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Workload and Productivity during Work from Home (WFH) for the Construction Workforce

Hongyue Wu[1]*, Yunfeng Chen[2]

[1] *Construction Automation, Robotics, and Ergonomics (CARE) Lab, School of Construction Management Technology (SCMT), Purdue University, HAMP Hall G293, 550 W Stadium Ave, West Lafayette, IN 47907, USA,* E-mail address: wu1513@purdue.edu
[2] *CARE Lab, SCMT, Purdue University, Knoy Hall Rm. 443, 401 N Grant Street, West Lafayette, IN 47907, USA,* E-mail address: chen428@purdue.edu

Abstract: A large number of employees shifted to Work from home (WFH) due to the COVID-19 pandemic, including the construction workforce. The changes in workload and productivity due to WFH impact the work performance and economic outputs of companies. However, there are mixed results about the impacts of WFH on workload and productivity. In particular, limited studies focused on specific types of work of different occupations in the construction workforce. This study aims to explore the impacts of WFH on workload and productivity considering different types of work for the construction workforce in the U.S. After identifying three main occupations and five types of work, an online survey (N = 69) was distributed. Descriptive analysis showed that participants had less workload (0.82 hours/week) and lower productivity (9.69%) during WFH. Three occupations had varied changes due to the different types of work. Analysis of Variance (ANOVA) indicated that there was no significant difference in workload, while productivity was decreased during WFH. In particular, the productivity of project-related work and communication and documentation decreased significantly. Overall, participants finished 2.85% less workload per week during WFH. The findings provide an insight into WFH in the construction workforce, which improves future remote or hybrid work arrangements in the construction industry.

Key words: work from home (WFH), productivity, workload, construction workforce.

1. INTRODUCTION

Work from home (WFH) has become mandatory for most employees due to stay-at-home orders during the COVID-19 pandemic [1], [2]. In January 2021, there were over 148,383 individuals still working from home [3]. After the pandemic, some employers may continue to apply WFH or hybrid work arrangements. The changes in workload and productivity during WFH may further influence the work stress [4], salaries, and employment status of employees [5], [6], economic outputs of companies, and the national economy [7], [8]. However, current studies showed conflicting findings on the impacts of WFH on workload and productivity [2], [4], [9], [10]. Thus, it is urgent to explore the changes in workload and productivity during WFH to contribute to WFH theories and guide future WFH practices.

Then, the construction workforce usually experiences long work hours, high workload, frequent travel needs, etc. [11], which results in lower job satisfaction and higher turnover intentions [12].

These problems may be alleviated by WFH by reducing commuting time and creating flexible schedules [10]. However, existing work identified that during WFH, the construction workforce experienced increased time spent on online communication and work activities, working irregular hours, less work engagement, etc. [13]. In addition, the construction workforce mainly has limited WFH experiences before the COVID-19 pandemic, which creates more challenges [1]. Thus, there is a need to further examine the impacts of WFH on the construction workforce to identify the possible challenges and improve WFH in the future. In particular, employees may have varying experiences during WFH due to the nature of the work that they perform [1], [6].

The study aims to analyze the impacts of WFH on the workload and productivity based on different types of work to provide an understanding of WFH for the construction industry and help individuals and companies improve future remote work or hybrid work arrangements. The research firstly identified three main occupations and specific types of work in the construction workforce. Second, an online survey was distributed to collect data in the U.S. Finally, descriptive analysis and Analysis of Variance (ANOVA) were applied to get the results.

2. LITERATURE REVIEW

Existing work showed mixed results about the impacts of WFH on workload and productivity. For workload, current studies indicated that WFH leads to an 8.2% increase in workload due to changes in communication patterns, technology issues, limitation of work-related resources, etc. [2], [4], [14]. However, another paper showed that teleworkers worked fewer hours than commuters during working days because teleworkers had the flexibility to distribute the work over more days in a week [10]. Then, it was indicated that work productivity was reduced due to distractions from family members, especially children, and a lack of in-person collaborations [4], [8]. On the contrary, some studies showed that WFH led to a 13% increase in work performance because of the more working time and quieter work environment [9]. Employees were more productive, happier, and less likely to quit when working from home [15]. There is no consensus about the impacts of WFH on workload and productivity. In addition, most studies were conducted in the general public, with emerging studies exploring this topic in the construction industry.

One potential reason for the conflicting results is the differences in the types of work performed. For certain occupations, for example, there is a positive correlation between the number of working hours and portability during WFH [16]. Employees with computer-supported tasks reported more work hours at home [17]. Also, employees whose work mainly relies on computer technology can have high productivity at home [18], while employees who have minimal computer use had difficulties in performing their work at home productively [19]. The project-driven nature of the construction industry indicates that the types of work cover both on-site and off-site work relating to the project and company management [11], [20]. Construction workforce face difficulties in coordinating onsite work remotely during WFH [13]. However, limited studies considered specific types of work in the construction workforce to analyze the workload and productivity during WFH.

In a word, current studies usually evaluated the workload and productivity during WFH for the general public, while the study focusing on WFH in the construction industry is emerging. In particular, limited studies focused on the specific types of work. This study explored the effects of WFH on workload and productivity for the construction workforce considering different types of work to provide an insight into the future remote work in the construction industry.

3. METHODOLOGY

3.1. Online survey design and measures

To explore the workload and productivity during WFH for the construction workforce, the study used an online survey to collect data in the U.S. Each participant needed to provide two sets of responses during (a) regular work (i.e., mainly work in the office or on-site) and (b) WFH. First, the participants provided demographic information, including occupation, gender, age, etc. Second, the days of WFH per week before and during the COVID-19 pandemic as well as the possible days of WFH per week after the pandemic were asked. Then, participants needed to specify their workload and productivity for each work content. Finally, combining workload and productivity, the participants were requested to specify the percentage of workload that they can finish per week with potential reasons if applicable.

When measuring workload and productivity, specific types of work were provided, shown in Figure 1. The construction workforce was divided into three main occupations: (1) on-site workers, who usually work outside the office; (2) office workers in project management, who mainly perform project-related tasks in the office; and (3) staff, who are responsible for the administration and support duties. For on-site and office workers in project management, one of their major types of work is project-related tasks, including estimating, scheduling, contract management, resources procurement and management, cost control, schedule control, safety control, quality assurance and control, risk management, etc. [21]. Then, staff in the construction industry also need to perform functional responsibilities relating to their positions, such as human resources, financing, marketing, consulting, etc., as well as office management, such as maintaining inventory, organizing the workplace, and other support tasks [22]. Finally, for all the workers, routine meetings/training/events, such as project meetings, company meetings, and professional training and communication and documentation are general types of work [21], [23]. In addition, there were "other" items for participants to specify the types of work that were not included in the survey.

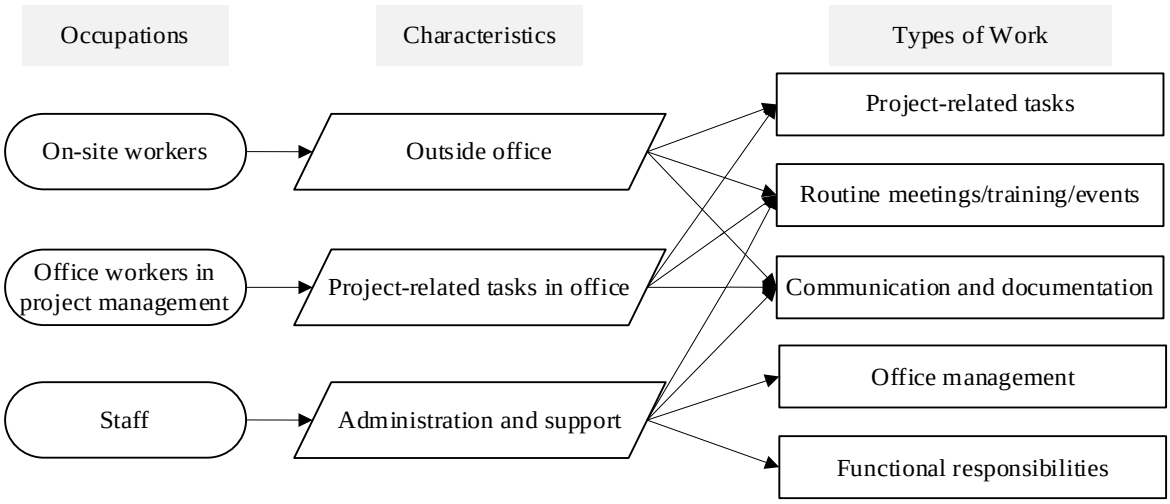

Figure 1. Types of work for the construction workforce

The key variables of this study were measured as follows. *Work-from-home* was dummy coded, where 0 indicates regular work, and 1 indicates WFH. *Workload* was measured by work hours per week [24]. *Productivity* was defined as "real output per hour" [25] and evaluated by a five-point Likert scale (1 indicated the lowest productivity, while 5 indicated the highest productivity).

3.2. Data collection and analysis

The survey was distributed to the construction workforce in the U.S. through individual emails and social media from May 7th to May 28th, 2020. Several construction-related professional associations and universities were also contacted. Finally, 69 participants from Architecture,

Engineering, Construction, and Operation (AECO) fields completed the survey. Responses of (a) regular work from 11 participants who had worked from home all the time and responses of (b) WFH from five participants who did not have WFH experiences were removed. As for workload, 25 responses whose total work hours exceeded 130 hours/week and two responses showing 0 work hours were removed to reduce outliers and unreasonable data. Finally, 95 (69×2 – 11 – 5 – 25 – 2) responses of workload were kept. Then, for productivity, the single imputation method was used to impute the item-level missing data by mean values. There were 122 responses (69×2 – 11 – 5 = 122) of productivity used for further analysis. Descriptive analysis and one-way ANOVA were applied to explore the impacts of WFH on workload and productivity, respectively. The PROC GLM package in SAS software was applied.

4. RESULTS AND DISCUSSION

4.1. Demographic information

Among the 69 participants, there were 55 men (72.46%) and 14 women (20.29%). Then, the average age was 41.12, ranging from 23 to 78 years old. For marital status, 50 participants were married or lived together with a significant other (70.42%), and 18 participants were single or divorced (26.08%). One participant did not disclose this information. Then, for the AECO fields, there were 22 engineers (31.88%), 21 architects (30.43%), 10 subcontractors (14.49%), 5 consultants (7.25%), 5 contractors (7.25%), 3 owners (4.35%), and 3 developers (4.35%). In addition, they were from various positions, such as project manager, structural engineer, BIM manager, etc. In particular, there were 8 on-site workers (11.59%), 7 staff (10.14%), and 54 office workers in project management (78.26%).

4.2. Workload

Table 1 shows the descriptive analysis and ANOVA results of workload for different occupations and types of work. Overall, participants worked 53.56 hours/week during regular work, while their workload was 52.74 hours/week during WFH on average. There was less workload during WFH (0.82 hours/week). In particular, on-site workers had much more workload during WFH (12.40 hours/week). One potential reason is that the data was collected in May 2020, when WFH was new to most construction workforce, especially the on-site workers [1]. The rapid shift to WFH created much additional work for on-site workers to transfer many tasks from on-site to home, which increased the workload. Then, the increased workload of routine meetings/training/events and communication and documentation during WFH (0.56 and 0.01 hours/week) may be due to the more time spent on online communication and meetings than in-person ones [13], [14]. On the contrary, office workers in project management and staff had decreased workload (2.06 and 0.20 hours/week). The first possible reason is that most of their tasks can be shifted to home easier than on-site workers. Second, the workload of functional responsibilities and project-related work decreased a lot (4.00 and 1.08 hours/week), which can offset the increased workload of other types of work. One explanation is that during the COVID-19 pandemic, many functional responsibilities were intermittent during WFH, and some project-related tasks cannot be finished remotely [17].

However, there were no statistically significant differences in workload according to the ANOVA test (*F-value* = 0.02 and p = 0.88). The construction workforce had a similar workload after shifting to WFH. In particular, for the different types of work, project-related work (*F-value* = 0.05 and p = 0.83), routine meetings/trainings/events (*F-value* = 0.25 and p = 0.62), and communication and documentation (*F-value* = 0.00 and p = 1.00) all showed no statistically significant differences in workload.

Table 1. Descriptive analysis and ANOVA results of workload [1]

Occupations (hours/week)	On-site workers		Office workers in project management		Staff	
Regular work	46.00		52.90		62.80	
WFH	58.40		50.84		62.60	
Differences (WFH – Regular)	12.40		-2.06		-0.20	
Types of work (hours/week)	Project-related work	Routine meetings/trainings/events	Communication and documentation	Office management	Functional responsibilities	Overall
Regular work	31.77	6.85	14.80	1.40	31.60	53.56
WFH	30.68	7.41	14.80	1.40	27.60	52.74
Differences (WFH – Regular)	-1.08	0.56	0.01	0.00	-4.00	-0.82
F-value	0.05	0.25	0.00	-	-	0.02
p-value	0.83	0.62	1.00	-	-	0.88

4.3. Productivity

Table 2 indicates the descriptive analysis and ANOVA results of productivity. Overall, the productivity decreased by 9.69% (-0.41/4.23) after shifting to WFH. All three occupations and corresponding five types of work showed the consistency of decreased productivity. According to the ANOVA (*F-value* = 11.35, $p < 0.01$), there were significant differences in productivity. The construction workforce had significantly lower productivity during WFH. One reason is probably the lack of WFH experience in the construction workforce [1].

In particular, there were more differences in productivity for staff, because there are more decreases in productivity of office management (-1.09/4.05 = -26.91%) and functional responsibilities (-0.77/4.03 = -19.10%) than in other types of work. Office management tasks (e.g., bookkeeping, record keeping, etc.) and many functional responsibilities (e.g., consulting, marketing, etc.) require close interactions with others to obtain and organize key information [22], which was impacted by the less efficient online communication during WFH [13], [14]. The results align with the decreased productivity of routine meetings/training/events and communication and documentation (-0.28/4.12 = -6.80%; -0.40/4.39 = -9.11%), which applies to all three occupations. ANOVA tests further supported the significant differences in productivity of communication and documentation (*F-value* = 9.87 and $p < 0.01$), while routine meetings/trainings/events (*F-value* = 3.15 and $p = 0.08$) showed no statistically significant differences. The possible explanation is that communication and documentation require a higher level of interaction between each other, while routine meetings/training/events cover many key talks or speeches with fewer discussions and interactions. For on-site workers and office workers in project management, the productivity of project-related work decreased (-0.50/4.21 = -11.87%) significantly according to the ANOVA

[1] Due to the limited samples of on-site workers and staff, as well as the types of work of office management and functional responsibilities, the ANOVA test cannot identify the possible differences. Thus, their results were not reported. Similar reason was also applied to 4.3 Productivity. It was also mentioned in the limitation part.

result (*F-value* = 17.13 and $p < 0.01$), because many project-related tasks rely on on-site information [11], [20], which is more difficult to obtain during WFH, especially during the pandemic. In particular, some construction sites were closed, which impacts productivity.

To sum up, the major challenges of WFH in the construction industry are inefficient online communication and difficulties in performing project-related work remotely. To improve future remote work, proper strategies should be applied, such as providing technical support for online communication, developing information systems to organize project-related information efficiently, upgrading organizational structures to improve communication efficiently, etc.

Table 2. Descriptive analysis and ANOVA results of productivity

Occupations	On-site workers		Office workers in project management		Staff	
Regular work	4.01		4.27		4.18	
WFH	3.39		3.92		3.42	
Differences (WFH – Regular)	-0.61		-0.35		-0.76	
Types of work	Project-related work	Routine meetings/trainings/events	Communication and documentation	Office management	Functional responsibilities	Overall
Regular work	4.21	4.12	4.39	4.05	4.03	4.23
WFH	3.71	3.85	3.99	2.96	3.26	3.82
Differences (WFH – Regular)	-0.50	-0.28	-0.40	-1.09	-0.77	-0.41
F-value	17.13	3.15	9.87	-	-	11.35
p-value	<0.01	0.08	<0.01	-	-	<0.01

4.4. Percentage of workload finished per week

Finally, the data on the percentage of workload finished per week showed that participants could finish 84.86% of their workload during regular work, while the average percentage was 83.31% during WFH. Participants could finish 2.85% less workload when shifting from regular work to WFH. The standard deviations indicated that there were more variances during WFH (SD = 17.87) than during regular work (SD = 12.67), which means participants reported more different performances during WFH. In addition, some participants indicated that there were no differences in the percentage of workload finished per week. Combining both workload and productivity, the construction workforce showed better work performance during regular work than WFH.

Participants provided the reasons for the changes in percentages of finished workload. On the one hand, for the participants who reported a decrease in finished workload during WFH, the possible reasons are (1) technical issues, such as “VPN does not always have good quality.”, “internet issues at home and better computers in the office”, and “limited access to facilities at home”; (2) more distractions from family and housework, such as “too many distractions”, “more distractions as kids at home”, and “family and home interruptions”; (3) low efficiency in online communication, such as “spending more time on communication and meetings”, “Ability to coordinate with different parties are important. Work from home has greatly reduced the communication efficiency.”, and “inability to coordinate in-person and quickly receive feedback on drawings”. On the other hand, some participants explained the reasons for the increase in finished workload at home: (1) fewer distractions, such as “no office distractions”, “I am alone at home with fewer distractions.”, and “less time making social talk”; (2) flexible schedule, such as

"more flexibility to perform work", "better use of time", and "better ability to control my time"; (3) no commuting time, such as "no commute and no travel time" and "less commute time". Companies and individuals should apply proper strategies based on these specific reasons to improve work performance during WFH.

5. CONCLUSION

COVID-19 created an unprecedented WFH experiment for most employees, including the construction workforce, while the changes in workload and productivity due to WFH are still unclear. This study applied an online survey to investigate the impacts of WFH on workload and productivity in the construction workforce considering different types of work. Five types of work of three occupations in the construction industry were identified. Descriptive analysis showed that the workload decreased by 0.82 hours/week and productivity decreased by 9.69% during WFH. Participants finished 2.85% less workload when shifting from regular work to WFH. ANOVA tests indicated that there were no significant differences in workload, while productivity decreased significantly during WFH. Project-related work and communication and documentation are two major types of work showing significantly lower productivity during WFH. Several possible reasons for the changes in workload and productivity were summarized based on participants' responses and literature, which can improve future remote work in the construction industry. The findings contribute to an understanding of WFH considering specific types of work and help improve future remote work in the construction industry.

However, the study has some limitations. First, the samples of each occupation are limited. Although the sample size satisfied the requirements of ANOVA, future study needs to collect more data, especially for on-site workers and staff. Then, the study relied on participants' recall comparing variables between normal work and WFH. Future work can apply several rounds of surveys to reduce the impacts of long-term memory. Also, the workload and productivity were measured subjectively by participants' self-reports. Future work may explore some objective measures. Finally, the WFH data was collected during the COVID-19 pandemic, which is a unique situation. The spread of virus and movement restrictions may affect the WFH experiences. Future work could collect data during normal times to better understand WFH.

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