
Design for Working from Home: Lessons Learned from Architects and Designers during the COVID Era

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ABSTRACT

Technology has revolutionized information and communication, with platforms now enabling employees to work remotely. The COVID-19 pandemic has further changed how people work worldwide. Several challenges have been identified for those working remotely, including uncomfortable work environments, increased stress, and depression. However, there is a lack of research on the working from home (WFH) challenges, successes, and conditions for design professionals. In this study, an anonymous online survey was administered to 93 remote architects and interior designers. The survey aimed to explore remote designers' experiences, physical work environment, and required equipment. Most respondents reported experiencing distractions, lack of social interaction and physical activities, and inadequate internet/tools while working remotely. However, 60% of participants reported higher productivity while working remotely and desired improved working conditions to continue WFH. Based on the study's findings, researchers aim to develop and evaluate a pervasive virtual reality enhanced WFH environment for designers in the future.

Keywords – Technology, Working from Home, Architects, Designers, Pervasive Virtual Reality

1. Introduction

The concept of remote work has been considered since the 1920s (Westfall, 1998), with the emergence of telework as a means of enabling work from home predicted by Allan Toffler and Jack Nilles in the 1970s (Nilles et al., 1976). The development of information and communication technologies, including smartphones and computers, has facilitated the ability to work from anywhere at any time, reducing the significance of geographical distance between workplaces and companies (Messenger & Gschwind, 2016). The trend towards remote work has gained momentum in recent years as individuals increasingly value flexible and mobile work styles. According to the American Community Survey, only 6% of Americans worked entirely from home in 2019, representing an increase of 2% from 2009 (Patrick Coate, 2021). However, the Covid-19 pandemic has caused a significant increase in the number of people working from home with an 8% increase in US workers reporting that they were working from home during the lockdown period (Brzezinski et al., 2020). In this regard, the US Census Bureau reports that over a third of US households have reported working from home more frequently since the onset of the pandemic (Marshall et al., 2021). A study by Dingel and Neiman (2020) found that 37% of US jobs can be performed entirely remotely, with this figure varying significantly across industries and cities. While developing economies may have less capacity for widespread remote employment, they are more susceptible to lockdowns. However, the rapid adoption of remote work during the pandemic has led to changes in work styles and time management

in many countries and has raised questions about the future of the workplace. While working from home may be a suitable decision under these forced circumstances (Langè & Gastaldi, 2020), it remains to be seen how the trend toward remote work will continue to evolve in the future.

Although numerous studies have examined the impact of remote work on employees' psychological well-being (Bellmann & Hübler, 2020; Grant et al., 2013), including job satisfaction (Niebuhr et al., 2022), stress levels (Seva et al., 2021), loneliness (Deutrom et al., 2022; Mann & Holdsworth, 2003) and performance (Jalagat & Jalagat, 2019), this particular study specifically investigated the physical work environment and required equipment of employees working from home, as well as their psychosocial states. Previous research primarily focused on the remote work experiences of various professions including software engineers (Smite et al., 2022), IT specialists (Dingel & Neiman, 2020), institutional staff (Afrianty et al., 2022), and bank employees (Borgia et al., 2022), whereas there is a dearth of information regarding the unique challenges and successes of WFH for design professionals. Therefore, this study aims to investigate designers' physical remote work environment conditions including furniture, required equipment, environment dimensions, and lighting conditions, and to explore the experiences and challenges these professionals encounter while working in a home-based office.

The literature suggests that working from home (WFH) can have both positive and negative impacts ((Bolisani et al., 2020; Galanti et al., 2021; Moretti et al., 2020). The COVID-19 pandemic has particularly highlighted the ways in which personal and work-related factors both facilitate and hinder WFH. Studies have identified a number of benefits associated with WFH, including increased autonomy and self-leadership (Galanti et al., 2021), enhanced productivity and flexibility (Jalagat & Jalagat, 2019), and the ability to better balance work and personal commitments amongst middle-aged employees (Piszczek & Pimputkar, 2021). In this regard, Kurland and Bailey (1999) found that remote work can enhance workplace productivity and improve job performance ratings (Bailey & Kurland, 1999). However, there are also negative aspects of WFH that have been identified in the literature, such as the blurring of work-life boundaries leading to increased anxiety and difficulty disconnecting from work (Grant et al., 2013), and increased social interaction among family members at home (Grant et al., 2013). Moreover, one study, contrary to most studies, stated that WFH negatively affects employees' performance and it is even worse when teammates are working remotely (Van Der Lippe & Lippényi, 2020). Additionally, stress can have a negative impact on employees' productivity when working remotely (Seva et al., 2021). Galanti et al. (2021) found that conflicts between work and family life and social isolation can affect WFH engagement and productivity.

The COVID-19 pandemic has continued to influence all aspects of working from home (WFH) and work styles. Recent research has found that WFH during the pandemic has provided a significant degree of opportunities and flexibility, as well as helped to contain the spread of Covid-19 by keeping the majority of people at home (Birimoglu Okuyan & Begen, 2022). A study by Moretti et al. (2020) found that those who worked from home during the pandemic reported feeling less stressed and as satisfied as those who worked in an office. However, WFH after the pandemic has also been accompanied by a number of challenges, including difficulty maintaining contact with colleagues, heavy reliance on communication systems (Bolisani et al., 2020b), and distractions from family members that can increase stress levels and impact performance (Guantario, 2020).

Table 1. Benefits and Challenges of WFH

<i>Authors</i>	<i>Benefits of WFH</i>	<i>Challenges of WFH</i>	<i>Sample</i>	<i>Sample Size</i>	<i>Method</i>
(Beck & Hensher, 2022)	<ul style="list-style-type: none"> - Reduced transportation costs - Possibility to work from anywhere and not from a centralized location - More flexible time management - Having more family time 	<ul style="list-style-type: none"> - Children and family interruptions during working hours - Less concentration at work 	Australian employees	3460	Three waves of online surveys
(Aczel et al., 2021)	<ul style="list-style-type: none"> - Enhanced efficiency - Enhanced wellbeing - Better at writing, reading, and evaluating data among researchers 	<ul style="list-style-type: none"> - Reduced connection with team - Researchers are less likely to collect data while working remotely 	Researchers working from home	704	Survey
(Galanti et al., 2021)	<ul style="list-style-type: none"> - Self-leadership - Autonomy 	<ul style="list-style-type: none"> - Conflicts between family and work life - Social isolation - Increased stress - Decreased productivity 	WFH full-time employees in Italian public and private organizations	209	Online self-report questionnaire
(Ipsen et al., 2021)	<ul style="list-style-type: none"> - More balance between work and life - Enhanced productivity - Improved management control 	<ul style="list-style-type: none"> - The constraints of home offices - Uncertainties at work 	Knowledge workers working remotely in 29 European countries	5748	An online survey in Danish and English
(Moretti et al., 2020)	<ul style="list-style-type: none"> - Reduced stress level 	<ul style="list-style-type: none"> - Absence of ergonomic office furniture - Less productive during pandemic - Less job satisfaction - Less physical health 	Remote administrative officers	51	Cross-sectional study, Questionnaire
(Bolisani et al., 2020b)	<ul style="list-style-type: none"> - Reduced transportation time - Eating and drinking food that you prepare yourself - Concentrating on your work without interruptions 	<ul style="list-style-type: none"> - Uneasy interactions with people - An inability to avoid lengthy meetings - Uncomfortable work environment 	Italian employees	931	Online survey
(Lupu, 2017)	<ul style="list-style-type: none"> - Flexible scheduling - Reduced expenses for organizations - Fewer interruptions - Improved concentration - A greater sense of motivation - More satisfaction - Better employee commitment 	<ul style="list-style-type: none"> - Technical issues that cannot be resolved remotely - Inequalities in salaries between office employees and teleworkers - Isolation among employees - Limitations to normal interactions with coworkers 	-	-	Review article

	- Reduction of time and disruptions increased work energy	- Difficulties in managing union activities			
(Johansson, 2017)	- Simple and inexpensive alternative of working in an office space - Privacy - Increased concentration in the quiet and peace that a home environment - Freedom - More flexible office hours - Parallel work with other household tasks	- Lack of surfaces or working space in the space that you designated for WFH - Lack of space for storage and organization - Difficulties in setting boundary between working hours and free time - Everything is taking place in the same environment. - Numerous distractions, which make it difficult to focus - Isolation at home as opposed to working with several colleagues in an office setting.	Swedish employees	7	Observation and Interview
(Bloom et al., 2014)	- Increased performance - More work satisfaction - Halves attrition rate	- Reduced performance-based promotion rate	Employees of Ctrip, a Chinese travel agency	249	Between-subjects design
(Grant et al., 2013)	- Technology access - Enhanced flexibility - Individual competencies - Enhanced work-life balance	- Decreased well-being because of overworking. - Lack of time for recuperation - Increased workload - Job insecurity	Remote employees from different organizations and sectors in UK	11	Semi-structured interview
(Tremblay & Thomsin, 2012)	- The ability to save money and time on commuting. - Allowing for more family time - Enhancing quality of life - Balancing work and family life - Increasing workplace flexibility and autonomy	- Increased dissatisfaction - Social isolation - Loss of team spirit	Management and staff members of a large ICT organization in Belgium	1343	Survey
(Forgacs, 2010)	- Wellbeing - Productivity and efficiency - Satisfaction - Increasing employment opportunities	- Individuals' lives and careers are weakening - Limiting job opportunities - Precarious environment	Medium and large enterprises in Hungary using telework	473	Screening survey

As Table 1 illustrates, the most frequently cited benefits of working from home (WFH) include improved work-life balance, more flexible scheduling, increased productivity, and reductions in costs. The most common challenges associated with WFH include social isolation, decreased work performance, and distractions. Although the aforementioned studies focused on the psychological and social impacts of working from home on employees, none of them inquired about the environmental

conditions and challenges of the employees' home-based workspaces, such as furniture, required equipment, environment dimensions, and lighting conditions, which employees are required to consider as part of their designated WFH environment. Moreover, none of these studies specifically focused on challenges faced by designers working from home. Designers typically require more collaboration with other team members such as project managers, developers, and other designers, which may not be easy to achieve when working remotely. Communication and collaboration may be hindered, leading to misunderstandings and delays in the design process. Furthermore, designers may require a larger workspace to accommodate their equipment and physical materials such as printed drawings, large format printers, and 3D printers. This lack of space and equipment may further hinder their productivity when working remotely.

Therefore, this study aims to address the gap in existing literature on the impact of WFH on designers. This study's goal is to investigate the physical environment and equipment needs of remote designers, as well as the psychological challenges they may face when working from home. The findings of this study will inform the development of a pervasive virtual reality (PVR) environment that will overlay on top of the actual environment (Valente et al., 2016), providing remote designers with access to more technology, facilities, and an ideal workspace. The PVR environment is expected to minimize distractions from the physical work environment and minimize the challenges that remote designers face, ultimately improving their focus and productivity.

2. Methods

2.1. Participants

An online questionnaire was sent to 30,800 people who work in the design and construction industries and asked them to fill out the survey if they had worked from home even for a short period of time and if they were architects or designers. The survey was completed by 93 participants (50 ± 0.5 years), including architects, interior designers, design project managers, and digital artists who occasionally or often worked from home. Although the survey was distributed to a significant number of design professionals, the response rate was low. This was likely due to the inclusion criteria of the survey, which stated that participants should only complete it if they worked from home and if they are an architect or interior designer.

Of the 93 participants, 39 participants (43.3%) identified as female, 51 (55.5%) identified as male, and 1 (1.1%) preferred not to disclose their gender (see Table 2). The age range of the participants varied, with one participant (1.1%) being between 18 and 24 years old, 18 participants (19.3%) being between 25 and 34 years old, 17 participants (18.3%) being between 35 and 44 years old, 11 participants (11.8%) being between 45 and 54 years old, 18 participants (19.3%) being between 55 and 64 years old, and 28 participants (30.1%) being over 64 years old. In terms of occupation, the majority of the participants were architects, with 63 participants (72.4%) identifying as such. Thirteen participants (14.9%) identified as interior designers, while five participants (5.7%) identified as design project managers or design students. Only one participant (1.1%) identified as a digital artist.

Table 2. Demographics of participants

<i>Variable</i>	<i>Total (%)</i>
Gender ^a	
Female	39 (43.3%)
Male	51 (55.5%)
Prefer not to answer	1 (1.1%)
Age (years)	
18-24	1 (1.1%)
25-34	18 (19.3%)
35-44	17 (18.3%)
45-54	11 (11.8%)
55-64	18 (19.3%)
>=65	28 (30.1%)
Occupation ^a	
Architect	63 (72.4%)
Interior designer	13 (14.9%)
Design project manager	5 (5.7%)
Design student	5 (5.7%)
Digital artist	1 (1.1%)

^aThe gender and occupation questions were not answered by all participants. The percentages presented in the table are based on the total number of participants who answered these questions.

2.2. Procedure

An anonymous online survey was conducted among interior and architectural designers who had previously engaged in remote work, even for a short period of time. The survey was distributed via email to the participants and aimed to investigate the type of equipment, furniture, lighting condition and settings that these professionals used in their designated home work spaces, as well as the average size and environmental characteristics of these spaces. Additionally, the survey sought to identify the experiences and challenges faced by these designers while working from home.

2.3. Instrument

The survey was designed by research team members to examine the experiences of architects and interior designers while working from home using a variety of design criteria. After undergoing review by three specialists on the survey, some modifications were made to the survey. The survey was subsequently administered to ten students to assess its comprehensibility. Firstly, the survey sought to elicit information about the designers' experiences and conditions of WFH through defined categories and the opportunity to provide open-ended responses, allowing participants to articulate their own perceptions of the current situation. Secondly, the questions were based on existing information about remote working, management, and the impact of the pandemic on respondents' lives as discussed in the media. Thirdly, the questionnaire was designed to be completed within approximately 10 minutes in order to minimize the likelihood of respondents leaving the questionnaire incomplete. The survey included 26 questions organized into six sections, covering topics related to the respondents' experiences of the following:

- a. Demographic questions (3): questions regarding participants' age, gender, and occupation.
- b. Work situation (2)
 - *Do you have a designated room for working from home?*
 - *Where in your home is your designated workspace?*
- c. Interior, furniture and equipment condition of their workspace (12 multiple choice questions): questions regarding participants' remote working space furniture, equipment, space materials, lighting, and space dimensions.
- d. WFH habits and physical activities (4)
 - *Do you have furniture that promotes physical activity like a sit-stand desk, a treadmill desk, or a float height-adjustable desk in your working from home environment?*
 - *When you work behind your laptop or PC, do you do any kind of physical activity? If so, please describe.*
 - *When you're working at your home office, do you frequently change locations during the day?*
 - *Have you considered getting a treadmill desk, sit-stand desk, or height-adjustable float desk for your home office to remain healthy?*
- e. Advantages and disadvantages of WFH (4 open-ended questions)
 - *Do you look forward to returning to the office? Why or why not?*
 - *Do you feel as productive at home as you are at the office? Please explain.*
 - *Would there be a main challenge that you would face on a regular basis while working from home? Please explain.*
 - *Are there any additional comments you wish to make regarding your working from home / mobile working conditions?*
- f. Overall quality of participants' working space (1 main question with 8 sub questions)
 - *Please rate the overall quality of the space that you work from home in terms of the following: Adequacy of Space, Artificial Lighting, Natural Lighting, Acoustics, Temperature, Aesthetic Appeal, Flexibility of Use, Air Circulation*

2.4. Analysis

The analysis of the open-ended, qualitative questions was conducted using NVivo qualitative data analysis software (version 2022). Descriptive statistics were reported and organized into seven clusters of quantitative variables and reported as frequencies and percentages. The responses to multiple-answer questions were analyzed using the Qualtrics analyze options and reported as percentages.

3. Results and Discussion

According to the results, 89.2% of the participants stated that they designated a space or room for working from home. The bar chart below (see Fig. 1) shows the current furnishings, equipment, and environmental setting that the majority of construction industry designers have in their homes. It

showed that 44.7% of participants claimed they had a separate home office where they could work from home. While the remainder designated guest rooms, living rooms, bedrooms, dining rooms, and other areas as their working spaces. Approximately 46.8% of respondents indicated their home offices were small or tiny, ranging between 70 and 130 square feet. Nearly 28.7% claimed that their designated space for working from home is medium, measuring around 224 square feet, while 12.8% responded that their home offices are large enough, measuring around 300 square feet.

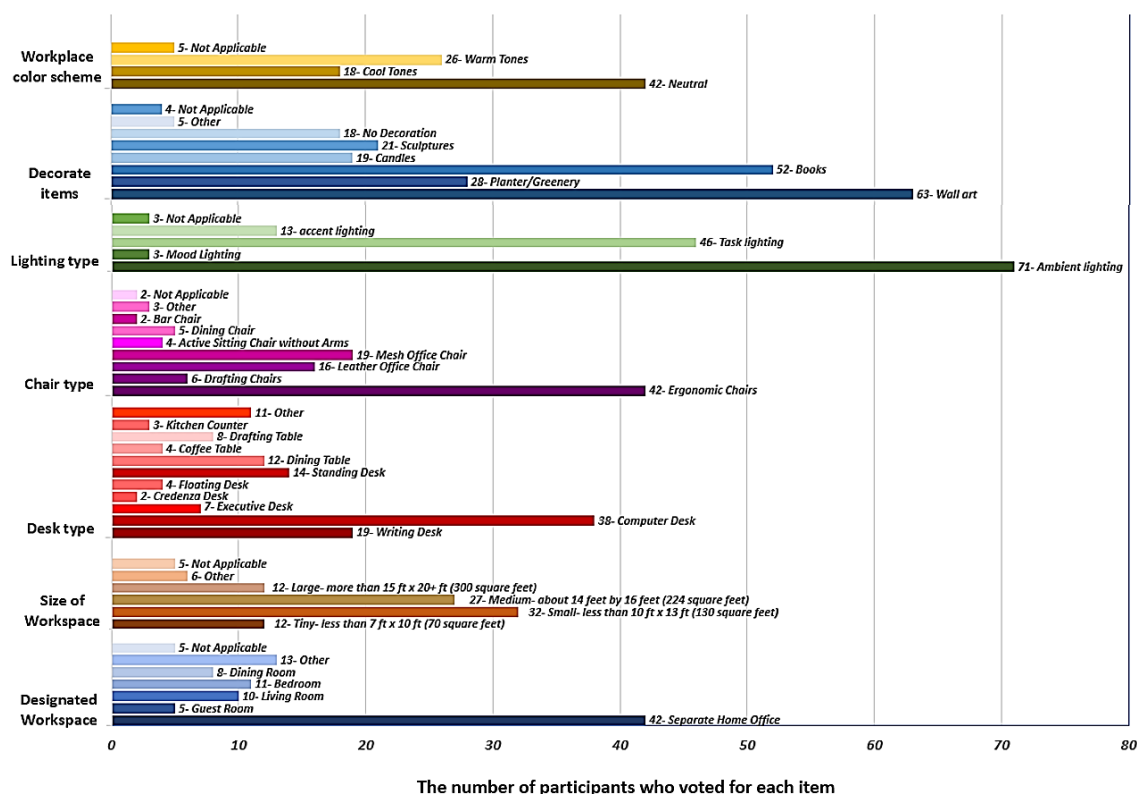


Fig.1. Participants' current furniture, equipment, and environmental setting

Regarding furniture, 30.6% of respondents replied that they were using a computer desk, while the rest of the participants were using a writing desk (15.3%), standing desk (11.3%), dining table (9.7%), drafting table (6.5%) and others. There is a growing trend among designers to use computers and digital software, rather than manual drafting techniques, in their work. This is largely due to the availability of a wide range of software options in the digital realm that allow designers to work efficiently and cost-effectively on multiple projects. However, it is important to note that manual drawing skills should not be overlooked, as they are valuable hand skills that does not require any tools (Keengwe, 2015). In 2020, a survey of interior design students found that the majority preferred using digital design tools and believed they were more practical than manual drawing. The participants cited the convenience and speed of digital tools as key factors in their preference and reported that they were able to accomplish tasks quickly and easily, regardless of location (Farooq & Kamal, 2020). Around 42% of respondents claimed that they use ergonomic chairs while they are working from home, while the rest claimed that they use mesh office chairs, leather office chairs, drafting chairs, dining chairs, and others.

With regard to lighting conditions in their WFH spaces, 52.2% of respondents reported having an ambient lighting source in their workspace, which is a type of general light that illuminates an entire area. Other responses included 33.8% using task lighting, such as table lamps, desk lamps, and swing arm lamps, and 9.5% using accent lighting, such as picture lights, candlelight, directed track or recessed lights, niche lighting, and wall sconces. There has been a longstanding focus among researchers on the relationship between indoor lighting conditions and factors such as employee health, engagement, and performance (Deng et al., 2021; Hescong & Mahone, 2003; Konstantzos et al., 2020). According to a review study by Konstantzos et al (2020), in the majority of the research, the effects of increased illuminance were favorably related to performance. Regarding color, research has shown that white lights and highly correlated color temperatures increase subjective and objective task performance. Additionally, it has been demonstrated that lighting has an impact on alertness (Sahin et al., 2014; Smolders et al., 2018), cognitive performance (Fostervold & Nersveen, 2008; Knez & Hygge, 2002), and melatonin suppression (Bellia et al., 2013). While previous studies have largely focused on the intensity and temperature of environmental lighting and its impact on employee performance (Boyce, 2014; Konstantzos et al., 2020; Mills et al., 2007), few have examined the preferred or optimal type of lighting for use in office settings. Moreover, Konstantzos et al. (2020) found that horizontal illuminance in relation to task performance was one of the major variables tested in previous studies. However, since computer screens are widely used these days, vertical illuminance also needs to be studied. There has been very little research on vertical illuminance and task performance.

Furthermore, the survey asked participants about the decoration items they use in their home offices. The most frequently mentioned items were wall arts, books, planters, sculptures, and candles with 30%, 24.7%, 13.3%, 10%, and 9.0%, respectively. As for the workplace wall colors, 46.1% of respondents stated that their workspace has neutral colors, 28.5% have warm tones, and 19.8% have cool tones.

3.1. Comparison of technological tools that participants currently have and what they need

As part of the survey, participants were also queried on the technological resources available to them in their WFH environments, as well as any resources they require to complete their tasks. Certain occupations may necessitate more technological or electrical devices for successful task completion, while others may not. The majority of architects and designers require scanning and printing devices and storage devices to save their projects and produce hard copies of their designs and drawings, which may not be available to all employees in their home offices, thus hindering their ability to complete their work effectively.

Participants were asked to identify the equipment they use in their home offices to carry out their tasks, and the results indicated that 68 participants utilized laptops, while 51 participants relied on PCs with multiple screens. Additionally, 26 respondents used tablets and 18 participants used single screens to complete their work. The study also asked about the additional equipment necessary for participants to perform their tasks. The majority of participants (69) stated that they required input devices such as scanners and mice, while 58 participants specified output devices like printers and speakers as necessary. In addition, 50 participants mentioned that storage devices like external hard drives and flash drives were critical to their work. A small number of participants (3) also noted the need for e-readers in their workplaces.

The findings from the study emphasize that numerous employees were not adequately prepared to work remotely during the Covid-19 pandemic due to a lack of necessary technology in their home offices. Therefore, it is crucial for companies to provide sufficient resources to their employees to facilitate efficient remote working.

3.2. Physical activity of participants when working from home

Previous studies indicate that remote workers tend to be less active and more sedentary during work hours compared to their counterparts who work in the office (Fukushima et al., 2021; Massar et al., 2022). However, the lifting of lockdowns has led to an increase in physical activity and improved mental well-being among workers (Massar et al., 2022). In this survey, participants were asked about their physical activity while working from home, as well as the equipment and furniture that promotes activity in their home offices. The survey revealed that a significant proportion of respondents, almost 84%, do not engage in any physical activity while working on their PC or laptop. Moreover, more than 70% of participants do not have any equipment that encourages physical activity in their home offices. The survey also asked respondents if they had considered purchasing furniture such as a treadmill desk, sit-stand desk, or height-adjustable float desk that promotes physical activity. Only 34% of participants reported that they had considered buying these equipment, while the majority had not thought about these equipment at all.

Some participants shared details about the physical activities they incorporate into their WFH routine. Three individuals reported using a small pedaling bike and stationary cycles either as a standalone piece of equipment or a smaller pedaling machine that fit underneath their desks, providing a low-impact way to keep their legs moving while they work. Others mentioned doing leg raises, squats, and stretches to stay active during their workday. Another strategy shared by four participants is to stand and walk around occasionally, taking short breaks throughout the day to move their bodies. In addition to these more traditional forms of exercise, some participants mentioned using unique strategies to incorporate physical activity into their workday. One individual reported standing on a wobble board, a piece of equipment designed to keep the legs in motion when standing. Others mentioned rocking, walking, jumping, or doing yoga during their work breaks. The comments emphasize various ways of incorporating physical activity into the WFH routine, regardless of the equipment or space available, whether through specialized equipment, traditional exercises, or unique strategies.

3.3. Challenges of working from home

After collecting and analyzing 70 comments in response to open-ended questions about the challenges of WFH, we categorized the comments into six primary categories based on their content:

Challenge 1: Lack of social interaction and communication & loneliness (37.1 %)

“Reaching team members in a timely fashion / Communication”

“Loneliness. There are times when it'd be nice to have a face-to-face conversation.”

...

Challenge 2: Distractions (24.3%)

“Yes, as you know, the most of designer and other [sic] must provide the isolation thinking time and make better concentration to his/her work. That [sic] is so Important in my point of view”

"Noise, distraction of child, pet, other."

...

Challenge 3: Work burn out & no clear boundary between work and home (8.6 %)

"Working too much because there is less clear separation between home & work"

"Getting away from work. It is always there."

...

Challenge 4: Inadequate tools and documents (7.1 %)

"I need better tools and facilities. I need a better computer system and internet for work. I think the rest is good."

"The main challenge I had was with the remote desktop setup I was using. It did not operate as smoothly/quickly as when I was at the office. I have to run various large programs, and this would sometimes present issues."

...

Challenge 5: Internet and VPN problems (7.1 %)

"Internet connectivity can be weak or intermittent."

"Just video meetings, when we want to be participating meetings [sic], the main challenge was that we could not hear each other well"

...

Challenge 6: Inappropriate work environment (7.1 %)

"My WFH space is in my room, so my bed is a distraction."

"Yes, it is a home and not an appropriate work environment."

...

Challenge 7: Other challenges (8.6 %)

"Distance to where my projects are located."

"Yes, the main one I've noticed is getting color schemes together from our material library. Online pictures of items aren't the same as in person and ordering a bunch of samples from home trying to guess the color is wasteful."

"Staying physically active is a challenge. Also, my work wardrobe has suffered. I don't have to dress for the office, so I haven't updated those items in years."

...

Based on the aforementioned comments provided by the participants, it appears that the most significant challenge faced by designers when working remotely is the lack of social interaction. Many designers work in groups, and there are limited applications that support real-time collaboration on projects, which can lead to feelings of isolation and disconnection from colleagues. The second most common challenge mentioned by participants is distractions, which has also been noted in previous study (Johansson, 2017). Participants reported difficulties in staying focused and productive due to distractions from family members, pets, and household tasks. Other challenges mentioned by

participants include working burnout and the lack of clear boundaries between work and home life, Internet and virtual private network (VPN) problems, and an inappropriate work environment. Inadequate tools and documents were also identified as a challenge for designers, particularly difficulties in printing large drawings and scanning documents. Overall, it is clear that designers face a range of challenges when working from home, and addressing these challenges will be critical for their efficiency and productivity.

3.4. Challenges while working remotely

The following table (see Table 3) highlights the frequency of words extracted from NVivo application in relation to the disadvantages mentioned by participants. The analysis of keyword tendencies and clusters indicates that there are six main clusters including 1. Inadequate tools and documents, 2. Internet and VPN Problems, 3. Lack of social interaction and communication/Loneliness, 4. Distractions, 5. Work burnout/No clear boundary between work and home, and 6. Inappropriate work environment. Among the most mentioned challenges, distractions and lack of social interaction and communication were mentioned most by participants with coverage of 4.0% and 4.1%, respectively.

Table 3. Challenges of WFH clustered by keywords tendencies and counts

	Count	Coverage ^a
Challenge 1: Inadequate tools and documents <i>Equipment, facility, tools, scan, print</i>	5	0.84%
Challenge 2: Internet and VPN Problems <i>Internet, VPN, server, internet connecting, internet connectivity, VPN connectivity</i>	6	1.68%
Challenge 3: Lack of social interaction and communication, and loneliness <i>Collaboration, human contact, coordinate, coordinating, connection, collaborative, collaboratively, communication, personal contact, personal connection, face to face, teamwork, loneliness</i>	15	4.07%
Challenge 4: Distractions <i>Distraction, concentration, noise, focus, interruption, disturbs, distracted, distract</i>	20	4.11%
Challenge 5: Working burn out, and no clear boundary between work and home <i>Burn out, working too much, work more, boundary, separation</i>	4	0.6%
Challenge 6: Inappropriate work environment <i>Workspace, work environment, workplace, space, environment</i>	3	0.55%

^a Coverage percentage refers to the proportion of the dataset that has been coded or analyzed.

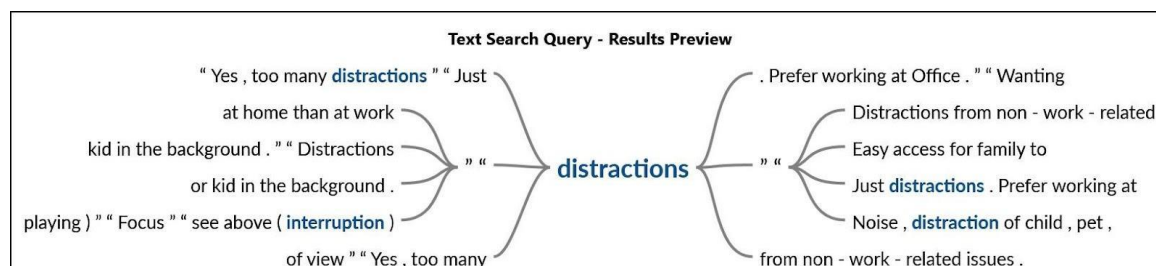


Fig. 2. Text trees according to distractions

Based on the participants' comments, the majority of architects and designers expressed that they experienced increased levels of productivity while working from their homes. This sentiment was attributed to several factors, including improved concentration, reduced stress levels, a greater degree of scheduling flexibility, and a decrease in both time and financial costs. In contrast, one-third of those surveyed indicated that they were more productive when working within an office environment due to enhanced collaboration and communication capabilities, greater access to technology, and fewer distractions. Lastly, a small subset of respondents indicated that their level of productivity and performance was contingent on the task at hand and that they may be more or less productive when working from home depending on the specifics of their work.

3.6. Preference to return to office

Participants were also asked if they would prefer to return to their offices or continue working from home or in a hybrid manner. Approximately 40% of participants indicated that they would like to return to the office, citing factors such as improved communication and collaboration, as well as access to better office equipment and a more conducive work environment (see Table 4). However, a majority of respondents (60%) stated that they would prefer to continue working from home or in a hybrid capacity, citing benefits such as cost savings, time savings, and increased flexibility and efficiency.

Table 4. Preference to return to office

Vote	Themes	Quotes
YES 35 (41.1%)	Better Communication and Collaboration (42.8%)	"Yes, better collaboration" ...
	Less distraction (7.1%)	"Yes, too many distractions working from home." ...
	More and better equipment (7.1%)	"I appreciate [sic] equipment (printer/scanner etc.)." ...
	Better environment (21.5%)	"Yes! I prefer working in my office, not at home. I enjoy the environment there." ...
	Better work-life balance (3.6%)	"Yes. I appreciate the separation of my home and my work environment. Being back at work allows me to better separate myself from work when I am home." ...
	Higher productivity and efficiency (10.7%)	"Yes, seemingly more productive" "Yes. Being back at work has made me more efficient and focused." ...
	More focus (7.1%)	"I can focus on my task when I'm working in the office." ...
NO 35 (41.1%)	No Commute (16.7%)	"No, because there is no need for transportation to the office." ...
	Save time (22.2%)	"No, because I work more easily at home, and I waste less time" ...
	More convenient and flexibility (27.8%)	"No, I work [sic] from home for seven years and like the convenience" "No. I appreciate the flexibility of working from home" ...

	Less cost (11.1%)	<i>"The cost of attendance [sic] is reduced."</i> ...
	Better mood (5.5%)	<i>"No, I am at home with my family and my mood is better"</i>
	More productivity (5.5%)	<i>"No, because I work more easily at home, and do more useful work"</i>
	Less distraction (5.5%)	<i>"No. Working from home gives me a space where I can design without distraction."</i>
	Healthier life (5.5%)	<i>"I also eat much healthier food at home."</i>
Hybrid 20 (23.5%)	Project priority (12.5%)	<i>"Sometimes - depends on the project I am working on"</i>
	Communication/ Proximity to coworkers (12.5%)	<i>"Yes and no; I miss being around people"</i>
	Preference (6.25%)	<i>"I prefer working from home 2 days a week and in an office for the rest of the week."</i> ...
	Less distraction (12.5%)	<i>"I only work one day a week from home now. I appreciate the balance of seeing people but also [sic] focus I can get working from home."</i>

In summary, approximately 40% of respondents preferred returning to their workplace, however, 60% preferred continuing to work from home or in a hybrid capacity. The reasons for preferring to work in their workplace varied. Some cited better communication and collaboration, saying it was easier to work with a team face-to-face and interact with colleagues. Others liked the social aspect of work and did not work well from home. Some preferred their workplace environment and equipment, while others appreciated the convenience and flexibility of working from home. Additionally, some respondents believed that working in the office increased their concentration and improved their mood, productivity, and efficiency. However, others did not like commuting, found working from home less distracting, and believed it gave them more focus, a healthier life, and a better work-life balance. Ultimately, the preference for working in the office, remotely, or in a hybrid model varied depending on personal circumstances and work requirements.

3.7. Limitations

One limitation of this study is that it was conducted with a relatively small sample of designers, including architects, interior designers, and design project managers who were working from home. This means that the findings may not be generalizable to employees in other disciplines or those working in office settings. In order to address this limitation, it would be beneficial to conduct future research using a larger sample of survey participants. Additionally, with a predominantly male and older audience participating in this study, future studies may want to consider ways to attract a more diverse group of participants.

Another limitation of the study is the potential for social desirability response bias, as respondents may have been influenced by a desire to present themselves in a certain way. Additionally, although anonymity was assured to the participants, there may still be some potential for bias in

participation. To mitigate these limitations, it would be beneficial to use more rigorous research methods in future studies.

3.8. Future Direction

In order to enhance generalizability and inclusivity, the sample size could be expanded, and the participant pool diversified. It would involve recruiting individuals from a variety of backgrounds in the design professions and including both remote workers and office workers. As for the methods, future studies should be more rigorous to address potential social desirability response and participation biases. This could include implementing measures to minimize bias, such as double-blinding techniques, and comprehensive data collection procedures. Researchers can also consider other qualitative research methods, such as interviews or focus groups, to complement quantitative findings and provide a deeper understanding of participants' experiences and perspectives. It would be valuable to allow designers to influence the quality of workspace in WFH environments, and more parameters enabling focus on design professionals can be included in the questionnaire.

4. Conclusion

The COVID-19 pandemic has compelled many organizations to adopt remote work as a way of maintaining productivity while ensuring the safety of their employees. This shift has been made possible by modern technology, which has revolutionized communication and information sharing. Although it is difficult to predict whether remote work will continue to be the norm post-pandemic, it is clear that it has the potential to significantly impact the way companies and government institutions manage their projects. However, despite numerous studies that have focused on the pros and cons of remote work, there is a gap in research on the physical work environment and the required technological equipment for employees who work from home. Additionally, there is a gap in investigating the unique challenges of remote designers' conditions. To address this gap, this study provides critical insights into the physical work environment conditions of designers, including their furniture, required equipment, environment dimensions, and lighting WFH conditions. The study also explores the experiences and challenges that these professionals encounter while working in a home-based office.

The findings indicate that 44.7% of participants had a separate home office where they could work. Additionally, almost half of the respondents indicated that their home offices were small or tiny, ranging between 70 and 130 square feet, which is not an adequate space for large printed drawings and printing and scanning facilities. Regarding furniture, around 30.0% of participants claimed to use a computer desk, while only 6.0% of participants use a drafting table. This trend indicates that architects and designers are increasingly using computers and digital software instead of manual drafting techniques. The availability of a wide range of software options in the digital realm enables designers to work efficiently and cost-effectively on multiple projects. Half of the respondents reported having an ambient lighting source in their workspace, which is a type of general light that illuminates an entire area. Also, since computer screens are widely used by designers these days, vertical illuminance needs to be considered. As for equipment that participants mostly use while working from home and the equipment they need to have, most participants use laptops, PCs, and tablets. Some of them also mentioned needing input devices such as scanners and output devices like printers to print large format drawings. Lastly, half of the participants mentioned that storage devices like external hard drives and flash drives were critical to their work.

Though numerous studies have been conducted on the productivity of remote workers, there exists a dearth of research concerning the challenges faced by remote designers and architects who work from home. Certain participants have highlighted several specific obstacles they encounter, such as a scarcity of material library samples in their houses to choose and match swatches and materials, the distance from project sites, the inability to work on large format drawings due to limited space at home, and the absence of software that facilitates simultaneous design collaboration. These individuals firmly believe that these challenges significantly hamper their productivity and overall efficiency.

Moreover, remote designers' responses regarding their challenges while working from home were divided into six main clusters including inadequate tools and documents, internet and VPN problems, lack of social interaction and communication/loneliness, distractions, working burnout/no clear boundary between work and home, and inappropriate work environment. While some of the challenges and comments faced by remote designers are similar to those experienced by remote workers in other professions, there are specific considerations to be made regarding the conditions and challenges unique to remote designers. One notable aspect pertains to their equipment requirements, with remote designers expressing the necessity for plotters, printers, and scanners, which may not be deemed indispensable in other professional domains. Moreover, certain designers underscore the significance of in-person collaboration with their design team for specific projects or layouts, as it greatly facilitates effective communication. This level of personal interaction may not hold the same degree of criticality in professions with comparatively less emphasis on teamwork. Lastly, we received comments from participants expressing dissatisfaction with their remote work environments. Some designers have emphasized the imperative need for more extensive storage capacities and a dedicated office setting within their homes to accommodate their large format drawings and drawing tools and ensure the availability of necessary materials and swatches.

However, despite these challenges, around 60% of designers feel more productive when they work from home. Nevertheless, around 40% of participants preferred working from the office due to better communication, collaboration, office equipment, and environment. Finally, around 60% of respondents expressed their preference for continuing to work from home or working in a hybrid model due to the flexibility, efficiency, and savings in time and money.

This study underscores the necessity for innovative solutions to optimize the remote work experience for designers. One viable solution is the utilization of pervasive virtual reality (PVR) to establish an immersive and collaborative work environment for remote designers that enable them to design and collaborate simultaneously. By overlaying virtual technology on top of the actual environment, remote designers can access more technological devices including additional screens, virtual keyboards, and virtual webcams. PVR provides a means for geographically dispersed colleagues to collaborate on specific projects in real-time.

In light of these findings, it is crucial to equip remote employees with the appropriate tools and equipment to maximize their productivity while working from home. Furthermore, employers must prioritize creating a culture and environment that fosters communication and collaboration among remote employees. Based on the identified challenges, this study endeavors to design and assess a PVR-enhanced work from home environment tailored to the needs of designers. This PVR environment seeks to minimize distractions, address the challenges faced by remote designers, and enhance their productivity and efficiency.

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