Smart workplace past Covid-19: Perceived challenges and potential smart solutions for university work environment

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Abstract. The COVID-19 has reshaped work environment by introducing a lot of challenges and transitions in the way we work. However, there are still inadequate studies exploring the changes and challenges in the post-pandemic work environment. This study explores the changing dimensions of university work environment on post-pandemic return to campus to identify the key challenges and present implications for smart workplace solutions. A focus group was conducted with university staff and students after return to campus focusing on workplace experience past Covid-19. The findings revealed that the main workplace challenges consisted of three categories: 1) Technological challenges, 2) workspace challenges and 3) non-technical challenges. These results present users' perception and experience with the workplace in post pandemic era. Moreover, implications are presented for smart workplace solutions to overcome the identified challenges in the post-pandemic work environment and design better workplaces from three perspectives.

Keywords: Workplace Challenges, Smart Workplace Solutions, University, Post-Pandemic Work Environment.

1 Introduction

The impacts of COVID-19 have been dramatic on workplaces, business activities and workers across the globe [1, 2]. The pandemic has transformed the work environment by introducing flexible work arrangements with fast adaptation of technology [3]. Many companies took help of digitization to overcome and adapt to the pandemic situation. There is a rapid increase in the use of technology by companies and in everyday life of people which is a proof of digital acceleration process to face the pandemic [2]. The virtual and remote working introduces several challenges such as limited collaboration, reduced trust, lack of role clarity, disrupted communication, and lowered team performance [3]. Moreover, the existing knowledge of remote work need further investigation in the pandemic context [4]. Therefore, there was a global concern regarding work from offices during this pandemic as all spheres of life were affected [5]. Now researchers have already switched their attention to visualizing the work era after the pandemic;

however, there are not enough studies on how the post-pandemic work environment will look [5].

The post-pandemic work era is envisaged to be increasingly technology driven and business models must evolve to adapt the changes in work environment that is expected to be more dynamic and virtual [3]. Nowadays half of the employees around the globe are working remotely at least few days in a week and are not at desk 50-60% of the times [6]. Therefore, the challenges and issues related to post-pandemic workplace in different industries and sectors needs to be addressed to cope with the increasing adoption [3]. Several researchers have investigated COVID-19 and its impact on work and workers in different areas (such as health, IT, business, education) and countries. However, the workplace challenges faced by university staff and students on return to campus after lockdown have not been focused a lot. It is important that workplace challenges in university scenario must be identified to design better workplaces that improve satisfaction and encourage staff and students for better performance.

The workplace in modern day should be fully aligned with the new ways of working and provide employees with digital workplace solutions (DWS) that raise engagement, increase efficiency, reduce cost and improve performance [6]. According to Attaran et al. [6] employees are eager for a smart workplace that can accommodate for changing workstyles. However, the organizations are only beginning to touch on potential applications of smart technologies for workplace and the adoption rate is still very slow. Remes et al. [7] uses the term "smart workplace solution" (SWS) to describe the end user applications related to helping occupants (employees). Their research focused on the user benefit side of smart buildings rather than the operational performance components of building such as energy, indoor conditions and security which had been the focus of research in previous years. This research study also focusses on the smart workplace solutions in the user context.

This study will explore the changing dimensions of the work in university environment on return to campus after Covid-19 pandemic. It identifies the key challenges in post-pandemic work environment focusing on physical, virtual and hybrid meetings/lectures and highlights some of the smart workplace solutions with the potential to overcome these issues. To achieve this, the study aims at answering the following research questions: 1) What are the main post-pandemic workplace challenges after return to campus in university environment? 2) What are the potential smart workplace solutions for the identified challenges?

2 Related Work

This section presents an overview of relevant studies on work environment during and after the pandemic to position our research and identify the gap in literature. To the best of our knowledge, no other studies are published yet that looks at the post-pandemic work environment in universities focusing on staff and students. Moreover, there are only few studies that focus on the changes in work environment after the pandemic.

2.1 Work Environment During the Pandemic

Researchers around the globe have investigated the impact of COVID-19 in different areas (such as health, IT, business, education) and countries. Aburas [8] reflected on the perceptions of work environment in Saudi Arabia during the COVID-19 pandemic. The data was collected using an online questionnaire. The findings showed that the area of most concern was elevator, and the area of least concern was meeting rooms. Moreover, female participants were more concerned about the office environment than male participants [8]. Kniffin et al. [1] reviewed work and organizational psychology research focusing on emergent changes in work practices (e.g., virtual teamwork, work from home) and for workers (e.g., unemployment, stress, social distancing) to understand implications of COVID-19 for work, organizations, and workers and identifying issues for further research. Moreover, moderating factors such as individual differences, demographic characteristics and organizational norms were also examined. Petrie et al. [9] reported on working experience and well-being of Australian paramedics during the pandemic focusing on mental health symptoms and work environment challenges. The survey of frontline healthcare workers showed that mental health symptoms (objectively measured) were common among paramedics and majority paramedics (almost two third) also self-reported experiencing burnout. The key issues highlighted by qualitative analysis included safety and risk in the workplace, lack of crisis preparedness, and upheaval and uncertainty at work and at home. The findings suggested the need for mental health support, adaptive working conditions and enhanced crisis preparedness for future.

Several researchers have focused on how work and workers are affected during the pandemic particularly focusing on remote working or work from home practices enforced during the pandemic. Previous research has highlighted some of the challenges and effects on workers in different areas. Wang et al. [4] explored remote workers' challenges during the pandemic and the characteristics of virtual work and individual differences that affect these challenges. They conducted a mixed-methods investigation using semi-structured interviews with Chinese employees and survey data from 522 employees working from home during the pandemic. Four main remote work challenges were identified from the interview: ineffective communication, loneliness, work-home interference, and procrastination. Moreover, the main virtual work characteristics affecting these challenges included workload, job autonomy, social support and monitoring and the main individual difference factor was self-discipline. The survey results showed that characteristics of virtual work were linked to performance and wellbeing of workers through the experienced challenges. Similarly, Dias et al. [10] explored how work from home and resultant social isolation affected teachers and students and identified the challenges, opportunities and implications for teaching processes during the COVID-19 pandemic period. The results of descriptive analysis showed that working from home and social isolation affected the feelings and sensations of students and teachers and highlighted the words hope, strangeness and frustration. Moreover, majority of the teachers stated that working from home and consequent social isolation affected their work and students' learning. Mangla [3] investigated the effect of cultural intelligence and its dimensions (behavioral, motivational, cognitive,

and metacognitive) on the challenges encountered by the virtual teams by surveying people who were working virtually during the pandemic period. The findings suggested that the behavioral dimension of cultural intelligence predicts the effectiveness of virtual team and address the challenges faced by them.

On the other hand, researchers have also investigated key factors and practices that can be used to manage and improve workforce. Arunprasad et al. [11] examined articles related to remote working to identify key factors to manage a remote workforce. The study proposed a conceptual model focusing on three outcomes (i.e., employee engagement, collaboration, and organizational agility) that can be used to manage remote workforce. The analysis identified five key factors (leadership, technology orientation, external processes, HRM practices, and organizational culture) to achieve these desired outcomes. On the other hand, Adikaram et al. [12] explored the adoption of Human Resource Management (HRM) practices for remote working during the pandemic and how it should continue in future in the Asian context. In-depth semi-structured interviews were conducted with 26 Human Resource Professionals (HRPs) from different industries in SriLanka. The findings highlighted different HRM activities (employee support, performance management and training, setting guidelines, and employee engagement activities) that were implemented to make remote working successful as an involuntary work arrangement during COVID-19 pandemic in Sri Lanka. However, it was found that most companies wanted to revert to on-site work after pandemic, making remote working a transitory work arrangement for crises rather than a permanent arrangement for work in most companies in Sri Lanka. Similarly, Kaushik and Guleria [13] analyzed both positives and negatives aspects of the work from home (WFH) concept focusing on the impact of COVID-19 on employee's working life and role of employers and HR managers to bring forth best practices. The study highlighted important issues such as adoption of a system of skilling, up-skilling, re-skilling and multi-skilling about technology, analytics, design thinking, artificial intelligence, and storytelling for preparing workforce to become more proficient by improving their skill set. Rassudov and Korunets [14] focused on changes in engineering education caused by pandemic. The main challenge is the hardware unavailability at home which makes it difficult to teach future engineers to operate and work with real hardware. This problem can be partially solved by implementing digital twin concept for industrial equipment offering remote learning process and improving the professional training quality as the pandemic ends.

2.2   Changes in post-pandemic work environment

Now a days researchers are interested in post-pandemic working, the changes in work practices that are here to stay and how the future workplace design should look like. However, this topic is still new, and researchers are only beginning to scratch the surface. Babapour et al. [15] identified the challenges in hybrid and remote work and highlighted the opportunities for a future sustainable work environment. Two qualitative studies were conducted with 53 participants including staff managers, employees, and service/facility providers at three Swedish public organizations focusing healthcare and infrastructure administration. The findings revealed that main benefits of remote work

were work-life balance, autonomy, individual performance, and increased flexibility. Whereas the main challenges were related to social aspects such as isolation and lost comradery. Moreover, employers should provide support and flexibility to employees and redesign workplaces to achieve the benefits of hybrid work as it was perceived to provide the best of remote and office work. Similarly, employees must develop competencies and new skills to adjust to new ways of working. In [16], authors investigated the challenges related to workplace faced by nurses who recovered from COVID-19. The qualitative analysis of in-depth semi-structured interviews with fourteen nurses resulted in 4 themes including corona phobia, declined ethical values, gradually leaving the job, infected nurses and forgotten patients. These themes along with 20 sub-themes explain the workplace challenges faced by nurses after their return to work and can be used for laying foundations for policies related to ethical care provision in health organizations for future pandemics. Similarly, Almeida et al. [2], in their study, analyzed the challenges and opportunities of digital transformation of companies in three business areas: marketing and sales, labor and social relations and technology. The digitalization impact is thought to be transversal to each business area and will foster the emergence of new digital services and products grounded on the principle of flexibility. Moreover, new working practices will incite the demand for new talent irrespective of their geographical location. Additionality, privacy and cybersecurity will be critical in supporting the integrated development of IoT, big data, artificial intelligence and robotics. Karl et al. [17] focused on the positive and negatives aspects of using video conferencing for work meetings during the pandemic and also provided guidance for workplace policies for continued use of videoconferencing. The qualitative content analysis identified six main themes out of which 3 were related to camera and microphone issues, 2 were related to eating and meeting management issues and 1 was related to work-from-home issues.

2.3   Smart Workplace Solutions

Recently, the concept of smart office has become popular, and many organizations adopt to smart office concept due to expected user benefits [5]. Traditionality, smart building concept had been focusing on how technology can make a building smart by improving its operations instead of the impact of smart building on human occupants [7]. However, companies are interested in smart building solutions that can facilitate users to maximize their potential [7]. The main goal of smart office is to provide efficient and effective workplace that respond better to user needs and work dynamics [5]. Therefore, it is important to develop smart workplace solutions to help users in addition to focusing on building functions [7].

Some activities that waste most of the time at work include ineffective meetings, searching for information and people, managing email, and re-creating work [6]. Previous research has shown that smart solutions that provide easy access to meeting places and control over the physical workspace can enhance user communication and improve their productivity and satisfaction [5].

Meetings are essential part of work environment in every organization for information exchange, knowledge creation or discuss for important decisions [18, 19]. Meetings rooms are always needed in every organization to conduct various events [20]. However, room booking, and management is a complicated and tedious task specially in large buildings with different types and sizes of rooms and with different equipment, dates, and times availability. Therefore, a smart booking system can make this task easier [21]. Many researchers focused on facilitating meeting activities by providing smart solutions such as scheduling systems for optimal meeting time selection or developing smart meeting rooms with automatic audio–visual recording [19]. Bulla et al. [20] proposed a conference room booking system to allow people to book rooms across multiple departments in different buildings. The booking system provide notifications to users by sending SMS or e-mail and includes remote device management, shared calendar management and unlimited users. Solankar et al. [21] examined various existing solutions and work done by other authors to suggest how meeting scheduling system can be improved to assist users in office environments to reserve rooms and schedule meetings efficiently with a simple android application. Although quite a few solutions have been developed for making meeting rooms smart, the systems that can manage real-time utilization and availability of meeting rooms are still very limited [19]. Tran et al. [19] presented a smart meeting room scheduling and management system based on real- time detection of meeting rooms´ occupancy status. This occupancy information is used to increase room utilization and support ad-hoc meetings by integrating it into scheduling application.

Most of these previous smart meeting systems aimed at making the meeting process (in its viewing and organization) more efficient by analyzing, summarizing, and archiving a meeting [18]. However, the post-pandemic work era has induced new requirements for workplace that needs to facilitate users to switch between physical, online and hybrid meetings as the work environment now a days is a mix of working remotely and from office. Therefore, current smart meeting room solutions need to cater for these additional challenges of post-pandemic work experience [18].

3   Methodology

This study is part of the project "Smart Workspace past Covid-19". The project focused on making the workplace more dynamic and flexible going ahead, providing unique tools to increase workplace experience and optimize office space usage. Therefore, the objective of this research study is to understand the adoption of smart workplace as a solution to post-pandemic work environment. However, for the initial step the focus is to identify the workplace challenges faced by users on return to campus after COVID-19 focusing on university staff and students. This information can provide insights into the changing user needs to cope with new ways of working which can guide the design of future workplace and smart solutions that can be adopted to solve the identified issues for better workplace environment.

To achieve the objective of this study, a focus group was conducted with university staff and students to gather their perceptions of the work environment after post-pandemic return to campus. Post COVID office/campus environment has a mix of physical and online lectures/meetings which introduces new challenges to adapt to the new hybrid environment demanding for a more agile and flexible space. Since staff and students are part of this environment and have to attend lectures/meetings on regular basis so we want to learn from their experience of preparing and arranging for them. The study uses qualitative data from focus group feedback to identify the challenges they have to cope with in post COVID campus environment.

The participants for focus group were contacted through university intranet channel and mailing list. The participants included academic staff, administrative and technical staff, and students. The focus group session was conducted on 22nd November 2021 at Gløshaugen campus, IT-building in Norwegian University of Science and Technology (NTNU), Trondheim, Norway. The session was approximately 1 hours and 30 minutes. The researcher explained the study objective to the participants and obtained their consent for the data collection. It was made clear that their participation is voluntary, and they can at any time withdraw their consent without giving any reason and all their information will then be deleted. No prior preparation or knowledge was required to participate in the focus group, participants just came with their laptops or were provide with one. At the end of the focus group session, a gift card was given to all participants as a token of appreciation to compensate for their time and effort.

The focus group started with the introduction to the project "Smart Workspace past Covid-19" and the objective of this research study. After that participants were asked to fill a short online questionnaire. The questionnaire focused on demographic questions (such as age, gender, position,) and questions related to workplace experience past Covid-19 (frequency of online meetings/lectures, frequency of physical (face-to-face) meetings/lectures, frequency of hybrid meetings/lectures, duration of online and physical meetings, time spent searching/booking and finding meeting rooms). After that the main discussion session started in which the researcher guided the group based on a predetermined set of topics. A tool named "ideaboardz" (https://ideaboardz.com/) was used to write thoughts and collaboratively discuss them. The topics for discussion included challenges related to post-COVID office/campus environment, online meeting/lecture, physical meeting/lecture, switching between a physical and virtual meeting/lecture, hybrid or split lecture/meeting, resources needed to follow the digital meeting/lectures, cancelled/rescheduled/ delayed meetings, other problems/points of friction that exist and suggestions for making workplace better and smarter. However, the discussion was more open, and participants could provide suggestions and open new discussion topics.

The qualitative data from focus group session was analyzed and interpreted using the grounded theory approach presented by Gioia et al. [22], which resulted in data structure for challenges and identified main issues in post-pandemic work environment. Qualitative analysis is important to access the thoughts of participants and develop an understanding of their experiences [23]. Finally, based on findings and feedback from focus group participants some suggestions and smart workplace solutions were presented for designing better and efficient workplaces for future.

4   Results and Discussion

This section presents and discuss the results from the focus group about the post-pandemic workplace challenges after return to campus in university environment. First the descriptive statistics of focus group demographics are presented, then the workplace experience focusing on frequency of meetings, duration of meetings and searching and finding meeting rooms is summarized. After that main categories and themes of workplace challenges faced by staff and students in university campus are identified and lastly implication and smart solutions are presented for post-pandemic workplace design.

4.1   Focus Group Demographics

A total of seven people participated in the focus group. The participants were aged between 25 to 59 years old. Gender distribution was fairly equal with 57.1% female participants and 42.9% male participants. The user group included academic staff (28.6%) including permanent academic staff (14.3%) and temporary academic staff (14.3%); Administrative or technical staff (42.9%) and students (28.6%).

4.2   Workplace experience post Covid-19

This section describes the participants experience of workplace on post-pandemic return to campus. The data was gathered using a questionnaire focusing on frequency of meetings/lectures, during of meetings/ and time spend searching and finding meeting rooms.

Frequency of meetings. *Online meetings*: Participants had different experiences when it comes to number of online meetings/lectures they attend in one month. Administrative or technical staff have comparatively more online meeting than students and academics; ranging from as low as once a week to three times a day. Academic staff mostly have online meeting twice a week, whereas students have online lectures twice or thrice a week. *Physical (face-to-face) meetings*: Participants had similar experiences with the number of physical (face-to-face) meetings/lectures they attend in one month. Administrative or technical staff have comparatively more physical meetings than students and academics, ranging from as low as once a week to 1-2 times a day. Academic staff mostly have physical meeting twice a week, whereas for some students all their lectures were physical after covid restriction were lifted whereas some had twice a week. It is important to note that this focus group was conducted in November 2021 when the Covid-19 restrictions were almost lifted for some period before the infection rate again increased with new omicron varied in December 2021. *Hybrid meetings/lectures*: Hybrid meetings are comparatively slightly less frequent than online and physical for students and administrative or technical staff. For administrative or technical staff its once or twice a week and for students its twice a month or depending on the situation due to COVID. Whereas for academic staff they are comparatively more frequent with two or three meeting in a week being hybrid.

Duration of meetings. The duration of online meetings is slightly shorter than the physical meetings for all user groups. For students, online lectures are between 2-3 hours duration whereas, physical lectures are of 2-4 hours duration. For academic staff

online meetings/lectures are 75-90 minutes whereas, physical meetings/lectures are 75-120 minutes duration. Lastly, for administrative or technical staff online meetings are between 45-60 minutes whereas physical meetings mostly last one hour.

According to focus group participants digital meeting sometimes end early and when they do its mostly 5 to 15 minutes before the schedule. However, digital and hybrid lectures can end as early as 30-60 minutes before.

Searching and finding meeting rooms. According to the focus group participants they spend 5-30 minutes searching and booking for available meeting room. One participant further elaborated that "it is quite easy to find the room in the beginning but at the exam time it is quite difficult to find the room and can take unto 30 minutes". Participants normally spend between 5-20 minutes finding the room location. Moreover, according to the focus group participants they save between 5 to 30 minutes when using technology (such as MazeMap) to find the meeting/lecture room location. Furthermore, the time spent searching for a new meeting room in case of changes (cancellation or rescheduling) in meeting is also between 5 to 30 minutes.

4.3 Main Challenges in Workplace Environment post Covid-19

Qualitative analysis was performed on feedback collected from focus group discussion. The focus group gathered participants' feedback regarding changes/challenges they have to cope with post COVID office/campus environment. The procedure described by [22] was followed for data analysis and presenting the challenges found in the workplace environment past Covid-19. We came up with the data structure with three levels: the first level are the issues highlighted in the raw data (feedback responses from focus group participants), the second level identified the themes for these issues and, the third level distilled these themes into categories of main challenges encountered in workplace environment past Covid-19. The three main categories that merged from data include:1) Technological challenges, 2) Workspace challenges and 3) Non-technical challenges. The themes and issues within each category are presented in **Error! Reference source not found.**.

These three categories characterize challenges in post-pandemic work in university environment. According to qualitative analysis (presented in **Error! Reference source not found.**.), the category "Technological challenges" is based on four themes related to issues linked to technology usage and acceptance in work environment. The themes include meeting equipment usage and availability, technical issues/need for assistance and help, technology acceptance, and software integration. Participants highlighted the need for different equipment such as (multiple screens, IT accessories, camera etc.) and being able to understand and use it quickly. Focus group participants also pointed out they encounter different technical issues with workplace technology such using video conference software, setting up meeting room, internet problems etc. Therefore, there is a need for technical support and assistance. Another issue is that some staff members are not familiar and comfortable with using the new digital meeting solutions such as zoom or teams. Moreover, integration between different systems and tools is also an issue as information (e.g., related to room booking) is not accessible across different systems.

The category "Workspace challenges" is related to workplace density, utilization, configuration, and small meeting spaces. Participants experience issues related to navigating to meeting/lecture room or going from one meeting location to the next. The participants also reported that finding an appropriate meeting room considering participant number and capacity limitation is difficult. Therefore, they end up booking too big room to be on safe side. This issue is more common in hybrid meetings when you are not sure about the number of participants who will attend physical vs online. The staff and students also thought that there should be transparency on space utilization as it will make workplace booking easier. It is particularly important when switching between physical and online meeting or lecture, when you need a nearby quiet space to sit and attend remotely, and when you need to find and rebook a new room quickly because meeting or lecture is cancelled or rescheduled, and attendees are waiting. However, many booked rooms are not used making it difficult to find a room when you need it. Moreover, sometimes there is misunderstanding if the meeting is physical only or there will be online option as well, as most participants now expect the possibility to attend remotely. Practical sessions are difficult to attend online. Lastly, participants highlighted the need for small meeting spaces which are important to attend online/hybrid meetings when you sit in a shared office or when switching from physical to online meetings.

Lastly, the "Non-technical challenges" category includes issues related to mitigating contamination, reminder and notification, privacy, time management and interaction/motivation. Participants experienced issues related to COVID-19 restriction and protocols such as vaccination, sanitization, one-meter distance, wearing mask etc. They pointed out that changing instructions are difficult to understand and there should be clear guidelines regarding new rules. Another issue in post-pandemic work environment is related to confusion between online and physical; sometimes not being notified who will attend in-person and who will attend remotely; and not being able to attend due to symptoms or not being informed in time. Moreover, participants are more concerned about privacy issues when working remotely or attending virtual meetings/lectures. Participants also reported issues related to time management and scheduling specially for classes with several study programs and for finding new time to suit all participants when rescheduling meetings. Lastly, the issue related to participants´ interaction, concentration or motivation becomes even more challenging in online and hybrid meeting/lectures where it is easy to forget digital attendees.

4.4   Recommendations and smart workplace solutions for post-pandemic workplace design

Our study also presents some recommendation for smart solutions based on focus group feedback and literature on smart workplaces. These suggestions can be used as a baseline for designing better workplaces that can carter for the identified challenges. Table 1 presents the workplace challenges and corresponding focus group suggestions and smart workplace solutions.
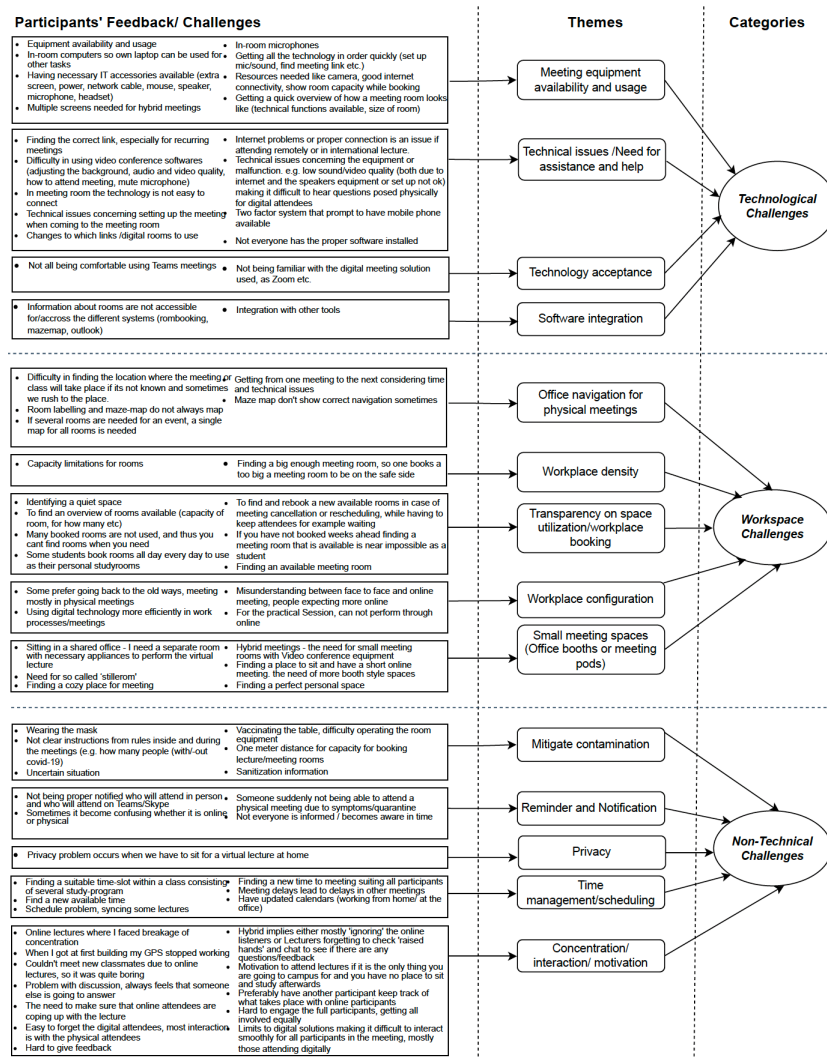
Participants' Feedback/ Challenges

Themes

Categories

Technological Challenges

Meeting equipment availability and usage
- Equipment availability and usage
- In-room computers so own laptop can be used for other tasks
- Having necessary IT accessories available (extra screen, power, network cable, mouse, speaker, microphone, headset)
- Multiple screens needed for hybrid meetings
- In-room microphones
- Getting all the technology in order quickly (set up mic/sound, find meeting link etc.)
- Resources needed like camera, good internet connectivity, show room capacity while booking
- Getting a quick overview of how a meeting room looks like (technical functions available, size of room)

Technical issues /Need for assistance and help
- Finding the correct link, especially for recurring meetings
- Difficulty in using video conference softwares (adjusting the background, audio and video quality, how to attend remotely, mute microphone)
- In meeting room the technology is not easy to connect
- Technical issues concerning setting up the meeting when coming to the meeting room
- Changes to which links /digital rooms to use
- Internet problems or proper connection is an issue if attending remotely or in international lecture.
- Technical issues concerning the equipment or malfunction. e.g. low sound/video quality (both due to internet and the speakers equipment or set up not ok) making it difficult to hear questions posed physically for digital attendees
- Two factor system that prompt to have mobile phone available
- Not everyone has the proper software installed

Technology acceptance
- Not all being comfortable using Teams meetings
- Not being familiar with the digital meeting solution used, as Zoom etc.

Software integration
- Information about rooms are not accessible for/accross the different systems (rombooking, mazemap, outlook)
- Integration with other tools

Workspace Challenges

Office navigation for physical meetings
- Difficulty in finding the location where the meeting or class will take place if its not known and sometimes we rush to the place.
- Room labelling and maze-map do not always map
- If several rooms are needed for an event, a single map for all rooms is needed
- Getting from one meeting to the next considering time and technical issues
- Maze map don't show correct navigation sometimes

Workplace density
- Capacity limitations for rooms
- Finding a big enough meeting room, so one books a too big a meeting room to be on the safe side

Transparency on space utilization/workplace booking
- Identifying a quiet space
- To find an overview of rooms available (capacity of room, for how many etc)
- Many booked rooms are not used, and thus you cant find rooms when you need
- Some students book rooms all day every day to use as their personal studyrooms
- To find and rebook a new available rooms in case of meeting cancellation or rescheduling, while having to keep attendees for example waiting
- If you have not booked weeks ahead finding a meeting room that is available is near impossible as a student
- Finding an available meeting room

Workplace configuration
- Some prefer going back to the old ways, meeting mostly in physical meetings
- Using digital technology more efficiently in work processes/meetings
- Misunderstanding between face to face and online meeting, people expecting more online
- For the practical Session, can not perform through online

Small meeting spaces (Office booths or meeting pods)
- Sitting in a shared office - I need a separate room with necessary appliances to perform the virtual lecture
- Need for so called 'stillerom'
- Finding a cozy place for meeting
- Hybrid meetings - the need for small meeting rooms with Video conference equipment
- Finding a place to sit and have a short online meeting. the need of more booth style spaces
- Finding a perfect personal space

Non-Technical Challenges

Mitigate contamination
- Wearing the mask
- Not clear instructions from rules inside and during the meetings (e.g. how many people (with/-out covid-19)
- Uncertain situation
- Vaccinating the table, difficulty operating the room equipment
- One meter distance for capacity for booking lecture/meeting rooms
- Sanitization information

Reminder and Notification
- Not being proper notified who will attend in person and who will attend on Teams/Skype
- Sometimes it become confusing whether it is online or physical
- Someone suddenly not being able to attend a physical meeting due to symptoms/quarantine
- Not everyone is informed / becomes aware in time

Privacy
- Privacy problem occurs when we have to sit for a virtual lecture at home

Time management/scheduling
- Finding a suitable time-slot within a class consisting of several study-program
- Find a new available time
- Schedule problem, syncing some lectures
- Finding a new time to meeting suiting all participants
- Meeting delays lead to delays in other meetings
- Have updated calendars (working from home/ at the office)

Concentration/ interaction/ motivation
- Online lectures where I faced breakage of concentration
- When I got at first building my GPS stopped working
- Couldn't meet new classmates due to online lectures, so it was quite boring
- Problem with discussion, always feels that someone else is going to answer
- The need to make sure that online attendees are coping up with the lecture
- Easy to forget the digital attendees, most interaction is with the physical attendees
- Hard to give feedback
- Hybrid implies either mostly 'ignoring' the online listeners or Lecturers forgetting to check 'raised hands' and chat to see if there are any questions/feedback
- Motivation to attend lectures if it is the only thing you are going to campus for and you have no place to sit and study afterwards
- Preferably have another participant keep track of what takes place with online participants
- Hard to engage the full participants, getting all involved equally
- Limits to digital solutions making it difficult to interact smoothly for all participants in the meeting, mostly those attending digitally

Fig. 1. Post-pandemic workplace challenges in university environment

5   Conclusion and Future Work

This study investigated the perception of staff and students about their experience regarding work environment on return to university campus after the pandemic. The main objective was to identify the post-pandemic workplace challenges in university environment. A focus group was conducted with university staff (academic and administrative) and students to discussion their experience regarding physical/online/hybrid meetings or lectures, switching between physical and online, and any other open issues related to workplace environment. The qualitative data from focus group was collected

using ideaboardz and questionnaire. The analysis resulted in three main categories of challenges in post-pandemic university work environment: Technological challenges, 2) workspace challenges and 3) non-technical challenges. The identified issues can serve as a foundation for redesigning the post-pandemic workplace and some implications for smart workplace solutions are presented based on focus group participants suggestions and literature. Some of the directions for future work include focusing on different smart solutions for making the workplace more dynamic and flexible and testing different tools for improving workplace experience and optimizing the office space usage. Future studies could also investigate the impact of gender and age differences on adoption of technology in smart workplaces.

Table 1. Proposed suggestions and smart workplace solutions for identified challenges.

Workspace Challenges	Focus Group suggestions	Smart workplace solutions	References
Meeting equipment availability and usage	Show the available rooms first. Have a system where you add the number of participants and tech needs and gives you the available room; short description for using equipment	A search box for spaces, tools & people; room displays, asset tracking and space releasing	[7]
Technical issues /Need for assistance and help	Virtual assistant to help with the setup and issues.	Helpdesk	[6]
Technology acceptance	Giving extra support and training to elderly staff for quick switching to digital systems.	Training to improve technology adoption; AI based training, virtual trainings, Compensation, and benefits structure; Smart training and development; employee support initiative to enhance employees' continuous learning when adopting new technologies.	[24, 25] [26-28]
Software integration	Automatic meeting updates (cancel/reschedule etc.) on all software when using different booking systems.	Synchronized innovation process	[29]
Office navigation for physical meetings	Linking navigation solutions to booking systems for giving the closest room options for multiple back-to-back meetings or when switching between physical and online.	wayfinding and indoor navigation solutions; current location of their colleagues	[7, 30]
Workplace density	If someone is looking for a room and do not find it, whenever it is available, they should get notified. And cancellation should be via sensor; cancel the meeting room at least 1 hour prior to that; There must be a colour code to distinguish vacant from booked rooms, allocated duration for automatic cancellation	Occupancy data analytics; real-time crowdedness and occupancy of workstations	[7, 30]
Transparency on space utilization/workplace booking	Automatic cancellation to free booked spaces that are unused. The computer should ask/notification - is there a booking you wish to delete? Needs to be easy to find booking to be carried out; Sensor-based detection and cancellation	Booking meetings and spaces; finding free spaces; unattendance information; people flow; room Occupancy Detection	[7, 31]

Workplace con-figuration	Flexible options and knowing in advance which options will be available. For example, if someone can join online, or which rooms can be used if need to switch to physical meeting as in exam season will be more crowded so if you don't book in advance, it will be difficult to get a room.	Flexibility of Workplaces, satellite offices, coworking spaces,	[32, 33]
Small meeting spaces	Several small meeting booths available across campus	Portable meeting pods/booths	[34, 35]
Mitigate con-tamination	Screen displaying updated guidelines of sanitisation on the door of each meeting/lecture room: Digital QR Code check-in system	Incident reporting system; smart ventilation	[7, 32]
Reminder and Notification	Automatic notification, not automatic deletion; Notification for confirmation for self-study, group rooms e.g., you are reminded to cancel if you do not need it.	Feeds and alerts	[6]
Concentra-tion/interac-tion/motivation	Involving participants by assigning different roles e.g., in video conference checking chat and facilitating interaction.	Smart human resources analytics: people analytics for smart evaluations and automated performance improvement programs Promotion of gamification Effective communication strategy to interact remotely via various communication channels such as video conference tools, e-mail, instant messaging	[26, 27, 36-38]
Privacy	Using VPN for work from home.	Adaptive and context-aware privacy preservation exploiting user interactions in smart environments; using secure authentication techniques preferably lightweight authentication mechanism such as Three-factor authentication and context-aware services.	[7, 39]
Time manage-ment/scheduling	Everyone should have synchronized and updated calendars; sharing calendar to efficiently decide availability	Smart scheduling systems; calendar sync	[7, 40]

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