

# Productivity analysis in work from home modality: An exploratory study considering an emerging country scenario in the COVID-19 context

Edilson Alves Rodrigues<sup>a,\*</sup>, Izabela Simon Rampasso<sup>b</sup>, Milena Pavan Serafim<sup>c</sup>,  
Walter Leal Filho<sup>d</sup> and Rosley Anholon<sup>a</sup>

<sup>a</sup>*School of Mechanical Engineering, University of Campinas, Campinas, Brazil*

<sup>b</sup>*Departamento de Ingeniería Industrial, Universidad Católica del Norte, Antofagasta, Chile*

<sup>c</sup>*Laboratory of Public Sector Studies, School of Applied Sciences, University of Campinas, Limeira, Brazil*

<sup>d</sup>*Faculty of Life Sciences, Hamburg University of Applied Sciences, Hamburg, Germany*

Received 15 September 2021

Accepted 10 December 2021

## Abstract.

**BACKGROUND:** The COVID-19 pandemic affected the work environment worldwide and forced companies to adopt work from home (WFH) suddenly.

**OBJECTIVE:** This study aims to identify factors that influence productivity in the WFH modality, considering the Brazilian scenario in the COVID-19 context.

**METHODS:** The approach used was a Delphi method with 19 specialists in the subject. Three rounds were conducted; in the third round, specialists indicated how the factor influences productivity through a scale. For the data collected in this last round, data was analysed via Grey Relational Analysis technique.

**RESULTS:** The results indicated that 17 factors could influence productivity in the WFH modality in the analysed context. Comparatively, the five factors with more capacity to influence productivity are 1) Availability of adequate equipment and peripherals to develop the work activities; 2) leadership support; 3) The adequate place to develop work activities; 4) Internet and electricity supply stability; and 5) Clarity from the collaborator regarding their role in the company, responsibilities and activities to be developed. The frequency analysis indicated that factors affect at least moderately productivity in WFH modality.

**CONCLUSIONS:** This article contributes to increasing knowledge associated with the WFH modality in the context of the COVID-19 pandemic. The information present here can be used by academics and managers, even in a post-pandemic scenario, to debate productivity in remote work modalities.

Keywords: Remote work, work efficiency, pandemic, Brazil, COVID-19

## 1. Introduction

The COVID-19 pandemic provided abrupt changes in people's lives, transforming personal and profes-

---

\*Address for correspondence: Edilson Alves Rodrigues, School of Mechanical Engineering, University of Campinas, Campinas, Brazil. E-mail: edilson\_rodrigues@hotmail.com.

sional aspects [1–5]. Regarding professional aspects, companies were forced to adjust their organisational practices [6–10]. Many organisations were forced to implement alternative workspaces to satisfy the social distancing requirements [1, 11, 12]. For administrative areas, to maintain their operations and avoid greater dissemination of the virus, companies opted to abruptly adopt the work from home (WFH) modality [6, 7, 13–21]. Few organisations had already developed initiatives related to WFH before the COVID-19 pandemic. These companies had the opportunity to apply the work modality in a planned and strategic form [18]. However, there was no time for planned actions and pilot testing, not even time to reflect [22]. The mentioned context needs to be included in future classes about companies administration to debate with students and future professionals the importance of human factors and ergonomic in the organization of the activities [23].

WFH is a work modality when activities are performed at home, distant from the company's traditional workplace; the collaborators are located in different geographic locations [24–26]. The evolution of this kind of work modality is due to information technology and telecommunication, which allow people to work remotely [2, 7, 27–33]. Nowadays, communication software such as MSTeams, ZOOM, Google Meet, among others, allow collaborators of a company to have videoconference calls, conversations and organise meetings with high productivity and efficiency [22, 34, 35].

Analysing the evidence-based literature makes it possible to see positive and negative points regarding WFH. Focusing on positive aspects, several authors highlight that using this modality, it is possible to improve workers' satisfaction and productivity [22, 25, 36–40]. More specifically, it is possible to increase well-being and reduce fatigue associated with commuting, a less stressful work environment, a better balance between work and family life [36, 38], and autonomy [39, 40]. For the companies, it is expected a significant cost reduction and productivity gains. Lastly, the public sectors expect a reduction in the social costs in commuting, environmental pollution and urban congestion [22, 25, 38, 40].

Despite the benefits mentioned, the evidence-based literature also highlights some disadvantages. One of the most significant challenges is delimiting the boundaries between professional and personal life [4, 21]; in other words, coping with family commitments and work has become one of the most critical challenges for remote workers [36]. Work invades life

domains because the worker has access to technology all the time [21, 41]; at the same time, family members demand more time, attention and care, since they are at home the whole day [15]. It is essential to highlight that some workers spend more time performing activities at home than office time [42], evidencing productivity loss. In addition, social isolation, consequent psychological challenges, lack of management and technical support, and other possible aspects need to be considered [28].

According to some authors, the adequacy of workspace to develop the activities also needs to be considered when productivity is analysed [43, 44]. The comfort of the environment, temperature and air renewal, the illumination conditions, noise levels control, the ergonomic conditions of the furniture, and technological infrastructure are essential elements to consider [43, 45, 46]. Of course, these aspects influence administrative and human relations and have consequences in psychological conditions [43]. Toniolo-Barrios and Pitt [4], mentioned that during the first months of the COVID-19 pandemic, workers were forced to improvise their furniture in office desks rapidly where a living room, bedroom, and kitchen became shared places (few people had dedicated offices in their houses). In addition, family members needed to share IT equipment and accessories [6] and the cost of the internet and energy supply increased when compared before the pandemic [6, 47].

In summary, while the WFH can provide some advantages, especially in the COVID-19 pandemic there were a series of challenges that people had to face associated with managing work and children care, household chores and general family demands, among other activities [4, 6]. All aspects influence the collaborator's productivity [6, 18, 20] and need to be better analysed, evidencing a research gap.

Before the enforced adoption of WFH in the COVID-19 pandemic, some author such as Choudhury et al. [48] already debated how remote work influence productivity. However, the evidence-based literature before the pandemic regarding WFH generally focused on more planned company projects, with elements and variables more controlled; in this sense, productivity could be analysed in a more pragmatic form. Productivity in WFH in the COVID-19 pandemic context is more complex and volatile and it needs to consider that most companies did not have time to plan the transition to this modality. In this scenario, it is essential to identify the factors that influence productivity in a specific moment

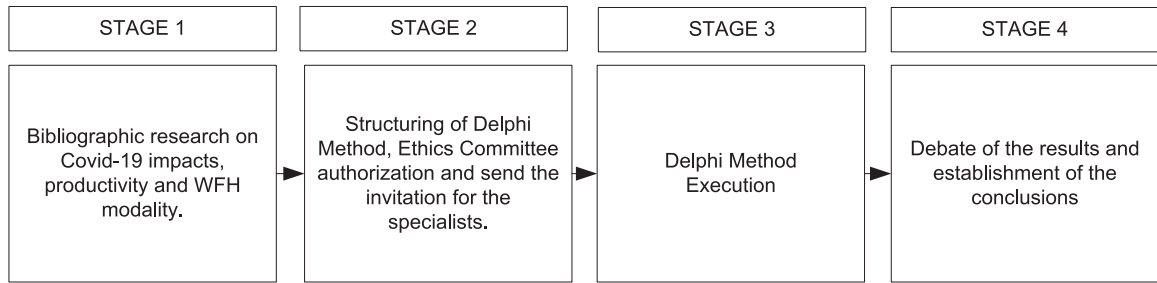


Fig. 1. Stages of the research.

not planned as the COVID-19 pandemic, evidencing a research gap to be explored. Considering this context and aiming to contribute to the knowledge base, this study's main purpose is to identify factors that influence productivity in WFH, considering the Brazilian scenario in pandemic context. A Delphi approach with specialists familiarised with the subject was used.

In addition to this expanded introduction that presented the theoretical background about WFH advantages and disadvantages, this article presents additional three sections. Section two is dedicated to presents methodological procedures, allowing readers to understand all aspects carried out to reach results. Section three presents the results, associated debates and limitations of the study. Section four presents the conclusion and final considerations.

## 2. Methodological procedures

Cooper and Schindler [49] mentioned that it is essential to develop well-defined stages to reach reliable results in a study. In this sense, five stages were defined to carry out this research, as presented in Fig. 1.

A bibliographic research characterised the first stage to understand better the COVID-19 impacts on companies, WFH modality aspects and productivity influences. For this purpose, articles were searched on scientific basis using the following terms and their combinations: "productivity", "telework", "work from home"; "remote work" and "COVID-19". Synonyms also were used. The following international scientific database was consulted "Emerald Insight"; "Science Direct", "Scopus", "Web of Science", "Springer" and "Taylor and Francis". It is essential to mention that with this search, it was possible to note that productivity in the WFH

modality in the context of COVID-19 is a research gap to be explored.

In the initial second stage, Delphi method procedures were defined. Delphi is a method to generate ideas or contributions regarding a specific theme through a collective communication process [50, 51]. The process is composed of rounds. Generally, in the first round, specialists present their opinion about a theme; after this round, a moderator synthesizes the main ideas and present a panel to all participants anonymously; based on information presented in this panel, participants can maintain, complete or change their opinion; the rounds continue up to a consensus or no more change is required by the participants [50–55]. Specifically, in this research, we conducted rounds up to no more changes were required by participants in their opinion. With a list of factors that can affect productivity, and using the scale presented in Table 1, participants finally indicated how each factor affects productivity in the WFH modality. It is essential to mention that two scores in each level were planned to allow a fine adjustment in the participants' responses if they desire.

All procedures planned and described above was approved by an Ethics Committee, as recommended

Table 1  
The scale used by specialists to indicate the influence of each factor on productivity

Score	Description
1 or 2	The factor in question hardly affects productivity in the WFH modality
3 or 4	The factor in question little affects productivity in WFH modality
5 or 6	The factor in question moderately affects productivity in the WFH modality
7 or 8	The factor in question strongly affects productivity in the WFH modality
9 or 10	The factor in question severely affects productivity in the WFH modality

by Brazilian Law for research with people involvement. As will be better described in section four, 25 specialists manifested their opinion; however, only 19 specialists continued up the last round. The literature argues that some participants dropouts are common during Delphi method rounds [50, 53, 55, 56]. To facilitate data management, the Google Forms platform was used to collect and store the data. The 19 specialists' group was composed of 14 managers or senior directors and 5 PhD academics who have experience in remote management during the pandemic or study on the theme.

For data analysis, three techniques were used. For the rounds in the Delphi process in which specialists debated the factor influencing the productivity in WFH modality, the technique used was content analysis according to Elo and Kyngäs [57] guidelines. According to these authors, it is necessary to select the unity of analysis in the preparation phase and verify if the data make sense. Elo and Kyngäs [57] explain that a unit of analysis can be a word or a phrase. In our study, the unity of analysis is the factors that influence the productivity in WFH. In the second phase, researchers need to choose an approach (inductive or deductive) [57] and we opted to conduct our analysis considering the inductive approach. In this kind of approach, researchers begin to analyse information without pre-defined categories; the categories are consequences of the analysis and appear with the evolution of analysis. The inductive approach included the following steps: open coding, coding sheets, grouping, categorisation and abstraction. With this information, a model of conceptual map can be defined, if this was the purpose of the researchers [57].

For the last round of Delphi, data was collected via a scale, and then, we have quantitative data. We decided to analyse this kind of data via frequency analysis and Grey Relational Analysis (GRA), according to Kuo et al. [58]. This technique allows to order variables comparatively; in our case, it will be possible to order comparatively factors that affect productivity in the WFH modality.

According to Kuo et al. [58], the first step to calculate Grey Relational Analysis is to structure a matrix with data considering scores given by the specialists, in our case, scores to each factor that affect productivity in WFH modality. In the sequence, it is necessary to normalize the scores on a scale from 0 to 1. For this, we decide to use Equation 1 [58] (note: we do not have criteria; we have respondents; then normalize criteria is both possible and results need to be considered according to it)

$$X_{ij} = \frac{Y_{ij} - \text{Min}\{Y_{ij}, i = 1, 2, \dots, m\}}{\text{Max}\{Y_{ij}, i = 1, 2, \dots, m\} - \text{Min}\{Y_{ij}, i = 1, 2, \dots, m\}}$$

for  $i = 1, 2, \dots, m$   $j = 1, 2, \dots, n$  (1)

The next step consists of calculating the difference of each element of the matrix normalised to the reference sequence, using Equation 2. Following the recommendation of [58], we chose as reference sequence the  $X_{0j}=1$

$$\Delta_{ij} = X_{0j} - X_{ij} \quad (2)$$

With value of  $\Delta_{ij}$  calculated, it is possible to calculate Grey Relational Coefficient ( $\epsilon$ ) via Equation 3. In this study, we decided to use as distinctive coefficient ( $\rho$ ) the value 0,5. The values of  $\Delta_{\max}$  and  $\Delta_{\min}$  are

Table 2  
The factor that impacts productivity in WFH modality

Factor	Description
F1	Level of overlap between personal and professional life in the same environment
F2	The balance between personal and professional life
F3	Professional engagement and capability of organising a work routine
F4	The adequate place to develop work activities
F5	Availability of adequate equipment and peripherals to develop the work activities
F6	Internet and electricity supply stability
F7	The team leader capability in planning and optimising the number of meetings (meetings need to be pragmatic and maintain the flow of information and pertinent decisions to work)
F8	Use level of tools that allow the fast exchange of information among the collaborators during the execution of the activities
F9	Collaborator familiarity with online platforms dedicated to communication and remote work
F10	Clarity from the collaborator regarding their role in the company, responsibilities and activities to be developed
F11	Collaborator capability of self-learning in a remote work environment
F12	Flexibility level granted to collaborator regarding its work hours.
F13	Dissatisfaction on the part of collaborators due to the development of activities at times not initially planned.
F14	Lack of access to certain resources and information that are available only inside the company facilities
F15	Financial support from the company for that the collaborator may bear the costs related to developing the professional activities in the remote environment
F16	Collaborator's sense of belonging
F17	Leadership support

calculated considering all values of  $\Delta_{ij}$ , calculated via Equation 2.

$$\varepsilon_{ij} = \frac{\Delta_{min} + \rho \times \Delta_{max}}{\Delta_{ij} + \rho \times \Delta_{max}} \quad (3)$$

Finally, the Grey Relational Grade (R) is calculated using equation 4. In this study, we adopted the same weights for all respondents; then, the value corresponds to the average values obtained from the Grey Relational Coefficient ( $\varepsilon$ ).

$$R = \frac{1}{n} \sum_{k=1}^n \varepsilon_i(k) \quad (4)$$

With values of R, the factors that affect productivity were ranked and outcomes analysed.

### 3. Results and discussions

In this section, it is analysed the main results obtained and they are debated considering the statements presented in the literature. After two rounds, the Delphi method made it possible to obtain 17 factors that affect productivity in the WFH modality, in the participants' opinion. (See these 17 factors in Table 2).

As mentioned in the methodological procedures section, in round three, participants evaluated the factors considering the scale presented in Table 1. An interesting information to be cited is that for all factors analysed, at least 58% of the respondents measured scores equal or greater than 5, indicating

that the factor in question affects at least moderately productivity in WFH modality. Scores measured by respondents were normalized, using equation 1, and are presented in Table 3.

In the sequence, the differences for each value of Table 3 from the reference sequence were calculated and the results are presented in Table 4.

Using Equation 3 and values of Table 4, Grey Relational Coefficients ( $\varepsilon$ ) and Grey Relational Grade (R) were calculated, as shown in Table 5.

The Grey Relational Grade values (R) were used to comparatively order the factors that affect productivity, as presented in Table 6.

Comparatively, the factor with more significant impact on the productivity of WFH modality was the availability of adequate equipment and peripherals to develop the work activities (F5). With the abrupt change to the WFH modality, not all workers had time and resources to set of equipment at home; once the technology becomes the only communication channel among teams, the availability of adequate equipment and peripherals to develop work activities passed to influence the productivity strongly. In addition, it is essential to remember that with all family members at home, IT equipment (laptops, tablets, printers), internet connection, desks to work and study needed to be shared, as highlighted by [6].

In the sequence, we have leadership support (F17). Leadership behaviour-oriented and committed relationships and team development are critical factors in overcoming the virtual environment's challenges

Table 3  
Score attributed by the respondents normalised to each identified factor

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17
R1	0.33	0.67	0.33	0.67	0.67	1.00	0.33	0.50	1.00	0.83	0.33	0.17	0.00	0.67	0.00	0.67	0.67
R2	1.00	0.83	0.17	0.50	1.00	0.50	0.50	1.00	1.00	1.00	1.00	0.00	1.00	0.00	0.00	0.83	0.83
R3	0.50	0.50	0.00	1.00	1.00	0.00	1.00	0.50	0.00	0.50	1.00	0.00	1.00	1.00	1.00	0.50	0.50
R4	1.00	0.43	0.43	0.57	0.71	0.71	0.57	0.57	0.57	0.86	0.57	0.14	0.71	0.57	0.00	0.86	1.00
R5	0.00	0.00	0.50	0.50	1.00	0.75	0.25	0.50	0.75	1.00	0.75	0.75	0.25	0.75	0.00	0.00	0.00
R6	0.50	0.50	0.50	0.25	0.75	0.50	1.00	0.25	0.75	1.00	0.50	0.00	1.00	0.50	0.25	1.00	1.00
R7	0.33	0.00	0.00	1.00	1.00	1.00	1.00	1.00	0.67	1.00	1.00	1.00	1.00	0.00	0.78	0.00	0.89
R8	0.25	0.00	0.25	0.25	0.50	0.25	0.50	0.50	0.25	0.75	0.75	0.75	1.00	1.00	0.50	1.00	1.00
R9	0.33	0.17	0.33	0.50	0.67	1.00	0.33	0.50	0.67	0.33	0.67	0.50	0.00	0.17	0.17	0.00	0.00
R10	0.43	0.71	0.57	1.00	1.00	1.00	0.71	0.71	0.29	0.86	0.71	0.86	0.57	0.00	0.29	0.29	1.00
R11	0.60	0.00	0.60	1.00	0.40	0.60	1.00	0.00	0.00	0.80	0.40	0.40	0.40	0.00	0.80	1.00	0.60
R12	0.67	0.33	0.67	1.00	0.33	0.33	0.33	0.33	0.33	0.00	0.33	0.00	0.33	0.33	0.67	0.67	1.00
R13	0.00	0.33	1.00	1.00	0.33	0.67	0.67	1.00	0.67	0.67	1.00	0.67	0.33	0.33	0.67	1.00	0.33
R14	0.67	1.00	0.00	1.00	1.00	0.33	0.67	1.00	1.00	0.67	0.67	0.33	0.33	0.33	1.00	0.67	1.00
R15	0.14	0.00	0.14	0.57	0.86	1.00	0.29	0.71	0.57	0.29	0.57	0.43	0.00	0.00	0.00	0.00	0.00
R16	0.67	0.00	0.17	0.33	0.67	0.67	0.83	0.67	0.50	1.00	0.83	0.67	0.50	0.17	0.50	1.00	1.00
R17	1.00	1.00	0.67	0.17	0.83	1.00	0.83	0.83	0.00	0.33	0.67	0.00	0.83	0.67	0.00	0.67	0.33
R18	0.71	0.29	0.43	1.00	1.00	1.00	0.71	0.57	0.71	0.57	0.71	0.43	0.57	0.00	0.86	0.29	0.86
R19	1.00	0.00	0.50	1.00	1.00	1.00	0.00	1.00	0.00	1.00	1.00	0.50	0.00	0.50	1.00	1.00	1.00

Table 4  
Differences for each value of Table 3 from the reference sequence

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17
R1	0.67	0.33	0.67	0.33	0.33	0.00	0.67	0.50	0.00	0.17	0.67	0.83	1.00	0.33	1.00	0.33	0.33
R2	0.00	0.17	0.83	0.50	0.00	0.50	0.50	0.00	0.00	0.00	0.00	1.00	0.00	1.00	1.00	0.17	0.17
R3	0.50	0.50	1.00	0.00	0.00	1.00	0.00	0.50	1.00	0.50	0.00	1.00	0.00	0.00	0.00	0.50	0.50
R4	0.00	0.57	0.57	0.43	0.29	0.29	0.43	0.43	0.14	0.43	0.86	0.29	0.43	1.00	0.14	0.00	0.00
R5	1.00	1.00	0.50	0.50	0.00	0.25	0.75	0.50	0.25	0.00	0.25	0.25	0.75	0.25	1.00	1.00	1.00
R6	0.50	0.50	0.50	0.75	0.25	0.50	0.00	0.75	0.25	0.00	0.50	1.00	0.00	0.50	0.75	0.00	0.00
R7	0.67	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	1.00	0.22	1.00	0.11
R8	0.75	1.00	0.75	0.75	0.50	0.75	0.50	0.50	0.75	0.25	0.25	0.25	0.00	0.00	0.50	0.00	0.00
R9	0.67	0.83	0.67	0.50	0.33	0.00	0.67	0.50	0.33	0.67	0.33	0.50	1.00	0.83	0.83	1.00	1.00
R10	0.57	0.29	0.43	0.00	0.00	0.00	0.29	0.29	0.71	0.14	0.29	0.14	0.43	1.00	0.71	0.71	0.00
R11	0.40	1.00	0.40	0.00	0.60	0.40	0.00	1.00	1.00	0.20	0.60	0.60	0.60	1.00	0.20	0.00	0.40
R12	0.33	0.67	0.33	0.00	0.67	0.67	0.67	0.67	0.67	1.00	0.67	1.00	0.67	0.67	0.33	0.33	0.00
R13	1.00	0.67	0.00	0.00	0.67	0.33	0.33	0.00	0.33	0.33	0.00	0.33	0.67	0.67	0.33	0.00	0.67
R14	0.33	0.00	1.00	0.00	0.00	0.67	0.33	0.00	0.00	0.33	0.33	0.67	0.67	0.67	0.00	0.33	0.00
R15	0.86	1.00	0.86	0.43	0.14	0.00	0.71	0.29	0.43	0.71	0.43	0.57	1.00	1.00	1.00	1.00	1.00
R16	0.33	1.00	0.83	0.67	0.33	0.33	0.17	0.33	0.50	0.00	0.17	0.33	0.50	0.83	0.50	0.00	0.00
R17	0.00	0.00	0.33	0.83	0.17	0.00	0.17	0.17	1.00	0.67	0.33	1.00	0.17	0.33	1.00	0.33	0.67
R18	0.29	0.71	0.57	0.00	0.00	0.00	0.29	0.43	0.29	0.43	0.29	0.57	0.43	1.00	0.14	0.71	0.14
R19	0.00	1.00	0.50	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.50	1.00	0.50	0.00	0.00	0.00

Table 5  
Grey Relational Coefficients ( $\epsilon$ ) and Grey Relational Grade (R)

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17
R1	0.43	0.60	0.43	0.60	0.60	1.00	0.43	0.50	1.00	0.75	0.43	0.38	0.33	0.60	0.33	0.60	0.60
R2	1.00	0.75	0.38	0.50	1.00	0.50	0.50	1.00	1.00	1.00	1.00	0.33	1.00	0.33	0.33	0.75	0.75
R3	0.50	0.50	0.33	1.00	1.00	0.33	1.00	0.50	0.33	0.50	1.00	0.50	1.00	1.00	0.50	0.50	0.50
R4	1.00	0.47	0.47	0.54	0.64	0.64	0.54	0.54	0.54	0.78	0.54	0.37	0.64	0.54	0.33	0.78	1.00
R5	0.33	0.33	0.50	0.50	1.00	0.67	0.40	0.50	0.67	1.00	0.67	0.67	0.40	0.67	0.33	0.33	0.33
R6	0.50	0.50	0.50	0.40	0.67	0.50	1.00	0.40	0.67	1.00	0.50	0.33	1.00	0.50	0.40	1.00	1.00
R7	0.43	0.33	0.33	1.00	1.00	1.00	1.00	1.00	0.60	1.00	1.00	0.82	1.00	0.33	0.54	0.33	0.82
R8	0.40	0.33	0.40	0.40	0.50	0.40	0.50	0.50	0.40	0.67	0.67	0.67	1.00	1.00	0.50	1.00	1.00
R9	0.43	0.38	0.43	0.50	0.60	1.00	0.43	0.50	0.60	0.43	0.60	0.50	0.33	0.38	0.38	0.33	0.33
R10	0.47	0.64	0.54	1.00	1.00	1.00	0.64	0.64	0.41	0.78	0.64	0.78	0.54	0.33	0.41	0.41	1.00
R11	0.56	0.33	0.56	1.00	0.45	0.56	1.00	0.33	0.33	0.71	0.45	0.56	0.45	0.33	0.47	1.00	0.56
R12	0.60	0.43	0.60	1.00	0.43	0.43	0.43	0.43	0.43	0.33	0.43	0.33	0.43	0.43	0.60	0.60	1.00
R13	0.33	0.43	1.00	1.00	0.43	0.60	0.60	1.00	0.60	0.60	1.00	0.60	0.43	0.43	0.60	1.00	0.43
R14	0.60	1.00	0.33	1.00	1.00	0.43	0.60	1.00	1.00	0.60	0.60	0.43	0.43	0.43	1.00	0.60	1.00
R15	0.37	0.33	0.37	0.54	0.78	1.00	0.41	0.64	0.54	0.41	0.54	0.33	0.33	0.33	0.58	0.33	0.33
R16	0.60	0.33	0.38	0.43	0.60	0.60	0.75	0.60	0.50	1.00	0.75	0.60	0.50	0.38	0.50	1.00	1.00
R17	1.00	1.00	0.60	0.38	0.75	1.00	0.75	0.75	0.33	0.43	0.60	0.33	0.75	0.60	0.33	0.60	0.43
R18	0.64	0.41	0.47	1.00	1.00	1.00	0.64	0.54	0.64	0.54	0.64	0.47	0.54	0.33	0.78	0.41	0.78
R19	1.00	0.33	0.50	1.00	1.00	1.00	0.33	1.00	0.33	1.00	1.00	1.00	0.33	0.50	0.33	1.00	1.00
Grey Relational Grade (R)	0.588	0.496	0.479	0.725	0.760	0.718	0.629	0.651	0.575	0.712	0.687	0.502	0.602	0.497	0.556	0.662	0.729

in troubled times. The WFH modality reduced the frequency of interactions among workers and their managers [36, 59] and, as a consequence, it may impact job satisfaction and productivity. Based on these concerns, organisational support is fundamental to remote workers' satisfaction and wellbeing as pointed out [28]. Especially in WFH in COVID-19 pandemic, isolation and stress affected workers; the managers' support was essential; they needed to show leadership behaviour and trust in the worker's autonomy [27] simultaneously. Hinojosa et al. [60] also

highlight the role of the pandemic in changing the relationships between leaders and workers.

The adequate place to develop work activities (F4) is the third factor that comparatively affects productivity in the WFH modality. This item included aspects associated with environment comfort such as space, temperature, air renewal, illumination level, noise level, furniture ergonomically designed, etc. There is a strong relationship between the workplace and workers' health and efficacy [61]. An inadequate workplace negatively influences efficacy, while

a well-organised workplace can be a vital resource for increasing productivity [62]. Sometimes, the space inside the house is limited, the desk and chair may not have the necessary adjustments to provide an ergonomically adequate work environment, especially in the long term. These aspects cause several symptoms related to health and may lead to problems in productivity.

To Sarsak [61], this poses the challenge of setting up a home workspace to be as ergonomically correct and safe as possible. To Grant et al. [41], having a peaceful private space to work without interruptions is seen as a great advantage. WFH usually affects concentration due to environmental distractions, such as doorbells, noisy pets and disruptive children [4].

As well as the availability of adequate equipment and peripherals, Internet and electricity supply stability (F6) also impact productivity and comparatively was ranked in the fourth position. The use of IT technology tools was widely intensified during the pandemic due to remote work; new challenges emerged, such as slow internet connection, electrical power failures, cyber-attacks and problems with the private virtual network [6, 47]. Generally, a slow internet connection is responsible for virtual meetings interruptions and compromises productivity [18].

The fifth position was evidenced by the factor "Clarity from the collaborator regarding their role in the company, responsibilities and activities to be developed (F10). The greater this clarity, the more autonomous the collaborator will be, and therefore, the greater the probability of being more productive [63]. In a virtual work environment, the workers have many tasks, including professional and personal shores, then [27] a clarity in professional activities will enable better performance and desired results [45].

Some limitations can be attributed to this study. The first is that, despite the participants' great experience, the respondents' answers reflected the moment of the COVID-19 pandemic in which the study was conducted. The pandemic has been characterized as a new situation for everyone and new studies emerge every month; further research may complement the information presented here. The second limitation is that the participants did not focus on a particular professional or business activity. If they did, some factors could stand out over others.

Table 6

Ranking of the factors that impact productivity in WFH modality

Ranking	#	Factor	Description
1°	0.760	F5	Availability of adequate equipment and peripherals to develop the work activities
2°	0.729	F17	Leadership support
3°	0.725	F4	The adequate place to develop work activities
4°	0.718	F6	Internet and electricity supply stability
5°	0.712	F10	Clarity from the collaborator regarding their role in the company, responsibilities and activities to be developed
6°	0.687	F11	Collaborator capability of self-learning in a remote work environment
7°	0.662	F16	Collaborator's sense of belonging
8°	0.651	F8	Use level of tools that allow the fast exchange of information among the collaborators during the execution of the activities
9°	0.629	F7	The team leader capability in planning and optimising the number of meetings (meetings need to be pragmatic and maintain the flow of information and pertinent decisions to work)
10°	0.602	F13	Dissatisfaction on the part of collaborators due to the development of activities at times not initially planned.
11°	0.588	F1	Level of overlap between personal and professional life in the same environment
12°	0.575	F9	Collaborator familiarity with online platforms dedicated to communication and remote work
13°	0.556	F15	Financial support from the company for that the collaborator may bear the costs related to developing the professional activities in the remote environment
14°	0.502	F12	Flexibility level granted to collaborator regarding its work hours.
15°	0.497	F14	Lack of access to certain resources and information that are available only inside the company facilities
16°	0.496	F2	The balance between personal and professional life
17°	0.479	F3	Professional engagement and capability of organising a work routine

#### 4. Conclusion

As mentioned before, the productivity analysis in the COVID-19 pandemic context is more difficult because companies did not have time to plan the transition to the remote work modality and variables and elements were less controlled compared with similar projects developed by other companies before the COVID-19 pandemic. This study investigated the main factors affecting WFH modality productivity during the COVID-19 pandemic, considering the Brazilian scenario. The findings presented here are essential to understand the mentioned period and be used in future research.

The methodology approach used the Delphi method; in the first and second rounds, factors were debated and in the third round, specialists assessed the mentioned factors using scale. Through an analysis of frequencies of scores, it was possible to note that all aspects in a general way affect at least moderately the productivity in the WFH modality. When analysed comparatively, through GRA analysis, five factors stand out: 1) Availability of adequate equipment and peripherals to develop the work activities; 2) Leadership support; 3) The adequate place to develop work activities; 4) Internet and electricity supply stability; 5) Clarity from the collaborator regarding their role in the company, responsibilities and activities to be developed. For the theory, this paper presents consolidated information that can be used in future studies. For the practice, managers can use the information to reflect on the aspect of productivity of their teams.

As propositions for future studies, we recommend that factors highlighted here to be studied by other researchers individually to understand their consequences on productivity better. We also encourage studies in specific sectors or certain professional activities.

#### Acknowledgments

This work was supported by the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) under Grant 304145/2021-1.

#### Conflict of interest

None to report.

#### References

- [1] Çoban S. Gender and telework: Work and family experiences of teleworking professional, middle-class, married women with children during the Covid-19 pandemic in Turkey. *Gender, Work Organ.* 2021;12684. <https://doi.org/10.1111/gwao.12684>.
- [2] Mallett O, Marks A, Skountridaki L. Where does work belong anymore? The implications of intensive homebased working. *Gend Manag.* 2020;35:657-65. <https://doi.org/10.1108/GM-06-2020-0173>.
- [3] Nyanga T, Zirima H. REACTIONS OF SMALL TO MEDIUM ENTERPRISES IN MASVINGO, ZIMBABWE TO COVID 19: IMPLICATIONS ON PRODUCTIVITY. *Bus Excell Manag.* 2020;S.I.:22-32. <https://doi.org/10.24818/beman/2020.S.I.1-02>.
- [4] Toniolo-Barrios M, Pitt L. Mindfulness and the challenges of working from home in times of crisis. *Bus Horiz.* 2021;64:189-97. <https://doi.org/10.1016/j.bushor.2020.09.004>.
- [5] Dogru-Huzmeli E, Cam Y, Urfali S, Gokcek O, Bezgin S, Urfali B, et al. Burnout and anxiety level of healthcare professionals during the COVID-19 pandemic in Turkey. *Work.* 2021;1-9. <https://doi.org/10.3233/WOR-210028>.
- [6] Anderson D, Kelliher C. Enforced remote working and the work-life interface during lockdown. *Gend Manag An Int J.* 2020;35:677-83. <https://doi.org/10.1108/GM-07-2020-0224>.
- [7] Biron M, Peretz H, Turgeman-Lupo K. Trait optimism and work from home adjustment in the COVID-19 pandemic: Considering the mediating role of situational optimism and the moderating role of cultural optimism. *Sustain.* 2020;12:1-21. <https://doi.org/10.3390/su12229773>.
- [8] Carroll N, Conboy K. Normalising the "new normal": Changing tech-driven work practices under pandemic time pressure. *Int J Inf Manag.* 2020;55:102186. <https://doi.org/10.1016/j.ijinfomgt.2020.102186>.
- [9] Chang Y, Chien C, Shen LF. Telecommuting during the coronavirus pandemic: Future time orientation as a mediator between proactive coping and perceived work productivity in two cultural samples. *Pers Individ Dif.* 2021; 171. <https://doi.org/10.1016/j.paid.2020.110508>.
- [10] Madero Gómez S, Ortiz Mendoza OE, Ramírez J, Olivás-Luján MR. Stress and myths related to the COVID-19 pandemic's effects on remote work. *Manag Res J Iberoam Acad Manag.* 2020;18:401-20. <https://doi.org/10.1108/MRJIAM-06-2020-1065>.
- [11] O'Leary DE. Evolving Information Systems and Technology Research Issues for COVID-19 and Other Pandemics. *J Organ Comput Electron Commer.* 2020;30:1-8. <https://doi.org/10.1080/10919392.2020.1755790>.
- [12] Prodanova J, Kocarev L. Employees' dedication to working from home in times of COVID-19 crisis. *Manag Decis.* 2021; ahead-of-p. <https://doi.org/10.1108/MD-09-2020-1256>.
- [13] Feiz Arefi M, Babaei-Pouya A, Poursadeqiyani M. The health effects of quarantine during the COVID-19 pandemic. *Work.* 2020;67:523-7. <https://doi.org/10.3233/WOR-203306>.
- [14] Dubey AD, Tripathi S. Analysing the Sentiments towards Work-From-Home Experience during COVID-19 Pandemic. *J Innov Manag.* 2020;8:13-9. [https://doi.org/10.24840/2183-0606\\_008.001\\_0003](https://doi.org/10.24840/2183-0606_008.001_0003).



- [15] Feng Z, Savani K. Covid-19 created a gender gap in perceived work productivity and job satisfaction: implications for dual-career parents working from home. *Gen Manag.* 2020;35:719-36. <https://doi.org/10.1108/GM-07-2020-0202>.
- [16] Lee H. Changes in workplace practices during the COVID-19 pandemic: the roles of emotion, psychological safety and organisation support. *J Organ Eff People Perform.* 2021;8:97-128. <https://doi.org/10.1108/JOEPP-06-2020-0104>.
- [17] Nagel L. The influence of the COVID-19 pandemic on the digital transformation of work. *Int J Sociol Soc Policy.* 2020;40:861-75. <https://doi.org/10.1108/IJSSP-07-2020-0323>.
- [18] O Connor M, Conboy K, Dennehy D. COVID-19 affected remote workers: a temporal analysis of information system development during the pandemic. *J Decis Syst.* 2021;00:1-27. <https://doi.org/10.1080/12460125.2020.1861772>.
- [19] Vyas L, Butakhieo N. The impact of working from home during COVID-19 on work and life domains: an exploratory study on Hong Kong. *Policy Des Pract.* 2020:1-18. <https://doi.org/10.1080/25741292.2020.1863560>.
- [20] Waizenegger L, McKenna B, Cai W, Bendz T. An affordance perspective of team collaboration and enforced working from home during COVID-19. *Eur J Inf Syst.* 2020;29:429-42. <https://doi.org/10.1080/0960085X.2020.1800417>.
- [21] Wang B, Liu Y, Qian J, Parker SK. Achieving Effective Remote Working During the COVID-19 Pandemic: A Work Design Perspective. *Appl Psychol.* 2021;70:16-59. <https://doi.org/10.1111/apps.12290>.
- [22] Kamal MM. The triple-edged sword of COVID-19: understanding the use of digital technologies and the impact of productive, disruptive, and destructive nature of the pandemic. *Inf Syst Manag.* 2020;37:310-7. <https://doi.org/10.1080/10580530.2020.1820634>.
- [23] Anholon R, Rampasso IS, Cooper Ordóñez RE. Human factors and ergonomics in the context of COVID-19: Planning for concepts insertion in a productive systems discipline. *Work.* 2020;67:519-21. <https://doi.org/10.3233/WOR-203305>.
- [24] Bellmann L, Hübler O. Working from home, job satisfaction and work-life balance - robust or heterogeneous links? *Int J Manpow.* 2020. <https://doi.org/10.1108/IJM-10-2019-0458>.
- [25] Tavares F, Santos E, Diogo A, Ratten V. Teleworking in Portuguese communities during the COVID-19 pandemic. *J Enterprising Communities People Places Glob Econ.* 2021;15:334-49. <https://doi.org/10.1108/JEC-06-2020-0113>.
- [26] Wong AHK, Cheung JO, Chen Z. Promoting effectiveness of "working from home": findings from Hong Kong working population under COVID-19. *Asian Educ Dev Stud.* 2020;10:210-28. <https://doi.org/10.1108/AEDS-06-2020-0139>.
- [27] Bartsch S, Weber E, Büttgen M, Huber A. Leadership matters in crisis-induced digital transformation: how to lead service employees effectively during the COVID-19 pandemic. *J Serv Manag.* 2020; ahead-of-p. <https://doi.org/10.1108/JOSM-05-2020-0160>.
- [28] Bentley TA, Teo STT, McLeod L, Tan F, Bosua R, Gloet M. The role of organisational support in teleworker wellbeing: A socio-technical systems approach. *Appl Ergon.* 2016;52:207-15. <https://doi.org/10.1016/j.apergo.2015.07.019>.
- [29] Cooper CL, Lu L. Excessive availability for work: Good or bad? Charting underlying motivations and searching for game-changers. *Hum Resour Manag Rev.* 2019;29:1-13. <https://doi.org/10.1016/j.hrmr.2019.01.003>.
- [30] Dwivedi YK, Hughes DL, Coombs C, Constantiou I, Duan Y, Edwards JS, et al. Impact of COVID-19 pandemic on information management research and practice: Transforming education, work and life. *Int J Inf Manage.* 2020;55:102211. <https://doi.org/10.1016/j.ijinfomgt.2020.102211>.
- [31] Groen BAC, van Triest SP, Coers M, Wtenweerde N. Managing flexible work arrangements: Teleworking and output controls. *Eur Manag J.* 2018;36:727-35. <https://doi.org/10.1016/j.emj.2018.01.007>.
- [32] Panigutti C, Perotti A, Pedreschi D. Doctor XAI An ontology-based approach to black-box sequential data classification explanations. *FAT\* 2020 - Proc 2020 Conf Fairness, Accountability, Transpar.* 2020:629-39. <https://doi.org/10.1145/3351095.3372855>.
- [33] Spurk D, Straub C. Flexible employment relationships and careers in times of the COVID-19 pandemic. *J Vocat Behav.* 2020;119:103435. <https://doi.org/10.1016/j.jvb.2020.103435>.
- [34] Fernandez P. "Through the looking glass: envisioning new library technologies" pandemic response technologies: remote working. *Libr Hi Tech News.* 2020;37:21-3. <https://doi.org/10.1108/LHTN-04-2020-0039>.
- [35] Hacker J, vom Brocke J, Handali J, Otto M, Schneider J. Virtually in this together—how web-conferencing systems enabled a new virtual togetherness during the COVID-19 crisis. *Eur J Inf Syst.* 2020;29:563-84. <https://doi.org/10.1080/0960085X.2020.1814680>.
- [36] Nakrošienė A, Bučiūnienė I, Goštautaitė B. Working from home: characteristics and outcomes of telework. *Int J Manpow.* 2019;40:87-101. <https://doi.org/10.1108/IJM-07-2017-0172>.
- [37] Toscano F, Zappalà S. Social isolation and stress as predictors of productivity perception and remote work satisfaction during the COVID-19 pandemic: The role of concern about the virus in a moderated double mediation. *Sustain.* 2020;12:1-14. <https://doi.org/10.3390/su12239804>.
- [38] Aguilera A, Lethiais V, Rallet A, Proulhac L. Home-based telework in France: Characteristics, barriers and perspectives. *Transp Res Part A Policy Pract.* 2016;92:1-11. <https://doi.org/10.1016/j.tra.2016.06.021>.
- [39] Anka A, Thacker H, Penhale B. Safeguarding adults practice and remote working in the COVID-19 era: challenges and opportunities. *J Adult Prot.* 2020; ahead-of-p. <https://doi.org/10.1108/JAP-08-2020-0040>.
- [40] Bajzikova L, Sajgalikova H, Wojcak E, Polakova M. How Far is Contract and Employee Telework Implemented in SMEs and Large Enterprises? (Case of Slovakia). *Procedia - Soc Behav Sci.* 2016; 235:420-6. <https://doi.org/10.1016/j.sbspro.2016.11.052>.
- [41] Grant CA, Wallace LM, Spurgeon PC. An exploration of the psychological factors affecting remote e-worker's job effectiveness, well-being and work-life balance. *Empl Relations.* 2013;35:527-46. <https://doi.org/10.1108/ER-08-2012-0059>.
- [42] Donnelly R, Johns J. Recontextualising remote working and its HRM in the digital economy: An integrated framework for theory and practice. *Int J Hum Resour Manag.* 2020;0:1-22. <https://doi.org/10.1080/09585192.2020.1737834>.

- [43] Fassoulis K, Alexopoulos N. The workplace as a factor of job satisfaction and productivity: A case study of administrative personnel at the University of Athens. *J Facil Manag.* 2015;13:332-49. <https://doi.org/10.1108/JFM-06-2014-0018>.
- [44] Marzban S, Durakovic I, Candido C, Mackey M. Learning to work from home: experience of Australian workers and organizational representatives during the first Covid-19 lockdowns. *J Corp Real Estate.* 2021. <https://doi.org/10.1108/JCRE-10-2020-0049>.
- [45] Harris R. Defining and measuring the productive office. *J Corp Real Estate.* 2019;21:55-71. <https://doi.org/10.1108/JCRE-05-2018-0016>.
- [46] Palvalin M, van der Voordt T, Jylhä T. The impact of workplaces and self-management practices on the productivity of knowledge workers. *J Facil Manag.* 2017;15:423-38. <https://doi.org/10.1108/JFM-03-2017-0010>.
- [47] Matli W. The changing work landscape as a result of the Covid-19 pandemic: insights from remote workers life situations in South Africa. *Int J Sociol Soc Policy.* 2020;40:1237-56. <https://doi.org/10.1108/IJSSP-08-2020-0386>.
- [48] Choudhury P (Raj), Foroughi C, Larson B. Work-from-anywhere: The productivity effects of geographic flexibility. *Strateg Manag J.* 2021;42:655-83. <https://doi.org/10.1002/smj.3251>.
- [49] Cooper DR, Schindler PS. *BUSINESS RESEARCH METHODS. TWELFTH.* McGraw-Hill; 2014.
- [50] Flostrand A, Pitt L, Bridson S. The Delphi technique in forecasting—A 42-year bibliographic analysis (1975–2017). *Technol Forecast Soc Change.* 2020;150:119773. <https://doi.org/10.1016/j.techfore.2019.119773>.
- [51] Linstone HA, Turoff M. The Delphi method: An efficient procedure to generate knowledge. *Skeletal Radiol.* 2002;40:959-61. <https://doi.org/10.1007/s00256-011-1145-z>.
- [52] Donohoe HM, Needham RD. Moving best practice forward: Delphi characteristics, advantages, potential problems, and solutions. *Int J Tour Res.* 2009;11:415-37. <https://doi.org/10.1002/jtr.709>.
- [53] Geist MR. Using the Delphi method to engage stakeholders: A comparison of two studies. *Eval Program Plann.* 2010;33:147-54. <https://doi.org/10.1016/j.evalprogplan.2009.06.006>.
- [54] Hasson F, Keeney S, McKenna H. Research guidelines for the Delphi survey technique. *J Adv Nurs.* 2000;32:1008-15. <https://doi.org/10.1046/j.1365-2648.2000.t01-1-01567.x>.
- [55] von der Gracht HA, Darkow I-L. Scenarios for the logistics services industry: A Delphi-based analysis for 2025. *Int J Prod Econ.* 2010;127:46-59. <https://doi.org/10.1016/j.ijpe.2010.04.013>.
- [56] Charbonneau É, Doberstein C. An Empirical Assessment of the Intrusiveness and Reasonableness of Emerging Work Surveillance Technologies in the Public Sector. *Public Adm Rev.* 2020;80:780-91. <https://doi.org/10.1111/puar.13278>.
- [57] Elo S, Kyngäs H. The qualitative content analysis process. *J Adv Nurs.* 2008;62:107-15. <https://doi.org/10.1111/j.1365-2648.2007.04569.x>.
- [58] Kuo Y, Yang T, Huang G-W. The use of grey relational analysis in solving multiple attribute decision-making problems. *Comput Ind Eng.* 2008;55:80-93. <https://doi.org/10.1016/j.cie.2007.12.002>.
- [59] Lapiere LM, van Steenberghe EF, Peeters MCW, Kluwer ES. Juggling work and family responsibilities when involuntarily working more from home: A multiwave study of financial sales professionals. *J Organ Behav.* 2016;37:804-22. <https://doi.org/10.1002/job.2075>.
- [60] Hinojosa AS, Shaine MJD, McCauley KD. A strange situation indeed: Fostering leader–follower attachment security during unprecedented crisis. *Manag Decis.* 2020;58:2099-115. <https://doi.org/10.1108/MD-08-2020-1142>.
- [61] Sarsak HI. Working from home: Self-assessment computer workstation set-up. *World Fed Occup Ther Bull.* 2020;0:1-8. <https://doi.org/10.1080/14473828.2020.1852764>.
- [62] Naqvi SMMR, Ishtiaq M, Kanwal N, Ali M. Impact of Job Autonomy on Organizational Commitment and Job Satisfaction: The Moderating Role of Organizational Culture in Fast Food Sector of Pakistan. *Int J Bus Manag.* 2013;8:92-102. <https://doi.org/10.5539/ijbm.v8n17p92>.
- [63] Liao C. Leadership in virtual teams: A multilevel perspective. *Hum Resour Manag Rev.* 2017;27:648-59. <https://doi.org/10.1016/j.hrmr.2016.12.010>.