Research Paper

An investigation of telecommuters perceived productivity from pre to post Covid 19 pandemic

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Abstract

The positive experiences with telecommuting during the pandemic have resulted in many companies adopting partial or full telecommuting as a preferred work option in many countries. This decision has to be critically evaluated considering, the different employment sectors, employee socio-economic characteristics and their overall productivity. In this study, descriptive statistical analysis has been performed to investigate the transformation in telecommuters' productivity from pre-pandemic to the new normal situation and the period in-between across different socio-economic strata and sectors along with identification of factors influencing productivity in the context of an emerging economy like India. An ordinal logistic regression model has been developed to estimate the relationship between telecommuter's socio-economic characteristics, organization characteristics and other influencing factors with their productivity. The analysis has been performed based on 431 responses collected through online survey via Google forms circulated across pan India. Female with children and experienced officials have been found to be suitable for telecommuting considering their ability to achieve productivity with better time management. Employers' initiatives and encouragement is also found to play a major role in achieving desired productivity while maintaining work-life balance. To the best of our knowledge, this study is one of the first to determine potential telecommuters in India based on perceived productivity.

Keywords

COVID-19, Telecommuting behaviour, Telecommuter productivity, Telecommuting, Telework, Work from Home

1. Introduction

During the Covid-19 crisis, teleworking was imposed forcefully by employers to ensure employees' safety and continuity of economic activity (Belzunegui-Eraso and Erro-Garcés, 2020) in different sectors, and in many sectors for the first time. In contrast, before the pandemic, telecommuting was mostly voluntary (Apgar, 1998). Telecommuting activity also gained momentum in the developing countries during this crisis. Different researchers (Beck and Hensher, 2020; Beck, Hensher and Wei, 2020; de Haas, Faber and Hamersma, 2020; Morikawa, 2020; Shamshiripour *et al.*, 2020; Nayak and Pandit, 2021) across the globe have attempted to explore the impact of the pandemic on telecommuting behaviour and telecommuters' productivity. Telecommuting behaviour can be estimated via percentage change in work from home (WFH) intensity (Beck and Hensher, 2020; Beck, Hensher and Wei, 2020; de Haas, Faber and Hamersma, 2020; Morikawa, 2020; Shamshiripour *et al.*, 2020) and relationship between influencing factors and WFH intensity is established through ordinal logistic regression (Morikawa, 2022). Similarly, telecommuter's productivity can be also explored via descriptive statistical analysis and regression models(Morikawa,

2020; Marzban *et al.*, 2021). Researchers have also established relationship between telecommuters' productivity and their mental well-being(Howe and Menges, 2021; Nolan *et al.*, 2021; Russo *et al.*, 2021; Sandoval-Reyes, Idrovo-Carlier and Duque-Oliva, 2021; Williamson, Colley and Foley, 2022).

Initially, the term telecommuters only referred to information workers primarily involved in computer-related work (e.g., data entry or word processors, or programmers) who worked from home (Mokhtarian, 1991). The definitions and classification of telecommuting are based on the variations of telecommuting behaviour particularly in regards to time and place of work and on the variation in duration and frequency of telecommuting (Handy and Mokhtarian, 1995; Varma *et al.*, 1998; Pratt, 2000). Since the 90s, the impact of telecommuting on employees' productivity drew researchers' attention (Hartman, Stoner and Arora, 1992; Cascio, 2000). Though the work characteristics remained almost the same, temporal and spatial attributes related to work activity varied widely. This has led to the analysis of telecommuters' productivity. Telecommuters can be also categorized as full time and partial telecommuters based on their telecommuting behaviour. 'Partial' telecommuters are defined as those individuals who physically visit offices on certain working days and during the rest of the working days, they perform work from home while full time telecommuters work from home only.

Productivity was traditionally defined as the ratio of outputs to inputs (Harris, 1994). Guzzo (1996) described individual-level productivity as the effectiveness with which a worker applies his or her talents and skills to perform work, using available materials, within a specific time (Guzzo, 1996). Few researchers associated this individual productivity with the group and organizational level productivity (Harris, 1994; Anderson and Harris, 1997). With the gradual increase in telecommuting, researchers have analysed the variation in WFH ability across employers' demographic characteristics (Feng and Savani, 2020; Gottlieb *et al.*, 2021), occupations and industry of employment (Dingel and Neiman, 2020; Holgersen, Jia and Svenkerud, 2021). In one of the earlier studies(Hartman, Stoner and Arora, 1991, 1992) based on 97 telecommuters from 11 different organizations, correlation between telecommuting satisfaction and productivity is tested with various factors. The analysis revealed that, performance evaluation system was significantly correlated with both telecommuting productivity and satisfaction. On the other hand, child care issues and most demographic and work characteristics are not significantly correlated with either telecommuting productivity or satisfaction. Technical and emotional support received from the telecommuting supervisor was found to be positively correlated with telecommuting satisfaction while, family disruptions and the ratio of telecommuting hours to total work hours was found to be negatively correlated with telecommuting satisfaction and telecommuting productivity respectively. In another empirical research in Canada covering 300 employees (Khalifa and Etezadi, 1997), responses were collected using a 7-point Likert scale to understand the impact of telecommuting on various factors which revealed that, telecommuting has a positive effect on quality of life, productivity, company's appeal to employees, environment and society but hinders the career development of employers and creates difficulties for employers to manage and control employees' activity. In another research (Hill et al., 1998) based on 157 telecommuters and 89 non-telecommuters working in IBM in US using qualitative analysis, telecommuting was found to positively effect productivity, morale, flexibility, working hours, work-life balance and negatively affect teamwork. Guimaraes and Dallow (1999) attempted to analyse the association between telecommuting success with several factors identified from the literature using a multivariate regression model which showed that implementation problems, employees characteristics, work characteristics, and supervisor characteristics influence telecommuting success. Neufeld & Fang (2005) conducted a two-phase survey where a semi-structured interview helped in identifying factors such as gender, presence of children, social interactions and situational factors such as resource availability and distraction-free work environment to be associated with telecommuter productivity. The second phase survey was designed based on the findings of the first phase. Eventually, 100

telecommuters from two organizations were surveyed and analysed using predictive discriminant analysis which showed that, telecommuters' social interactions with colleagues, managers, and family members strongly influence their beliefs and attitudes, which further impacts telecommuters' productivity. Abdel-Wahab (2007) analysed the telecommuting adoption choice, reasons behind willingness and unwillingness to telecommute, impact of telecommuting on productivity and job satisfaction based on 228 Egyptian information and telecommunication workers using a 5-point Likert scale which revealed that, desired productivity and job satisfaction can be achieved by telecommuting if adequate facilities are available. Gajendran & Harrison (2007) conducted a meta-analysis of 46 studies and concluded that telecommuting have a positive effect on job satisfaction, performance, turnover intent, stress and work-family conflict but results in a decline in relationships among co-workers. In addition to individual and work characteristics, Turetken et al. (2011) analysed the effect of technological characteristics (good network connection) on telecommuters' productivity, performance and satisfaction. Bosua et al. (2013) also concluded that adequate IT support and appropriate management strategies can increase telecommuters' productivity. In regards to studies from developing countries, Ahmed et al. (2014) analysed the impact of various predetermined factors like motivation, job satisfaction, time management, economics, socio-environmental factors and teamwork on telecommuters' productivity in Pakistan using descriptive statistical analysis. Most of the researches discussed earlier are either confined to a particular profession and covered a few influencing factors. Only a few studies employed predictive models which limits the ability of these studies to forecast future scenario and to assess impacts of policy measures adopted for successful implementation of telecommuting. The factors investigated are also sometimes adopted from different geographies which may not be appropriate considering the nature of telecommuting, potential benefits, and implementation problems. Factors also differ with time, ethnic-cultural and socio-economic heterogeneity across geographic areas (Guimaraes and Dallow, 1999). In addition, these researches only proved that desired productivity and job satisfaction can be achieved through telecommuting in the presence of adequate facilities, but the required facilities and connected factors were not explored. In addition, as telecommuters' productivity is a complex phenomenon which varies with time, space and technological advancement, the determination of factors only from literatures might lead to loss of many relevant factors.

With the onset of the pandemic, several studies have explored the impact of the uncertainties associated with the pandemic, stress due to continuous lockdown and employers' initiatives to relief stress on telecommuter's productivity and on employees' future telecommuting adoption decision. Recent studies (Tanpipat, Lim and Deng, 2021; Bao *et al.*, 2022; Mukherjee and Narang, 2022) in developing countries have focued on exploratory analysis of telecommuter's perceived productivity during pandemic for IT sector employees (Bao *et al.*, 2022; Mukherjee and Narang, 2022) and employees from corporate offices (Tanpipat, Lim and Deng, 2021). Other studies from developing countries (Vyas and Butakhieo, 2020; Kumar *et al.*, 2021; Sutarto, Wardaningsih and Putri, 2021; Afrianty, Artatanaya and Burgess, 2022; Chu, Chan and So, 2022) have focused on how various factors like overwork, family distractions, discomfort, lifestyle choices and organizational factors impact the telecommuters' job performance, mental health (stress) and life satisfaction while working from home. None of these researches have explored the variation in telecommuters' productivity with the socio-economic characteristics and the impact of various hindering or encouraging factors on employers' productivity in detail.

Accordingly, a set of research questions have been identified and presented below.

a) How do telecommuters' perceived productivity vary with the socio-economic strata of telecommuters from pre-pandemic to post-pandemic era?

b) How do telecommuters' perceived productivity vary between partial telecommuters and full-time telecommuters from pre-pandemic to post-pandemic era?
c) How do telecommuters' perceived productivity vary with organizational characteristics in India from pre-pandemic to post-pandemic era?
d) What are the factors that impact the productivity of telecommuters?
e) Who are the potential telecommuters in India?

The remaining part of the paper is divided into four sections. The next section discusses the methodology, data collection and study area characteristics. Section three attempts to address the research questions thorough descriptive statistical analysis and predictive models along with their interpretations. The final section includes the conclusion of this paper along with recommendations for future research.

2. Methodology

This research assesses the impacts of the pandemic on telecommuters' productivity. First, we have attempted to identify the hindering and accelering factors for teleocmmuters productivity in the context of a developing country like India directly from primary survey data which will help in framing strategies and policies to make telecommuting sucessful from employers' and employees' perspective. In addition, we have explored the variation of telecommuter productivity with socio-economic characteristics. Finally, predictive models are developed to recognize the future potential telecommuters along with identification of appropriate policy interventions for employers, organizations and city administration towards the creation of a healthy economy for all. Separate assessments are conducted for three phases namely; Phase 1: pre-pandemic, Phase 2: during national lockdown when emergency travels were only allowed and Phase 3: new normal situation when lockdown was terminated with limited travel restrictions and a few confinement zones.

A two-stage online survey (i. during national lockdown and ii. during new normal situation) has been conducted using Google forms (https://forms.gle/4EvAKLsXDbfuHggd9; https://forms.gle/H5WaywBPhVmy3pPT6) via social media platforms like LinkedIn and Facebook for approximately 2 and 3 weeks respectively. The survey was conducted during the months of March and April during both 2021 and 2022. Factors influencing telecommuters' productivity to be included in the survey were determined from open-ended questionnaires during an initial pilot survey. A total of approximately 13500 individuals were reached, which resulted in 235 responses in phase 1 and then 258 responses in phase 2 surveys respectively. After data cleaning, 431 completed responses are accepted among which 213 and 218 responses are accepted from phase 1 and phase 2 surveys respectively. Readers may refer to previous research conducted utilizing the same data set (Nayak and Pandit, 2021) to have a detailed insights on survey methodology, timelines, sample characteristics and questionnaire. Table 1 shows the sample characteristics for data collected from both the phases separately and together. The table shows the socio-economic heterogeneity of the responders in terms of gender, age, marital status, education level, income level, occupation, types and scale of organizational structure. The telecommuters perceived productivity compared to productivity at office has been recorded in terms of percentage.

At first, an exploratory analysis has been performed to understand the variation in telecommuters' perceived productivity across various socio-economic strata and various sectors and scale of organizations during pre and post pandemic period. Next, an ordinal logistic regression model is

developed to test the impact of telecommuting behaviour (working time), individual (gender, age, education status), household (presence of children) and organizational characteristics, employees' participation decisions on other activities, distance to workplace and other influencing factors on telecommuters' perceived productivity.

Table 1. Overview of the sample

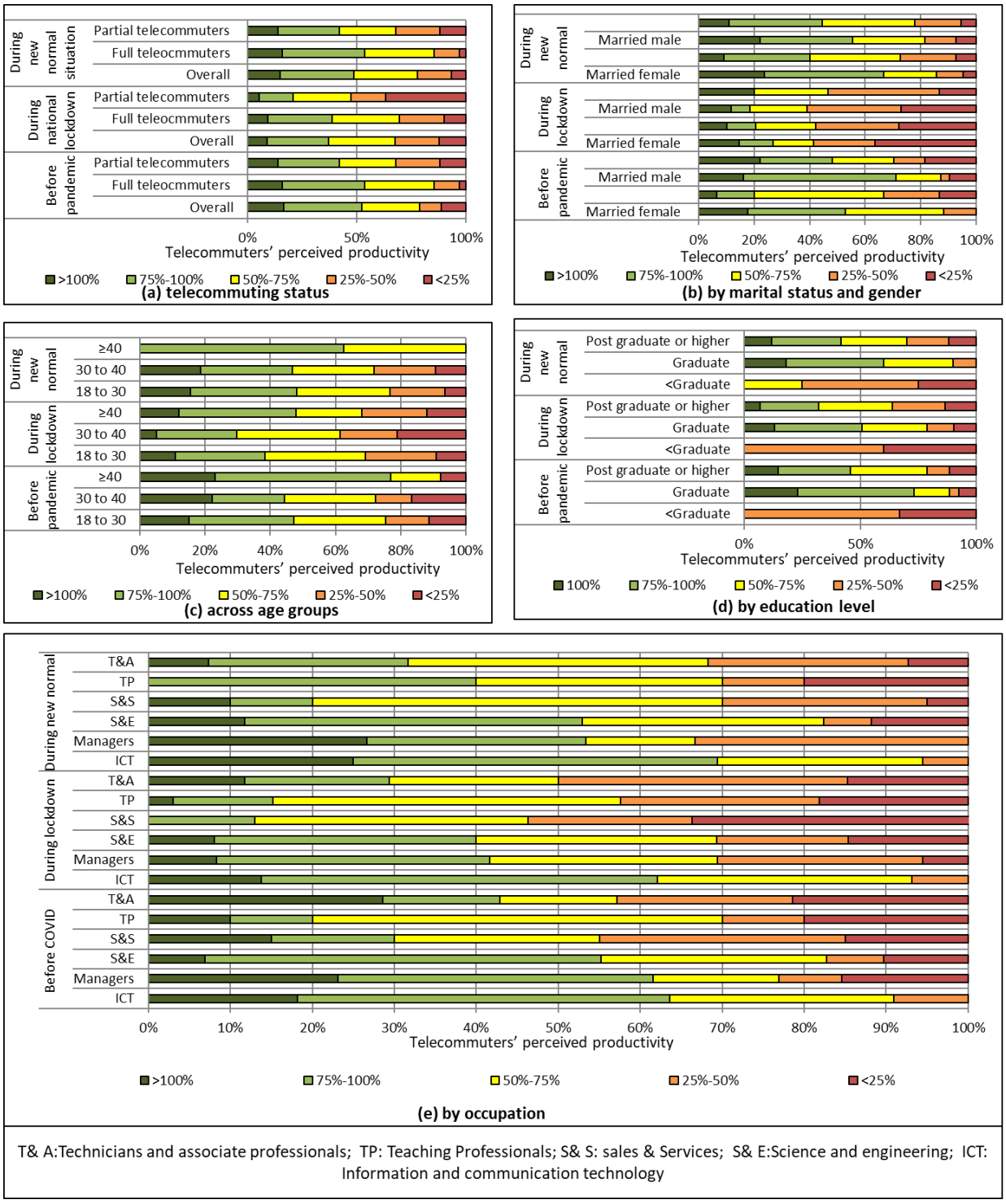
Attributes	Phase I	Phase II	Both phase
Female	40%	32%	34%
Male	60%	68%	66%
Single (marital status)	53%	57%	54%
Married (marital status)	47%	43%	46%
Age	μ = 32.52 (s= 8.52)	μ = 32.73 (s=9.74)	μ = 32.79 (s=9.38)
Household Size	μ =3.55 (s=1.24)	μ =3.48 (s=1.17)	μ = 3.5 (s=1.2)
Number of wage earner at home	μ = 1.76 (s=0.65)	μ = 1.72 (s=0.67)	μ = 1.73 (s=0.66)
Having children	35%	35%	36%
≤Graduation (education level)	2%	9%	5%
Graduation (education level)	28%	42%	38%
≥Post-graduation (education level)	70%	49%	57%
<10k (income level)	6%	12%	9%
10k to 30k (income level)	21%	28%	24%
30k to 50k (income level)	25%	30%	27%
50k to 1 Lakh (income level)	25%	21%	24%
1 Lakh to 1.5 Lakh (income level)	9%	3%	6%
>1.5 Lakh (income level)	14%	6%	10%
Occupation			
Managers	17%	13%	14%
Science and engineering (S&E)	35%	20%	29%
Teaching professionals (TP)	16%	9%	12%
Technicians and associate professionals (T&A)	16%	27%	21%
Information and communication technology (ICT)	14%	19%	17%

Health professionals (HP	1%	5%	3%
Sales and services (S&S)	2%	6%	4%
Types of organizations			
Administrative and support activities (A)	6%	9%	8%
Education (E)	37%	23%	30%
Financial and insurance activities(F)	4%	4%	4%
Information and communication (I)	15%	19%	17%
Manufacturing (M)	5%	2%	3%
Professional, scientific and technical activities (P)	27%	30%	29%
Wholesale and retail trade (W)	2%	4%	3%
Scale of organizations			
Micro	8%	2%	5%
Small	25%	17%	21%
Medium-sized	25%	18%	22%
Large	42%	63%	52%

3. Results and Discussion

3.1. Impact of the pandemic on Telecommuters' productivity

During the lockdown, telecommuters' productivity declined due to lack of proper arrangement of telecommuting facilities (working space at home, access to hardware, software and files, network connectivity), forceful conversion of unwilling employees to telecommute and due to stress and uncertainties associated with the pandemic (Figure 1). Interestingly, during the new normal situation, telecommuters' productivity improved to levels similar to that before the pandemic situation. Similar trends have been found across all socio-economic groups of employees (Figure 1b-e and Figure 2 a-c) and types and sizes of organizations (Figure 3 a-c). Employers' initiatives and encouragement to facilitate telecommuting was found to play a key role in telecommuters' productivity levels (Figure 1a). It is interesting to note that, full time telecommuters were able to achieve higher productivity compared to partial telecommuters (Figure 1a) indicating that more exposure to telework leads to increase in productivity. However, a swift shift from full-time to partial telecommuting (25%) has been observed during new normal situation in earlier research (Nayak and Pandit, 2021).



T& A:Technicians and associate professionals; TP: Teaching Professionals; S& S: sales & Services; S& E:Science and engineering; ICT: Information and communication technology

Figure 1 ***Impact of the pandemic on telecommuting productivity across various groups of employees (Individual characteristics)***

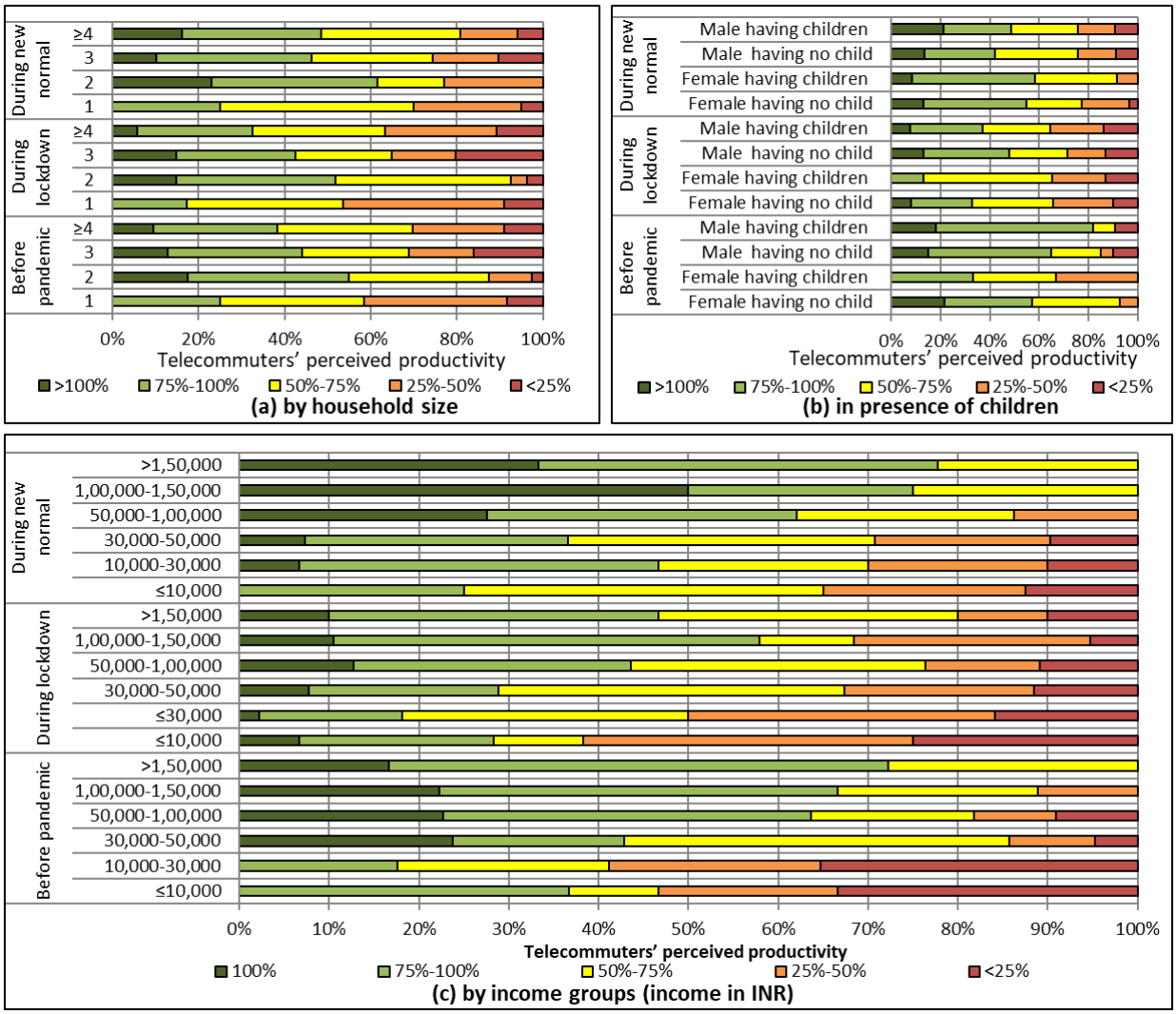


Figure 2 Impact of the pandemic on telecommuting productivity across various groups of employees (Household characteristics)

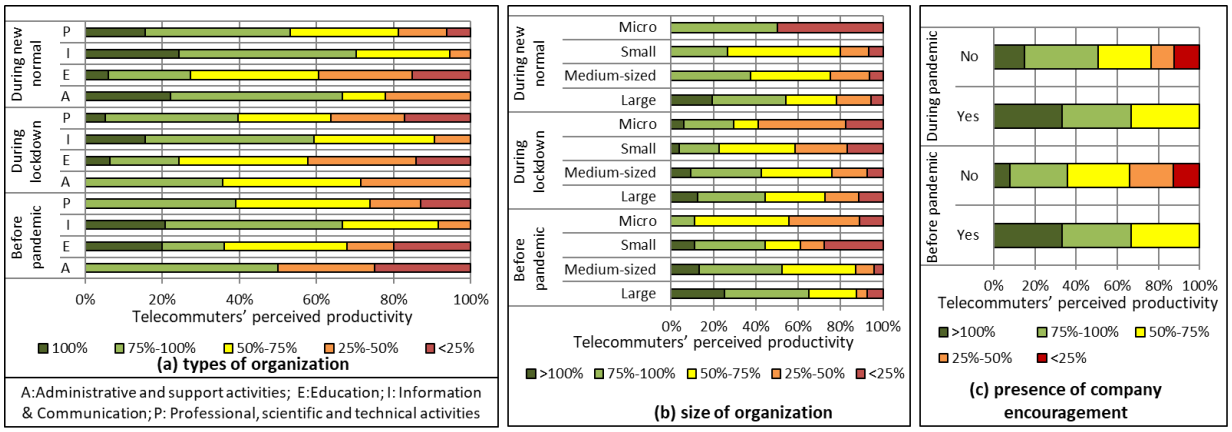


Figure 3 Impact of the pandemic on telecommuting productivity across various organizations

3.2 Factors impacting Telecommuters' productivity

Before COVID-19, 53% and 80% of the telecommuters are found to achieve at least 100% and 75% productivity(perceived) respectively. These values declined to 37% and 67% respectively during the national lockdown and again improved to 49% and 78% respectively during new normal situation (Figure 1a). This change in productivity levels helped in identifying the factors impacting telecommuting. In response to an open-ended questionnaire based preliminary survey, telecommuters were able to identify the challenges faced while telecommuting such as resource constraints, poor network connection, lack of communication with other team members and instructors, distraction by other family members, uncomfortable working environment, involvement in household works, lack of social communication, overwork, poor time management, requirement of mandatory field works, requirement for meeting clients face to face and uncertainties due to pandemic. These factors hindering telecommuting productivity were subsequently used in the first and second stage surveys (Figure 4). Lack of communication with team members and instructors (37%) is the most frequently stated factor followed by resource constraints (36%), involvement in household work (29%) and distraction by other household members (27%). Telecommuters also reported a lack in social communication (21%), poor network connectivity (17%), and the tendency of working overtime (18%) as retarding factors for telecommuting productivity. Few telecommuters also stated poor time management (13%) and poor mental health condition (9%) responsible for their unsatisfactory work performance at home. Though stress due to pandemic (25%) was also found to be responsible for poor productivity, in the post-COVID situation, it is likely to be eliminated.

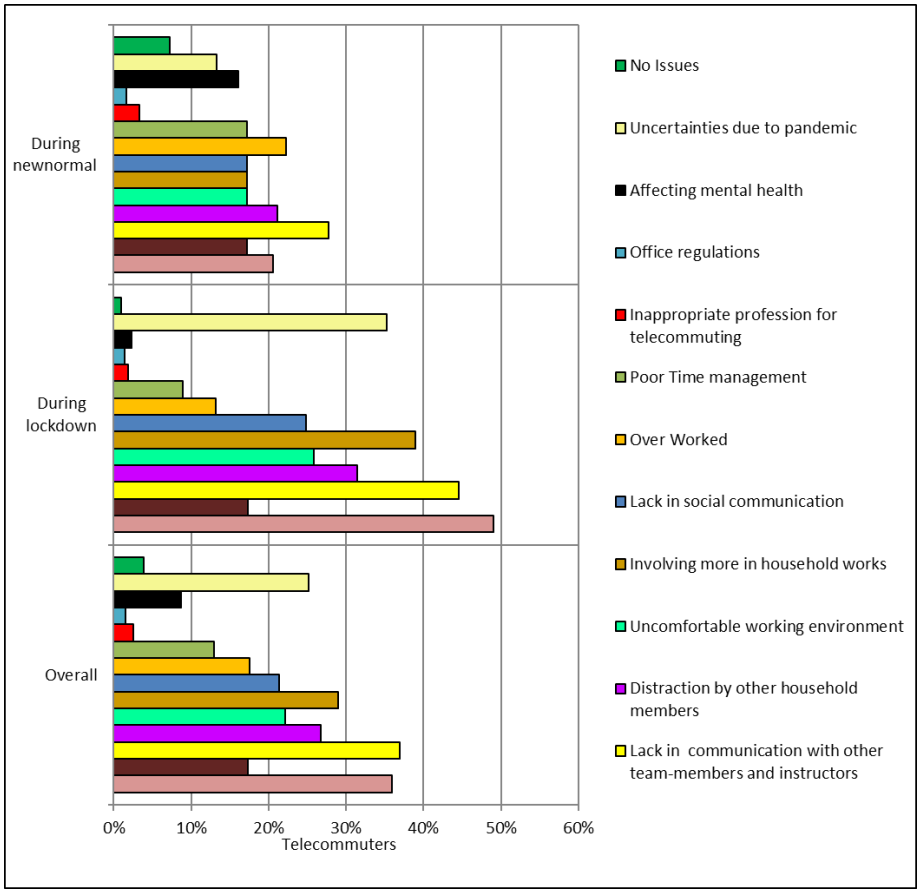


Figure 4 Factors impacting telecommuting productivity

3.3 Potential telecommutes in India

An ordinal logistic regression model (OLR) was developed in order to identify the efficient telecommuters from different socio-economic groups and to identify the important influencing factors affecting telecommuters' productivity. The OLR model has been developed based on 121 samples collected during the second stage survey since travel and other restrictions were minimized during this stage and stress due to continuous lockdown and uncertainties have also subsided. Table 2 shows the model specifications and the variables significant at 95% confidence level. The highest productivity category is used as reference category i.e. the higher value of beta will indicate the chance of achieving more productivity compared to other categories of that variable.

The model indicates (Table 2) that females are more productive compared to male during telecommuting. It is interesting to note that presence of children increases productivity as telecommuting allows flexibility in working time thus allowing efficient household management especially for mothers (Figure 1). Interestingly, age is found to be insignificant in the model whereas, Figure 1 showed that productivity increases with experience. The workers from all the sectors are able to achieve desired productivity except a few such as workers in emergency services like electricity, gas, supply and construction companies. The odds ratio also indicates that telecommuters involved in financial and insurance activities, professional, scientific and technical activities and information and communication sectors are more productive compared to other professions. Telecommuters are able to maintain their productivity better if they follow similar work hours and duration like actual office. It has been observed that workers utilising their saved travel time of work trip to fulfil other needs like shopping and maintenance activities are usually more productive while telecommuting, whereas, involvement in social activities during this time leads to distraction followed by productivity reduction.

The six hindering factors like lack of social interaction, distraction by other HH members, uncomfortable working environment, overwork, poor time management and mental health are found to be significant among the 13 factors identified earlier. Telecommuters have acknowledged several advantages of telecommuting such as ability to fulfil household responsibility and to avoid peak hours. Avoiding peak hours is a significant contributor to telecommuters' productivity. Workers who have to travel longer distance to reach their physical office are found to perform better at home compared to work from office.

Table 2 Logit model explaining telecommuters' productivity

Model Fitting Information	**Model**	**-2 Log Likelihood**	**Chi-square**	**df**	**Sig**	**Pseudo R-Square**	**Cox and Snell**	**Nagelkerke**	**McFadden**
	Intercept Only	357.981	-	-	-		0.815	0.860	0.570
	Final	153.882	204.15	77	0.001	**Goodness-of-Fit**	**Chi-Square**	**df**	**Sig**
Test of Parallel Lines	**Null Hypothesis**	153.832				**Pearson**	295.528	391	1.00
	General	.001	153.832	231	1.000	**Deviance**	153.832	391	1.00

Variables in the Equation	B	S.E.	Wald	df	Sig.	95% C.I. for EXP (B)		Reference category
						Lower	Upper	
<25% Productivity	2.743	5.487	0.250	1	0.617	-8.011	13.497	**>100% Productivity**
25%-50% Productivity	7.711	5.624	1.880	1	0.170	-3.312	18.734	
50%-75% Productivity	11.857	5.686	4.348	1	0.037	0.713	23.002	
75%-100% Productivity	16.593	5.837	8.082	1	0.004	5.153	28.032	
Age of telecommuter	-0.77	0.071	1.176	1	0.278	-0.216	0.062	
Telecommuter is male	-4.007	1.055	14.927	1	.001	-6.146	-2.009	Gender_Female
Married telecommuter has child	3.007	1.205	8.602	1	.003	.998	5.017	Child_absence
Highest education qualification of telecommuter is not a college Graduate	4.399	3.778	1.356	1	0.044	-3.006	11.804	Post Graduate or higher
Highest education qualification of telecommuter is Graduate	2.041	1.113	3.364	1	0.067	-0.140	4.222	
Wholesale and retail trade; repair of motor vehicles and motorcycles	1.443	3.578	0.163	1	0.087	-5.589	8.455	Administrative and support service activities
Professional, scientific and technical activities	5.043	2.156	5.471	1	0.019	0.817	9.268	
Information and communication	5.342	4.171	1.640	1	0.020	-2.832	13.571	
Financial and insurance activities	6.059	3.688	2.710	1	0.001	-28.218	-7.115	
Electricity, gas, steam and air conditioning supply	-17.666	5.383	10.769	1	0.001	-28.218	-7.115	
Education	4.377	2.474	3.130	1	0.077	-0.472	9.226	
Construction	-1.192	4.800	0.062	1	0.804	-10.60	8.216	

						0		
Lack of social interaction while telecommuting	-2.433	1.688	2.126	1	0.045	-5.703	0.837	No
Distraction by other HH members while telecommuting	-2.106	1.391	2.293	1	0.013	-4.831	0.620	No
Uncomfortable working environment at home	-3.969	1.737	5.224	1	0.022	-5.66	7.373	No
Overworked while telecommuting	4.312	1.648	6.841	1	0.009	1.081	7.543	No
Poor time management while telecommuting	-3.154	1.418	4.949	1	0.026	-5.933	-0.375	
Staying at home affecting mental health	-2.719	1.422	3.656	1	0.056	-5.505	0.068	No
Able to fulfil household responsibility while telecommuting	2.689	1.136	5.606	1	0.018	-4.195	3.463	No
Able to avoid peak hours by telecommuting	4.265	1.400	9.276	1	0.002	1.520	7.009	No
Telecommuters able to utilise time by removing work trip for social visits	-3.645	1.544	5.574	1	0.018	-6.671	-0.619	No
Telecommuters able to utilise time by removing work trip for shopping	5.709	2.148	7.066	1	0.008	1.500	9.919	No
Telecommuters able to utilise time by removing work trip for maintenance	1.583	1.250	1.604	1	0.205	-0.867	4.033	No
Telecommuting in early morning	-0.733	0.869	0.711	1	0.399	-2.437	0.971	No
Telecommuting in morning	-2.797	1.316	4.521	1	0.033	-5.376	-0.219	No
Telecommuting in	2.179	1.049	3.965	1	0.046	0.034	4.342	No

afternoon								
Telecommuting in evening	2.621	1.180	4.936	1	0.026	0.309	4.933	No
Telecommuting at night	-0.253	1.266	0.043	1	0.837	-2.657	2.151	No
Telecommuting in late night	-0.442	2.537	0.030	1	0.862	-5.414	4.530	No
Average Home to office travel time <5 Mint	-6.264	3.773	2.757	1	0.047	-13.659	1.130	TT_>60Mint
Average Home to office travel time 5-15Mint	4.870	2.546	3.658	1	0.056	-0.121	9.861	
Average Home to office travel time 15-30Mint	4.115	2.774	2.201	1	0.138	-1.322	9.552	
Average Home to office travel time 30-60Mint	5.344	2.575	4.307	1	0.038	0.297	10.390	

4. Recommendations and conclusion

This research explores the impact of pandemic on telecommuters' productivity across various socio-economic groups and organizations in India. This research has also identified six major hindering factors on telecommuter's productivity based on the local context. Many of these reasons are related to employees' inability to maintain work-life balance which can be resolved through proper training session, working guidelines and weekly engagement in non-work virtual activities by employees. Employer's initiatives such as incentives to work from home, motivational workshop to encourage WFH play a significant role in telecommuters' productivity. Telecommuters' productivity increases with the increase in average work duration and frequency of telecommuting. Thus, female with children and experienced officials can be considered as potential telecommuters considering their ability to achieve productivity with better time management. Employees also appreciate the advantages of avoiding peak hours. Partial telecommuting i.e. visiting office once or twice a week can be encouraged during off-peak hours instead of full telecommuting which also fulfils the need for social communication and to keep track of their work progress as per deadlines. The ordinal logit model also established that, workers are more productive during their usual office hours at home. Hence, employees can be asked to visit office during non-office hours for face-to-face meetings thus also avoiding the peak hours. To the best of our knowledge, this study is one of the first to determine potential telecommuters in India based on perceived productivity.

5. Declarations of interest:

None

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