., 2021). Nevertheless, several of the questions analyzed in this work (see Section 3.3 and Section 3.4) were not found in the current literature. In particular, this is the case of the questions for which statistical significance was found.

Since this theme is somewhat extensive, only some parameters (such as dependents, home-work dislocations, productivity, etc.) were chosen (see Section 2 for more details). To achieve this goal, an online survey was created and distributed to which 195 individuals answered. From those answers, at the end, a total of 176 were considered valid.

From the collected data, it can be concluded that having worked in a remote regime before the pandemic period is correlated with a higher frequency of use of teleconference tools after this period. One can also conclude that people who do not feel safe about coming back to a fully on-site regime are more likely to prefer a fully remote regime, while the ones who do feel safe are more likely to prefer a hybrid regime. Both these conclusions are supported by statistical significance. Additionally, although not statistically significant, it was also found that (i) having dependents and someone's support in their care could possibly negatively affect participants' work; (ii) having dependents could possibly show a relation to a preference for a mainly on-site hybrid regime; and (iii) company employee dimension could show a relation to participants' feel of support to maintain productivity.

2. Methodology

To study the impact of COVID-19 on software professionals, a survey was conducted with a significant number of participants from 38 different companies in Portugal.

A survey is an interesting empirical tool that uses the same questionnaire for all respondents and allows statistical handling of the collected answers. Another important advantage of surveys over other mechanisms is that they do not demand too much effort from those that answer the questions (if those are well built, most of the times, the answer is simply "yes" or "no"), which can lead to having a larger number of participants. On the other hand, surveys are limited, since one has to believe that participants answered truthfully, risking getting answers that do not reflect what individuals really think.

Objectives. The main objective of this work is to *study the impact that the change to remote work, due to the COVID-19 pandemic, caused (on multiple levels) to software professionals*. Since answers were collected between December 2021 and May 2022, the results report to that period (although participants' answers may consider events prior to that).

Research questions. The elaborated research questions (RQs), based on the survey objectives, are:

RQ1 Does participants' gender relate to having no support from someone in their household?

RQ2 Do participants who have dependents suffer a negative impact on productivity?

RQ3 Are participants who have dependents and no support from someone in their household more negatively affected at work than those who do?

RQ4 Does having to work more hours than the regular work schedule relate to a change in productivity?

RQ5 Does adopting strategies to maintain productivity have a positive impact on said productivity?

RQ6 Do longer commuting home-work times (i.e., over 30 minutes) relate to a preference for remote work?

RQ7 Does having worked in a remote regime before the pandemic period relate to the frequency of use of teleconference tools?

RQ8 Are participants that do not feel safe about coming back to a fully on-site regime more likely to prefer another regime (i.e., fully remote or hybrid) than those who feel safe?

RQ9 When it comes to the hybrid regime, do participants that have dependents in their household prefer a mainly remote regime?

RQ10 Does company employee dimension relate to the participants' feel of support to maintain productivity?

Population and inclusion criteria. This study target population is software professionals that work in Portugal and switched from an on-site regime to a remote regime during the COVID-19 pandemic.

The questionnaire (and, consequently, the survey) is anonymous and analyzes multiple domains, containing two questions that filter irrelevant answers:

1. To exclude participants who do not consent that their data is used for research purposes;
2. To exclude participants who, during the pandemic period, did not change from an on-site regime to a remote regime.

Questionnaire structure. Based on the RQs, the questionnaire is divided into several sections, namely:

- personal data;
- academic and professional data;
- ascendents/descendents (dependents);
- household (for participants who have dependents);
- caregiver support (for participants who had support from household members);
- aid measures from the company;
- working hours;
- extra hours;
- commuting to work and housing;

- moving from your house;
- productivity;
- productivity strategies;
- remote regime;
- necessary equipment;
- future work regime, with three possible subsections: fully on-site regime, fully remote regime, and hybrid regime.

The conceived questionnaire consists of 20 sections and 40 questions, not all mandatory, since a certain answer may skip some sections and questions. As mentioned, the first two questions are used to exclude irrelevant answers. The next three questions are then used to characterize the participants' personal data and five more to characterize the participants' professional data, although only four were used in the analysis and one of these (company name) was turned into a category. The remaining questions intend to analyze the multiple studied domains, such as dependents, work hours, productivity, and preferred work regime. It should be noted that questions that involve writing and some regarding *housing* and *necessary equipment*, for example, were not considered for the statistical analysis, since most answers were not related to the pandemic and to the change to remote work. These concrete questions can be found in the first author's previous work (Almeida, 2022).

Survey validation.   Before the survey was widely distributed, five answers from two different companies were collected so that both the questionnaire accuracy and the survey viability could be validated.

Survey distribution.   The questionnaire was originally written in Portuguese, however, to not exclude foreign workers, it was translated into English. Both were shared and data was collected from both. For this study, the chosen platform was Google Forms, one of the most widely-used survey platforms. The two links for the Portuguese and the English versions of the survey were sent to software professionals via email and LinkedIn (via direct messages and posts) and shared through Instagram stories. They were encouraged to share the survey with their colleagues who might also take it. Since the survey is anonymous, an email address was provided so that participants who wanted to know the study results could ask to be contacted. The survey was available between 2021/12/13 and 2022/05/02. In total, 195 answers were collected, from which 176 were considered valid.

Statistical analysis.   All the analyzed variables are categorical, that is, they have two or more categories (e.g., "Yes" or "No"), but there is no intrinsic ordering to the referred categories (Watt and Collins, 2019). Therefore, the chi-squared test (χ^2) was used for all RQs in order to assess the existence of statistically significant differences between groups, regarding said categorical variables. *Pearson's χ^2 test* was used whenever the percentage of cell count expected to be less than five was inferior to 20%. When the referred percentage was equal or superior to 20%, *Fisher's exact test* was used instead. For measuring the effect size, the value of ϕ was used for variables that only include two

categories each and the value of ϕ_c was used when at least one of the variables included more than two categories. All the values of p that are lower than 0.05 were considered statistically significant.

3. Results and Analysis

In this section, the results of this study are presented and analyzed, starting with the participants (Section 3.1) and then the RQs (Section 3.2).

3.1. Participants

The Portuguese version of the survey has 165 answers and the English one has 30. There are two answers from individuals who did not work in Portugal and 17 answers from participants who did not change from an on-site regime to a remote regime during the pandemic period. Thus, the valid answers are **176** (90.3% valid answers). To ease the analysis, a Python script was created to automatically translate the answers in Portuguese to English. Both surveys were then merged to analyze all the answers together.

Regarding the 176 valid answers, 40 of them are from females, 135 from males, and one is from another gender. Most participants (127; 72%) are between 18 and 35 years old, 45 participants are between 36 and 50, and five are between 51 and 65. Most participants were born in Portugal (159), six in Brazil, four in France, two in Angola, and several other countries (Canada, Germany, Netherlands, South Africa, and USA) have one participant each. Regarding the academic background, 93 completed a M.Sc., 62 have Bachelor's degree, 10 a Ph.D., nine a professional course, and two concluded high school. As can be seen in Table 1, participants have a range of 41 different job positions, including back-end developers (17), chief executive officers (7), and project managers (14).

3.2. Research Questions

In this section, an overview of the results for each RQ are introduced and studied. Tables 2–11 summarize the referred results and each data cell presents the number of answers and its percentage (within parenthesis) in the corresponding line. For example, in Table 2, the number of female participants that answered *yes* to the *support from someone in household* was eight, representing 61.5% of the total females that answered (13). Each table also presents the statistical test used and the *p* value. For the RQs for which statistical significance was found, the *effect size* is also presented.

RQ1. Results for the RQ "*Does participants' gender relate to having no support from someone in their household?*" can be regarded in Table 2. In total, 38.5% of the female and 36.4% of the male participants did not have support from someone in their household, which means the difference between them is only 2.1%. Nonetheless, there were 50% fewer answers from female participants, which could mean that, if there had been more answers from this group, this percentage variation could be different. Despite this fact, this data still seems to indicate that **gender could possibly show a relation to having no support from someone in the household**.

Table 1. Frequency of participants' job position.

Job position	Count	Job position	Count
Back-End Developer	17	Product Manager	1
Business Analyst	2	Product Owner	3
Chief Executive Officer (CEO)	7	Professional Services Operations Team	1
Chief Product Officer (CPO)	1	Project Manager	14
Chief Technology Officer (CTO)	5	Quality Engineer	4
Cloud Automation Engineer	1	Quality Manager	1
Commercial	3	Research and Development Director	1
Data Engineer	8	Researcher	2
Data Scientist	3	Security Engineer	1
Database Administrator	1	Senior Consultant	1
Deep Learning Engineer	1	Site Reliability Engineer	1
DevOps Engineer	5	Software Engineer	5
Embedded Systems Developer	10	System Administrator	3
Engineering Director	1	System Analyst	4
Engineering Manager	2	Systems Architect	2
Full-Stack Developer	26	Team Manager	1
Integration Developer	3	Tech Leader	1
Knowledge Manager	1	Technical Consultant	1
Mobile Developer	3	Test Engineer	9
Network Engineer	1	Web Developer	14
Product Designer	5		

Table 2. Overview of RQ1 results.

Gender	Support from someone in household		Count
	No	Yes	
Female	5 (38.5%)	8 (61.5%)	13*
Male	12 (36.4%)	21 (63.6%)	33*

Stats.	Fisher's exact test $p = 1.000$

*The number of answers is just 46, since not all participants have dependents and therefore did not answer.

RQ2. Table 3 presents the results for the RQ "*Do participants who have dependents suffer a negative impact on productivity?*". This study shows that 17.3% of participants with dependents had a negative impact on their productivity, while only 12.3% of participants without dependents had a negative impact[1]. Additionally, 54.4% of participants with dependents considered their productivity increased, whilst only 48.4% without dependents answered their productivity increased. Thus, it seems that **having dependents could possibly relate to an impact on productivity, not only negative, but also positive**.

RQ3. Data from Table 4 can be used to answer the RQ "*Are participants who have dependents and no support from someone in their household more negatively affected at work than those who do?*". One third (33.3%) of the participants who have dependents and no support and two thirds (66.7%) of the participants who have both dependents and

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[1]The answers "Decreased significantly" and "Decreased slightly" are considered a negative impact on productivity while "Increased slightly" and "Increased significantly" are considered positive.

Table 3. Overview of RQ2 results.

Depen-dents	Productivity variation					Count
	Decreased significantly	Decreased slightly	Stayed the same	Increased slightly	Increased significantly	
No	2 (1.5%)	14 (10.8%)	51 (39.2%)	44 (33.8%)	19 (14.6%)	130
Yes	2 (4.3%)	6 (13.0%)	13 (28.3%)	20 (43.5%)	5 (10.9%)	46

Stats.	*Fisher's exact test* $p = 0.404$

support were negatively affected at work. In this case, and since the total number of answers is similar, it seems that **those who have dependents and support could possibly be more negatively affected at work** (contradicting the RQ), which can imply that perhaps the referred support was not sufficient or that other factors may be contributing to said negative impact.

Table 4. Overview of RQ3 results.

Negatively affected at work	Support from someone in household		Count
	No	Yes	
No	10 (40.0%)	15 (60.0%)	25*
Yes	7 (33.3%)	14 (66.7%)	21*

Stats.	*Pearson's χ^2 test* $p = 0.762$

*The number of answers is just 46, since only participants who have dependents answered these questions.

RQ4. Table 5 shows the results for the RQ "*Does having to work more hours than the regular work schedule relate to a change in productivity?*". This question, as all the others, is only related to working extra hours in the pandemic period (due to the change to remote work). Even though there were about 50% fewer answers from participants that did not comply with their work hours, the percentages of "Decreased significantly" and "Decreased slightly" were around the double when compared to the other group, which reveals a **tendency for a decrease in productivity when work hours were not respected**, although the lack of statistical significance does not allow the attainment of certainty.

Table 5. Overview of RQ4 results.

Comply with work hours	Productivity variation					Count
	Decreased significantly	Decreased slightly	Stayed the same	Increased slightly	Increased significantly	
No	2 (3.4%)	10 (17.2%)	18 (31.0%)	19 (32.8%)	9 (15.5%)	58
Yes	2 (1.7%)	10 (8.5%)	46 (39.0%)	45 (38.1%)	15 (12.7%)	118

Stats.	*Fisher's exact test* $p = 0.324$

RQ5. The results for RQ "*Does adopting strategies to maintain productivity have a positive impact on said productivity?*" are presented in Table 6. A total of 53.6% of the participants that adopted strategies had some positive impact on their productivity, whilst only 46.7% of the ones that did not adopt strategies had an increase in their productivity[2]. In this case and since the answer count is similar, it seems that **adopting strategies does have some positive impact on productivity**. Even though with the presented data no certainty can be obtained, the fact that different groups may consider distinct types of strategies might have affected the results.

Table 6. Overview of RQ5 results.

Adopt strategies	Productivity variation					Count
	Decreased significantly	Decreased slightly	Stayed the same	Increased slightly	Increased significantly	
No	-	10 (10.9%)	39 (42.4%)	31 (33.7%)	12 (13.0%)	92
Yes	4 (4.8%)	10 (11.9%)	25 (29.8%)	33 (39.3%)	12 (14.3%)	84

Stats.	*Fisher's exact test* $p = 0.158$

RQ6. Table 7 illustrates the results for the RQ "*Do longer commuting home-work times (i.e., over 30 minutes) relate to a preference for remote work?*". A total of 15.1% of the participants that take under 30 minutes to get to work, 20% that take 30 minutes to one hour, and 20% that take over one hour to commute to work answered that they preferred a "fully remote" regime, which is a somewhat even distribution. Only two participants (2.5%) preferred a "fully on-site" regime. Thus, the "hybrid" regime is the most preferred option for all kinds of participants, accounting for about 80% in all groups of commuting times. These facts seem to indicate that **commuting times may not be the primary factor for preferring remote/hybrid work**, although statistical significance could not be found.

Table 7. Overview of RQ6 results.

Commuting home-work times	Preferred work regime			Count
	Fully on-site	Hybrid	Fully remote	
Under 30 minutes	1 (1.2%)	72 (83.7%)	13 (15.1%)	86
30 minutes to one hour	1 (1.3%)	63 (78.8%)	16 (20.0%)	80
Over one hour	-	8 (80.0%)	2 (20.0%)	10

Stats.	*Fisher's exact test* $p = 0.841$

RQ7. The results for the RQ "*Does having worked in a remote regime before the pandemic period relate to the frequency of use of teleconference tools?*" are presented in Table 8 and, unlike the previous RQs, these are statistically significant. A total of 52.9% of participants who did work in a past remote regime used teleconference tools with the

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[2]The answers "Increased slightly" and "Increased significantly" are considered a positive impact on productivity.

same frequency as before the pandemic period whilst only 33.6% of the participants who did not work in a remote regime in the past used said tools with the same frequency. With this data, it can be affirmed that **having worked in a remote regime before the pandemic period has a correlation with a higher frequency of use of teleconference tools during the pandemic**. In this case, the effect size was computed, and, since ϕ is greater than 0.15, the aforementioned correlation is strong (Akoglu, 2018).

Effectively, participants that have worked in a remote regime before the pandemic period had to use teleconference tools to communicate with their team members or attend meetings. Essentially, their job was exactly the same, only the time period when it occurred changed. Thus, the frequency of use of those tools is somewhat expected to be similar in both periods (i.e., before and after the pandemic). On the other hand, participants that did not work in a remote regime in the past probably rarely used teleconference tools in their tasks, which confirms the smaller frequency of use of those tools.

Table 8. Overview of RQ7 results.

Past remote regime	Same frequency of use of teleconference tools		Count
	No	Yes	
No	83 (66.4%)	42 (33.6%)	125
Yes	24 (47.1%)	27 (52.9%)	51

Stats.	*Pearson's χ^2 test* $p = 0.019$ $\phi = 0.180$

RQ8. As in the previous RQ, the results for the question "*Are participants that do not feel safe about coming back to a fully on-site regime more likely to prefer another regime (i.e., fully remote or hybrid) than those who feel safe?*" are statistically significant (Table 9). 38.9% of participants who feel "Significantly insecure" prefer a fully remote regime, whereas 61.1% prefer a hybrid regime; 14.3% and 85.7% of participants who feel "Slightly insecure" prefer a fully remote or a hybrid regime, respectively. In fact, no participants in the referred groups prefer a fully on-site regime. Moreover, 16.7% of participants who feel "Significantly secure" prefer a fully remote regime, while 79.2% prefer a hybrid regime and only 4.2% prefer a fully on-site regime; 3.3% and 96.7% of participants that feel "Slightly secure" prefer a fully remote or a hybrid regime, respectively. Thus, with the present data, it can be affirmed that **participants are more likely to prefer a fully remote regime if they do not feel secure** and that **participants who feel safe about coming back to a fully on-site regime would still prefer to switch to a hybrid one**. Here, the value of ϕ_c (*effect size*) is greater than 0.15, which means that the relation between both analyzed variables is strong (Akoglu, 2018).

It is somewhat expected that participants who do not feel safe about coming back to a fully on-site regime would more likely prefer a fully remote regime when compared to the ones who do feel safe. This regime allows them to avoid being in their physical workplace and possibly being infected with viruses. In this case, for example, a mainly remote hybrid regime would always imply that part of the work hours had to be spent on-site, which could still be another viable alternative if their company did not allow a

fully remote regime. On the other hand, participants who feel safe to come back to a fully on-site regime tend to prefer a hybrid regime, which may seem peculiar, but such regime can provide an on-site portion and, at the same time, the comfort of working remotely, reducing commuting times and costs, thus allowing better schedule management.

Table 9. Overview of RQ8 results.

Safe about fully on-site	Preferred work regime			Count
	Fully on-site	Hybrid	Fully remote	
Significantly insecure	-	11 (61.1%)	7 (38.9%)	18
Slightly insecure	-	24 (85.7%)	4 (14.3%)	28
Neutral	-	41 (78.8%)	11 (21.2%)	52
Slightly secure	-	29 (96.7%)	1 (3.3%)	30
Significantly secure	2 (4.2%)	38 (79.2%)	8 (16.7%)	48

Stats.	*Fisher's exact test* $p = 0.032$ $\phi_c = 0.213$

RQ9. The results for the RQ "*When it comes to the hybrid regime, do participants who have dependents in their household prefer a mainly remote regime?*" are illustrated in Table 10 and show that 47.1%, 35.3%, and 17.6% of participants who have dependents prefer a mainly remote, balanced hybrid, or a mainly on-site regime, respectively. When comparing to participants who do not have dependents, there are over 50% more participants that prefer a mainly on-site regime. Thus, even though this data is not statistically significant, it seems that **having dependents could possibly show a relation to a preference for a hybrid mainly on-site regime**, contradicting the RQ. This can be explained in part due to the fact that taking care of their dependents for long periods may have had a negative impact on participants' personal and professional lives.

Table 10. Overview of RQ9 results.

Dependents	Preferred hybrid regime			Count
	Mainly on-site	Balanced hybrid	Mainly remote	
No	9 (8.3%)	30 (27.5%)	70 (64.2%)	109*
Yes	6 (17.6%)	12 (35.3%)	16 (47.1%)	34*

Stats.	*Pearson's χ^2 test* $p = 0.135$

*The number of answers is just 143, since not every participant prefers a hybrid regime.

RQ10. Table 11 illustrates the results for the RQ "*Does company employee dimension relate to the participants' feel of support to maintain productivity?*". A total of 68.8% of participants from small enterprises, 75.6% from medium-sized enterprises, and 80.2% from large enterprises felt support to maintain productivity. Even though with the presented data no certainty can be achieved, it seems that **company employee dimension could possibly show a relation to professionals' feel of support to maintain productivity**. The fact that there are more answers from participants who work in large enter-

prises can explain this, which could mean that results could differ if there had been more answers from the other groups.

Table 11. Overview of RQ10 results.

Company dimension	Company support (productivity)		Count
	No	Yes	
Small enterprises (up to 49 employees)	15 (31.3%)	33 (68.8%)	48*
Medium-sized enterprises (50 to 249 employees)	10 (24.4%)	31 (75.6%)	41*
Large enterprises (250+ employees)	16 (19.8%)	65 (80.2%)	81*

Stats.	Pearson's χ^2 test $p = 0.334$

*The number of answers is just 170, since some participants preferred not to say which company they work for.

3.3. Literature Parallelism

RQ1 hinted that gender could possibly show a relation to having no aid in caregiving of dependents. Even though there were less 50% female answers, they still had a slightly bigger percentage of not getting support when compared to male ones. Previous work (Russo et al., 2021b) states that gender does not reveal any differences in their considered variables, which, in this study case, is not entirely true. On the other hand, Machado et al. (2021) reached a similar conclusion to this study regarding gender *vs.* the lack of support and childcare.

Following the findings in RQ2, RQ4, and RQ5, productivity possibly suffered both positive and negative impacts (depending on the question), agreeing with what has been found (Bao et al., 2022). However, the referred conclusion is not in line with:

- Bezerra et al. (2020) who claim that productivity mostly did not suffer a negative impact;
- Russo et al. (2021b) who state that productivity did not change;
- Guler et al. (2021) who declare that productivity increased in general;
- Šmite et al. (2022) who affirm that productivity did not change significantly.

By analyzing RQ3 results, it can be concluded that having dependents and support from someone in participants' household seems to impact their productivity more negatively than those who do not have support. Ford et al. (2021) reached a similar conclusion on productivity impact when considering proximity to family members, claiming that it is beneficial for some and detrimental for others.

In the revised literature no similar or different conclusions were made that can relate to RQ6, RQ7, RQ8, RQ9, and RQ10.

3.4. Results Overview

Statistical significance could not be obtained for several of the RQs. Nonetheless, some ideas can be formulated:

- having dependents and support in their care from someone in participants' household could possibly negatively affect their work;

- having dependents could possibly show a relation to a preference for a mainly on-site hybrid regime;
- company employee dimension could show a relation to participants' feel of support to maintain productivity.

However, the results for two of the research questions, namely RQ7 and RQ8, show statistical significance:

- the results for RQ7 indicate that having worked in a remote regime before the pandemic period has a strong correlation with a higher frequency of use of teleconference tools after this period, which is reasonable since these participants were already familiarized with the use of such tools;
- for RQ8, the results demonstrate that participants who do not feel safe about coming back to a fully on-site regime are more likely to prefer a fully remote regime than the ones who feel safe and the latter are more likely to prefer a hybrid regime. This seems coherent, since a fully remote regime allows them to avoid being in a "public" workplace and a hybrid regime implies that, on some days, the job has to be done on-site. Like in the previous RQ, this relation is strong.

4. Threats to Validity

In this section, the possible threats to the validity of this work are presented and divided into four categories (Wohlin et al., 2012).

Conclusion Validity. One of the possible issues is the *low statistical power*. Indeed, for some RQs, no statistical significance was found. Nevertheless, the number of valid answers (176) provides a certain amount of confidence in the findings, which are mostly in line with the state of the art. Different statistical tests were used to not *violate assumptions of statistical tests*. Different RQs use distinct datasets, which were validated beforehand. More details about test considerations can be found in (Almeida, 2022).

Internal Validity. If the *instrumentation* (in this case, the survey) is badly designed, it may affect the experiment. To mitigate this threat, a few answers were collected before releasing the survey widely. These answers confirmed that the survey did not raise any issues with the participants and thus confidence was achieved in order to send it to a wider audience. Regarding the *selection* of participants, Wohlin et al. (2012) say that volunteers are generally more motivated for this kind of study, which was the case for all the collected answers.

Construct Validity. A possible issue is participants trying to *guess the hypothesis*. This is always a possibility, being quite difficult to validate. Nevertheless, although some questions have been posed in a negative/positive form, the answers were in the opposite direction. This provides some confidence that participants were trying to give real answers, instead of trying to make the answer "fit" the question.

External Validity. This kind of threat may limit the generalization of the results. In this study, all participants work in Portugal. This was a choice as it was intended to study the effects of COVID-19 on the Portuguese software industry. Nonetheless, almost 10% of the answers came from foreigners working in Portugal. Although this is not sufficient to make the results generic for those outside of our country, the obtained results are generally in line with the current literature, which is mostly international.

5. Related Work

Several other authors have studied the impact of the pandemic on the software industry. As in this work, productivity is one of the variables that has been studied. Bao et al. (2022) conclude that productivity possibly suffered both positive and negative impacts, results that are in line with this work. However, others have achieved different conclusions: Bezerra et al. (2020) claim that productivity mostly did not suffer a negative impact; Russo et al. (2021b) state that productivity did not change; Guler et al. (2021) declare that productivity increased in general; and Šmite et al. (2022) affirm that productivity did not change significantly.

Having dependents and the possible impact of their care was also addressed by Ford et al. (2021), reaching similar conclusions as in this study, that is, proximity to family members is beneficial for some and detrimental for others. When it comes to gender, Russo et al. (2021b) state that it does not reveal any differences in their considered variables, which in this study's case is not entirely accurate. On the other hand, Machado et al. (2021) reach a similar conclusion to the present work regarding gender *vs.* lack of support and childcare, with the proviso that, in this study, dependents refer to both children and elderly (e.g., parents or parents-in-law).

Many other articles were analyzed to better define the scope of this work, although their conclusions are not entirely related to the ones achieved in this study, since the considered variables are not the same. For example, Oz and Crooks (2020) state that communication between different teams increased more than within them and extra work-hour messaging became much more frequent. Russo et al. (2021a) claim that time distribution of working activities before and during the pandemic is very similar and working in a remote regime is not a challenge by itself. Guler et al. (2021) indicate that back pain increased significantly, revealing a decrease in employee health. Miller et al. (2021) conclude that reaching milestones was challenging, and Šmite et al. (2023) claim that workers adapt to their work condition with time. Chinnaiah and Smt.Chythra (2021) found that challenges faced by married and unmarried employees and employees with different educational backgrounds are significantly different and, lastly, Nguyen-Duc et al. (2022) affirm that startups did not perceive the impact of remote work differently.

A more detailed analysis of each of these works can be found in the first author's previous work (Almeida, 2022).

6. Conclusions

The COVID-19 pandemic has been devastating in multiple domains, and its impact cannot be fully calculated and most certainly will never be forgotten. With that in mind, the main objective of this work is to study one of the impacts that the COVID-19

pandemic caused, that is, the impact that the change to remote work caused (on multiple levels) on software professionals.

From analyzing the related work and from the presented work, it can concluded that there is an abundance of different approaches, but the results are somewhat similar – overall, software professionals that worked remotely during the pandemic period did not suffer the severe negative impact many would expect.

Additionally, companies should work on strategies to help their employees, however, those must be done for each and every single one of them individually, since different people have different needs.

One possible increment to this study would be to broaden its participants, for example, by conducting the survey in other countries and possibly finding a relation between them and their policies. Another possibility is to conduct the same survey again and try to obtain more answers in order to make some research questions statistically significant. To expand this study, one could also elaborate another questionnaire and conduct another survey on these same 38 companies in order to understand if there were some changes and how did they adapt, now that the effects of the COVID-19 pandemic have a different nature.

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