The Impact of Work from Home (WFH) on Workload and Productivity in Terms of Different Tasks and Occupations

Hongyue Wu[1] and Yunfeng Chen[2(✉)]

[1] Construction Animation, Robotics, and Ergonomics (CARE) Lab, School of Construction Management Technology (SCMT), Purdue University, West Lafayette, IN 47906, USA
wul5l3@purdue.edu

[2] CARE Lab, SCMT, Purdue University, West Lafayette, IN 47906, USA
chen428@purdue.edu

Abstract. Most people have to work from home (WFH) due to stay-at-home orders in response to COVID-19 pandemic. The shifting of work environment from regular office to home has caused changes in workload and productivity, which may lead to reduced salaries for employees, economic loss of the companies, and impacts on the national economy. Thus, it is urgent to explore the impacts of WFH on workload and productivity of different employees. A nationwide survey was distributed to collect data about the workload and productivity of regular work and WFH considering different types of tasks and occupations. The findings indicate that WFH causes an increase in workload for all participants by three hours per week and a loss of productivity for 38% participants. Moreover, the technical issues, such as less efficiency of online communication technologies, are the core reasons for the decrease in productivity. For different occupations, employees who regularly work in an office or workstation show a higher workload because their major work can be done at home but require more time due to the technical issues, while on-site occupations and many researchers have less workload because their major work cannot be done at home, such as onsite work and experiments. Then, the workload and complexity of tasks lead to the differences in productivity. In the future, the key problems are how to address the technical issues and strengthen the human-computer interaction to improve the productivity, and support on-site work and lab-based tasks to improve the feasibility of WFH.

Keywords: Work from home (WFH) · Productivity · Workload · Home-based work

1 Introduction

Due to the COVID-19, the United Stated (U.S.) was under stay-at-home orders. At the end of March 2020, more than 308 million people, which accounted for 94% of the U. S. population, had to stay at home [1]. Therefore, many workers have to work from home. It was indicated that over 34% of employees who were commuting are now

C. Stephanidis et al. (Eds.): HCII 2020, LNCS 12427, pp. 693–706, 2020.
https://doi.org/10.1007/978-3-030-60152-2_52

working from home in the U.S. [2]. Also, over 16 million knowledge workers have started home-based work since March 27, 2020 [3]. This rapid change has caused many problems. Many employees reported the change of workload at home and suffered from a productivity loss, especially the new home-based workers [3]. The loss of productivity will not only lead to a decrease in salaries of employees [4], but also the economic loss of companies and even the whole industry and national economy. Besides, many companies provide or consider the options of partial or complete home-based work in a long-term [5]. It was reported that previous experiences of Work from Home (WFH) are helpful for employees to adapt to future remote work [3]. There are studies investigating the impacts of WFH on quality of life and the online content contributions of workers [6, 7]. Also, many researchers investigated the feasibility of WFH due to the impacts of COVID-19 considering different types of work, demographic information, different areas, etc. [8–10]. However, there is still a lack of research focusing on the impact of WFH on workload and productivity using quantitative evidence. Thus, this research aims to fill the gaps to analyze the differences of workload and productivity between regular work and WFH, and identify the reasons leading to these differences.

To achieve this goal, a nationwide survey was conducted to collect data about the workload and productivity of both regular work and home-based work for employees with different occupations. Then, the workload and productivity of different tasks were compared to show the impacts of WFH. Finally, the reasons causing the change in workload and productivity were discussed to sheds light on how to support future home-based work based on current experiences.

2 Literature Review

It was indicated that 37% of U.S. jobs can be conducted at home, including educational services, professional and technical services, management, finance and insurance, and information [11]. Therefore, WFH is a popular trend for current employees. The advantages of WFH are the flexible schedule, cost-saving for transportation, and better work-life balance, while there are also disadvantages including the loss of work motivation and productivity, possible data security problems, etc. [12]. For example, a study showed that 56% of 1014 respondents reported less productivity and less workload when working from home [13].

Furthermore, there are many researches exploring different factors that influence productivity of WFH. First, the distraction from family members is a core problem impacting productivity for parents, especially women [14]. Also, the lack of in-person collaboration caused by home-based work may lead to a decrease in creativity and innovation [14]. Meanwhile, it was indicated that WFH could lead to the increase in mental health disorders because of the workplace transmission and limitation of work relationships [8, 15], which also drain the productivity. Besides, many organizations lack proper plans and resources to support home-based work [4], which is a major reason for the loss of productivity for the employees.

However, how WFH impacts the workload and productivity are still unclear due to the lack of quantitative evidences. Therefore, this paper aims to explore the differences in workload and productivity between regular work and WFH, and identify the

problems causing the change of workload and productivity to support current and future home-based work.

3 Research Methodology

A nationwide survey about WFH were distributed this May in the U.S. More than 13000 people were reached individually by email, LinkedIn, or other social media. Meanwhile, 15 different professional associations were reached out to help distribute the survey. Total responses are 774, with a response rate of 6%. For the workload and productivity of employees with different tasks, there are 200 complete responses, which were used for further analysis.

3.1 Participants

The participants are employees in the U.S. from both industry and education areas, covering seven different occupations [16, 17], which are listed in Table 1. Also, the participants cover 26 different states from all regions in the U.S.

Table 1. Occupations of participants in the survey.

Categories	Occupations	Definitions
Education	Teacher/Instructor	Major work is teaching
	Researcher	Major work is research
	Professor	Need to do both teaching and research
	Staff	Major work is administration
Industry	On-site occupations	Usually conduct your work outside office
	Project management occupations in office	Usually conduct project-specific work in office
	Staff	Major work is company administration and support

3.2 Measurements

Different tasks cover listening, speaking, reading, and writing using both traditional ways and electronic devices, which are shown in Table 2. The tasks were compiled considering both the major skills and the devices/tools that will be used [18, 19]. In other words, these tasks indicate different types of information that employees can obtain and communicate with others. Based on the following tasks, the hours spent on each task per week were used to measure the workload, while the productivity was evaluated by a five-point Likert scale.

Table 2. Tasks for employees considering listening, speaking, reading and writing.

Category	Tasks
Listening & Speaking	Phone call
	In-person meeting
	Online meeting
	Other communication (text/chat/etc.)
	Presentation
Reading & Writing	Email
	Review documents in print
	Prepare documents in print
	Review documents on-screen (computers/iPads/etc.)
	Prepare documents on-screen (computers/iPads/etc.)
	Other tasks on paper (calculation/drawing/etc.)
	Other tasks on electronic devices (calculation/drawing/coding/etc.)

4 Data Analysis and Results

4.1 Demographic Information

Occupation. The distribution of different occupations is shown in Fig. 1. The project management occupation in office in the industry has the highest proportion of 32% (64 responses). At the same time, professors in the education area account for 31% (61 responses). Then, staff in the education area accounts for 9% (18 responses). After that, the number of responses from researchers in the education area is 16 (8%). Also, the percentage of staff in the industry is 7% (14 responses), which is the same as on-site employees in the industry. Finally, teacher/instructor in the education area accounts for 6% (13 responses). Overall, there are 108 responses from the education area, while 92 responses from the industry. Meanwhile, the respondents cover different majors, including architecture, engineering, construction, and operation, management, public administration, etc. Therefore, the data can represent the workload and productivity of diverse occupations and fields.

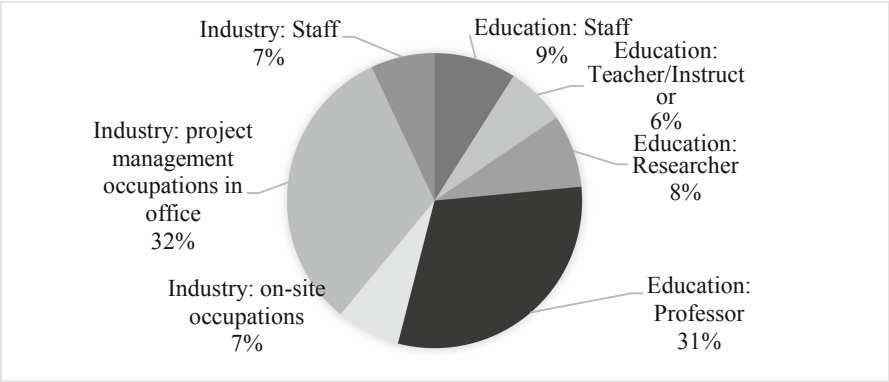

Fig. 1. The distribution of occupations for 200 responses.

Age and Gender. The participants cover different ages from 23 to 79 with only one participant who didn't want to provide this information. The distribution of age is shown in Fig. 2. The major part is from 31 to 39 years old, which accounts for 26.63%. Also, there are 43 respondents who are 23 to 31 years old. Then, the third area is from 39 to 47 years old, which accounts for 17.59%. After that, 29 participants whose ages range from 47 to 55. Besides, the number of participants who are older than 55 years old is 39, which accounts for 19.60%. It shows that the distribution of age covers a large range and mainly focuses on the range from 23 to 55, which is also the common age of current employees [20].

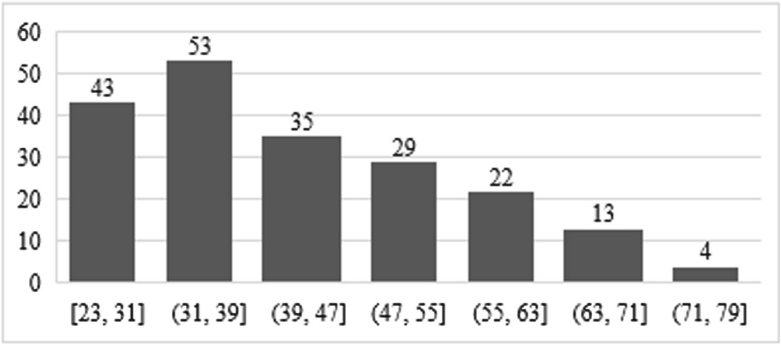

Fig. 2. The distribution of ages for participants.

As for gender, about 78% of participants are male, while only 20% of them are female. In addition, there are 2% (3 respondents) chose the Non-binary, Not listed, or Prefer not to disclose. The result is shown in Fig. 3.

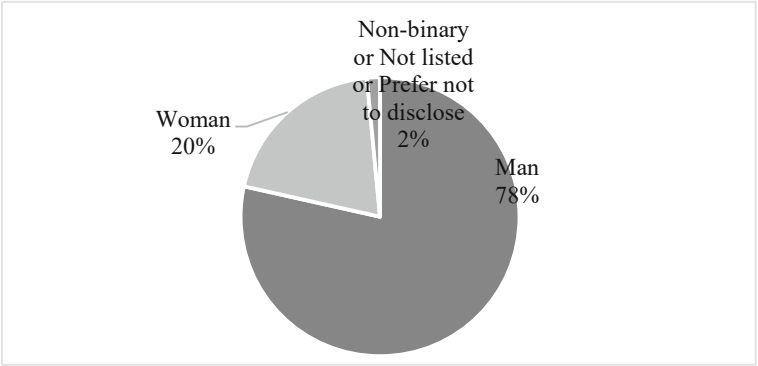

Fig. 3. The distribution of genders for participants.

4.2 Analysis of Workload

Different Tasks. The mean and standard deviation of hours that the participants spent on each task for both regular work and WFH per week are shown in Table 3. After data screening, four responses were not used for the analysis of workload because their total working hours per week is higher than 165 h, which is unreasonable. Therefore, there are 196 responses that were used for the following analysis.

For regular work, email and in-person meeting are the tasks that require most hours to finish (6.7449 h/week and 6.4786 h/week on average), while prepare documents in print and other tasks on paper (such as calculation/drawing/etc.) account for the smallest part (1.7474 h/week and 1.5638 h/week on average) of total workload. Considering WFH, email and online meeting show more working hours per week (7.6097 h/week and 7.0536 h/week on average), while in-person meeting and prepare documents in print have less workload (0.8699 h/week and 0.8827 h/week on average).

For the differences between regular work and home-based work, seven out of 12 tasks show higher workload when working from home. For the category of listening and speaking, in-person meeting decreases most (5.6087 h/week) and presentation reduces by 0.2474 h/week for home-based work, while the workload of the other three tasks increases from 0.6071 to 5.1505 h/week. As for the category of reading and writing tasks, all the tasks relevant to printed paper and documents (prepare documents in print, review documents in print, and other tasks on paper) decrease ranging from 0.1913 to 0.8648 h/week, while the other four tasks relating to electronic devices increase ranging from 0.4974 to 1.3750 h/week.

In addition to the tasks listed above, the respondents added some other major tasks or specific tasks that they wanted to mention. The answers include webinars, brainstorming, other technical tasks, individual work, etc. In total, the overall workload of regular work is 43.0268 h/week on average with a standard deviation of 26.3376. For WFH, the average workload per week is 46.0967 h with a standard deviation of 29.1805. Therefore, WFH lead to an increase of overall workload by 3.0699 h/week.

However, the standard deviation is 23.2634, which means there are significant individual differences.

Table 3. Workload of different tasks for regular work and WFH.

Category	Tasks	Regular work (hours/week)		Work from home (hours/week)		Differences (regular work - WFH)	
		Mean	SD	Mean	SD	Mean	SD
Listening & Speaking	Phone call	3.4043	6.8023	4.3431	5.6054	−0.9388	6.6507
	In-person meeting	6.4786	6.1122	0.8699	3.0314	5.6087	5.8809
	Online meeting	1.9031	2.6118	7.0536	6.3974	−5.1505	5.9521
	Other communication (text/chat/etc.)	2.6250	4.5464	3.2321	4.5883	−0.6071	3.3853
	Presentation	1.8148	2.2511	1.5673	2.2187	0.2474	1.6144
Reading & Writing	Email	6.7449	5.7678	7.6097	6.1523	−0.8648	4.0371
	Review documents in print	2.3929	2.9218	1.6020	2.9587	0.7908	2.5665
	Prepare documents in print	1.7474	2.7021	0.8827	1.9139	0.8648	2.4058
	Review documents on-screen (computers/iPads/etc.)	4.6939	4.2545	6.0689	5.1790	−1.3750	4.3915
	Prepare documents on-screen (computers/iPads/etc.)	5.0459	5.4418	5.9770	6.5332	−0.9311	4.0296
	Other tasks on paper (calculation/drawing/etc.)	1.5638	3.4869	1.3724	3.6132	0.1913	1.5057
	Other tasks on electronic devices (calculation/drawing/coding/etc.)	3.3495	6.6004	3.8469	7.1437	−0.4974	3.0066

Different Occupations. To better understand the differences of workload between different occupations, the total working hours for each occupation, which are the summation of all the hours spent on each task, were listed in Table 4.

In the education area, the workload of staff is the highest in both regular work and WFH (45.8889 h/week and 53.1111 h/week on average), while teacher/instructor shows the least workload (26.0385 h/week for regular work and 33.8846 h/week for WFH). Considering the differences between regular work and WFH, only the workload of researchers decreases when working from home by 5.2 h/week, while the other three occupations have more workload of home-based work, ranging from 6.1918 to 7.8462 h/week.

For industry, the average workload of regular work is higher than the average in the education area. On-site occupations have the most working hours per week for regular work (53.0769), while project management occupations in office shows the highest workload when working from home (51.5726 h/week). As for the differences, only project management occupations in office have more work to do when working from home, increasing by 3.371 h/week. However, the on-site occupations and staff shows less workload by 6.6154 and 3.7857 h/week.

Table 4. Total workload for different occupations.

Category	Occupations	Regular work (hours/week)		Work from home (hours/week)		Differences (regular work - WFH)	
		Mean	SD	Mean	SD	Mean	SD
Education	Staff	45.8889	13.0964	53.1111	19.8906	−7.2222	13.2023
	Teacher/Instructor	26.0385	22.5725	33.8846	27.5999	−7.8462	14.1604
	Researcher	39.0667	31.7630	33.8667	24.1753	5.2000	29.4666
	Professor	37.5123	18.1280	43.7041	27.4931	−6.1918	21.4662
Industry	On-site occupations	53.0769	45.8411	46.4615	34.0260	6.6154	54.9144
	Project management occupations in office	48.2016	26.7178	51.5726	29.2643	−3.3710	16.7057
	Staff	51.1429	32.5195	47.3571	42.2513	3.7857	15.2829

4.3 Analysis of Productivity

Different Tasks. The mean and standard deviation of productivity for both regular work and WFH are shown in Table 5. Productivity is defined as a real output per hour, which was measured by a five-point Likert scale with 1 indicating the lowest productivity and 5 indicating the highest productivity.

For regular work, in-person meeting shows the highest productivity, which is 4.1640 on average. Then, prepare documents on-screen and presentation also have high productivities, which are 4.0757 and 4.0571 on average respectively. However, online meeting and other communication through text/chat/etc. show lower productivity than other tasks (3.7257 and 3.7457). It is interesting to see that the differences in productivity among tasks are not significant because all the results are between 3.7 and 4.2 out of 5. Moreover, the overall productivity of all the listening and speaking tasks are 4.0311 on average, while it is 4.1058 for the reading and writing tasks. Besides, the standard deviations of all the scores range from 1.1457 to 0.7851.

As for WFH, email and review documents on screen show the highest productivities, which are 4.0885 and 4 on average. But the in-person meeting had a significant lowest productivity, which is only 2.7835 out of 5. In this part, there is a significant difference in productivity among all tasks, which is different from regular work. It indicates that WFH leads to the variance of productivity among tasks. For the overall productivity, the listening and speaking tasks (3.7268) have lower productivity than the reading and writing tasks (3.9683), which is the same as regular work. In addition, the standard deviations range from 1.4806 to 0.9104.

Then, for the differences between regular work and home-based work, five out of 12 tasks show higher productivity when working from home, which are phone call, review documents on-screen, other communication, email, and online meeting. Online meeting has the highest improvement in productivity when changing from regular work to WFH (0.53 on average). On the other hand, in-person meeting shows a significant decrease in productivity of home-based work (2.585 on average). Also, all the tasks

relevant to documents and paper in print represent lower productivity when working from home.

Table 5. Productivity of different tasks for regular work and WFH.

Category	Tasks	Regular work		Work from home		Differences (regular work - WFH)	
		Mean	SD	Mean	SD	Mean	SD
Listening & Speaking	Phone call	3.8033	1.1457	3.7234	1.1646	−0.0200	1.4317
	In-person meeting	4.1640	0.9891	2.7835	1.4806	2.5850	2.1202
	Online meeting	3.7257	1.0138	3.9479	0.9907	−0.5300	1.7361
	Other communication (text/chat/etc.)	3.7457	1.0196	3.7740	1.0251	−0.1000	1.4035
	Presentation	4.0671	0.9791	3.4658	1.2847	0.5450	1.5749
	Overall productivity	4.0311	0.8472	3.7268	0.9988	0.2750	1.4246
Reading & Writing	Email	3.9635	0.9835	4.0885	0.9420	−0.1200	1.2977
	Review documents in print	3.8571	1.0513	3.5865	1.2378	0.8550	1.9909
	Prepare documents in print	3.7484	1.0787	3.4173	1.2500	0.7350	1.7493
	Review documents on-screen (computers/iPads/etc.)	3.9202	0.9244	4.0000	1.0000	−0.0950	1.3285
	Prepare documents on-screen (computers/iPads/etc.)	4.0757	0.8875	3.9462	1.0792	0.1000	1.4284
	Other tasks on paper (calculation/drawing/etc.)	3.9291	0.9830	3.7259	1.1292	0.2550	1.3148
	Other tasks on electronic devices (calculation/drawing/coding/etc.)	3.9530	1.0090	3.8725	1.1107	0.0600	1.2467
	Overall productivity	4.1058	0.7851	3.9683	0.9104	0.1300	1.3121

Considering the overall productivity of all the participants, the average overall productivity of the two categories is used. For regular work, the overall productivity is 3.8850 with a standard deviation of 1.0724. Then, for WFH, the overall productivity is 3.6825 with a standard deviation of 1.0706. Therefore, the difference in productivity between regular work and home-based work is 0.2025 with a standard deviation of 1.2820. It shows that WFH has caused the loss of productivity. As for the differences in productivity for each participant, 38% of the participants experienced less productivity for WFH, while 37.5% of them showed an increase in productivity. 24.5% of the respondents indicated there are no obvious differences in productivity between regular work and home-based work.

Different Occupations. For the differences between seven occupations, the overall productivity of each occupation, which was calculated by the average of overall productivities of two categories, is shown in Table 6.

In the education area, for regular work, professor shows the highest productivity (4.082 out of 5), while the teacher/instructor has the lowest productivity (3.4615). Then, considering home-based work, the productivity of teacher/instructor becomes the highest (3.7308), whereas researcher shows the lowest productivity (3.2813). In addition, considering the differences between regular work and WFH, only

teacher/instructor reports the increased productivity when working from home (0.2692), while the other three occupations have reduced productivities ranging from 0.1389 to 0.4089.

For industry, project management occupations in office shows the highest productivity for regular work (3.9844), while on-site occupations have the lowest productivity (3.3571) when they work on-site due to the complexity of their work contents and environment. Meanwhile, for WFH, project management occupations in office still have the highest productivity (3.8672), but it decreased comparing with regular work (0.1172). The productivity of staff decreases the most (0.5) when working from home among all the seven occupations. However, on-site occupations shows an increase in productivity for home-based work (0.2857).

Table 6. Overall productivity for different occupations.

Category	Tasks	Regular work (hours/week)		Work from home (hours/week)		Differences (regular work - WFH)	
		Mean	SD	Mean	SD	Mean	SD
Education	Staff	3.8611	0.8368	3.7222	0.8613	0.1389	0.8712
	Teacher/Instructor	3.4615	1.3301	3.7308	0.6651	−0.2692	1.3168
	Researcher	3.6563	1.4574	3.2813	1.4602	0.3750	0.9747
	Professor	4.0820	0.7862	3.6721	0.8750	0.4098	0.8921
Industry	On-site occupations	3.3571	1.8855	3.6429	1.5495	−0.2857	2.8603
	Project management occupations in office	3.9844	0.9999	3.8672	1.0437	0.1172	1.2432
	Staff	3.7857	0.7523	3.2857	1.3966	0.5000	1.1266

5 Discussion

Overall, the results indicate that WFH leads to an increase in workload and a loss of productivity for current employees. The workload increases by 3 hours per week on average (from 43.0268 h/week to 46.0967 h/week), while over 38% of participants report a decrease in productivity.

The major difference in workload is that the working hours for all the tasks on-screen and using electronic devices are increased when working from home, while the workload of reading and writing tasks based on printed papers and documents is reduced. It shows that tasks relying on printed papers and documents or in-person communication have been changed to online communication and work based on electronic devices. Many participants reported that “I don’t have access to a printer”, “I cannot have face-to-face meetings with my colleagues”, and “There is a lack of access to resources and documents in office”, which cause the change of workload. In addition, the results indicate that email showed the highest percentage of workload for both regular work and WFH. It has become the most commonly used way for people to conduct professional communications. Therefore, WFH makes people use more

technologies to assist their work, such as electronic devices and online communication tools, which means the human-computer interaction becomes more important.

Then, considering different occupations, all the occupations in the industry had higher working hours per week than occupations in the education area. Professionals in the industry have a more stressful schedule than employees in the education area. Then, after shifting to WFH, staff in the education area, teacher/instructor, professor, project management occupations in office show increased workload. It may be because of their regular work in an indoor work environment, which means their major tasks can be done at home computers or other electronic devices [11]. However, WFH makes the workload become heavier from several aspects. Many respondents indicated that "more time to prepare online courses", "it takes longer to complete documentation virtually", and "more hours to contact and communicate with co-workers".

On the contrary, the researcher in the education area, on-site occupations, and staff in the industry show less workload when working from home. There are several possible reasons for the difference. One of the major reasons may be that many of their work contents cannot be done at home. For on-site occupations, many participants indicated that "safety management requires direct observation and interaction with jobsite staff" and "there are some quality and safety tasks I cannot do as well even with the drone and camera". Also, many researchers showed that "our research is mainly lab-based experiments for which lab facilities are required" and "various events were canceled because of the pandemic". Therefore, there is less work that they can finish at home. However, for staff in the industry, their workload is reduced although their regular work is conducted in the office. The respondents proposed some explanations including "fewer projects, fewer employees, fewer payables and receivables" and "some documentation must be completed when we are allowed to return to the office". Therefore, the change of workload is relevant to the status of the industry and requirement of their companies.

Then, for the decrease in productivity, the technical issue is the main reason. First, the reduced productivity of remote communication leads to lower productivity. The results show that in-person meeting has the highest productivity during regular work, while it has the lowest productivity of WFH because of the limitation of face-to-face meeting. Therefore, the major part of communication should be finished by online meeting, whose productivity increases. However, when changing to online meetings at home, their productivity is lower than in-person meetings during regular time, which indicates that remote communication by technologies cannot have the same high efficiency as face-to-face communication. Majority of the respondents complained about the less efficiency of communication when working from home, such as "face to face communication is more efficient", "working from home has greatly reduced the communication efficiency", and "collaboration with team members is more difficult. Communicating via email and conference calls, while helpful, are not as productive as typical in-person communication". Therefore, there is a need to improve the efficiency of virtual meetings and communication based on technologies to better support home-based work.

Also, when working from home, the tasks on electronic devices, such as review documents on-screen, email, online meeting, etc., have higher productivity, while the tasks based on printed papers or in-person communication, such as review documents

in print, other tasks on paper, in-person meeting, etc., have lower productivity. The main reason may be the lack of access to resources as mentioned in previous part. Online meeting shows the highest improvement in productivity because most people mentioned that "communication with colleagues is critical for collaboration". But they cannot have face-to-face meeting at home, which means the in-person meeting shows a significant lower productivity. However, current technologies allow them to communicate with each other online. Therefore, tasks based on electronic devices have become a common and more productive way to finish work when working from home. However, WFH still causes a loss of productivity because of the technical issues mentioned by the respondents, such as "Slower technology at home, wi-fi issues, only one monitor", "Less efficient due to technology available", "There have been WIFI issues working from home that I don't experience at work", etc. Therefore, future studies should focus on how to address these problems and enhance human-computer interactions to improve the productivity of WFH.

Besides, another key reason for the loss of productivity is the distractions from family, especially childcare and housework. Many respondents made comments about it, such as "More distractions/responsibilities at home", "As the schools and daycare are closed, I need to do parenting, teaching, and spend more time cleaning and sanitizing", "Household demands, childcare, child education", "Interference with private life (household, family matters, etc.)", and "I'd rather work at the office. That's where I work. No kids, dog, laundry, but big screen, etc." Therefore, future research should pay attention to the work-life balance when WFH to improve work performance.

Finally, for different occupations, only teacher/instructor in the education area and on-site occupations in the industry show higher productivity, while the other five occupations have reduced productivity when working from home. The possible reason for the difference is that teacher/instructor only needs to work for the online courses at home. The single type of work makes it easier to adapt to WFH and have high productivity, while professor, staff, project management occupations in the office all have various types of work and need to spend much time communicating with others. The task complexity impacts the productivity [21]. Meanwhile, for on-site occupations, their productivity increases potentially because of the lower workload. However, although the researchers have less workload, their productivity decreased possibly because it takes them more time to adjust some lab-based tasks to home.

6 Conclusion

Due to stay-at-home orders under this pandemic, most employees have to shift from regular work to WFH. It has caused changes in workload and productivity, which impact employees, companies, and the national economy. Therefore, there is an urgent need to understand the differences between regular work and WFH. A nationwide survey was distributed to explore the workload and productivity considering different types of tasks and occupations. The results indicated that WFH leads to an increase in workload by 3 hours per week on average, and over 38% of respondents show a loss of productivity when working from home.

Moreover, there are differences in workload and productivity among different tasks and occupations. For the workload, WFH needs to use more technologies, including computers, online communication tools, etc., which require a high-level of human-computer interaction. However, the technical issues, including less efficiency of online communication, difficulties of technology accessibility, WIFI issues, etc. are major reasons for the reduced productivity. Also, the distraction from family is another key factor impacting productivity when working from home. Considering different occupations, employees whose tasks are regularly finished in an office or using computers show a higher workload because most of their work can be done remotely. However, on-site occupations and researchers, whose major work needs to be done onsite or in the lab, have less workload at home. Then, teacher/instructor and on-site occupations show higher productivity due to their single type of work or less workload. However, the other five occupations suffer a loss of productivity due to the increased workload, complexity of tasks, high-level of communication with others, and difficulty of shifting work from regular place to home.

The paper contributes to the theoretical understanding of WFH considering both workload and productivity from the new perspectives of different tasks and occupations. Also, the findings can provide insight for both individuals and institutions or companies on WFH and how to improve their remote work efficiency in practice. According to the findings, future studies should focus on the development of technology to support better online communications and reduce problems caused by technology, which can improve the productivity of WFH. Also, it is critical to enhance the human-computer interaction and develop innovative tools that allow people to finish on-site tasks, lab-based work or other things that cannot be done remotely now at home in the future.

References

1. Secon, H.: An interactive map of the US cities and states still under lockdown - and those that are reopening. Business Insider. https://www.businessinsider.com/us-map-stay-at-home-orders-lockdowns-2020-3. Accessed 30 May 2020
2. Brynjolfsson, E., Horton, J., Ozimek, A., Rock, D., Sharma, G., Ye, H.Y.T.: COVID-19 and Remote Work: An Early Look at US Data. Unpublished work (2020)
3. Team at Slack: Report: Remote work in the age of Covid-19. https://slackhq.com/report-remote-work-during-coronavirus. Accessed 21 Apr 2020
4. Ralph, P., Baltes, S., Adisaputri, G., Torkar, R., Kovalenko, V., et al.: Pandemic Programming: How COVID-19 affects software developers and how their organizations can help. https://arxiv.org/abs/2005.01127. Accessed 30 May 2020
5. Shamir, B., Salomon, I.: Work-at-home and the quality of working life. Acad. Manage. Rev. **10**(3), 455 (1985)
6. Choudhury, P., Koo, W., Li., X.: Working from Home Under Social Isolation: Online Content Contributions During the Coronavirus Shock. Harvard Business School Technology & Operations Mgt. Unit Working Paper, 20–096 (2020)
7. Baker, M.G.: Who cannot work from home? Characterizing occupations facing increased risk during the COVID-19 pandemic using 2018 BLS data. https://www.medrxiv.org/content/10.1101/2020.03.21.20031336v2. Accessed 30 May 2020

8. Gottlieb, C., Grobovšek, J., Poschke, M.: Working from home across countries. Covid Econ. **8**, 71 (2020)
9. Hensvik, L., Le Barbanchon, T., Rathelot, R.: Which jobs are done from home? Evidence from the American Time Use Survey. https://www.iza.org/publications/dp/13138. Accessed 29 May 2020
10. Gupta, A.: Accelerating Remote Work After COVID-19. https://www.thecgo.org/research/accelerating-remote-work-after-covid-19/. Accessed 29 Apr 2020
11. Dingel, J.I.: How Many Jobs Can be Done at Home? National Bureau of Economic Research, NBER Working Paper, (2020)
12. Purwanto, A., Asbari, M., Fahlevi, M., Mufid, A., Agistiawatti, E., et al.: Impact of work from home (WFH) on indonesian teachers performance during the Covid-19 pandemic: an exploratory study. Int. J. Adv. Sci. Technol. **29**(5), 6235–6244 (2020)
13. Rubin, O., Nikolaeva, A., Nello-Deakin, S., te Brömmelstroet, M.: What can we learn from the COVID-19 pandemic about how people experience working from home and commuting?. Centre for Urban Studies, University of Amsterdam. https://urbanstudies.uva.nl/content/blog-series/covid-19-pandemic-working-from-home-and-commuting.html. Accessed 06 May 2020
14. Gorlick, A.: The productivity pitfalls of working from home in the age of COVID-19. Stanford News, Stanford University Communications, California, USA (2020)
15. Lam, H.W., Giessner, S., Shemla, M.: Tips: loneliness and working from home during the COVID-19 crisis. https://discovery.rsm.nl/articles/431-tips-loneliness-and-working-from-home-during-the-covid-19-crisis/. Accessed 27 Mar 2020
16. King, W.R., Cleland, D.I.: Project Management Handbook. Van Nostrand Reinhold, New York (1988)
17. Houston, D., Meyer, L.H., Paewai, S.: Academic staff workloads and job satisfaction: expectations and values in academe. J. High. Educ. Pol. Manage. **28**(1), 17–30 (2006)
18. Czerwinski, M., Horvitz, E., Wilhite, S.: A diary study of task switching and interruptions. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Vienna, Austria, CHI 2004, vol. 6, pp. 175–182 (2004)
19. Reddy, K.J.: Relevance of listening and speaking skills for engineering students in their professional career. Strength Today Bright Hope Tomorrow **19**(11), 150–159 (2019)
20. U.S. Bureau of Labor Statistics: Labor Force Statistics from the Current Population Survey. https://www.bls.gov/cps/demographics.htm#age. Accessed 15 June 2020
21. Goparaju Purna, S., Ayesha, F., Sanghamitra, P.: Measuring productivity of software development teams. Serb. J. Manage. **7**(1), 65–75 (2012)