Working from Home during a Pandemic: The Impact Covid-19 had on Software and Web Development

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Abstract—COVID-19 has not only impacted our health, safety, and social lives but our occupations as well. Places such as restaurants, gyms and schools have been negatively impacted by the pandemic, forcing some to shut down or close for a period of time. Majority of these workers were forced to leave their jobs or work from home. For software and web development industries, working remotely is not a new concept. We analyzed the possible impacts of COVID-19 on the software and web development industries, and if they have sustained or changed their productivity throughout the pandemic. We researched various experiments (surveys, statistics, interviews) on the impacts of Covid-19 on software and web development industries and were able to analyzed any possible trends and consistencies. We observed significant variation in the results to determine whether COVID-19 impacted software and web development as a whole. Each company responded in different ways and took action according to what was best in their circumstances. Most of the research showed that developers were able to put out the same production at home compared to a facility space. Majority of software and web development companies required their employees to stay-at-home and work remotely with their teams. With the quick technological advances of email, online chatting, and video calling, development teams were able to adapt quickly to the requirements of not being able to have all their employees in the same space.

Index Terms—Agile, Bugs, COVID-19, Pandemic, Remote, Software Development, Web Development, Well-Being

I. Introduction

Over the past few years the state of the world has changed drastically due to the SARS-CoV-2 (Covid-19) disease. On January 30th, 2020 the World Health Organization (WHO) declared Covid-19 a global health emergency due to its world-wide spread [1]. Since Covid-19 is so easily spreadable with a wide range of symptoms, most of the world came to a halt with little to no warning. The biggest impact came when the 'stay at home' orders came. In America around seventy-five to eighty percent of Americans say that they live paycheck to paycheck [2]. This caused problems when most Americans could not go into work and needed to start tapping into savings just to survive. This caused a a drastic change to how work and business is done, online communication apps such as Zoom and Google Meets took over as the new locations for team meetings, project collaboration, and any other communication that may have only been a few steps away in the office space. Apps such as these made working without an office building doable.

With the entire world making grave changes to adapt and slow the spread rate of Covid-19, no exception was made to software and web developers. Like most industries, software and web developers were expected to work from home to avoid close contact and develop physical distancing. Many were able to make a smooth transition, but for most the switch was sudden and unpredictable [3]. Generally working from home includes a home office or a quite work environment allowing for work to be finished uninterrupted. This sudden shift to working from home included many distractions that create poor work environments for software and web developers. Many have children that can no longer attend school and therefore require supervision and help while working with online school or even more maintenance is required for young children that used to attend childcare or daycare. Moreover, while software and web developers lost access to their offices; kitchens, bedrooms, and living room couches became their new work spaces [4].

Every industry was effected by the loss of job locations and work environments. Software and web programs although had no loss in production by any means. On the contrary, one study found that productivity slightly increased with

developers working from home [3]. The studied was compared to one done before Covid-19 that looked at the productivity of developers in their work environment [5]. Other studies have also shown evidence that web and software developers have been able to make a smooth transition into their home work environment. However, the evidence showed that; for the most part, the move to working at home had little to no impact for web and software developers. Two studies done; one at the beginning of Covid-19 and the other after employees had time to adapt, show the data that was collected. The first study showed slightly more employees being negatively effected by the change - the majority having no impact. The second study showed slightly more employees being positively impacted by the move to working at home with majority still seeing no impact [6].

II. RELATED WORK

Covid-19 has had a strong, negative impact on various different industries in the world, but one seemed to amplify from it - Software and Web Development. A professional environment is what fuels one's motivation to work, but the pandemic caused the majority of employees to work remotely which was a huge setback for big manufacturers, except for software and web developers.

Not only did web developers take great advantage from remote employment but their productivity was also unaffected as it did "not impact code quality" [7]. A study carried out on 100 GitHub projects developed in Java, by 279 software development professionals, portrayed the results of the impact of Covid on "task completion time, productivity, and quality of work" [7] through the following graph.
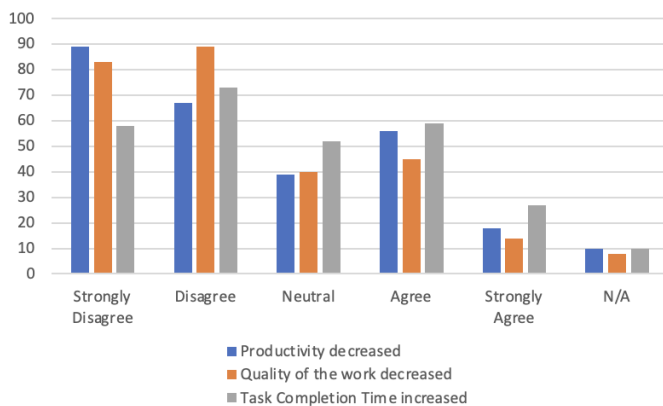

Fig. 1. Productivity Graph

Figure 1 illustrates that most developers disagreed with the assumptions stating that productivity was decreased, quality of work downgraded, or more time was spent on completing tasks while working from home.

Arguably, although this was the least impacted industry from the pandemic, it did affect developers to some extent. Developers impacted the least to most were junior and senior developers, respectively. This was particularly because junior

developers seemed "to have switched to remote working to a lesser extent" [8]; possibly due to the desire for a professional environment and to be acquainted with more people.

An intelligence report called Covid- 19 Impact Analysis by Randstad presents the following clustered bar-graph exhibiting the effect of the virus on key finance jobs in the UK.
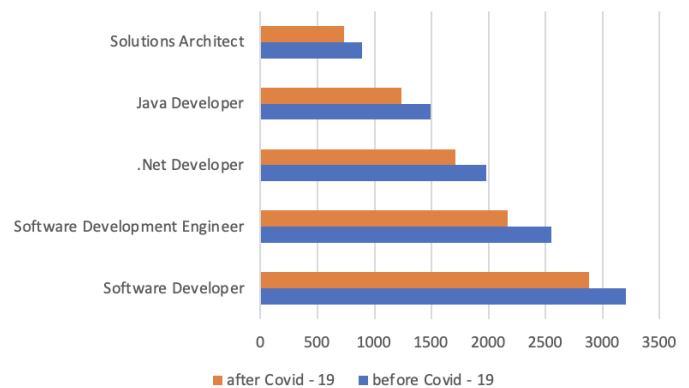

Fig. 2. After-effects Graph

Figure 2 above sets forth after-effects of Covid-19 on several different software jobs and as was foreseeable, these jobs were claimed "not being as heavily impacted…" [9] as compared to other jobs. It would be fair enough to conclude that there was a minute decrease in jobs for this employment sector. It also strengthens the fact that although software and web-developers did face the consequences caused by the ram of Covid, the damage was minute as compared to employees for other industries as shown in figure 2.

According to an article by NCBI (National Center for Biotechnology Information), a higher demand for software products during the pandemic has caused software and IT industries to "expand significantly" [10]. These products include "MS teams, Zoom…" [10] and other platforms for digital communication.

Furthermore, software development has boomed in five particularly important ways due to the widespread virus. As per an article by MarketFinance, the IT industries have "weathered the COVID-19 storm reasonably well." [11] Firstly, because developers were working remotely, productivity increased. Through a report from ASG Technologies, "more than half of respondents surveyed" [11] claimed that they were able to concentrate better on IT and software development projects as a result of working remotely. Secondly, the need for software developers surged. The marketing director of Randstad UK stated that remote working had caused many firms to actually ponder upon "what jobs and skills are truly essential" [11]. This could potentially be a major factor as the urge for IT developers inflated "by 93% in January 2020" [11]. By the same token, there was a boost in digital spending causing "70% of businesses" [11] in just the UK to assist themselves in digital mechanization. Moreover, since the reliance on eCommerce was all the more, a survey inspection by ASG (Accelerated Strategy Group) disclosed that almost "60%

of businesses" [11] were dependent on online mechanisms to facilitate contact-free assistance. Lastly, online healthcare assistance sparked. One the most eminent examples of this is "the coronavirus chat-bot Corona-Help.uk" [11]. This platform was designed by Amazon and launched in the UK by their government. The intention for this was to help people answer their concerns and queries related to COVID-19.

III. RESEARCH/FINDINGS

The data shown is defined in several categories. This provides a more precise understanding on the impact of COVID-19 on the web and software development industries because there are many variables involved. The research analyzed are in different forms as well, such as graphs and surveys. One of the main impacts COVID-19 has on web and software development is not being able to work in an office setting. Employees are required to stay at home and work remotely. This exponentially increased the labor supply and demand for online work all around the world such as India and the UK [12]. Everything a developer was used to in a work setting, (environment, work space, personalization, social compatibility, resources) changed drastically. This created a lot of questioning in whether the productivity, communication, and overall the well-being of employees would change.

A. Well-Being

An experiment by P. A. d. M. S. Neto et al. studied this concept by creating a survey that asks various questions [7]. One topic they researched was the well-being of the developers. These respondents consisted of 279 employees who work in all sorts of conditions, whether that is from company size, college degree, family size, and experience. An important stat to show is that 82% of the developers worked in an office setting before the pandemic and 17% worked remotely before then. P. A. d. M. S. Neto et al. studied three characteristics of well-being. These are levels of sleep disorder, stress, and overall happiness.
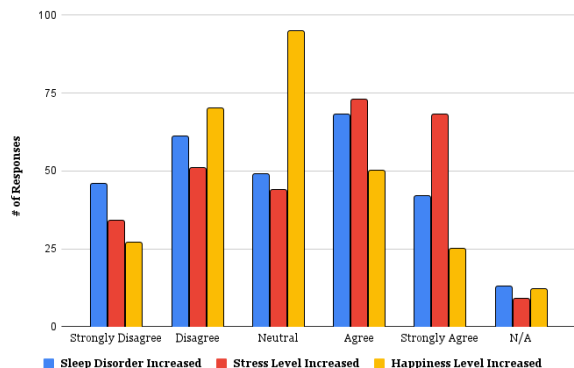
Fig. 3. Well-Being Graph

From the bar graph presented above, it is inconclusive to prove that working remotely has impacted the employees overall. Another separate experiment by D. Ruso et al. found

that "office-setup is not significantly related to well-being and productivity" [13]. With sleep disorder, 39.4% of the developers claimed it has increased, but 38.4% had decreased sleep disorder so there is no sway in either way. Level of happiness is slightly similar, with 38.4% of all respondents having no change. There is a difference between disagree (34.7%) to agree (26.8%) with happiness level. Stress level is the odd element in the data. This is because most respondents claimed to have higher stress level working at home, with 50.5%. From the detailed responses, this is because of the situation overall about covid-19, not because of the work conditions. In contrast to these other findings, Ralph et al. found that "software professionals who are working from home during the pandemic are experiencing diminished emotional well being and productivity, which are closely related" [4]. Employee well being and productivity being closely related is agreed upon by all of our sources but working from home affecting well being one way or the other is not. Ralph et. al assessed emotional well being using the WHO's five-item well being index (WHO-5), which is a 6 point scale from 0 to 5. The advertised their survey across various social media websites and in many languages. Figure 4 shows the number of responses for each WHO-5 score before remote working started. Figure 5 shows the number of responses for each WHO-5 score after remote working had started.
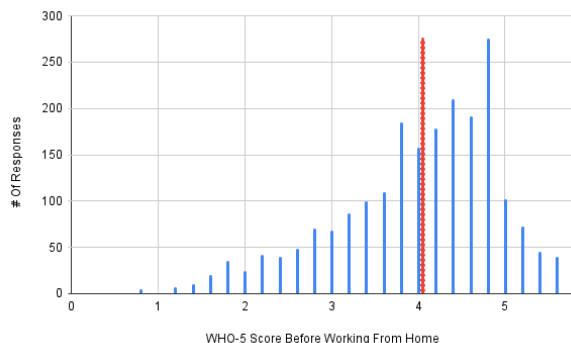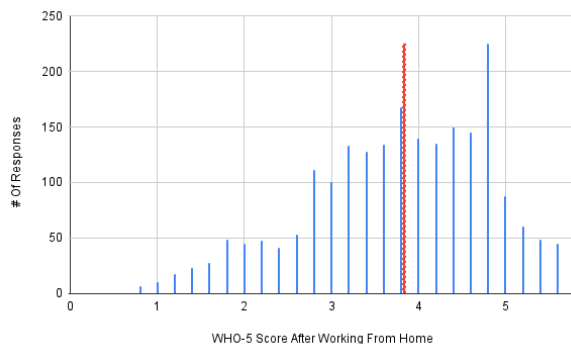
Fig. 4. WHO5 Chart Before Remote Working

Fig. 5. WHO5 Chart After Remote Working

The vertical red line in these graphs marks the mean. The mean WHO5 score from respondents before the switch to working home was 4.05. The mean WHO-5 score from respondents after the switch to working from home was 4.05 with a median of 4.25. The 5% decrease in median WHO-5 score from changing to working from home shows that it did negatively affect those in the study. Another study found that around 2/3rds of developers report increased well being after transitioning to working from home [13]. The reason different studies are coming to different results is likely due to confounding variables like programming language. Bao et al. found that working from home "has both positive and negative impacts on developer productivity for C++ projects in terms of different metrics" but has an entirely negative impact on Java projects. They also found that working from home has a larger impact for developers of large projects than developers of smaller projects [14].

B. Bugs

Another part of development that is analyzed is the increase or decrease of bugs while being forced to work from home. Because of teams not being able to communicate each other in the same space, communication and compatibility are impacted. This can lead to more or less bugs within the software. Akond Rahman and Effat Farhana created an experiment to find this result [15]. They researched 129 COVID-19 software projects that are open sourced from GitHub and found 550 bug reports within those projects. First, 7 kinds of software projects were identified (in order from most reported to least): Aggregation, Mining, Statistical Modeling, Education, User Tracking, Volunteer Management , Medical Equipment. Next, they determined 8 types of bugs (in order from most reported to least): UI, Data, Dependency, Algorithm, Syntax, Security, Performance, and Documentation. With this in place, are the amount of bugs found impacted by the pandemic of COVID-19? P. A. d. M. S. Neto et al. "A deep dive on the impact of covid-19 in software development" not only survey developers on their well-being but the amount of bugs too, claiming the inspiration from Akond Rahman and Effat Farhana's research [7]. They ask the same 279 employees from the well-being analysis two questions; if the amount of bug-fixes is lower since working from home, and if the amount of bug-fixes is higher since working from home.

As shown from Fig. 6, 45.3% of employees thought that the level of bug-fixes has not changed since being forced to work at home. Both questions were concluded with neutral or disagree meaning that they could not notice the change of bug-fixes or believe it has increased or decreased. While 12.4% of developers agreed, it is important to point out that more developers experienced less bug-fixes (44 responses) than more bug-fixes(25 responses).

C. Agile

One type of development practice that has been implemented heavily since the stay-at-home mandate is the agile methodology. Majority of development companies (roughly
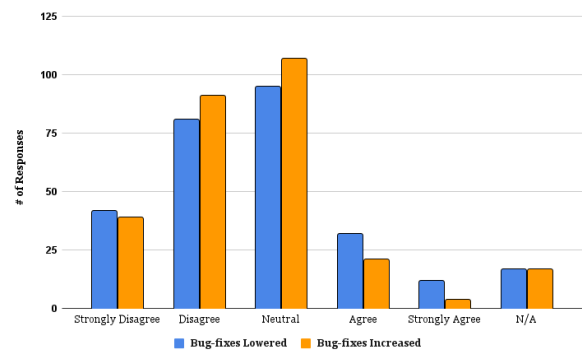

Fig. 6. Bugs Graph

90%) are applying this model in modern teams [16]. This is because this emphasizes a lot of collaboration and communication, in order to be successful and efficient. These elements seem to be the most impacted by the pandemic, since teams are not able to be physically together, but developers have been using agile approaches before the pandemic occurred. Globalization and technological advancements such as email, video calls and internet have made teams break the geological and cultural barriers like never before [17]. This isn't a perfect solution though, and still makes communication and collaboration difficult for developers. A study explored this concept to find specifically what parts of agile are impacted by COVID-19 [18]. The researchers conducted a two-part survey involving 2265 developers, the 1st analysing the culture, support, and milestones in each team early on in the pandemic. They took this data for the 2nd survey, asking more specific questions about the communication, collaboration and social interaction. As to show what the results were made from the surveys, a table will be provided to show the elements that showed the most change from working at home:

TABLE I
PRODUCTIVITY AND COMMUNICATION TABLE

Increases	Both	Decreases
Scheduled meetings	1 on 1 collaboration	Communication ease with team
Team member notifications	Ad-hoc meetings	Knowledge flow within the team
External team bonding	Ability to make team decisions	Awareness of teammate's work
Making impactful contributions	Team members supportive of ideas	Ability to brainstorm
		Social interaction & connection

A note here to point out is that a team's productivity level significantly changes the factors. For example, being supported of ideas changed drastically on both sides because a productive/non-productive team leans the percentage in that same direction. The data ended up showing that working remotely did not impact the productivity. About 55% of developers had the same team productivity, 22% with more,

and 23% with less. The biggest change from COVID-19 is not from the production but social characteristics, roughly 3 out of every 4 developers (75%) missing the social interaction within their teams. This shows that a decrease or lack of social interaction does not coincide with and decrease in production. It fully depends on the team's functionality and how they interact with one another. If there is a lack of communication or collaboration, the production will not output what is needed to be successful [19].

D. Advantages and Disadvantages

One study performed by Microsoft research, sent out surveys to evaluate how software engineers were adapting to work life at home. The study was compiled by sending two separate surveys at different times. The first was sent answered by 1,369 participants and the second was sent answered by 2,265 participants [6]. Both surveys aimed to draw out what the employees working from home found beneficial and non-beneficial about their new work environments. The
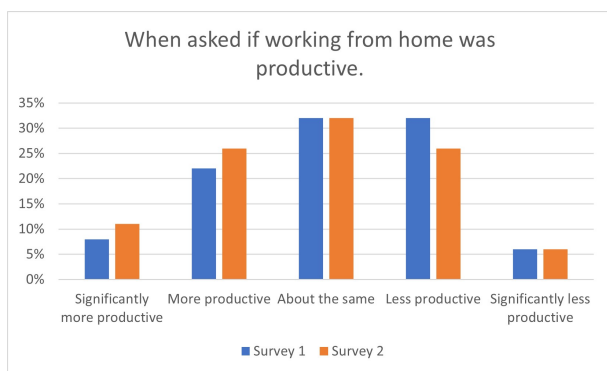

Fig. 7. Productivity Graph

graph above shows how both surveys have a majority of the software engineers stated that working from home was about the same as working in the office. In the first survey more responses came back with less productive and significantly less productive, while in the second survey a larger percentage of the responses came back as more productive and significantly more productive [6]. This information shows how in the earlier stages of Covid-19 software developers had slight problems because everything was so new. Once the developers had time to get used to their home environment their production levels increased again.

Other question in this study gave insight into what software engineers four beneficial and disruptive about working from home. Some of the benefits that came back included: the commute, schedule flexibility, work environment, and personal comforts. Disruptions that were stated were as following: internet connectivity, family/children, and communication [6].

IV. RESULTS CONCLUSION

Through various authentic sources, surveys, and statistics, it can be stated that the results of this pandemic are ongoing and will be everlasting with a different amount of might on the

software development and IT industries as compared to others; however, this industry successfully comprehended the gravity of the situation led by the pandemic, and was able to procure most productivity. The cons weighed to be as substantial as they were for other industries, which include lack of motivation, sleep disorder, increased stress level and much more [7], but software developers embraced their environments, and provided more than adequate output.

All in all, it can be concluded that majority of software developers were able to make the most out of remote working as not only did they state "lack of commute as a positive aspect" of telecommuting, but also claimed to have self-contentment, minimal distractions, a peaceful work environment, and a flexible schedule; giving rise to them maintaining a prosperous work-life balance. [20]

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