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Abstract

Digital technologies, especially information communication technologies (ICTs), make remote work a fashionable method. Remote workers can work from their homes, satellite offices, neighbourhood work centers, and even on the road. People are subjected to various physical environments when working from different places, impacting their work satisfaction, performance, and productivity. In this paper, we conducted an exploratory factor analysis to find factors in a physical environment questionnaire item pool created in a previous study. We also adjusted the factor model and tested its validity and reliability. This questionnaire will be used in research on workplace location, physical environment, and work performance.

Keywords: Exploratory factor analysis, EFA, Physical environment, Remote work, Questionnaire design.

1. Introduction

The development of digital technology has led to several new ways to work (NWW). A typical example is teleworking. Teleworking allows people to work outside conventional workplaces, i.e., employer premises, and communicate with co-workers and clients through telecommunications or computer-based technology (Bailey & Kurland, 2002). Remote workers work from home and anywhere else, such as in satellite offices, neighbourhood work centers, and even on the road (Barsness et al., 2005). Surveys show that more people will likely choose to work remotely in the post-pandemic era (Barrero et al., 2021; Gold, 2021). In other words, remote work will get much more popular. This eventuality opens the opportunity for scholars to research topics about people's work environments in the case of remote work.

It is already known that the physical environment impacts employee's work (e.g., Al-Omari & Okasheh, 2017; Davis, 1984). So, it is reasonable to infer that the remote workplace environment can impact remote workers. Scholars studying the relationship between the physical environment and work performance have used questionnaires to gather data for assessing the relationship. The previous questionnaires include items on temperature, lighting, use of machines, and many other factors. Some questionnaires have items about people's control over workplaces. However, previous questionnaires are not explicitly designed for the case of remote work. It is also unknown what factors in the remote work environment impact people and how these elements impact people. This research is important because we found these factors and created a questionnaire based on them. For example, most previous questionnaires do not include items related to technology such as Internet connection or factors related to workers' affective feelings such as enjoyment. We first conducted a qualitative study to discover what remote workers thought of their work environment and how it impacted their work performance. In that study, we interviewed five remote workers and asked how their work environment impacted them. The interviews, plus existing literature, allowed us to generate an item pool containing 65 items. In the present study, we applied an exploratory factor analysis (EFA) to find factors impacting people's

remote work and identify the items associated with each factor. Then, we tested the validity and reliability of the proposed factor model with confirmatory factor analysis (CFA).

The remainder of this paper is organized as follows: In Section 2, the impacts of the physical environment, the differences between employer premises and remote work workplaces, as well as some questionnaires related to the physical environment are reviewed. In Section 3, we introduce our methods and present our results. We also briefly introduce how we created the item pool in this section. The extracted factors are renamed in Section 4, where we also introduce the improvement of our questionnaire. In Section 5, we present the limitations of our research and future studies.

2. The physical work environment

The physical environmental conditions such as sound, temperature, and space can impact people as *stressors*. Such stressors could produce physiologically and psychologically strains (Sander et al., 2019). Examples of physiological strains include increased heart rate and blood pressure (Kristiansen et al., 2009). The psychological strains include fear, tension, anxiety, and other responses (Ganster & Rosen, 2013). A recent study shows that remote workers' satisfaction with environmental conditions, including air quality, ventilation, temperature, and other elements, is positively related to their mental health (Bergefurt et al., 2022). Further, environmental stress could negatively impact people's work performance (Lamb & Kwok, 2016).

Scholars also study the impact of the work environment in *job design* research. Physical environmental elements could moderate the relationship between job characteristics and work outcomes (Oldham & Fried, 2016). In the questionnaire developed and validated by Morgeson and Humphrey (2006), the work context dimension measures the physical environment. Humphrey et al. (2007) expanded the job characteristics model proposed by Hackman and Oldham (1976) with work context characteristics. Humphrey et al. (2007) hypothesized that among work context characteristics, work conditions and ergonomics are positively related to positive behaviour and attitudinal outcomes and are negatively associated with negative behavioural outcomes. Their results show limited support for the impacts on positive attitudinal outcomes.

A good workplace should meet workers' needs. *Person-environment fit theory* indicates that a good match between workers' needs and supplies in the environment leads to increased productivity and well-being (Edwards et al., 1998). However, some remote workers experience misfit issues (Bergefurt et al., 2022). Generally, the fit is high in employer premises because such locations are specifically designed for working. They typically have sufficient equipment and devices while the temperature and lighting are satisfactory. However, employees may perceive a lower fit when working remotely because they are in an environment designed for living or relaxation and may not have sufficient devices and supplies (Microsoft, 2021).

The physical environment is included in some questionnaires. Campion and Thayer (1985) proposed a Measure of Job Design Questionnaire (MJDQ), while Campion (1988) revised it into a self-report questionnaire. Items such as noise, climate, lighting, displays, and workplace layout in this questionnaire are related to the physical environment. Further, Edwards et al. (1999) conducted a factor analysis and revised it into a four-factor questionnaire, where the biological and perceptual-motor factors measure the physical environment. Similarly, in the Work Design Questionnaire developed by Morgeson and Humphrey (2006), the dimension of work context measures the physical environment. The questionnaire used in a study by Lee and Brand (2005) measured satisfaction with and control over the workplace and distraction in the workplace. However, these questionnaires are not specifically

designed for the case of remote work. In this study, we validate a more comprehensive questionnaire designed for the case of remote work.

3. Methods

3.1 The item pool

In March and April 2021, we interviewed five remote workers. These workers were in different industries, including information technology, finance, medicine, education, and government. When participating, they had been working from home for almost one year since the start of the COVID pandemic, while two of them occasionally worked remotely before the pandemic. During the interviews, we asked the participants to describe and evaluate their work environment and asked them questions about what they liked and disliked in the environment, how their work environment impacted them, and some other questions. We also asked the participants to compare their remote workplace and their offices. These questions covered the adequacy, arrangement, symbolic features, and sense of control of the workplace environment, as Carnevale and Rios (1995) suggested.

After analyzing the interviews, we proposed some new items that were not included in previous works, such as items about supplies of food and drink and items about the Internet connection. Such new items, plus those in previous works, contributed to the item pool of this study. The items in the item pool cover the four dimensions in Carnevale and Rios's (1995) theoretical model. Items in the Adequacy (AD) dimension are related to devices, climate, Internet connection, ergonomics, and supplies. In the Arrangement (AR) dimension, items are related to decoration, distraction, and relaxation. Besides, the dimension of Sense of Control (SC) includes questions about control over their workplaces. Lastly, Symbolic Features (SF) include the sense of belonging, sense of working, sense of achievement, relaxation, and motivation. The original item pool is presented in the Appendix.

3.2 Procedure

To collect data for the EFA, we published the questionnaire on Qualtrics and distributed it through Amazon Mechanical Turk (Mturk). Each respondent received US$0.5 as compensation after submitting responses. From October 15 to Nov 7, 2021, 770 responses were collected. We firstly deleted incomplete responses. Answers from respondents indicating that they were non-remote workers were deleted because they could not provide valid answers. We also deleted the responses submitted within 5 minutes since such respondents answered questions so fast that they may not carefully read each one. Besides, there are plenty of responses with missing values. There are no patterns among these missing data, and these values are missing at random. Therefore, we deleted these responses with missing values. Overall, 416 responses were valid, above the threshold of 325 (Gorsuch, 1988; Hair et al., 2010). The response rate was 54.03%.

3.3 Data analysis

We employed IBM SPSS 28.0 for EFA in this study. Generally, EFA is used to "discover the number of factors influencing variables and to analyze which variables 'go together' " (Yong & Pearce, 2013, p. 80). We applied Principal Axis Factoring (PAF) as the extraction method with Varimax rotation. Before data analysis, some items were eliminated.

3.3.1 Descriptive analysis

In this study, all respondents were adults and knowledge workers. They had been working remotely for more than three months when participating in this research. More than half were males (62.98%), while about one-third were females (37.02%). Most of them were between 21 to 40 years old (79.15%), but some people were aged below 20 (0.85%) or above 60 (2.13%). More than half of them had worked for more than one year (53.19%). For the frequency, 43.40% of the respondents worked remotely two or three days a week, while 37.45% worked remotely more frequently. Most of them worked from their

home (75.74%), but some people worked from shared workplaces (19.15%), libraries (3.83%), or cafes (0.85%). Last, most of the respondents were from the industry of IT (48.94%), financial (15.74%), and education (8.94%).

3.3.2 Item elimination

There were no items deleted due to low correlations. Although five items had low correlations with most other items, they had relatively high correlations with each other, indicating some patterned relationships. Besides, the pair of items that have bivariate correlations above 0.9 should be removed. In our data set, the largest bivariate correlation is 0.729, below the threshold of 0.9 (Yong & Pearce, 2013). Items with communalities below 0.3 should also be removed (Field, 2009). In our dataset, all communalities are above this threshold. Two items (AR9 and AR10) were deleted due to low loadings. Three items (AD18, AD20, and SF5) were deleted since they had high loadings on two subfactors in the process of subfactor extraction. Two items (AD24 and SF2) were deleted since they were not conceptually related to the subfactors they loaded on. Overall, seven items were eliminated, and 58 items were included in the EFA.

3.3.3 Factor analysis

We set the number of factors extracted as four in factor analysis. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) was 0.965, above the threshold of 0.7. Bartlett's Test of Sphericity was significant at the 0.001 level. Besides, the eigenvalue was 1.917, above the threshold of 1, and the cumulative percentage of variance was 56.584%, above 50%. Therefore, the data was suitable for factor analysis.

The threshold of loading in this step was 0.4. As is shown in Table 1, while the majority of items coded as AD had loadings above 0.4 at Factor 1, three items coded as AR (AR1, AR3, and AR4) had loadings above 0.4 on both Factor 1 and Factor 2. They were included in Factor 1 since their loadings on this factor were higher. There are AR items and SF items in Factor 2. Items in Factor 3 are SC items. Last, there were five items in Factor 4, which were coded as AR or SF. The results differed from Carnevale and Rios's (1995) theoretical model. Regarding the reliability, the value of Cronbach's alpha of the whole questionnaire was 0.974, while the values of Cronbach's alpha of the four factors were, respectively, 0.969, 0.945, 0.895, and 0.766. The values were above the threshold of 0.7. The results illustrated the acceptable reliability of the four factors and the whole questionnaire. Since there were too many items on Factors 1 and 2, we attempted to extract subfactors. The factor rotation matrixes are shown in Table 2 and Table 3, respectively.

Subfactors of Factor 1. All items coded as AD and AR1, AR2, AR3, and AR4 were in the subfactor extraction of Factor 1. After trial-and-error, we found that the best number of factors extracted was three. The result of KMO was 0.967, above the threshold of 0.7, while Bartlett's Test was significant at a 0.001 level. The eigenvalue was 1.136, which was above the threshold of 1. Besides, the cumulative percentage was 62.815%, above the threshold of 50%. Therefore, the data was good for factor analysis. The result showed that there were 14 items in Subfactor 1-1, 11 in Subfactor 1-2, and four in Subfactor 1-3.

Subfactors Factor 2. The method used to extract subfactors of Factor 2 was similar. The result of KMO was 0.953, above the threshold of 0.7, while Bartlett's test was significant at a 0.001 level. The eigenvalue was 1.329, above the threshold of 1. The cumulative percentage of variance was 59.273%, above the threshold of 50%. Therefore, the data was suitable for factor analysis. The result showed that four items had loadings above 0.4 on both subfactors, but we included them on Subfactor 2-1 since their loadings were higher on this subfactor. In the end, there were 13 items in Subfactor 2-1 and five in Subfactor 2-2.

Continued

	1	2	3	4
AD7	**0.713**	0.198	0.112	0.237
AD6	**0.711**	0.268	0.222	-0.076
AD3	**0.71**	0.273	0.139	0.097
AD5	**0.707**	0.322	0.143	0.123
AD13	**0.703**	0.183	0.189	0.226
AD2	**0.703**	0.215	0.213	0.026
AD14	**0.696**	0.25	0.203	-0.142
AD28	**0.691**	0.271	0.235	-0.03
AD9	**0.691**	0.246	0.153	0.216
AD16	**0.69**	0.303	0.168	-0.088
AD17	**0.684**	0.312	0.156	0.044
AD1	**0.679**	0.306	0.14	0.139
AD21	**0.678**	0.274	0.093	0.176
AD19	**0.676**	0.209	0.132	0.169
AD27	**0.655**	0.269	0.194	0.034
AD23	**0.652**	0.291	0.194	0.22
AD8	**0.644**	0.271	0.21	0.098
AD12	**0.635**	0.206	0.156	0.189
AD10	**0.634**	0.255	0.209	0.083
AD26	**0.627**	0.255	0.319	-0.019
AD4	**0.618**	0.36	0.213	0.051

Continued

	1	2	3	4
AD15	**0.575**	0.348	0.075	0.121
AD25	**0.556**	0.24	0.308	0.075
AD11	**0.548**	0.255	0.102	0.14
AD22	**0.524**	0.179	0.267	0.205
AR4	**0.504**	0.45	0.219	0.079
AR1	**0.476**	0.423	0.208	0.233
AR3	**0.471**	0.461	0.11	0.253
AR2	**0.41**	0.382	0.2	0.164
SF14	0.378	**0.647**	0.14	0.061
SF18	0.379	**0.646**	0.193	0.054
SF17	0.307	**0.645**	0.146	0.194
SF16	0.372	**0.598**	0.057	0.072
SF8	0.384	**0.58**	0.315	0.008
SF1	0.151	**0.576**	0.233	0.398
SF15	0.377	**0.574**	0.059	0.19
SF4	0.391	**0.556**	0.292	0.021
SF3	0.359	**0.552**	0.243	0.208
SF12	0.419	**0.52**	0.263	-0.124
SF19	0.448	**0.514**	0.265	0.015
AR8	0.185	**0.513**	0.154	0.374
AR7	0.32	**0.512**	0.253	0.362

Continued

	1	2	3	4
SF6	0.401	**0.503**	0.342	0.021
AR6	0.238	**0.474**	0.244	0.334
SF13	0.322	**0.46**	0.421	0.191
SF7	0.344	**0.451**	0.271	0.23
AR5	0.37	**0.442**	0.221	0.351
SC6	0.304	0.244	**0.747**	0.088
SC2	0.23	0.17	**0.66**	0.208
SC5	0.294	0.281	**0.631**	0.241
SC3	0.336	0.269	**0.593**	0.205
SC4	0.364	0.367	**0.585**	0.019
SC1	0.235	0.203	**0.563**	0.373
AR11	0.093	0.065	0.036	**0.709**
AR12	0.012	0.063	0.007	**0.653**
SF9	-0.02	0.037	0.204	**0.526**
SF11	0.161	0.216	0	**0.508**
SF10	0.025	0.073	0.251	**0.427**

Table 1: The Factor Rotation Matrix of the Item Pool

Continued

	1-1	1-2	1-3
AD3	**0.637**	0.415	0.229
AD2	**0.629**	0.32	0.331
AD17	**0.626**	0.408	0.23
AD26	**0.624**	0.305	0.288
AD5	**0.616**	0.444	0.271
AD1	**0.608**	0.382	0.306
AD28	**0.606**	0.348	0.351
AD27	**0.594**	0.434	0.166
AD4	**0.588**	0.3	0.384

Continued

	1-1	1-2	1-3
AD25	**0.556**	0.378	0.151
AD15	**0.552**	0.376	0.174
AD9	0.348	**0.686**	0.281
AD7	0.33	**0.66**	0.337
AD13	0.373	**0.659**	0.269
AD21	0.425	**0.588**	0.251
AD19	0.414	**0.58**	0.236
AD11	0.282	**0.574**	0.207
AD23	0.429	**0.572**	0.3

Continued

	1-1	1-2	1-3
AD12	0.319	**0.561**	0.347
AD8	0.344	**0.56**	0.394
AD10	0.377	**0.514**	0.359
AD22	0.319	**0.451**	0.326
AR4	0.327	0.267	**0.719**
AR2	0.235	0.23	**0.678**
AR3	0.229	0.382	**0.626**
AR1	0.323	0.323	**0.594**

Table 2: Rotated Factor Matrix of Factor 1

Overall, as a result of factor extraction, we extracted four factors, two of which had subfactors. However, the factor model is different from the theoretical model. Specifically, although items coded as SC were in an individual factor (Factor 3), Factor 1 contained both AD and AR items. Both Factor 2 and 4 had SF and AR items. After testing the validation, we renamed these factors and subfactors.

	2-1	2-2
SF19	**0.72**	0.252
SF12	**0.713**	0.177
SF18	**0.673**	0.378
SF8	**0.672**	0.353
SF14	**0.67**	0.359
SF6	**0.649**	0.304

Continued

	2-1	2-2
SF4	**0.641**	0.343
SF15	**0.616**	0.337
SF16	**0.608**	0.32
SF3	**0.583**	0.447
SF17	**0.577**	0.481
SF13	**0.545**	0.429

Continued

	2-1	2-2
SF7	**0.484**	0.447
AR6	0.249	**0.718**
AR7	0.37	**0.702**
AR8	0.258	**0.687**
SF1	0.354	**0.672**
AR5	0.329	**0.67**

Table 3: Rotated Factor Matrix of Factor 2.

3.3.4 Validation of the model

As a result of EFA, we divided our questionnaire items into four factors, while two of them had subfactors. In this step, we followed Hair et al.'s (2010) suggestions to perform a CFA to validate our results. From June 25 to June 28, 2022, we collected and prepared data again, using a similar strategy, and performed CFA with the new dataset.

We tested the model containing only first-order factors (Subfactor 1-1, 1-2, 1-3, Subfactor 2-1, 2-2, Factor 3 and 4). The preliminary result showed that the correlation between Subfactor 1-1 and Subfactor 1-2 is as high as 0.894. Therefore, we put the two subfactors together in the revised factor model. Besides, in the revised model, seven items (SF1, SF7, SF9, SF10, SF14, SF15, and SF16) were deleted due to low loadings.

Continued

Factor	Item	Std. Loading	Cronbach's Alpha	Composite Reliability
F1_1 and F1_2	AD14	0.804	0.968	0.97
	AD16	0.817		
	AD6	0.818		
	AD3	0.818		
	AD2	0.795		
	AD17	0.769		
	AD26	0.721		
	AD5	0.824		
	AD1	0.766		
	AD28	0.78		
	AD27	0.724		
	AD4	0.766		
	AD25	0.631		
	AD15	0.685		
	AD9	0.709		
	AD7	0.738		
F1_3	AR4	0.861	0.853	0.853
	AR3	0.731		
	AR2	0.745		
	AR1	0.734		
F2_1	SF13	0.604	0.857	0.856
	SF17	0.586		
	SF3	0.679		
	SF4	0.619		
	SF6	0.621		
	SF8	0.673		
	SF18	0.635		
	SF12	0.605		
	SF19	0.666		
F2_2	AR5	0.695	0.826	0.824
	AR8	0.699		
	AR7	0.762		

	AD13	0.765		
	AD21	0.735		
	AD19	0.69		
	AD11	0.668		
	AD23	0.71		
	AD12	0.684		
	AD8	0.76		
	AD10	0.758		
	AD22	0.558		

	AR6	0.79		
F_3	SC6	0.82	0.855	0.856
	SC5	0.746		
	SC4	0.785		
	SC3	0.681		
	SC2	0.616		
	SC1	0.56		
F_4	SF11_R	0.396	0.662	0.611
	AR12_R	0.844		
	AR11_R	0.614		

Table 4: Standardized factor loading, Cronbach's alpha, and composite reliability

	AVE	F1_1and F1_2	F1_3	F2_1	F2_2	F3	F4
F1_1and F1_2	0.551	**0.742**					
F1_3	0.592	0.538	**0.770**				
F2_1	0.400	0.374	0.506	**0.633**			
F2_2	0.544	0.323	0.613	0.585	**0.738**		
F3	0.500	0.349	-0.221	0.624	0.558	**0.707**	
F4	0.415	0.192	0.521	-0.050	-0.323	-0.063	**0.645**

Table 5: AVE and correlations

As is shown in Table 4, in the revised model, the minimal standard loading was 0.394, below but very close to the threshold of 0.4. This item was not reduced since, for each factor, there should be more than three items. The other loadings were above 0.5. All Cronbach's alpha and composite reliability values were above the threshold of 0.6, indicating that the revised model's reliability was acceptable. Regarding the measurement of the model fit, the value of CMIN/DF was 2.157, with a p-value below 0.001. The value of CMIN/DF was below the threshold of 3. The value of the Normed Fit Index (NFI), Tucker-Lewis Index (TLI), and Confirmatory Fit Index (CFI) were 0.738, 0.83, and 839, respectively. Two of these three indicators were above the threshold of 0.8. Root Mean Square Error of Approximation (RMSEA) was 0.065, below 0.08. These indicators illustrated an acceptable convergent validity of the model. Besides, we referred to average variance extracted (AVE) and correlations to test discriminant validity. As was shown in Table 5, AVE values of the combination of Subfactor 1-1 and 1-2, Subfactor 1-3, Subfactor 2-2, and Factor 3 were above 0.5. For Subfactor 2-1 and Subfactor 4, the AVE values were lower but above 0.4. The square roots of AVEs (shown as bold numbers in the diagonal cells) were above the correlations of the corresponding paired items. The result showed an acceptable discriminant validity of the revised model.

4. Discussion

In this study, we did EFA on a questionnaire item pool. We created the items according to five interviews as well as previous literature. We made a factor model from EFA and tested the factor model. We modified the model in the process of CFA and obtained acceptable results. In this section, we name these factors and subfactors and discuss the improvement of our proposed questionnaire.

4.1 Names of the factors and subfactors

Factor 1 contains AD and AR items. While AD items are about the adequacy of the workplace, AR items are related to the size of the space, organization of the space, and overall satisfaction. Because adequacy refers to the quality of the workplace, including space, temperature, furniture, and work support such as equipment, supplies, and office assistance (Carnevale & Rios, 1995), all items in Factor 1, including the four coded as AR, are related to the adequacy of the workplace. Therefore, we name Factor 1 "*Adequacy*."

Factor 1 is divided into three subfactors in the EFA and revised into two subfactors as a result of CFA. The items in Subfactor 1-1 involve i) devices, ii) Internet connection, iii) places for relaxation, and iv) supply of food and drink. In Subfactor 1-2, questionnaire items measure i) lighting, ii) temperature and iii) ergonomics. In effect, these elements are related to people's functional comfort. Functional comfort "refers to the degree to which [the] environment supports users' tasks" (Vischer, 2008, p. 100). While facilities are important, the elements like lighting and ergonomic furniture help ensure functional comforts (Vischer, 2007). Therefore, we name this subfactor (the combination of Subfactor 1-1 and 1-2) "*Functional Adequacy*." In Subfactor 1-3, four items measure the workplace size, organization, and storage, so we name Subfactor 1-3 "*Space adequacy*."

All items in Factor 2, coded as AR or SF, measure people’s feelings in workplaces. Five items (SF1, 7, 14, 15 and 16) were deleted in the process of CFA. This factor is further divided into two subfactors. For Subfactor 2-1, items are related to i) sense of familiarity, ii) sense of achievement, iii) sense of professionalism (*deleted in CFA*), and iv) sense of relaxation. Overall, these items measure people’s joyfulness in remote workplaces. Thus, Subfactor 2-1 is named "*Enjoyment*." Items in Subfactor 2-2 are about the decorations in the workplace. Precisely, these items measure i) how the decoration motivates people, ii) people's comfort regarding the decoration, iii) how the decoration inspires people (*deleted in CFA*), and iv) people’s appreciation of the decoration. Overall, such items measure the extent to which the environment attracts people. Therefore, we name Subfactor 2-2 "*Attractiveness*" and name Factor 2 "*Affects*."

In Factor 3, all items are coded as SC, which means these items are about people’s sense of control over the physical environment. We name this factor "*Control*" since the items measure people’s actual control over the physical environment. Wherever they work, their control over the physical environment is one of their basic needs (Ganster & Fusilier, 1989). Several empirical works have tested the importance of people's control over the environment (e.g., Chandrasekar, 2011; Lee and Brand, 2005).

Factor 4 also includes items AR and SF items. Two factors (SF9 and SF10) were deleted in CFA. The items are about i) visual distractions, ii) the frequency of being distracted by others, iii) the frequency of stopping working and talking to others, and iv) aloneness (*deleted in CFA*). While the first three issues distract people, the sense of aloneness can also distract people (Sekhon & Srivastava, 2019). Therefore, these items measure people's perception of distraction. Accordingly, we name this factor "*Distractions*."

In conclusion, four factors found in this research are i) Adequacy, ii) Control, iii) Affects, and iv) Distractions. Both Adequacy and Affect have subfactors. The Adequacy factor combines i) Functional Adequacy and ii) Space Adequacy. The factor of Affect includes i) Enjoyment and ii) Attractiveness.

4.2 Improvements of the present questionnaire

Relatively, our questionnaire is more specific and comprehensive for the case of remote work. Physical environment, in effect, has been studied in other research and included in other questionnaires. The questionnaire in this research combines the advantages of previous questionnaires as we produced a more comprehensive questionnaire by adding some items associated with remote work. In particular, this questionnaire added items related to information technology facilities. Information technology is an essential element for remote workers. We also include people's affective feelings in this questionnaire. These items are essential because workers are not only subjected to workplace resources but also subjected to their feelings.

5. Conclusion

In this paper, we conducted an EFA to find factors in a questionnaire and conducted a CFA to

validate the factor model. We revised the factor model and achieved a four-factor model with a better model fit. The results of the CFA illustrated acceptable reliability and validity. The four factors are Adequacy, Affects, Control, and Distractions. The Adequacy factor was further divided into two sub-factors, Functional Adequacy and Space Adequacy. The factor of Affects was further divided into Enjoyment and Attractiveness. Control and Distractions factors do not have subfactors.

5.1 Limitations and future studies

This study has some limitations. Firstly, we did not find the dimension of the symbolic feature. According to previous works, symbolic features should be measured since they influence work outcomes. Secondly, as a result of the current study, control is an individual factor, but some scholars think it should be included in physical or psychological comfort (Budie et al., 2018; Vischer, 2007). Thirdly, some items were deleted in the data analysis due to loading issues. Although this step is necessary to guarantee the quality of the questionnaire, some deleted items are meaningful. The richness of the questionnaire items may have been reduced a little. Fourthly, the current research sample differs from the general population. The result of CFA is slightly different from the result of EFA. Both issues show that the generalizability of the conclusion of this research could be limited.

In future studies, we will revise and improve the questionnaire further and apply it to study the impact of the physical environment and geographical location in the remote work scenario. Such a study is critical and relevant given the trend of choosing more remote work by both individuals and companies.

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Appendix. The item pool

Item ID	Item	Source
AD1	I am satisfied with the number of the devices with which I work.	(Carlopio, 1996)
AD2	I am satisfied with the efficiency of the devices with which I work.	(Carlopio, 1996)
AD3	The quality of my equipment is sufficient to work effectively.	(Lee, 2006)
AD4	I have everything I need in my workplace.	Interview
AD5	Equipment in my workplace can satisfy my work.	Interview
AD6	Equipment in my workplace can satisfy my communication with clients and co-workers.	Interview
AD7	I am satisfied with the lighting in my workplace.	(Carlopio, 1996)
AD8	I am satisfied with the temperature in my workplace.	(Carlopio, 1996)
AD9	In terms of lighting, I feel comfortable in my workplace.	Interview
AD10	In terms of temperature, I feel comfortable in my workplace.	Interview
AD11	I do not feel too hot or too cold in my workplace.	Interview
AD12	I like the intensity of the lighting in my workplace.	Interview
AD13	I like the colour of the lighting in my workplace.	Interview
AD14	I can get access to the Internet easily in my workplace.	(Lättman et al., 2016)
AD15	I seldom meet Internet outages in my workplace.	Interview
AD16	The speed of the Internet in my workplace allows me to communicate with my clients or coworkers smoothly.	Interview
AD17	I can get all information and files needed with the Internet connection in my workplace.	Interview
AD18	I can work in my preferred position in my workplace.	Interview
AD19	Height of my table is fit for me or adjustable.	Interview; (Brisson et al., 1999)
AD20	Height of my chair is fit for me or adjustable.	Interview; (Brisson et al., 1999)
AD21	I have my hand supported in my workplace.	(Brisson et al., 1999)
AD22	I have my feet supported in my workplace.	(Brisson et al., 1999)
AD23	I have my back supported in my workplace.	Interview
AD24	I am physically comfortable in my workplace.	Interview
AD25	I can get food and drink in my workplace.	Interview
AD26	My workplace has good places for break.	(Haynes, 2008)
AD27	After taking break, I can go back to work quickly.	Interview
AD28	I feel relaxed after the workplace break.	Interview
AR1	My workplace is large enough.	(Lee, 2006)
AR2	I have ample storage in my work area.	(Lee, 2006)
AR3	I am satisfied with the organization of my workplace.	Interview
AR4	I am satisfied with the space of my workplace.	Interview
AR5	I like the decorations (pictures, photos, etc.) in my workplace.	Interview
AR6	These decorations motivate me.	Interview
AR7	These decorations make me feel comfortable.	Interview

AR8	These decorations make me want to work.	Interview
AR9	My workplace is free from excessive noise.	(Edwards et al., 1999)
AR10	My workplace provides an undisturbed environment so that I can concentrate on my work.	(Lee, 2006)
AR11	My workplace has many virtual distractions. (R)	(Lee, 2006)
AR12	People in my workplace distract me frequently. (R)	Interview
SC1	I am able to control temperature or airflow in my workplace.	(Lee, 2006)
SC2	I am able to control the artificial lighting level in my workstation.	(Lee, 2006)
SC3	I determine the organization of my workplace.	(Lee & Brand, 2005)
SC4	I can personalize my workplace.	(Lee & Brand, 2005)
SC5	I can adjust, re-arrange, and re-organize my furniture as needed.	(Lee & Brand, 2005)
SC6	I can determine the decorations of my workplace.	Interview
SF1	There is something in my workplace (quotes, pictures, etc.) that inspire me.	Interview
SF2	My workplace is attractive and makes me want to go to work.	Interview
SF3	I like to work when I am in my workplace.	Interview
SF4	I feel relaxed in my workplace.	Interview
SF5	There is something in the workplace helping me keep relaxed.	Interview
SF6	Compared with offices, I feel more relaxed in my remote-work workplace.	Interview
SF7	I do not feel stressful when I am in my workplace.	Interview
SF8	Working in my workplace is easy because I feel comfortable.	(Hoffman et al., 2002)
SF9	I feel alone in my workplace. (R)	(Hoffman et al., 2002)
SF10	I rarely talked to others in my workplace. (R)	(Hoffman et al., 2002)
SF11	I stop to talk to people I recognize in my workplace.	(Hoffman et al., 2002)
SF12	I am familiar with my workplace.	Interview
SF13	When working in my workplace, I feel at home.	Interview
SF14	I feel professional when I am in my workplace.	Interview
SF15	My workplace makes me feel that I am at work.	Interview
SF16	My workplace is designed for work.	Interview
SF17	I have a sense of achievement in my workplace.	Interview
SF18	I feel that I have accomplished a lot when working in the workplace.	Interview
SF19	I have successfully finished some tasks in the workplace.	Interview