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Study on Impact of Increased Virtual Meetings and Collaborations on Mental Workload, Sense of Productivity, and Well-being of Employees Working Remotely

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Abstract. Covid-19 pandemic has caused disruptions across different industries hence pushing several companies to shift to either fully remote or hybrid work set-up. This shift in work set-up has increased the number of virtual meetings amongst employees. The purpose of this study is to evaluate the impact of increased virtual meetings and collaborations on mental workload, sense of productivity and well-being of employees through informal online survey, heart rate measurement using wrist-worn wearable device and personal workload assessment using NASA-Task Load Index mobile application. The study also assesses tendency of employees to multitask during virtual meetings and its possible outcomes. This paper also suggests work practice enhancements that companies may consider to help reduce or prevent adverse effects of sustained mental workload and technostress that can affect employee performance and well-being while working remotely.

Keywords: virtual meetings, mental workload, technostress, multitasking, productivity, remote work

1. Introduction

The Covid-19 pandemic has caused disruptions for all industries globally. It has also pushed several companies and organizations to move to remote work set-up either temporarily or permanently. This translates to utilizing virtual meetings for collaborations amongst employees. Use of virtual meetings would have been likely in place for several organizations prior pandemic but the frequency of use is expected to have increased when employees connect remotely for work. The shift in work set-up has also expectedly impacted informal and spontaneous interactions that could be beneficial for teamwork and collaborative discussions [1], [2], [3].

Mental workload (MWL) related to technostress are expected to have increased with increased usage and dependence on virtual meetings and interactions. Mental workload has been described as the relationship between demands placed upon individuals and their capacity to cope with the tasks at hand [4][5][6]. Technostress is described as the amount of stress that an individual feels and manifests when he or she uses a specific type of technology or when in direct or indirect contact with it [2]. Among the noted technostress creators are techno-overload and techno-invasion [2]. Techno-overload are situations where Information and Communication Technology (ICT) forces users to work faster and longer [7], [8]. While Techno-invasion describes the invasive effect of ICT wherein the individuals are subjected to situations that he or she could be reached out to at any time [8]. This may lead for employees to feel the need to be constantly connected blurring the lines between work and personal contexts [8].

Microsoft has initiated intensive research as part of their New Future of Work Project to fully assess the impact of the pandemic on work practices [1]. As part of Microsoft's initiative, Cao et.al also has conducted a study on multitasking behavior during remote meetings [5]. Even prior the pandemic, there have been several

studies on mental workload and technostress among employees and the impact to employees' well-being and performance [6], [7], [8], [9], [10], [11].

Galy has noted that there is no existing tool that can precisely measure mental workload in the field but there are several evaluation methods that have been used such as physiological measures (frontal EEG, heart rate or heart rate variability) and subjective measures (Subjective Workload Assessment Technique and NASA Task Load Index) [4]. This study aims to evaluate the impact of increased meeting and virtual collaborations on employees in terms of mental workload and productivity using informal survey, heart rate variation (HRV) and NASA-Task Load Index (NASA-TLX) assessment. In the absence of more sophisticated equipment, wrist-worn wearable device is used for heart rate measurement while individuals are at rest and while engaged in online meetings [12], [13]. Through this study, recommendations for enhancements for work practices for either fully remote or hybrid set-up are presented for reference [1] [14].

2. Methodology

Mixed methods research was employed in this study. In order to get an assessment on how employees are faring during virtual meetings and collaborations, an online survey with a number of probing questions have been sent out via social media platform wherein respondents shared information on self-assessment on daily number of online meetings, online interactions, productivity and well-being after a work day.

A small group of volunteers was also requested to measure their heart rate via wrist-worn wearable device while at rest and while in online meetings. Heart Rate variation (HRV) has been studied as physiological indicator for mental workload measurement [4] [13]. The same group of volunteers was also requested to download and use the NASA-TLX mobile application to perform a personal assessment on the workload after a virtual meeting with multitasking done in the background.

3. Results

3.1. Online Survey

An online survey created was shared through the author's social media platform. 101 individuals responded to the said survey from 24 Sep 2021 to 08 Oct 2021. The goal of this online survey is to have an informal assessment to determine the effect of increased virtual meetings and collaborations to mental workload, productivity and well-being of employees working remotely.

From the obtained results, large percentage of respondents are from the professional services industry (42%) and are in Individual contributor (42%), Team Lead / Supervisory (32%) and Managerial (19%) roles. 52% of respondents are working remotely and the rest are working in hybrid set-up wherein there are scheduled workdays to report to the company workplace. 77% of respondents are from Asia-Pacific region while 18% are from North American/Latin American region and 5% are from European/Middle eastern region.

The survey results also emphasize the increase in online meetings with 77% of respondents noting that the number of online meetings has significantly increased from previous regular work set-up. 75% responded that they attend 1 to 5 online meetings in a day and majority (77%) shared that average duration of online meetings is one (1) hour. 64% also responded that they multitask during online meetings.

It is interesting to note that 36% of respondents are likely to extend working when working remotely in contrast to 27% that are not likely to extend working beyond work hours.

68% of respondents feel more productive working remotely as they get more things done but interestingly 42% also agree that they experience burnout and exhaustion more while in remote work set-up. In spite of this, 64% prefer working remotely than working in company workplace. Details of the survey questions and tabulated results are shown in following table.

Table 1: Survey Questionnaire

Questionnaire
Q1. What industry do you work in? a. Industrials (Manufacturing, Construction et.al.) b. Energy, Utilities c. Transport, Logistics, Warehousing d. Media, Creative Industries e. Data Infrastructure, Telecom f. Healthcare, Life Sciences g. Education h. Retail / ecommerce i. Real estate, Rental and Leasing j. Hospitality, Food, Leisure Travel k. Public Service, Social Service l. Professional, Scientific and Technical Services (Engineering, Software development, Legal, Business support etc.) m. Financial and Accounting Services n. Others
Q2. Which category best describes your role at work? a. Executive / CEO b. Manager / Department Head c. Team Lead / Supervisor d. Individual Contributor e. Other
Q3. Are you fully working remotely or in hybrid set-up? a. 100% Working remotely b. hybrid set-up
Q4. Which category below includes your age? a. 18-20 b. 21-29 c. 30-39 d. 40-49 e. 50-59 f. 60 or older
Q5. What is your gender? a. Female b. Male c. Non-binary d. Prefer not to say
Q6. Where are you located? a. Asia Pacific b. Europe, Middle East, and Africa c. North America, Latin America
Q7. On an average, how many daily online meetings do you attend? a. 1 to 5 b. 6 to 10 c. 11 and above
Q8. Has the number of your online meetings significantly increased when working remotely? a. Yes, it has significantly increased b. No, it is just the same as before
Q9. What is the average duration of your online meeting? a. 30 mins b. 1 hour c. 2 hours and above
Q10. Do you multi-task while in an online meeting? a. Yes b. No c. Sometimes
Q11. Are you required to have web camera on during virtual meetings and collaborations? a. Yes b. No
Q12. On an average, how many emails do you send in a day for work? a. 1 to 5 b. 6 to 10 c. 11 and above
Q13. On an average, how many work-related instant messages (IM) do you send and respond to? a. 1 to 5 b. 6 to 10 c. 11 and above
Q14. Does your company have an automated micro-break reminder when you are logged on? a. Yes b. No
Q15. How likely you do you extend working when working remotely? (rating scale from 0 for Not at all likely to 10 for Extreme Likely) Responses of 9 to 10 are tabulated as “would likely to extend working.” Responses of 7 to 8 are tabulated as “neutral.” Responses of 0 to 6 are tabulated as “would not likely to extend working."

Q16. How would you rate your sense of productivity and preference between working remotely and working physically at the company workplace? (See TABLE II for Likert Scale)

Table 2: Q16 Likert Scale

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Disagree**
I feel more productive when working remotely as I get more things done.	○	○	○	○	○
I experience burnout and exhaustion more when working remotely.	○	○	○	○	○
I prefer working remotely over working physically at the company workplace	○	○	○	○	○

Table 3: Survey Results (Q1-Q15)

Data	**%**
Industry	
Data Infrastructure, Telecom	5%
Healthcare, Life Sciences	7%
Retail / ecommerce	4%
Energy, Utilities	7%
Engineering	1%
Financial and Accounting Services	4%
Industrials (Manufacturing, Construction, etc.)	13%
Media, Creative Industries	2%
Professional, Scientific and Technical Services (Engineering, Software development, Legal, Business Support etc.)	42%
Public Service, Social Service	3%
Transport, Logistics, Warehousing	1%
Others	12%
Role	
Executive / CEO	1%
Manager / Department Head	19%
Team Lead / Supervisor	32%
Individual Contributor	42%
Other	7%
Work Set-up	
100% working remotely	52%
Hybrid set-up	48%
Age bracket	
21-29	16%
30-39	59%
40-49	20%
50-59	3%
60 or older	2%
Gender	
Female	65%
Male	35%
Location	
Asia Pacific	77%
Europe, Middle East and Africa	5%
North America / Latin America	18%
Number of online meetings	
1-5	75%
6-10	22%
11 and above	3%
Online meetings have significantly increased	
Yes	77%
No	23%
Average duration of online meetings	
30 mins	19%
1 hour	76%
2 hours and above	5%
Multitasking during online meetings	

Yes	64%
No	5%
Sometimes	31%
Required to have web camera on during meetings	
No	86%
Yes	14%
Number of emails sent per day	
1-5	20%
6-10	24%
11 and above	56%
Number of work-related instant messages sent or respond to	
1-5	12%
6-10	19%
11 and above	69%
Has automated micro-break reminder	**%**
No	93%
Yes	7%
Likelihood to extend working	**%**
Would likely extend working	36%
Neutral	38%
Would not likely to extend working	27%

Table 4: Q16 Results

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
I feel more productive when working remotely as I get more things done.	0%	14%	19%	42%	26%
I experience burnout and exhaustion more when working remotely.	7%	17%	35%	32%	10%
I prefer working remotely over working physically at the company workplace	1%	14%	22%	32%	32%

3.2. Heart Rate Measurement

Among the physiological mental workload measures that are commonly used is heart rate variation (HRV) [4]. In absence of more sophisticated equipment, use of wrist-worn wearable device has been used to detect mental workload [13]. A group of five (5) individuals working remotely has been requested to measure their heart rate using their wearable devices while at rest and while in virtual meetings with multitasking performed in the background. The goal of this study is to provide a non-subjective assessment of physiological indicator of mental workload during online meetings by evaluating differences between heart rate at rest and while engaged in meetings. Use of wearable device is also a non-intrusive method as the individuals can easily check their heart rate.

From the obtained results, an average of 25% increase in heart rate is observed while in an online meeting with multitasking in the background.

Tabulated results are shown in follow.

Table 5: Heart Rate Results

	Heart Rate at Rest	**Heart Rate during online meeting**	**% difference**
1	69	90	30%
2	73	92	26%
3	85	98	15%
4	89	103	16%
5	80	109	36%

3.3. NASA-TLX

The same group that was engaged for Heart Rate Measurement study was requested to download NASA-TLX mobile application and to perform a self-assessment on workload after being in an online meeting while performing multiple tasks in the background. NASA Task Load Index has been included in the most-used subjective measures for workload assessment that includes 6 items that cover mental, physical and temporal demand, effort, frustration level and performance [4].

From the results, an average of 66% weighted rating is obtained. It is interesting to note that 4 of 5 of respondents rated mental demand with weight of 4 to 5. Effort is also given a rating of 4 by majority of respondents which could be expected as respondents performed multiple tasks while in online meetings. The following tables summarize the obtained results.

Table 6: Nasa-Tlx RATING

	Mental Demand	Physical Demand	Temporal Demand	Performance	Effort	Frustration
1	75	70	65	20	80	65
2	90	35	80	90	90	65
3	90	45	85	20	90	70
4	75	40	60	10	65	30
5	65	45	60	50	50	40

Table 7: Weight Rating Given to Nasa-Tlx Factors

	Mental Demand	Physical Demand	Temporal Demand	Performance	Effort	Frustration
1	2	3	3	2	4	1
2	4	0	3	5	2	1
3	5	0	3	3	3	1
4	4	1	2	4	4	0
5	4	2	3	2	4	0

Table 8: Overall Weighted Rating

	Overall Weighted rating
1	65.33
2	86.33
3	73.67
4	50.67
5	55.33

4. Discussion and Analysis

The results of the conducted survey and assessments indicate that mental workload has increased with the increased number of online meetings with multitasking done in the background. Virtual meetings are critical communication channels for remote work in the absence of in-person interactions [5]. However, online meetings also provide employees the opportunity to perform other tasks in the background. Survey results support this as 64% of respondents admitted to performing multitasking during online meetings. The majority of respondents (86%) also shared that they are not required to have web cameras on during online meetings. This could be due to different factors such as bandwidth problems and fatigue caused by the need to look presentable [1]. However, without “visual presence” in the online meetings, personnel can perform other tasks in the background such as responding to emails or work-related instant messages among others [5]. This could help improve personnel’s productivity as more tasks can get done as 68% of respondents shared, they feel more productive when working remotely. However, this can also lead to negative outcomes such as loss of attention/engagement and mental fatigue [5]. This is also consistent with the perspective shared by Sweller from his cognitive load theory wherein secondary tasks can impose cognitive overload which leaves little

capacity for other aspects of the primary task at hand [12]. A sustained mental overload could impact a person's performance due to increasing errors with the tasks and a decline in motivation [6]. Results from the survey partly support this as 42% shared to experience more burnout and exhaustion when working remotely.

The heart rate variation results using wrist-worn wearable devices indicate a considerable measure of mental workload experienced during online meetings with multitasking performed in the background. The average 25% increase is emphasized given that the main activity is not physically demanding. This result is complemented by the subjective assessment via NASA TLX wherein the average rating for the workload is at 66% and higher ratings were given to mental load and effort.

Ragu-Nathan, Tarafdar, and Tu also highlighted in their study that ICTs and collaborative software (e.g. virtual meeting platforms and mobile communication tools) could create technostress particularly for their capabilities for "constant connectivity" which could lead employees to extend beyond regular working hours [8]. Employees can be contacted anywhere and anytime and they may often feel the pressure to respond immediately [8]. ICTs have also made it routine for employees to handle different streams of information hence they may feel forced to work faster and longer to cope with the increasing requirements and demands [8]. Microsoft's study for the New Future of Work initiative also points that longer workday may also be partially due to the interweaving of work and life tasks and the elimination of commute to work when working remotely [1]. Time reclaimed from daily commute may have been absorbed by work as the boundary lines between work and life are blurred [10]. Managing and coping with simultaneous streams of information could result to information and communication overload wherein individuals are exposed to more information they can efficiently handle [8]. On the other hand, the urge for employees to stay connected could lead to techno-invasion [8]. These factors may already pre-exist in regular work set-up but may have been further emphasized in remote work. The presence of these technostress factors in the remote set-up is supported by the results from this study as there is a significant percentage of respondents who admitted to likely extend working beyond work hours (36%) and a high percentage of respondents who multitask during online meetings (64%). It is also interesting to note that in spite of the indicators of increased mental workload and high vulnerability to burnout and exhaustion (42%), the majority of respondents (64%) still prefer to work remotely. Some factors that may contribute to this perspective are the increased sense of productivity and the flexibility with the time that remote work setup could offer [1] [10].

This study, however, is subject to several limitations including that only small number (5) of participants were available for heart rate variation (HRV) and NASA-TLX assessment due to scheduling constraints. The researcher relied on the shared results and was not present while these assessments were performed in observance of pandemic quarantine protocols. The wrist-worn wearable devices used by the respondents are not standardized in terms of brand and model and do not have available correlation data. Age, gender, and health factors of respondents that may have affected the heart rate values are also not included in the scope of the HRV study. The background tasks performed by respondents while in virtual meetings were also not quantified, standardized and detailed. Further research on this topic could improve on these limitations by engaging more respondents for the assessments and incorporating factors that could affect the empirical results

5. Conclusion

Through the conducted survey, physiological and subjective mental workload assessments, this study has determined that (1) the increased number of virtual meetings and collaborations contributes significantly to increased mental workload of employees working remotely. There is also an (2) increased sense of productivity and (3) prevalent multitasking behavior during online meetings among the respondents. In addition, the study also determined (4) potential increased presence of technostress sources such as information / communication overload and techno-invasion that can contribute to employee's mental workload and eventual vulnerability to burnout and exhaustion. To help address these negative outcomes, companies could look into work practices that could reduce mental workload and technostress for either remote or hybrid work set-up. Automated micro-break reminders could help prevent screen fatigue amongst employees and may help to encourage them to relax in between tasks or during lengthy virtual meetings [14]. It is also helpful for employees if companies do not impose enabling of web camera during meetings. This

may give opportunity for multitasking behavior however this also eliminates the fatigue felt by employees due to the need to look presentable or to have aesthetically pleasant background while working remotely [1]. Discouraging back-to-back and lengthy virtual meetings could also be beneficial. Sharing guidelines with employees on assessing if virtual meeting is needed could lessen the number of meetings as there are scenarios or agendas that can just be discussed through emails or instant messages. Depending on business requirements and scenarios at work, companies could also encourage employees to unplug after regular work hours to help prevent mental workload from techno-invasion.

To improve this study, future researchers could gather more participants and expand the scope to include factors such as age, gender, health, work and industry and their corresponding effects to quantitative and qualitative results. Statistical methods could also be employed for data processing and analysis to avoid bias. Further study on the effect of deployment of work practices aimed to reduce mental workload and technostress could provide companies more information on which practices are best to adapt moving forward with either remote or hybrid work set-ups [15][16][17].

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