

What have we learned? A Conceptual Framework on New Zealand Software Professionals and Companies' Response to COVID-19

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Abstract

Context: The COVID-19 pandemic posed challenges to people from all professions and walks of life, and software professionals were no exceptions.

Objective: In this study, we investigated the impact of the COVID-19 pandemic on software professionals and their work practices with a focus on New Zealand. We specifically examined how software professionals and companies responded to different challenges, which is missing in the current literature.

Method: We conducted an exploratory study to learn how COVID-19 challenged software professionals and their responses to these challenges. We interviewed eighteen software professionals working in different New Zealand software companies providing them an opportunity to reflect on how they and their companies faced and dealt with the pandemic. We performed thematic analysis to identify various themes from our data set.

Results: We found that software professionals faced various personal, financial, and work setup-related challenges. COVID-19 impacted the

productivity and workload of software professionals. It also affected the software development practices for teams, specifically for colocated teams. We observed that software professionals tried to workaroud some challenges by themselves. We found that software professionals demonstrated empathy to their coworkers and supported each other during tough times. We also found that software companies facilitated software professionals in several various ways. We present a framework of the perceived responses of the software professionals, teams, and companies to various challenges they faced during the pandemic. **Conclusion:** Our results reveal that software professionals with specific demographics, e.g., working and single parents, contractual employees, and employees working for smaller companies, were most impacted by the COVID-19 restrictions. Our findings indicate that, through the COVID-19 pandemic, software companies trusted and empowered their employees and equipped them with the right tools and equipment and a healthy environment.

Keywords: COVID-19 pandemic, Impact: Challenges, Software professionals

1 Introduction

The COVID-19 pandemic sent shock waves through the world. The outbreak led to substantial implications. It affected the health, emotional, and social states of people and caused the world to face an economic downturn. It changed the way people lived and worked, causing restrictions like social distancing, mask wearing, and self-isolation. Like all other industries, the software industry needed to react and change based on these restrictions.

Soon after the outbreak, the software industry transitioned to a remote (work-from-home) setup to live with the changing times. Fortunately, for many software companies, working from home was not a unique concept. Many companies already had distributed teams, with employees working in different cities or countries, and some software professionals already worked from home occasionally. However, the COVID-19 restrictions forced more widespread work from home arrangements during the pandemic. This work setting both introduced challenges for the software professionals and brought new benefits [1–4].

A growing body of research studies have examined how COVID-19 has impacted life worldwide, and in particular investigated various aspects of the pandemic in software engineering, both in academia and the software industry. These studies have uncovered human, social, economical, and technical impacts of the pandemic [1, 2, 4–13].

In response to the pandemic, New Zealand is arguably a special case. They are well known for completely closing their borders early on, and were able to lift the strict pandemic-related restrictions earlier than many other countries (in June 2020). The country experienced a relatively normal life for quite

some time until the Delta outbreak's first case was confirmed (in August 2021). Their response to COVID-19 had been highly successful in limiting the virus spread. They were in a unique position to learn from the experiences of the rest of the world since COVID-19 entered New Zealand significantly later than other countries, and they have been less significantly impacted by COVID-19. They enforced shorter but more intense lockdowns. They closed borders to limit the spread. During the time between these restrictions, most software organisations moved to a predominant hybrid working environment [14]. None of the previous studies focused on New Zealand, so it was worthwhile investigating the challenges and perceived responses to COVID-19 and collating with previous studies for new insights. Thus, examining the challenges and responses in a New Zealand setting allowed us to study the responses during COVID-19 restrictions and the responses after these restrictions were lifted. To understand the adaptations that software companies and developers in New Zealand experienced during the pandemic and its effect on their personal and professional life, we posed the following research questions.

RQ1: *What is the impact of COVID-19 on software professionals? What challenges did they face?*

RQ2: *How did software professionals, teams, and companies respond to various challenges and support each other during the COVID-19 pandemic?*

We interviewed eighteen software professionals from seventeen different New Zealand companies and asked how COVID-19 impacted them. During our data analysis, other related studies began to be published. As a result, our discussion of insights includes a reflection and comparison to the findings in related work. To the best of our knowledge, while some papers inferred recommendations for companies to support software professionals during the pandemic, none of the related studies specifically investigated the perceived response of software professionals and companies to the challenges faced during the pandemic restrictions. In our study, we specifically aimed to fill this gap by investigating the response of the professionals, their companies, managers, and teams to the challenges they faced during the pandemic. To understand how they supported each other during the pandemic, it was important for us to obtain appropriate context and background to these responses, namely the challenges they faced during the pandemic. Our study participants reflected on the struggles they faced during the pandemic and uncovered how they, their companies, managers, and teams dealt with these struggles.

Our study brings two main contributions:

- A comprehensive account of the challenges that software professionals and companies faced during the pandemic within New Zealand's unique context, and how these challenges relate to the challenges reported by other studies in different settings.
- A conceptual framework that outlines and relates a variety of responses of the software professionals, teams, and companies to the various challenges they faced during the pandemic.

By uncovering challenges and responses to the pandemic from the specific conditions of New Zealand, this work has significant implications for both researchers and practitioners. It extends and validates the challenges other software engineering researchers reported. It presents a guide to practitioners highlighting how different software professionals and companies responded to several challenges. Other practitioners can learn from their experiences, reflections, and insights.

2 Related Work

Multiple studies have explored the impact of COVID-19 on information technology professionals [6–9] and academics [10–13]. For example, some studies explored productivity and highlighted the productivity imbalance w.r.t gender [10–13]. Few investigated stress w.r.t. participants’ demographics, e.g., gender, marital status, and the parental status of the participants [8, 9].

Many researchers have studied various aspects related to the pandemic and have published numerous studies in the field of software engineering. The objective, context, or contribution of each research study is different. Some focused on specific aspects, e.g., developers’ wellness and productivity [1, 5, 15], collaboration and communication-related aspects [3, 16], gender inequality [17], job satisfaction and work-life balance [18]. Others studied software development practices [19–21], typical working day activities of software developers’ [22], onboarding process [23], benefits and challenges of working from home [2], work settings [14], and points of gratitude experienced by software engineers while working from home [4].

A survey was conducted to study the **benefits and challenges** experienced by developers and managers while working from home during the pandemic [2]. It reported the prevalence and impact of the benefits and challenges. It also unveiled the relationships between the benefits of working from home and developers’ productivity and between challenges and productivity. Developers reported less time on commute, spending less money, flexible work hours, closer to family, more comfortable clothing as the main benefits of working from home. They reported missing social interactions, poor work-life boundary, poor ergonomics, less awareness of colleagues’ work, less physical activity as the main challenges while working from home. COVID-19 negatively affected the well-being of developers who suffered from stress, sadness, anxiety, and frustration due to multiple reasons, e.g., isolation, travel restrictions, closer of daycare and gyms, uncertainties for the future [24].

A nightly diary study reported experiences of **software developers** over the first ten weeks of the WFH [4]. Some of the challenges reported by the participants included having too many meetings, feeling overworked, and physical and mental health. Women reported gratitude related to the comfort of working from home. One of the studies explored how the COVID-19 pandemic has impacted the **onboarding process of new hires** in the software development teams at Microsoft [23]. Moving from physical offices to working from

home settings introduced challenges such as missing social connectedness. Several software companies encouraged social interactions in different ways during the pandemic. These include Friday pizza, questionnaires on music knowledge, chatting, playing games, and sharing meals with employees from other countries on video calls [25].

Studies have reported on the **well-being of software developers** and the **productivity of developers and teams** in the COVID-19 pandemic [1, 15, 26, 27]. Ralph et al. conducted a global study on the impact of COVID-19 on developers' wellness [1]. They identified poor disaster preparedness, fear relating to the pandemic, and improper work setup at home adversely affecting well-being. They identified a close relationship between wellness and productivity. They suggested that software companies need to focus on employee well-being to improve employee productivity. They also reported that women, parents, and people with disabilities are more likely disproportionately affected and suggested the need to facilitate and support employees' especially women, parents, and disabled persons. Russo et al. studied the relevant predictors of well-being and productivity for software engineers working remotely during the pandemic [26]. They identified 51 variables related to well-being or productivity from literature and ran several correlations and regression investigations to identify predictors of well-being and productivity. The study findings confirm a correlation between well-being and productivity. On average, software engineers' well-being increased during the pandemic and nine factors (out of 51) were associated with well-being and productivity. They also reported that working from home was not a significant challenge for software engineers. Bao et al. studied developers' daily activities to find the impact of working from home on developer productivity [27]. They found that working from home has different impacts on developer productivity. These vary with metrics (builds/commits/code reviews count) and project characteristics (project type/age/size, programming language). They also reported that developers have different productivity when working from home. Bezerra et al. conducted a survey study in Brazil to understand how human and organisational factors (e.g., work environment, teams collaboration, organisation, communication, motivation) impact team productivity while working remotely during the COVID-19 pandemic [15]. Their findings report that most participants (greater than 70%) remained productive, felt motivated, and communicated well with their co-workers. They also noted that factors like an external interruption, environment adaptation, and emotional issues significantly influence productivity.

Another study focused on ways software development teams **collaborate and communicate** when working from home [3]. Findings reveal that many developers found reaching milestones challenging, impacting their team productivity. The study also reported factors related to team culture that were affected, such as communication and social connection. Developers missed social interactions with their colleagues and struggled to brainstorm and communicate with colleagues. To explore the impact of COVID-19 on **software**

projects and professionals [5], a mining study of 100 Java projects was conducted studying project metrics, e.g., number of commits, issues, pull requests, branches, comments. To further understand the impact on daily activities and well-being, they surveyed professionals and reported observations on productivity, code quality, and well-being. An example observation is that working from home during the pandemic did not impact code contribution. Another example observation from the repository analysis indicated a decreasing trend in the number of bug fixes commits, but results from the survey contradicted this observation.

A few studies also looked at the impact of the pandemic on **software development and management methods and practices** [19–21]. The research findings indicate that the pandemic did not significantly impact the software development teams, practices, and artifacts. They reported that using different online tools and adapting practices were beneficial during the pandemic. The team communication improved when everyone went remote. Another study explored **gender inequality** during the COVID-19 pandemic by looking at how working from home impacts women and men differently [17]. It revealed that women faced challenges in performing housework and child care responsibilities with a lack of support, and organisations addressed men’s needs and concerns more. They suggested that organisations should support women software engineers working remotely and provide a flexible and empathetic workplace.

Most of these studies primarily focused on the impact of the pandemic on specific aspects (e.g., the onboarding process of new hires [23], developers’ wellness [1], gender inequality [17]). The majority of these studies collected data through surveys (e.g., [1], [2]), unlike ours, which used interviews. Interviews allow researchers to delve deeper into particular areas of interest by asking follow-up questions to clarify any concerns or strengthen their understanding. Some of these studies were limited to a specific setting. For example, studies by Rodegher et al. [23] and Bao et al. [27] were based on one company, i.e., Microsoft [23] and Baidu [27]. Some studies were based on one country. For example, a study by Bezerra et al. [15] was based on data from Brazil only. On the other hand, our study focused on different companies within New Zealand. We collected perceptions from software practitioners across seventeen companies from New Zealand. These variations in contexts brought nuances to our research. There were similarities and differences in findings between our study and previous studies. We highlight them while reporting our results in response to RQ1 in Section 4. We have reported the challenges faced by the developers as personal, financial, work environment, work, and work practices-related challenges. We touched upon different facets of the personal-level issues of the developers, such as their health, anxiety, safety, job insecurities, domestic responsibilities, and loneliness. Several previous studies have discussed these issues separately, but to the best of our knowledge, none of the prior qualitative studies have covered all of these facets in detail. We have compared our findings with other studies which reported similar issues (in Section 4.1). Similarly,

not much was reported about how COVID-19 impacted developers financially. Our study illustrates what financial difficulties developers faced w.r.t. their earnings, leave balances, contract renewals, and resignations. Previous studies have reported WFH-related challenges in a great deal. Our analysis also reported similar issues, i.e., lack of reliable internet connection, ergonomically-sound furniture, equipment, and dedicated workspace. In addition, our study revealed frustrations developers faced due to a lack of IT support and services during the COVID-19. While reviewing the literature, we found that

Table 1 Participants Demographics Summary

Demographics	Number (N)
Role	Developer (6)
	Tester (3)
	Product Owner/ Manager (3)
	Senior/Software Engineer (2)
	Integration Engineer (1)
	Data Scientist (1)
	Leadership Role (1)
	Senior Technical Analyst (1)
Age	Between 20 to 30 (5)
	Between 31 to 40 (10)
	Between 41 to 50 (3)
Gender	Men (9)
	Women (9)
Domain	Retail (1)
	Banking (2)
	Accounting (1)
	Insurance (2)
	Cloud Services (1)
	Health Care (2)
	Embedded Systems (1)
	POS & Inventory(1)
	Productivity (2)
	Payroll (1)
	Online Payments (1)
	Transport (1)
	Finance (2)
Status	Single (2)
	Couple (4)
	Parents (10)
	Single Parents (2)
Company Size (NZ)	Small [employees <= 100] (10)
	Medium [employees between 100 and 499] (4)
	Large [employees>= 500] (4)

a very few studies examined how software practitioners perceived companies responded to different challenges during the pandemic. We examined the perceived responses of the software professionals, teams, and companies to the various challenges. The prior work did not cover this side of the COVID-19

in depth. Some researchers proposed recommendations based on their analysis and findings or participants' suggestions for improvements while studying different aspects of the pandemic. For example, they suggested paying for home internet, arranging home equipment and furniture, paying attention to emotional well-being, improving remote communication infrastructure, and understanding the different needs of the employees [1, 3, 15]. Our study also reported some responses similar to their recommendations and are supported by empirical evidence. We reported different responses (Section 5), which we have categorized into people, work, and leadership sides of organisations (during thematic analysis) and presented them as the conceptual framework (in Figure 1). The framework puts together our findings on the responses of software professionals, teams, managers, and companies against different personal, financial, work environment, work, and work practices related challenges reported by the participants. It shows what attributes/elements (e.g., bonding, empathy, trust, support, trust, communication, transparency, technology, equipment, environment) contributed to the people, work, and leadership sides of organisations.

3 Research Method

3.1 Data Collection

We made a call for participation in this study through networking sites (LinkedIn, Meetup Groups) and personal references. We collected data from first eighteen participants who responded to our call through semi-structured interviews. All these participants were experienced software practitioners working in seventeen different software companies based in New Zealand. Table 1 summarises the demographics of the participants involved in the study. All the participants were actively involved in software development activities and performed roles such as developer, tester, product owner, software engineer. We refer to them as software professionals in this study. The data set included 50% women and 50% men who were singles, couples, working parents, and single parents. The experience of the participants in the software development ranged from 2 to 20 years. Participants were working for software companies developing software solutions for a diverse range of markets, e.g., healthcare, accounting, finance, and transport. The data collection was spread across three months during June 2021- September 2021. In the beginning, most of the interviews were conducted in person (n=10). But after the COVID-19 Delta outbreak, we conducted them through Zoom under lockdown restrictions (n=8). These interviews lasted 30-45 minutes on average. Some examples of the interview questions asked from the participants are listed below. More questions can be found in the supplementary material.

Q: What challenges did you encounter while working during the pandemic?

Q: What helped you to workaroud those challenges, any strategies you or your team members found useful?

Q: Have you had any additional support from your team or manager? Can you

Table 2 Companies and Participants Demographics; Company Size (# of employees in New Zealand (NZ)): Small (# of employees ≤ 100), Medium (# of employees between 100 and 499), Large (# of employees ≥ 500)

Company #	Size (NZ)	Product Domain	Participant #	Age	Gender	Role
C1	M	Retail	P1	50+	W	Tester
C2	L	Banking	P2	35-40	M	Developer
C3	L	Accounting	P3	25-30	W	Developer
C4	M	Insurance	P4	35-40	W	Tester
C5	S	Cloud Services	P5	39-35	W	Tester
C6	S	Insurance	P6	35-40	M	Product Owner
C7	S	Health Care	P7	35-40	M	Developer
C8	S	Embedded Systems	P8	35-40	M	Software Engineer
C9	M	POS & Inventory	P9	25-30	W	Senior Software Engineer
C10	S	Health Care	P10	35-40	M	Integration Engineer
C11	L	Finance	P11	30-35	M	Senior Technical Analyst
C12	L	Banking	P12	30-35	M	Product Owner
C13	S	Productivity	P13	35-40	W	CEO
"	"	"	P14	25-30	W	Data Scientist
C14	S	Transport	P15	35-40	M	Senior Developer
C15	S	Payroll	P16	25-30	W	Developer
C16	M	Online Payment	P17	35-40	W	Product Manager
C17	S	Finance	P18	25-30	M	Senior Developer

please share some examples?

Q: Did your company implement anything specific to address your challenges?

Q: Are you happy with how your team or company responded to the pandemic?

Why and why not?

Q: Any improvements you would suggest to cater your needs well in the future?

All the interviews were audio-recorded and transcribed by the main author or automatically through zoom. We manually checked each transcript against the audio when the generated transcripts were unclear.

3.2 Data Analysis

We performed data analysis through thematic analysis (TA) [28]. TA facilitates a systematic identification and organisation of common patterns, i.e., themes in the data set. We followed Braun and Clarke's six phases of thematic analysis [28], i.e., phase 1: familiarizing with the data, phase 2: generating initial codes, phase 3: searching for themes, phase 4: reviewing potential themes, phase 5: defining and naming themes, and phase 6: producing the report. Next, we elaborate on how these phases were conducted in this study (examples provided in Table 3).

We read the transcripts multiple times to make sense of the data and highlighted the potential areas of our interest annotating the transcripts in Nvivo, a data analysis tool. Then, we analysed the highlighted areas relevant to our primary research questions (RQ1 & RQ2). In phase 2, we performed a systematic analysis of the data through coding. We assigned labels to annotated parts of the transcripts from phase 1. It was done through open-coding using Nvivo, clearly identifying the code name and its associated text segment. We applied

Table 3 Data Analysis Process: Application of Thematic Analysis

Participants' Quotes	Initial Codes	Themes
☹️ <i>We were really kind of workaholic and trapped in with kids, it was really difficult. (P6)</i>	Workaholic,	Personal Challenges
☹️ <i>If you're working at home in the lockdown with your kids jumping on your lap and all the time, it's inevitable. (P2)</i>	Working with kids around	
☹️ <i>As we were listening about redundancy from here and there (news & friends) we had fears and our managers had no idea what is coming up next. So you feel like hopeless (P1).</i>	Job insecurities, Hopelessness, Future uncertainties	
☹️ <i>Insecurity for jobs and insecurity about how is the world going to work has been always been in our mind. (P9)</i>		
☹️ <i>This item is dependent on USA_API tribe and who's going to sort that out. (P6)</i>	External dependencies	Development Challenges
☹️ <i>We had a few people who decided to leave like by their own will and we were supposed to replace them but then pandemic started we decided to not hire. Even though we had so much of workload, they did not hire new people.</i>	Hiring freeze, no replacements adding more work	Work Challenges
☹️ <i>So they're not pushing us to put out the latest and greatest, in that respect, we weren't under the pump. (P2)</i>	Less work pressure	Form of Support
☹️ <i>CEO saying we're not going to unnecessarily retrench employees. They clarified multiple times almost in every call that their intention is that nobody is made redundant. (P5)</i>	Keeping employees well informed	Open Communication
☹️ <i>CEO would send messages and remind people that look we're not looking to fire people. (P2)</i>		
☹️ <i>Initially, we were on Skype as an organisation. So that was a bit flaky on our VPN, but then we moved into Microsoft Teams and it became more efficient. (P12)</i>	Previous tools not efficient	Tools Challenges

coding until the entire data set was fully coded and we captured patterns within the data.

Next, while grouping similar codes, we noticed that specific themes started to “*represent some level of patterned response or meaning*” within the data set [29], e.g., categorisation of challenges and responses. In the next phase, we ensured that the themes addressed our research questions, are not covering too much, not overlapping, have a clear purpose [28]. For example, one theme *personal challenges* was drawn from the codes like *looking after kids, job-securities, hopelessness, future insecurities*. We found that this theme was covering a lot, so we further categorised it into sub-themes of *anxiety, safety, job insecurities, domestic responsibilities, loneliness*. Following the same process, we categorised both the challenges and responses under different sub-themes and themes. Then, we made sure that our final set of sub-themes and themes generated provided the best mapping with our research questions. The themes developed were reviewed to ensure that the themes captured the essential elements of the data w.r.t. the research questions and present a meaningful and coherent storyline about the research. Although informal writing in the form of research notes started in the initial phases, the final report is prepared in the last phase of TA. The results are formulated and reported by addressing the research questions, which we have elaborated on in the results section (Section 4 - 5). The first author collected and analysed the data. However, all the six phases of thematic analysis were conducted with mutual understanding and detailed discussions amongst the co-authors. The themes generated were validated through discussions during fortnightly team meetings throughout the study. When there were any disagreements or differences of opinion, we opted for a healthy conversation leading to solutions benefiting our research study.

During our data collection and analysis, we became aware of many other similar studies being published. Therefore, in our data analysis, we compared our findings to these studies and report accordingly in our discussion of insights. We structure our contributions in the form of a framework (Figure 1) that presents the perceived responses of the software professionals, teams, and companies to various challenges bringing into context the unique New Zealand setting. We describe the framework in Section 5. Before that, to give context, we describe our findings on challenges experienced by our New Zealand respondents in our studied organisations in Section 4.

4 What is the impact of COVID-19 on software professionals?

The pandemic impacted software professionals in several different ways. They faced many challenges which we have reported as personal and financial challenges. We have also reported challenges which were related to their work, i.e., work setup and space, productivity and workload, and software development practices. Table 4 presents the themes and sub-themes of the challenges

faced by the developers. We acknowledge that the current literature presents concrete results on the impact of the pandemic on the software development teams and individuals. Therefore, we present and discuss our findings in light of existing software engineering studies on the impact of the pandemic.

Table 4 Impact of COVID-19 on Software Professionals

Themes (Challenges)	Sub-Themes
Personal	Health Anxiety Safety Job Insecurities Domestic Responsibilities Loneliness
Financial	Jobs Earnings Leave Savings
Work Environment	Tools & Infrastructure Equipment Working Space & Conditions IT Support
Work	Slower Transitional Pace Lack of Motivation Varying Productivity Levels Lack of Support Manager's High Expectations More Reporting to Manager More Work Responsibilities Imbalanced work home life Varying Commitment levels Fear of Delivering Enough
Work Practices	Cadences Development Practices Artefacts Dependencies

4.1 Personal Challenges

Participants reported personal challenges that were mainly related to their health, safety, and family. The pandemic created fear and uncertainty for everyone due to job insecurities. They reported going through a variety of negative emotions, such as *stress*, *frustration*, *anxiety*, *insecurity*, *loneliness*. Coping with all these difficulties was challenging.

Health: A common challenge was a prolonged screen time and less physical activity while working from home. In an office environment, people tend to move from one desk to another to ask questions, e.g., during formal or informal team meetings, which gives them some time away from their screens. As a

result, participants faced common health issues like headaches and eye stress. One participant shared their problems as.

'In office we leave screens for meetings but at home we just stick them for the entire day. Because of this my health issues were increased like headache, eyes stressed and tired, I felt all these.' (P7)

Other studies have also reported a reduced physical activity while working from home during the pandemic [2, 15] in addition to stress and headache, tiredness, sore back [4]. Sleep disorders were also experienced [5]. On the contrary, a study reported improvement in health as there was no commute and the developers got to have more sleep and rest [2].

Anxiety: There was a constant fear for those with family overseas of losing their sick relatives and not being able to reach their countries. Not being closer to their families created anxiety and grief. A participant shared about a colleague who lost their loved ones and could not join their families.

'It was devastating to hear about colleagues who lost one of their parents because of Covid and were just helpless.'(P12)

One participant's team member who was away on holiday when New Zealand closed borders was stuck overseas, adding anxiety and uncertainties around reaching back. Participants had these fears in their minds throughout these stressful times. Similar concerns were also reported in other studies [25].

Safety: Participants also expressed concern for the safety of their family members. Many preferred to work from home whenever possible to avoid public transports and events to protect vulnerable family members, e.g., elderly partners or parents. They were reluctant to attend public gatherings. A participant expressed concern over their partner's health as.

'My partner is a lot older than me. He's 70 years old and I'm very much worried about his health. My going out makes him more vulnerable.' (P1)

Another participant disliked the idea of having a work conference earlier post lockdown. Generally, there was a fear and anxiety of contracting COVID-19, as indicated by other studies and working from home was considered an advantage for their safety [4, 5, 15].

Job Insecurities: Participants were worried about their jobs. There was the stress of being made redundant. The participants felt terrible for their colleagues who were laid off due to COVID-19. It created job insecurities. They were worried about being the next in line. A participant shared their experiences and feelings as.

'Even though you weren't one of them, but you worked with them. After we went into lockdown, they (leadership) started making decisions. When somebody who wasn't made redundant, he would ring me up and talk about it. There was quite a lot of an emotional time, really upsetting and very sudden and scary.' (P1)

Lack of job security was also evident from other studies [25].

Domestic responsibilities: were reported amongst common challenges faced by the participants. It was hard for them to juggle roles (parent, spouse, work) while working. Employees with small or school going children were highly impacted.

‘Because me and my wife were both full time working. So we had to juggle the kids, I would attend critical meetings, and then have her looking after the kids and then we’d swap.’ (P12)

Multiple studies confirm that women and parents were significantly impacted by the pandemic [1]. Sharing work with child care responsibilities, being physically co-located with family, children, or pets were reported as the most frequent challenges [3, 25]. Similarly, staying focused with young kids and meeting their expectations to spend time or help was hard to manage [2].

There were times when family members had time clashes with meetings. It was challenging to accommodate multiple meetings in a limited space and with other family members around. In such cases, one of the family members had to talk to the manager to reschedule to look after the kids needing supervision at home. But finding a time suiting everyone was a bit challenging.

‘Personally my wife and I were stressed like if we had a meeting at the same time. Sometimes, I had a meeting and my son also needed me for the meeting at the same time it was difficult to manage, meeting clash was difficult to handle.’ (P7)

Some developers struggled more because of their personal situations. For example, a divorced parent found it challenging to work full time and look after three kids due to lack of support. They had to work harder to support their kids and perform their job responsibilities as a father and a full-time software developer as indicated.

‘It’s very difficult when they’re here. They’re all going to school remotely. I get up early, so I start at five in the morning. So, I’ve done probably three hours work before the kids in start to wake up. And then usually, they’ll have school zoom meetings around 9 o’clock.... So, after they get up, the day gets quite fragmented. And then it becomes quite long, I do a bit here, but there and I got to help someone. And then it kind of drags out for a long time, because I make sure I do everything work a whole day, but also helping the kids. So it makes for a very long day...’ (P15)

On the contrary, some developers struggled less because of their situations. For example, a working mother shared how having a spouse who was out of work during the lockdown made their life easier.

‘I was positively impacted. My husband got unemployed and used to prep everything for me to cook dinner. He did all of any support that my son needed for school, whether it been getting set up for Google meets, or having power to his laptop at the dining table or, or whatever he needed.’ (P17)

The partners of essential workers (e.g., health-care and retail workers) who did not have children reported that working during the lockdown did not change much in their lives. They kept working from home while their partners followed their usual work routine.

‘Actually, she (essential worker), so she got to maintain a normal schedule. Home life wasn’t too much different other than we couldn’t go out and do stuff.’ (P18)

Conversely, when essential parent workers left the house each day, their partners had to work and take care of kids, putting them in the same position as ‘single parents’.

Participants reported experiencing many awkward moments with kids and pets during these times. While having kids and family around, it was hard for them to isolate themselves. Parents struggled to respond to their kid’s needs side-by-side and work. They shared that in the beginning, they felt embarrassed, but with time, everyone was aware of these challenges and accepted it as a regular thing. Participants shared some moments as:

‘Often when I’m at home, either the kids will jump over the keyboard or my pet over when I’m in a meeting and start doing something they shouldn’t.’ (P3)

‘Many times it happened like you are in a management meeting with your colleagues and your child comes and you are excusing to the management about your child and sometimes their children come in during the meeting such things were usual and the challenges were known.’ (P11)

Loneliness: Some single participants shared experiencing loneliness and isolation during the lockdown. They found it challenging. Some indulged in work, while others ended up in increased screen time, e.g., watching TV shows and playing video games to keep them busy. These responses varied across developers. One participant shared that not socializing during lockdown was a problem for them, whereas their colleagues enjoyed staying home. A participant felt alone being at home and missed social interaction at work.

‘I’m just been in my flat. And I’m not very close friends with anyone and feel a bit isolating..’ (P16)

Participants missed social connectedness while working from home. They get to chat with others at the office while grabbing a coffee, taking a break in the kitchen, or sharing space while having lunch or smoke breaks. Other studies have also reported instances of missing social interaction and feelings of loneliness during the pandemic [3, 26].

4.2 Financial Challenges

The financial hit from COVID-19 influenced people from all walks of life and software professionals were no exception. Not all software companies were prepared to face this financial impact. Consequently, some software professionals lost their jobs and faced salary deductions.

Jobs: Participants revealed that some of their colleagues lost their jobs abruptly. It included employees from all tiers, from senior management to junior roles. Participants also shared that their contractor colleagues, like software consultants, did not get any contract renewals. But the companies honored their agreements and didn’t terminate them earlier. Participants also faced situations where their employers refused to take resignation letters back during the lockdown.

Earnings: Many participants mentioned salary deductions as a common challenge. Some had minimal deductions for a specific time, while others experienced flexible deductions. A participant opted for a flexible deduction,

i.e., 10%, due to a personal situation of working for certain hours as a visa requirement.

‘My issue is that I am on a work visa. And because of that, I needed to have a certain amount of hours and salary. And taking 20% would be an issue for my visa.’ (P9)

Financial difficulties and temporary paycuts during the pandemic were also reported by other studies [25].

Leave balance: Participants also reported situations when they wanted to cancel the leaves they applied before the lockdown. Some struggled as their employers refused to cancel them. They had to avail them during the lockdown. Some employers encouraged their employees to use their existing accrued leave time before a certain time, e.g., before the end of the financial year.

Savings: On a positive side, a few participants pointed out that they saved the money from their children’s daycare and after-school expenses. Similarly, some were happy not to pay the parking charges at work. A study also revealed that developers saved money they used to spend on the commute and eating out [2].

4.3 Work Environment

Participants shared struggles they faced when working from home. These include lack of reliable internet connection, ergonomically-sound furniture, equipment, dedicated space, and delay in getting IT support. Other studies also highlighted these challenges [1, 2, 4, 5, 25].

Tools & Infrastructure: Developers faced various tools, infrastructure, teething or performance-related issues. Many participants reported that at the beginning of the lockdown, their company’s VPN infrastructure was compromised. Even though some employees used to work from home remotely, but with lockdown, everyone had to join remotely, putting the load on the infrastructure. Some employees had low broadband packages and not everyone’s workstation was configured to connect remotely. On top of that, broadband companies were facing an overwhelming load impacting many developers. A participant expressed frustration over bad internet while working from home. *‘I was living with my parents for some time, they had quite bad internet connection. And it was quite annoying over calls kept cutting out or like not hearing what the people said, really frustrating.’* (P16)

Some companies asked their employees to log on to the network only for critical work. Such issues were experienced for a relatively shorter period. A participant shared how it impacted them, leaving the option for a limited number of employees to connect to the company’s network.

‘We had a rough patch because our VPN couldn’t accommodate all users. So we had to get people to sit at home and not do anything until we resolved VPN capacity issues.’ (P12)

Multiple studies also reported connectivity issues. These include VPN access from home, broadband, and bandwidth-related problems [2, 4, 5]. It was also

reported that internet and remote connections issues were mainly faced at the beginning of the pandemic [4].

On the other hand, companies working in distributed settings had a smooth transition, as indicated below.

‘So we were pretty lucky that all worked with everybody to WFH. We were able to access the code access, pre-production environments and things like that. So that wasn’t too bad for us, but I know of other companies they’re overloaded the system and they really couldn’t access the VPN.’ (P3)

Participants experienced other minor issues on an ongoing basis during the lockdown, e.g., the mic stopped working for the speaker, system restarting for updates, power unplugged unintentionally. But over time, people started developing an understanding that such things can and will happen and supported each other.

Equipment: Working from home with limited equipment was not easy for everyone. Work offices have equipment which makes them more productive. Participants struggled to work from home without extended screens and other supportive equipment. Some participants reported facing minor issues. One participant shared frustration over managing two laptops to use a camera.

‘It took months for me to get a camera working on my work laptop. So, for two months, I was managing two laptops, I would do the comms on my personal laptop... so that was really annoying having to manage two laptops.’ (P17)

‘Very few people had decent audio devices.’ (P11)

Some developers did not have any work laptops or personal computer at home and they had to wait until the company arranged laptops for them, as indicated by one of the participants.

‘There were about half the company didn’t have laptops. So for the first couple of weeks of lockdown, our service desk was literally building laptops for people. So there were people that literally could not do their jobs, because they didn’t have a work laptop.’ (P6)

Some developers could not perform their day-to-day responsibilities due to inaccessibility to special equipment. A developer mentioned needing ten phones and tablets for mobile testing and windows and mac machines for iOS development to perform their routine work. One participant revealed that they could not do very urgent work on the point of sale during the lockdown due to missing equipment. Luckily, one of the developers took all the equipment and they had to do both the development and testing using that equipment. Others mentioned holding off on the work that required access to the necessary equipment. Other studies also noted insufficient hardware as a key challenge while working from home during the pandemic [1, 2]. Some developers needed powerful workstations to carry out their job responsibilities. They had to use their personal laptops instead. Some required peripherals such as mice, keyboards, noise-cancellation headphones for effective working [2].

Certain people struggled more in getting equipment during these times. For example, a female employee returning from maternity leave had trouble getting hold of her laptop, which was left unused in the office for six months.

An employee who went on vacation to their home country before the lockdown struggled to get the work started. It took some time for the company to arrange a laptop and virtual set up to let the employee work remotely. New developers also faced delays in receiving their machines. A participant working in a banking domain indicated the delays a new resource faced in setting up a working machine. In a normal situation, it was easier and done quickly, but it took far longer during the lockdown.

‘So we have to load it with a lot of security software like hardware encryption, and VPN software. So it has to be pre-loaded as user name and pre-registered on the computer and then shipped to the user.’ (P2)

Working Space: Some developers had space issues as they lived in small apartments or shared spaces with others. Not everyone had a reasonable and dedicated working space set up with desks, chairs, and power sockets. This was common in employees of companies who were only allowed to work from the office prior to COVID-19. Employees who were working from home occasionally had some setup in place. Other studies also found challenges with home work environment and settings, e.g., lack of space to set up a home office, desk, chair, multiple screens [2, 25].

It was common to work while being surrounded by their partners, children, siblings, parents as also indicated by other researchers [2, 25]. Developers who were sharing accommodation and had other people in the house had a different set of challenges. Studies indicate that some developers had to work from non-dedicated spaces (e.g., kitchen table, garages, laundry rooms) [2]. Many developers faced delays in getting the purchased desks and chairs and some deliveries due to COVID-19. A participant shared how developers utilised their home stuff to set up a working space.

‘We had a joking competition early on which was the worst possible desk setup. One of my colleagues was literally on the ironing board with boxes stacked with a monitor on top of boxes. Then literally having three screens that were mounted on monitor, on a sustained desk, and sort of everything in between. So, it was less about the technology issues, I would say more about the space issues..’ (P17)

IT Support: Facilitating a large number of employees was challenging for the network and security departments and teams. Some companies had strict security policies with limited access to employees. Only the IT person can do any software installation. Before lockdown, the IT guy would walk to the machine and get the issue sorted. Just giving a call or reporting an incident was enough to get any software installed. It became challenging during the lockdown as the queue kept increasing with requests causing delays for minor issues.

4.4 Work

Developers reported work related challenges. Some of these can be reported under the personal challenges but we have placed all the work related challenges here. Some examples are slower transitional pace towards working from home, lack of support, more work responsibilities and reporting.

Slower transitional pace: COVID-19 impacted the productivity of the majority of software professionals, especially in the beginning. Productivity was lower than usual due to many reasons such as shifting to new ways of working and other challenges mentioned in Section 4.3. But within days, software professionals adapted to new ways of working to regain the momentum. The whole business operating rhythm for the companies and teams changed when COVID-19 hit the world. It shifted towards keeping the lights on critical work rather than driving projects forward. The focus was to ensure that nothing breaks or crashes for the users or clients.

Lack of Work Motivation: Some participants quoted that it was hard to stay motivated all the days during the lockdown. There were days when they felt more excited about work, but then there were days when they struggled to stay motivated. The motivation of team members varied across days. Normally, everyone in the team was busy doing their tasks but there were days when someone in the team had to work harder to pull everyone together. Driving everyone as a team virtually was a challenge.

‘Some days, it would be kinda, I wouldn’t say not a lot of work, but quite like, you know, what you’re doing and and you just put your headphones on and work away. And then other days, it’s just, everything’s chaotic, and you kinda have to get everyone involved towards the stuff.’ (P18)

Other researchers also reported decreased work motivation during the pandemic [2, 5, 21, 26, 30]. Developers struggled to stay motivated while working from home, particularly completing boring tasks [4]. However, another study found that 49 out of 58 participants reported staying motivated while the rest felt little motivated to complete tasks [15].

Low Productivity: While looking at how developers perceived their productivity during the pandemic, we found that many developers reported being less productive. Single parents and working parents reported low productivity, especially when the schools were closed due to childcare and home-based schooling responsibilities on top of housekeeping chores. Another study reported a 40% drop in productivity of working parents who had difficulties due to lack of childcare support [2]. Similarly, developers living in a shared accommodation reported to be less productive.

‘In my case, for example, I had my two young kids at home, so it was difficult to have the same output as being in the office.’ (P3)

Another developer shared how working from home was challenging with other distractions.

‘I’m not very good at working from home. I tried it a few times and I just wasn’t very productive. I just feel like I just tend to, like get more done in the office,

I think it's just the environment of being at home, just do something else for a little bit and then get caught up. And I just, it's hard to stay motivated.' (P16)
Another developer shared how working from home worked well for their co-workers, but not for them.

'Yeah, they've [team] been really good. The only thing is like, my productivity has gone down in lockdown. Like, I just feel like someday I don't achieve anything. Some days have been good.' (P7)

Ford et al. also indicated a variation in productivity with the difference in situations with remote work [2]. Some developers reported being more productive, while others were disadvantaged with remote working. Ralph et al. reported reduced productivity for developers while working from home during the pandemic [1]. Other studies also suggest that several factors affected the developers and teams' productivity when working from home [15, 26, 27]. External interruptions in the form of family, children, co-workers, loud sound is identified as a key factor for reduced productivity [15].

It was hard for the developers to stay productive at all times. A participant found working from home slower until they purchased additional equipment. They acknowledged setting up the right environment boosted their productivity. Another study also supported this and revealed that a poor home working environment is related to developers' productivity [2].

Some developers reported being more productive. The time they initially spent on commuting, facing traffic issues, and getting ready for work was utilised in working. Similarly, having no distractions and spending time socialising at the office kept them more focused on work.

'Definitely more productive to be honest. Because you start early in the morning, you come out of the bed, and you open your laptop and start working, there is no commute involved, you don't have to go to the office, and you know all those things, and no coffee breaks, and smoking breaks and all those things.' (P10)

A lead shared that their team members delivered more during these times. They spent more time working which boosted their productivity. Many participants reported working more than usual hours.

'I think because people did not have to commute. At least that's how I was doing it. Sometimes I was working late. And I was the watching time and I was like, 'Oh, that's usually I would be gone at that time. That would not be home yet. And so I was thinking I can continue to work a little bit more.' (P9)

'I think I just had the same amount. But they're working more. So that's maybe how we were more productive? Because, yeah, if you have the same work, but you're working a little bit more, you're delivering more.' (P5)

This is also supported by existing research that brings insights into changes in developers' productivity during the pandemic. Studies indicated decreased, increased or stable productivity depending on various reasons [2]. A study noted that the majority of the survey participants reported stable, or improved productivity, but a substantial number of participants reported being less productive [2].

There were managers who were not concerned about productivity. They expected slight variations in productivity encouraging employees to focus on their well-being. They kept the work timings flexible to meet their needs. A participant shared that the overall productivity of the team balanced out due to diversity they had in the team. Some team members had higher output while others struggled, balancing out the overall team productivity. Another product owner shared that they did not observe any variations in terms of the team velocity.

‘I worked in a team of very talented software engineers, I did not see any change. Our velocity was pretty consistent, I think we took, we might have taken a slight dip consciously at the beginning, because we very much advocated start late, finish early, get out for a walk in the morning, get out for a walk at night, just to keep yourself sane...’ (P17)

Some participants shared the workload was the same and managers did not explicitly restate the expectations. There was a general expectation that people would continue to work and do what they used to before the lockdown. *‘Because we’re coding and we should be able to do that just as effectively in the office as at home. So, I think the expectation was pretty much unchanged. It’s a bit more fragmented now..’* (P2)

Lack of Support: Developers who joined a new company before the pandemic struggled at work due to a lack of support. They were reluctant to ask for help as the co-workers were also struggling in their lives. There were many instances when they had to wait for a domain expert to share their knowledge or help them solve any technical issue. It impacted their productivity and frustrated them.

‘Many people like me just joined the company and for initial months we were sitting doing nothing because we were facing bottle necks, we needed help and the availability was very limited.’ (P8)

High expectations: Participants felt that their managers had high expectations during these times. It was common to have an informal chat after working hours about work. Many developers shared instances of team conversations on slack, responding to the manager’s email, or answering teammates’ queries outside working hours.

‘Even line management was thinking that ‘Okay, he’s gonna respond, right’. Expectations were high because it’s lockdown, whether it’s sunny, windy or whatever weather. They were thinking they are at home, they can’t do anything much. So they’re gonna respond us. So even I was chatting with my manager, like around 7-8pm in general is not the case.’ (P6)

Another study mentioned a similar challenge. It was common to receive work-related correspondence outside working hours. There was an expectation of being highly responsive to teammates’ messages and emails at all times [2].

More Reporting to Manager: Few participants expressed concerns around a lot of reporting to the manager. They had to approach the manager to inform them of their progress frequently and make them aware of any work dependencies. It could be because not every manager fully trusted their employees when

they were working from home. Managers putting in more reporting could be a way to ensure their satisfaction on work commitment.

‘I felt I have to tell every single thing to my manager which I was not doing previously for every task I have to report before and after at the day end , during the task as well.’ (P7)

More Work Responsibilities: Some teams were short of resources before the COVID-19. Due to delays because of COVID-19 and a hiring freeze, team members had to share the responsibilities of the missing resources.

‘For that (left) person, we didn’t get any replacement, we did not hire a new team member. But all of the work was divided equally within the team, which was like causing a lot of stress. I would say that the workload was quite a lot during the time.’ (P4)

Another participant shared how workload increased for specific employees in the company. The company’s VPN could not accommodate everyone in their teams for almost three months until it managed to get all employees back on VPN to perform their job functions. Software professionals had to perform the responsibilities of other coworkers adding more workload.

‘They classified employees based on how critical the function that they perform and I was one of those employees. What that meant was also picking up the work of others, it was quite a busy time. And because I was kind of performing a critical function for the company, it was extra load of work.’ (P12)

Software professionals in leading roles such as technical managers had to work more during these times. A participant acknowledged their team lead’s extra work as:

‘Our dev team lead, she’s kind of in charge of all of us and the work we’re doing. There was a bit of extra workload for her.’ (P3)

Software professionals from industries (e.g., online payment, e-commerce, health, cloud services) stated a significant increase in the amount of work due to the rising needs of their business and clients.

No working routine/Imbalanced work home life: Some participants reported hectic routines. It was common for software professionals to work outside business hours. They were working more than their usual hours. There was flexibility in joining and finishing time, but it came with a trade-off of overworking. Because outdoor activities and social gatherings were not allowed, it was common to keep busy with work. To fulfill their domestic responsibilities during the day, parents worked at a later time.

‘I personally did spend a lot of hours, long nights, trying to catch up with work that were just kind of piling up, and did notice quite a few of the team members were were online as well.’ (P12)

Developers were putting in extra time in office work. It resulted in imbalance of work and home life. One of the participants mentioned imbalance of work home life as.

‘My office and my home was quite mixed up in those days, and which I don’t like it, because when I leave office generally, or when I exit that door, I know I’m done with the day.’ (P6)

‘For people like me and a lot of people in my team, we really need that disconnect. We’re probably working a lot more than 40 hours a week and not really noticing it which is not a good thing..’ (P4)

‘It felt like we are always connected to our machines.’ (P5)

Numerous studies also reported that developers struggled to set up work and home boundaries [4, 5, 25, 30]. They spent a lot more hours than their usual working hours. In contrast, some studies indicated that working from home helps balance work-life with flexible working time [2]. Working from the office builds a routine separating work and personal life for some developers [21]. Otherwise, it’s hard to keep track of time while working from home.

Varying Commitment level: The commitment level of software practitioners varied across individuals. Participants revealed that some of their teammates were unresponsive on slack during the day. They did not bother to let others know about their unavailability when they were going away for a few hours. A few members were leaving earlier and wouldn’t bother to make up those hours later. On the other hand, some employees demonstrated higher commitment. They were completing their eight hours by starting earlier or working later, e.g., working parents were compensating their hours after the kids were sleeping.

‘... had to struggle at the hours on you to work as well. Yeah, taking some time out to like, be with the kids, look after them and stuff. So that was definitely the biggest challenge where I wanted to make sure that I work my eight hours and don’t take breaks and also be with the kids in some way.’ (P3)

Fear of not delivering enough: Participants expressed their fears of not doing or delivering enough to others. Many times, being in the office physically is taken as a measure of doing work and being productive. There is an assumption that people are working even if they are not. It’s hard to assess if people put in their required hours when working remotely. A participant mentioned how it bothered them in the beginning.

‘... When you are in the office, everyone just thinks ‘Oh, she’s here so she’s working’. And sometimes you’re not doing anything during your day and you go home and that’s all good. But at home, I was like, people are going to judge me on my productivity. So I need to get things done. So I think I had more of this pressure of thinking, no one is watching me. So I have to deliver work to show that I was working can help.’ (P9)

4.5 Work Practices

We found that where COVID-19 impacted software professionals, it also impacted software development activities and practices but on a limited scale. Most of the teams did not find it significantly challenging as they were used to working from home on an occasional basis. Both our findings and related studies indicate that many teams working in a distributed or remote environment were able to transition to fully remote work [19] and minor changes were made to software development practices, artifacts, or roles [20]. Studies also indicate

that working from home during the pandemic did not significantly impact the efficiency and performance of software teams [20], project success [21], pace and work quality [19].

Cadences: Teams started/kept practicing the cadences virtually. They actively used tools such as Microsoft teams, Google G Suite, Zoom, Slack, Discord. Participants reported facing some challenges with tools initially as also indicated by other studies [20, 30] but within few days or weeks they were able to run these events smoothly. Our results and literature indicate that teams with distributed teams or members were impacted the least as they already used virtual tools to facilitate them [19].

‘It was much the same, because we’re always distributed so COVID didn’t really make much of a difference.’ (P10)

Daily stand-ups were the most common and frequently happening cadences for team communication. They were easiest to switch to online with few adaptations. Teams had longer daily stand-ups with a different format where members discussed aspects beyond sharing the usual status and impediments. It was mainly an event where everyone in the team was present virtually. The time of the stand-ups varied for teams. But teams preferred having it in the afternoon to accommodate participants working outside the usual 9am-6pm office clock and facilitating parents who needed to help their kids set up for their school. Teams moved the timing of the stand-ups to later parts of the day. Many participants confirmed that the number of meetings also increased during these times.

‘We had more than usual meetings so that we could catch up each other more than once in a day to see how things are going.’ (P11)

Other studies have also reported adjustments to cadences [20]. Teams doing weekly meetings started daily stand-up meetings to increase team synchronization. Some teams introduced another meeting after the daily stand-ups to promote communication within the team. Some teams extended these to accommodate communication issues, for confirmations on work items, and to chat [21].

Many teams struggled with brainstorming virtually as a replacement for face-to-face interactions using whiteboard. Cadences which relied more on discussions such as retrospectives, sprint planning, refinements were more effective when done in person as per most of the participants. Generally, people absorb information visually as participant says.

‘Every developer have their own expertise some can understand voice, and some needed wordings and personally, I understand more through white board so I faced difficulty in understanding..’ (P7)

These events were impacted by decreased engagement over digital communication channels, e.g., the absence of physical boards and post-its and the inability to express and share emotions as with face-to-face communication. But participants agreed that it wasn’t something that significantly impacted the quality of their work or project outcomes. However, many participants found these sessions more effective when done in person.

Studies noted that teams practiced retrospectives using tools (e.g., Retrium, Word, EasyRetro) [20, 21]. Generally, nothing much changed in the way retrospectives and sprint planning meetings were conducted [20]. But not all team members found the experience of online retrospectives pleasant compared to the in-person [21]. Studies reported that sprint planning meetings were less detailed and showed decreased engagement of the development team [7, 21].

For some teams showcasing their work became challenging. A participant working on embedded systems mentioned that most of their demos were on the software layer and they had a virtual version of their operating system running on the hardware so they struggled. Few companies planned their major releases involving their squads every six months. They used to fly (e.g., from Auckland to Wellington) to other offices to plan everything for the next three to six months together. These gatherings were replaced with virtual planning meetings.

Some participants found communicating with clients challenging during the pandemic. Non-technical clients preferred in-person meetings and some clients had internet connectivity and timing issues. Other researchers also report this [30, 31].

Development Practices: The core development practices ran smoothly with online tools and cloud based platforms. But developers faced some issues which were due to other reasons, e.g., inaccessibility to the equipment, lack of support. Participants mentioned that they did not have all the gadgets at home, so sometimes, they had to delay working on that task for testing purposes.

‘We had the gadgets, usually those gadgets will stay in the office premise, because obviously, we were working from offices more, but now we have those gadgets at home..’ (P5)

‘So some teams are working with this small terminal, to take payments eftpost and it’s just a few people so it was easy for them to just take them home.’ (P9)

Developers stated that screen sharing for resolving configuration related issues was challenging.

‘Screen sharing was quite tricky. You need to look at the code and it’s really difficult for your eyes to walk through especially if the configurations are missing.’ (P6)

Many teams were working distributively and using cloud-based development tools. They acknowledged a seamless transition with CI/CD and TDD practices, automation in place, and builds integrated with pull requests. Both literature or participants did not report anything challenging about these practices.

‘So we were using Bitbucket and we had set up build servers. So one of the problems was if a server went offline (for power) ‘Could someone actually go into the office to turn it back on.’ (P2)

Pair programming was challenging because of missing in-person communication. Participants stated that doing these practices with someone sitting

next to them and demonstrating things in front of the screen was better. Participants reported a smaller number of pair programming sessions during the lockdown. Not all participants found screen sharing as the best option. In situations, when someone wants to pair program, it was done through slack chat, screen sharing. A study reported that pair programming has changed in *frequency, sequence, and intensity*. The quality of pair programming has changed due to constraints introduced with distributive settings and digital collaboration [20] resulting in less sessions [21].

Code Reviews: For many teams, current practices for code reviews did not have a lot of verbal communication. It was mainly written down on the code using the code reviewing tools. For example, teams who were practicing code reviews on GitHub still managed to do it online. Code reviews were impacted by not being able to communicate with each other synchronously.

Estimation: Teams estimated work items by playing poker using virtual cards or numbers which everyone selected and then SM revealed the estimates followed by a discussion on why they chose that, very much similar to in person estimating. None of the teams found it challenging. Other studies also report this. Communication tools (such as MS Teams, Slack) replaced planning poker cards. The Scrum Master would verbally count down from three and the team members would publish their estimates in the team channel [20].

Artefacts: Teams maintained the artefacts through management tools, such as Jira, Trello, Microsoft's Azure DevOps (formerly VSTS). They kept using these tools like they were before COVID-19. We found that the pandemic did not significantly impact artefacts such as product backlog creation, the definition of done, and acceptance criteria from both literature [19] and our data set. However, a few participants shared that their team often raised a concern that the user stories and acceptance criteria were not designed for people working remotely.

'You might need to ask for clarification a lot for like JIRA tickets. It's not well defined.' (P2)

Other studies also indicate that many teams were using online tools (e.g., in Jira, Trello) to manage their backlogs before the pandemic. Those working with physical backlogs reported missing the physical activity of interacting with the backlog and less transparency without the physical backlog [21].

Dependencies: Participants reported that dependencies within teams were managed easily in meetings or informally on chat. Software professionals faced challenges to manage external dependencies, e.g., something to be done by a network or system team or site reliability engineering (SRE) on the cloud.

5 How did software professionals, teams, and companies respond to various challenges and support each other during the COVID-19?

As indicated earlier, many researchers studied the impact of the pandemic on software professionals. But a very few examined the responses and the changes

adopted by the companies and teams. While investigating the responses, we found that software professionals, teams, and companies responded to various challenges in several different ways. We have categorised their responses under *people*, *work*, and *leadership* (shown in Figure 1). The icon **C** represents company, **t** represents teams, **M** represents managers, and **d** represents developers in the following sub-sections.

5.1 People

Support: We observed that companies supported their employees in different ways. For examples, the support was provided from different stakeholders of the software companies, i.e., senior leadership, human resource department, technical managers, and coworkers. It varied in forms from informal calls to financial support. Similarly, team members supported each other.

- **Check-in calls:** **C** **M** were reported by the majority of participants from smaller, medium, and larger companies. However, the person making these calls varied with the size of companies. For example, a participant from a medium-sized company reported that the HR department staff called every employee to check. For smaller companies, senior managers and team leads made these calls to check on how everyone was doing. Participants appreciated their efforts and stated it as a nice gesture. Team managers were generally very ‘supportive, cooperative, kind’ as reported by the participants. The managers tried to make them feel as if they were at the office by calling their team members to have a friendly chat with them. Some of the phrases commonly heard by the participants from the managers were ‘*How are you? How’s your family doing?*’. It was also a typical pattern to inquire of any obstacles teams might be facing as, ‘*Are you facing any issues?*’, ‘*How can we help?*’, ‘*Any challenges you would like to solve or where we can support you?*’ were common questions shared by the participants.
- **Paid days off:** **C** The management appreciated employees’ efforts. They rewarded employees in different ways. Some provided time off to relax and lessen their stress, e.g., declaring an extra holiday, calling it ‘refresh me day’, ‘Matariki holiday’. Employees were allowed to take one or two holidays during a specific month, as an extra paid holiday. It was motivating for the employees that their efforts were appreciated. They also constantly reminded the employees to take care of their health, not getting exhausted, panicking, or stressing out.
- **Monetary Incentives:** **C** Companies gave monetary incentive as a token of appreciation for their employees’ work and dedication. Some companies offered good bonuses at the end of the year to express appreciation of their employees work. Few gave an assigned amount to every employee to support them through pandemic time acknowledging their efforts.
- **Well-being Hampers:** **C** It was also reported that employers parceled well-being gift hampers/baskets to pamper their employees and make them feel special. The employees truly appreciated these gestures. These

included items such as herbal teas, pop corns, cookies, chocolates with a personalised note of appreciation.

- **Logistic:** **☉** **f** **d** Companies mostly took care of logistical issues. But even team members were quite supportive of each other in this matter. For example, a participant who was commuting to work on an electric scooter was offered a ride by a colleague to carry equipment (e.g., extra screens, desktop) to home to facilitate WFH. Some developers managed such issues by themselves.
- **Paid with no work:** **☉** Companies supported their employees when they were not doing any work. For example, a company paid a large number of its employees when they could not connect to the company's VPN for about three weeks and perform their jobs. The company had been very supportive, acknowledging it was not their employees fault.
- **Flexible Pay Cuts:** **☉** Some companies offered flexible options for pay cuts to their employees to decide what was best for them. A startup company offered options for pay cuts for a pre-defined period of three months. Participants acknowledged this to be better than coming up with one standard option for everyone or any redundancy plan. The employee decided how the company should apply the pay cuts from the options, i.e., 10% pay cuts, but working regular hours, 20% pay cuts and not working one day of the week, and 40% pay cuts not working two days a week.
- **Furlough leave plan:** **☉** To avoid any lay off, some companies came up with a short-term furlough leave plan. The employees were not paid for one day fortnightly for a pre-defined period. The participants appreciated it as an acceptable trade-off to secure their jobs and avoid any redundancy. Another company put everybody on a four-day week and within a couple of months they were back on five days a week work routine.
- **Defer business innovation:** **☉** Companies put their big plans on hold to facilitate their employees. A participant shared that they barely delivered any new feature for quite some time. It was just support work and being responsive to customers where they needed help. Another participant from a high-demand domain, i.e., online payments, shared how the company decided not to pursue innovations. The higher management made tough calls about prioritization mostly cutting out innovations to lessen pressures on their staff.
- **Hiring Freeze:** **☉** To avoid any layoff, companies suspended hiring new resources. They made it clear to their current employees that they may experience an increase in the workload.
- **Cutting Expenses:** **☉** Companies applied budget cuts on traveling, training, and other improvement plans such as new office buildings or renovations to secure their current resources.
- **Supportive Culture:** **☉** **f** Employees were encouraged to ask for help. Those who needed time off to take care of their kids were accommodated. Everyone was encouraged to look after their health and well-being.

Reminders for employees to go for a walk and get some fresh air were common in company-wide calls. It was common for the teams to chat about informal stuff to advise each other or share their problems. Separate slack channels were created and used for such purposes.

- **Self-care:** **d** On a personal level, participants ensured having activities such as breaks, walks to break prolonged screen time. Some indulged in activities (playing video games, watching TV series) to keep them busy. To avoid work gatherings, developers availed their annual leaves. A developer utilized their annual leave to avoid encountering a large crowd at a work conference as a solution. They avoided public commutes and instead used personal vehicles or worked from home where possible for safety concerns.
- **Self-support:** **d** It was also very common that single parents, working parents, family members with special needs were working later at night or early mornings to suit their conveniences and deal with their personal challenges. For instance, parents switched responsibilities on alternate days to look after the kids. Another parent availed annual leaves when day care centres were closed. Similarly, both parents were working half day at different times to look after the kids. Parents also utilised their annual leaves to look after their children. Developers who joined soon before the pandemic put extra effort into searching and reading relevant resources to educate and upskill themselves.

Empathy: Managers and teammates were empathetic towards each other. This empathetic behavior was reflected in their day to day activities.

- **Setting low expectations:** **C M** Participants shared that higher management did not set high expectations from the employees during these stressful times. They understood that people might not perform as they used to in usual circumstances. Some employers gave precedence to employees' well-being over productivity. The managers made it clear that they were not expecting high output from the employees.
- **Work life balance:** **M** Some participants revealed that their managers put less workload on their teams at the start of the pandemic. The managers ensured that everyone was doing and managing well and ensuring that they were not too stressed or labored. The focus was to ensure that people were not burning out. Managers clarified that being at home doesn't mean that they need to work. They encouraged them to take regular breaks and maintain a work-life balance, reiterating its significance to employees at multiple events.
- **Accommodating needs:** **M t** Developers empathized with teammates in particular situations and supported them. A team member who just came after maternity leave struggled while working from home due to a lack of childcare support. The other team members helped her by responding to her emails outside working hours. Similarly, managers and teammates catered to developers who needed to support their kids or working spouses by scheduling the meetings keeping their teammates' preferences in mind. Participants also reported moments of silence during

meetings. Attendees would be silent; they would mute their microphones or switch off their video. But everyone in the team was quite accommodating and would respect their choice. With flexible work timings, some members were working quite late. Developers stayed connected on phones for emails or informal responses on slack channels to support teammates working in different working slots.

- **Caring: t** With flexible work timings, some members were working quite late. If someone was sending an email late, they would explicitly mention that it is not urgent work and they can look at it tomorrow. Teammates were empathetic to each other. It was to take the pressure off them. While approaching others outside work hours, teammates would first check their availability. It was a nice gesture to ask permission and wait for the other person to confirm with the whole family at home.

Team Bonding: During the COVID-19 times, companies and teams tried to maintain the bonds between teammates in different ways. They promoted team bonding activities to promote healthy team culture, boost team morale, and improve their productivity.

- **Virtual catch ups: t** Teams had informal (synchronous or asynchronous) conversations in which people talked about things happening in their lives outside work. Team members discussed challenges they were facing at home with kids, shared recipes they have tried, suggested any TV shows or series others should watch on Netflix, and generally discussed how they were coping at home. A team introduced an optional current affairs chat every two weeks on the calendar where people can talk about what's happening in the world and what they think about it. Teams planned virtual catch ups to keep everyone well connected during these times. It provided them opportunity to share their problems, making them feel they're not alone with their struggles, and benefit from each other's experiences.
- **Team bonding activities: c t** To maintain team camaraderie, teams had team bonding activities such as games, celebrating birthdays. They supported social connections through virtual coffee mornings and weekly pizza parties. Few companies introduced a virtual onboarding company-wide lunch to welcome all new hires. Similarly, some teams scheduled a virtual onboarding team lunch. The new employee would order the meal and the company would reimburse the meal's cost. The company or team would learn more about the new member during this social event.
- **Virtual work sessions: t** Teams scheduled an optional co-working event sent out as a google invite to everyone in the team. It is an empty Google meet video call that anyone can jump in and work together. Even if they are not talking, they are online with other teammates simulating an office environment.

5.2 Work

Technology: Tools played a pivotal role in performing work responsibilities and for better communication and collaboration amongst different stakeholders. We found that teams already using or started using virtual tools for software development practices were the least impacted. Teams faced some manageable challenges.

- **Communication & Collaboration:** **C t M** Using communication and collaboration tools was more of a necessity than an option during the pandemic. Choosing and using same set of tools was effective, e.g., Microsoft teams suite, Google suite. Tools used to facilitate distributed members were scaled up so the whole company could use them. Companies increased and scaled their VPN infrastructure. Some configured backup VPNs to support loads and slow response times. Companies changed their tools and applications to enable smooth remote working. A company that used Skype as a communication tool switched to Microsoft teams. Teams encouraged to use channels for information sharing amongst team members and discouraged using direct messages or one on one conversations when it is about anything relevant to the product. Few companies also provided guidance on using different communication platforms.
- **Software Development:** **t** Teams reviewed external dependencies in their stand-ups. They created a dependency matrix to highlight these dependencies and tagged related people on Confluence. Teams were managing software artefacts using tools like Jira, VSTS and using online integrated development environment such as web or cloud IDE. There were times when the details about the work items were missing or insufficient. But teams did not put in place any team specific rule or strategy formally. Team members would just have a conversation to fill in the missing details. To follow up on anything, they preferred communicating on slack channels rather than talking to someone directly. To facilitate code sharing and pair programming, screen sharing using a plugin with IDE worked effectively. When they were short of resources, developers left comments with details (e.g., this has been verified only on X device due to unavailability). Team members preferred setting up a spontaneous call and talking it through when the work was code-related. Communicating asynchronously or messaging results in misunderstanding or misinterpreting reviewers' comments. Participants also shared sending reminders as the assignee might forget after commenting on someone's pull request to speed up the review process. Participants mentioned making drawings on their notebooks to explain any point and sending the snapshots as a workaround for face-to-face discussions.
- **Management:** **t** Teams used tools for running retrospectives, brainstorming, planning poker virtually. Teams adapted these cadences, e.g., extending meeting timings, breaking longer sessions into multiple, shorter sessions, gathering anonymous feedback through digital tools and found these adaptations helpful. Participants reported that using tools like Miro,

Jamboard for whiteboarding helped to perform brainstorming virtually. Some teams adapted versions of conventional methods, e.g., a single person in the team, i.e., manager, product owner, scrum master, would draw on a small digital board or an iPad and share the images with the team. One manager even bought a physical board to facilitate such activities, but the team did not find it effective.

- **IT Support:** **t** IT teams configured a small web page tutorial ‘WFH Wiki’ to guide employees to download a VPN, install, troubleshoot, and fix their connectivity issues. The participants found it very useful and a quick workaround to getting hold of a network person to resolve any minor configuration-related issues. On an occasional basis, they were requested to reboot the machines physically.

Equipment:

- **Using work equipment:** **C** Companies allowed employees to carry equipment like additional monitors, webcams, and noise-canceling headsets to be more productive while working from home after the manager’s approval. Some employees had special equipment needs, e.g., eftp, mobiles, tablets, gadgets, both windows machine and Mac Book for iOS development to carry out their job responsibilities. Employers ensured that their needs were met.
- **Purchasing supportive equipment and services:** **C** **d** Some companies purchased special equipment such as laptops, noise cancellation headphones, internet connections, wireless devices, understanding the different needs of the employees. Many developers purchased accessories from their pockets, such as webcams, audio devices, routers, Wi-Fi adapters and routers to work from home. Some developers upgraded their broadband packages to resolve connectivity issues.
- **Funding equipment for home office Set up:** **C** Several companies offered stipends to their employees to purchase equipment such as monitors, noise cancellation headphones, webcams to set up a better work from home setup.

Office Ergonomics/Environment:

- **Supplying work furniture:** **C** Some companies cared about promoting a proper and healthy culture for remote work. They purchased ergonomically-sound furniture like a desk and chair for their employees, while others allowed their employees to take these items from their office to home for the time being. At some companies, these options were available to a certain group, i.e., permanent employees. Some companies allowed teams to take chairs home. Some participants could not avail these facilities due to personal constraints. For example, while appreciating the company’s generosity, a participant shared that their apartment was too small to accommodate any additional office equipment.
- **Funding partial home office Set up:** **C** Some companies granted a fixed amount COVID-19 allowance, e.g., \$500 to purchase any furniture,

e.g., sit/stand desks, ergonomic chairs of their choice for effective working and productivity.

- **Setting up both home and work offices:** 🍷 Companies even helped employees to setup home offices in parallel to their office place. This facilitated them to work at both places based upon their needs and preferences.

5.3 Leadership

Transparency: 🍷 The leadership of some companies was quite transparent to the employees. They were open about their processes and the current and future direction of the company, such as financial situations and potential repercussions of the pandemic on the staff. For example, they shared that employees may not get bonuses until the business is back at the place. They clarified in multiple instances that they are not going to retrench employees unnecessarily. Some employers even organised ‘All Employees’ forums to provide opportunities to get information on future directions. But a few companies made abrupt decisions, leaving no way for the employees to voice their concerns. The employees were unaware of the rationale behind the redundancy criteria/strategies due to a lack of transparency. Even within the department, no one would know who is being redundant and from which team.

Communication: 🍷 The higher management of most of the companies stayed in contact through company-wide calls, video recordings, or emails. They provided an open door policy for the employees to come and ask questions or raise concerns. Some even held Q&A sessions to address their concerns. The participants found constant reassurance by the top management comforting during the uncertainties. Many participants agreed that management tried their best to ease the stress out of the employees. At the beginning of the pandemic, the weekly communication intended to keep everyone well informed of the situation and ease them out. Over time, it reduced going from fortnightly to monthly or scheduled on a need basis when there was something important to share.

Trust: 🍷 Participants revealed trust issues that the leadership of some companies had with their employees. Some managers were concerned about developers’ commitment and productivity being out of sight. As it was hard for them to evaluate their commitment and productivity, they scheduled more meetings to keep track of work progress. Some managers held one meeting a day that aimed to remove any barriers the members may have faced. Some companies put procedures to track developers’ timings and daily activities through additional reporting, e.g., logging time in/out, the number of hours. On the other hand, some managers trusted teams and let them manage their work with little guidance. They let them take and fulfill responsibilities on their own but were available to support them. They allowed flexible working hours. A participant acknowledged that they had the flexibility to choose their work time, but they were aware of their responsibilities. There was self-accountability that came with this flexibility and empowerment that the employers have given to

their employees. Most companies offered employees flexibility and freedom of work timings and settings even after the lockdown.

5.4 Discussion

In response to RQ1: *What is the impact of COVID-19 on software professionals? What challenges did they face?*, we found that COVID-19 impacted software professionals in several ways. We noticed that COVID-19 impacted participants from different roles, ages, gender, domain, and company size. They faced personal challenges which were mainly related to them and their family's well-being, health, and safety. Our findings indicate that the working parents were highly impacted as they had to work and look after kids side by side. Our findings indicate that COVID-19 impacted a small number of software professionals financially. These include people working for startup companies, small businesses, or specific groups such as contractors. Employees of larger software companies and businesses in demand did not face any significant impacts in the form of redundancies and pay cuts. Our results suggest that the level of financial impact on software professionals changed with their contexts, i.e., employee's contract (permanent, contract), employee's situations (visa situations), the department they work for (some departments are paid less, e.g., support staff compared to engineering teams).

Since New Zealand had the first case later than the rest of the world, it bought them time to prepare. Participants confirmed that they started working from home before New Zealand enforced lockdown nationwide. It gave them time to settle in with the new work settings. Similarly, companies with teams or offices located in different parts of the world got to learn from the experiences of their teams. A few participants compared their experiences with lockdowns or varying alert levels due to COVID-19. Some found the first lockdown (March 2020) more challenging than the second one (August 2021), while others reported the opposite due to different reasons and contexts. For some participants, WFH and spending time with family was exciting initially, but it became distressing with future uncertainties and ongoing insecurities. Some revealed that their personal situations changed with different lockdowns. For example, the availability of childcare facilities during the second lockdown or a jobless spouse during the second lockdown, but in the first lockdown, the childcare centers were closed. So, participants went through different experiences with COVID-19 lockdowns or varying alert levels.

In terms of workload, we noted that generally the workload was same as in usual circumstances. But there were certain domains such as retail, health-care, and payments, where the business needs went high resulting in more work. Productivity of the software professionals sustained or went high during the lockdown. Some developers who were living alone or surrounded by young children felt being less productive but that was more of their personal evaluation. They mentioned varying levels of productivity based on their personal situations. Few shared that their productivity levels were different on different days based on their moods and motivations. While the majority of the

managers reported that developers maintained their productivity during these times. Software development practices were least impacted in teams that were following many of their practices virtually to facilitate remote stakeholders prior to COVID-19. This applied to teams distributed across different regions of the world. For example, the majority of one participant's (P6) team was based in New Zealand but a few team members were based in India. Another participant's (P10) team members were distributed in New Zealand, Ireland, and Pakistan.

Other teams transitioned to virtual mode of communication in some time. A common challenge that emerged was conducting brainstorming activities online especially in the beginning until they experimented with different tools and started using the one that best met their needs. Many participants performing roles such as developers, scrum masters, managers, product owners missed the visibility through physical boards. They struggled in the beginning until they adopted alternatives to physical boards such as using tools like Miro and Microsoft whiteboard for brainstorming and collaborating or a manager demonstrating on a mini-physical board. Some participants, particularly new team members, reported fewer pair programming sessions and felt disadvantaged on missing opportunities for knowledge sharing. Generally, software practitioners were able to perform their day to day responsibilities without any significant impact with few adaptations.

While investigating RQ2: *How did software professionals, teams, and companies respond to various challenges and support each other during the COVID-19?*, we observed that software companies and teams supported each other through paid-days off, monetary incentives, less work pressure, care. This support enabled them both employers and employees to survive and sustain during COVID-19. We noticed that software companies responded to the financial challenges differently. Their reactions were driven by contexts, i.e., company age, size and type of industry and customers, economic and business state. The response of bigger companies was different from new, smaller startup companies. A few companies made some abrupt decisions which had immediate repercussions. For example, a small retail company laid off staff and within a few weeks, they were hiring people. This was because the retail business started flourishing contrary to their expectations. We also found that bigger and medium sized companies were able to sustain their employees compared to smaller companies. Bigger and medium sized companies were found more supportive through funding partial home office set up, deferring business innovation, and paying even when staff was not working. COVID-19 evinced that software professionals can fulfill their responsibilities if equipped with the right tools and equipment. Similarly, selecting and using the same technology and tools company-wide enables them to perform their jobs better. COVID-19 made employers realise that employees can work and still be productive while being out of sight. Our analysis indicates that employees appreciate employers and managers who respond to employees' concerns, demonstrate empathy, and care about providing a healthy work environment. Employees appreciated the

support and acknowledged it helped them fulfill their responsibilities and stay productive and motivated to fight against the tough time. Employees shared that work time flexibility enabled them to balance work and domestic responsibilities better. Employees valued employers who prioritised their health and well-being during these challenging times.

COVID-19 enforced employers to enable a culture of trust, build greater autonomy at work, empower their employees, and make things transparent. Our findings suggest that keeping transparency and sharing information is appreciated by the employees. Employees acknowledged the management's communications through all different mediums for providing transparency. Participants shared that companies that contributed or allowed the employees to use their work place furniture were able to perform their responsibilities well from home. The transition to new post-COVID-19 work settings, i.e., remote working, opens opportunities for employees to receive better salaries than in their original companies. On the other hand, it also seems to benefit IT companies. They have access to a larger talent pool without any limitation to a geographic zone. Future studies can investigate how this is impacting the companies and employees.

5.5 Threats To Validity

In this section, we discuss the potential threats and how we attempted to mitigate them. Qualitative research typically concerns the credibility and reliability of the application of the research methodology and results that are impacted by researcher bias, researcher error, and participant bias. Hence, we considered these threats throughout the study.

The first author led the data collection and analysis. This included generating the first order codes, sub-themes, and themes while applying thematic analysis. The research team then collectively discussed these codes and themes, to validate the procedures and results, and to mitigate the threats related to researcher bias. We conducted two interviews per day to mitigate researcher fatigue and any resulting researcher error threat. To minimize participant bias, we adopted several mitigation strategies. First, we ensured that participants understood that research would not reveal their identity in any way to encourage candid conversations. Before collecting any data, we shared the research details with the participants. It included research objectives, potential risks, participant information sheets, and consent forms. We ensured that the interview schedule suited the participants.

To address the threat of construct validity, the interview questions used for data collection were collectively designed and reviewed by the research team. The first author conducted a pilot interview with a doctoral student who previously worked in industry to assess the duration of the interviews, clarity of the questions, and coverage of the research scope.

Regarding threats relating to external validity and generalizability of the research findings, as the study was limited to New Zealand software companies, the findings cannot be generalized to the international software development

community. However, we managed to recruit participants from different roles, experience levels, gender, company domains, and sizes and a fair number of participants for a qualitative study [32, 33]. Another threat to validity is related to the number of companies and roles involved in the study. Our selection of participants might suffer from sampling bias. We chose participants who responded to our call of participation first. However, we ensured that all our participants were actively involved in software development. The participants were representatives of their organisations. Our data set represents a balanced distribution of roles, genders, and domains. But we acknowledge an uneven distribution of participants with respect to company size, status, and age groups as evidenced in Table 1. We collected data from eighteen participants across seventeen organisations from New Zealand, so we do not claim comprehensive respondent coverage from multiple organisations.

5.6 Future Work

Future studies can investigate the effectiveness of the responses of the companies, managers, teams, and members against the COVID-19. Future research can confirm that companies that empowered employees, demonstrated transparency, trust and empathy towards them performed better. It resulted in higher level of commitment and made employees self-accountable. Similarity, teams who adapted to meet their needs out performed. Companies with a strong trust culture and entrusted their employees enabled them to perform better. An international survey with developers can validate the findings of this study and extend the response of the software companies and developers in future work. A quantitative survey can enable a more detailed analysis of the conceptual framework in different settings and demographics like gender, experience, or age. We did not look at the perception of non-experienced professionals in this study, as all our participants were experienced professionals. Future studies can also explore this area.

6 Conclusion

COVID-19 pandemic placed software companies and developers into inevitable situations. The software industry was fortunate to operate still during these unprecedented times, unlike many other industries. The digital nature of the work allowed software professionals to continue working. But it impacted software companies and developers in several ways. This study is a reflection on the impact of COVID-19 on software professionals and by software professionals. We have reported their experiences, challenges, and insights on the perceived impact of COVID-19. We explored how software companies supported their employees. From the reflections on the impact of COVID-19 by the software professionals, we have learned that communication (synchronous and asynchronous) and collaboration platforms combined with software development environments and visual tools are effective for working virtually. Therefore,

employers should remove any technical barriers to communication and collaboration. They should ensure that employees have a suitable environment to work from home and are equipped with all the work necessities. The final takeaway is that leadership needs to be transparent, promote bi-directional, open communications, listen to employee needs, and trust and empower them. They should be open to changes and be agile and flexible towards changing conditions of times.

Acknowledgments. We thank all participants who contributed to this study. We would also like to thank our anonymous reviewers for their feedback that helped to improve the quality of this work.

Declarations

Conflict of Interests and Funding. The authors declare that they have no conflict of interest. This research was partially funded by the Natural Sciences and Engineering Research Council (NSERC). This study was conducted under approval from the Human Participants Ethics Committee at the University of Auckland.

Data Availability

The authors cannot share the data set to maintain the anonymity of the study participants and fulfill Ethics requirements.

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