3 Analysing production disturbances for aligning work organisation, human resource management, and digital transformation

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Introduction[1]

Workplace innovation is defined as the implementation of combined interventions in the domains of work organisation, human resource management (HRM) and supportive technologies, aimed at simultaneous improvement of organisational performance and quality of working life of employees (Pot, 2011). This definition clarifies that workplace innovation is seen as a set of 'combined interventions', including the implementation of technologies. In current times of digital transformation, in which major technological advances are having a profound impact on economies, businesses, and the personal lives of people throughout the world (Schwab, 2018), the question arises of how to embed these new technologies in an integrated workplace innovation approach. Moreover, the COVID-19 crisis has caused a disruption to business, and entrepreneurs and employees now need to respond to this – new technology is likely to become a major element of their solutions (Javaid et al., 2020). New technology could become a driver for change, but at the same time, it challenges work organisation and HRM to enable the implementation of these new technologies.

Howaldt et al. (2017) argue that workplace innovation should be given a more central place in the process of digitalisation, emphasising the close relation-

[1] This research was supported by grant S006018N – Paradigms 4.0, Research Foundation Flanders (FWO), Belgium.

ship between organisational performance (labour productivity, innovation capabilities) and better jobs (competence development, well-being at work). A growing body of literature (e.g., Müller et al., 2018; Govers & Amelsvoort, 2019) convincingly shows that implementing new digital technologies exceeds purely technical aspects, suggesting that companies willing to exploit the opportunities yielded by these technologies need to invest in a broad implementation strategy that accounts for a fit between technological investments, organisational design, and HRM practices. Nevertheless, research shows that companies often struggle to reach such a broad implementation strategy (e.g., Veile et al., 2019).

In this chapter, we aim to clarify the conceptual relation between work organisation, HRM, and (digital) technologies, and their potential impact on organisational performance and quality of working life, by focusing on the concept of production disturbances from a cybernetics-based perspective (Achterbergh & Vriens, 2009). Examples of production disturbances include not only machine breakdowns and information shortages but also delayed deliveries of materials or unexpected orders. Using this concept, we explore how workplace innovation in the era of digital transformation may take form, and derive topics for future research.

We start this chapter with a brief literature overview showing that the interplay between the division of work, HRM, and technology has received attention in recent literature on the ongoing digital transformation. The next part of the chapter presents a definition of production disturbances and how disturbances can be dealt with. Thirdly, we elaborate on the potential impact of production disturbances on organisational performance and quality of working life. In the fourth part, we describe the division of work, HRM, and technology as infrastructural conditions for preventing and handling production disturbances in times of digital transformation. We then illustrate the importance of a combined approach of the three infrastructural conditions with insights from our recent research on virtual teams (Vereycken & Ramioul, 2019), complemented with a case study on ongoing workplace innovation practices in a machine production company. To conclude this chapter, we argue that focusing on production disturbances could offer a fruitful route for further developing workplace innovation research.

Digital transformation

Recent literature on the ongoing digital transformation has highlighted the interconnection between the division of work, HRM, and digital technology (Smits et al., 2020). Shamim et al. (2016) argue that since the digital transformation creates an unstable environment, the required innovation and change management fits best with a division of work characterised by decentralisation, empowerment, few rules, horizontal communication, and teamwork. Decision-making processes in such organisations are expected to be faster, and both managers and employees would be able to react more flexibly to evolving challenges (Veile et al., 2019). In addition, a complex digital transformation affects all organisational processes, and rigid organisational structures would be less able to implement such profound changes (Fettig et al., 2018). Nevertheless, Wilkesmann and Wilkesmann (2018) found that technologies tend to reinforce the reproduction of routines and have employees filling the gaps in functionally fragmented, hierarchical organisations. On the other hand, in organisations with a more decentralised and multidisciplinary division of work, technologies mainly contribute to innovations. Following the existing organisational structures, path-dependency likely steers the selection, implementation, and use of new technologies (Lall et al., 2016). Conversely, Cagliano et al. (2019) show that enterprises tend to transition from a vertical, centralised organisation to a flat, decentralised organisation when technical complexity increases. Veile et al. (2019) recommend adapting job design to encompass new tasks and responsibilities when working with new technologies to decrease stress risks and promote well-being. Kadir and Broberg (2020) advise on the level of remuneration following task complexity, training opportunities, teamwork, and social support.

Furthermore, the importance of HRM is mentioned in order to change the corporate culture. Veile et al. (2019) emphasise the need for a cultural change in willingness to learn, openness to new things, and the promotion of creativity and an entrepreneurial mindset. Kiel et al. (2017) mention a flexible corporate culture, reflected in leadership style, allocation, training, employee involvement, and industrial relations. A focus on creativity is needed to rapidly learn from failures (Veile et al., 2019). Many new technological applications have a strong potential to create an autonomy-supportive context and may challenge traditional HRM and leadership practices (Hertel et al., 2017). Appropriate digital skills to understand and handle the new technologies are necessary for a digital transformation, which can be met through training or by attracting specialist employees (Veile et al., 2019). Employee involvement is frequently underlined as a precondition for successful implementation (Veile

et al., 2019), affecting perceived well-being and operational performance (Kadir & Broberg, 2020). In terms of COVID-19, Kumar et al. (2020) argue that digitalisation offers the potential to contribute to the improvement of social distancing and social well-being.

In short, multiple studies stress the interconnections between the division of work, HRM, and technology. We will now argue that the concept of production disturbances is key to understanding these interconnections and may provide handles to improve the alignment between the division of work, HRM, and technology.

Production disturbances

Ingemansson (2004) had already noticed many debates on what production disturbances are. These debates are continuing (Bokrantz et al., 2016). Organising production processes in a way that allows them to run smoothly and avoid the risk of disturbances has been a major concern of many management models, for example Lean Thinking (Womack et al., 1990); Quick Response Manufacturing (Suri, 2010); and Sociotechnical System Design (de Sitter et al., 1997). Many of these management models can be understood as variations on the three regulation levels described in Ashby's introduction to cybernetics (Ashby, 1957). In every organisation, transformation processes can be seen which convert specific inputs (including raw materials, labour, and information) into certain outputs (i.e., products and services). For organisational transformation processes to run as intended: (1) goals have to be set for them; (2) infrastructural conditions (in terms of division of work, HRM, and technology) have to be designed to ensure that these processes realise their goals; and (3) these processes have to be monitored to avoid and repair problems. Achterbergh and Vriens (2009) refer to these three levels as 'control', 'design', and 'operational regulation'.

Operational regulation can be understood as a cyclic process. The output is monitored in terms of the set goals. If the gap between the two is problematic, actions are taken to intervene in the transformation process to ensure that the output will reach its goals. A production disturbance is a problematic gap between the current state of the output and the desired state.

Disturbances can either be internal or external to the transformation process. Examples of internal disturbances are machine breakdowns, information shortages, and employee downtime. External disturbances include delayed deliver-

ies of materials, changing legislation, and unexpected customer demands. The COVID-19 pandemic causes a whole range of (external) production disturbances, from supply chain disruptions, reduced workforce capacity, and changing markets to stringent safety regulations (Kumar et al., 2020).

It should be clear that challenges related to production disturbances are not limited to manufacturing industries. For instance, in healthcare, disturbances hinder seamless care delivery (John, 2008); in the public sector, bureaucratic silos are linked to disturbances in administrative processes (Torfing, 2019); in education, the growing complexity of the teacher's mandate is connected to risks of disturbances in the pedagogical process (Woods, Jeffrey et al., 2019). Preventing and handling disturbances remains a continuous challenge in many societal sectors.

Organisational performance and quality of working life

Pot's (2011) definition of workplace innovation stresses workplace innovation's dual aim of improving organisational performance and quality of working life. Production disturbances may have a considerable impact on both.

Concerning organisational performance, today's production systems are required to deliver high productivity, resource efficiency, and flexibility, and these requirements will continue to rise with the realisation of digital manufacturing (Bokrantz et al., 2016). Handling production disturbances is crucial. A production disturbance directly impedes production performance (Ylipää, 2000) and decreasing the number of production disturbances contributes to more reliable production systems (Ingemansson, 2004). Modern production requires disturbance-free operations in chosen equipment and more precise knowledge of when and where to intervene in order to prevent production disturbances (Sandberg & Aarikka-Stenroos, 2014). Based on a literature review, Bokrantz et al. (2014) conclude that disturbances not only decrease productivity, increase product cost and reduce profitability, but also often result in direct safety risks for operators and may even threaten a company's competitiveness. The bottom line is that effective handling of production disturbances is essential to achieve a high level of reliability in production systems (Ingemansson, 2004). And the COVID-19 pandemic has been challenging companies in various sectors of activity, forcing many to adopt new working practices, including teleworking (Almeida et al., 2020).

The possibility of having to deal with (potential) production disturbances is also a key aspect of the quality of working life. Work-related stress is caused by situations at work in which an employee faces problems but is unable to solve them. De Sitter (2000) operationalises experienced stress while performing a task in terms of the capacity to effectively deal with disturbances. Karasek (1979) explains that stress and health risks are determined by the imbalance between job demands and the level of job control, which affects the decision-making power available to the worker facing those demands. In other words, these risks depend on the balance between job demands (implying regulation needs) and operational regulation capacity (or job control). Karasek's model predicts an increased risk of psychological strain and physical illness when job demands outweigh the operational regulation capacity and, conversely, increasing motivation and learning opportunities when higher job demands are in balance with the appropriate operational regulation capacity. The occurrence of unforeseen production disturbances increases job demands, which may entail increased stress and health risks, especially when the available operational regulation capacity is insufficient to cope with the production disturbances.

Infrastructural conditions

Production disturbances can be both a possible source of productivity loss and a potential threat to the quality of working life. Achterbergh and Vriens (2009) state that certain 'conditions' have to be present to realise transformation processes and regulate them operationally. Operational regulation comprises monitoring transformation processes and intervening in them to solve or prevent production disturbances. These conditions are divided into three classes: (1) conditions for the division of work, referring to defining and allocating tasks and responsibilities in an organisational structure; (2) conditions for HRM, referring to recruiting and developing skilful, knowledgeable, and motivated personnel; and (3) conditions on the 'technological means' required for realising transformation processes and regulating them operationally, including machines and digital tools. The interplay of these three types of conditions impacts the probability of disturbances and the ability to handle them.

These three types of conditions match the three domains in which workplace innovation interventions are implemented (Pot, 2011). Optimising these infrastructural conditions should lead to both decreasing the required regulation and increasing the potential for regulation.

Division of work

Coordination requirements emerge from interdependencies between tasks of organisational units (i.e., departments, teams) or employees (Painter et al., 2016). Task interdependencies are the outcome of choices in the division of work, which refers to how work is divided into distinct tasks and how the coordination of these tasks is achieved (Mintzberg, 1979). Task interdependency between organisational units arises when tasks related to one product or order are assigned to separate units, leading to coordination requirements between those units. Within organisational units, task interdependency arises when different tasks are assigned to separate jobs, which again creates coordination requirements. A high degree of task interdependency increases the probability of production disturbances related to coordination challenges and limits the regulation capacity of employees because they have to rely on others to solve disturbances. Conversely, a division of work in which task interdependencies and the related coordination needs are more limited, such as autonomous teams, not only has a reduced probability of (coordination-related) production disturbances but may also show a higher regulation capacity to prevent and solve production disturbances (Vereycken & Ramioul, 2019).

Human resource management

Organisations hire people through employment contracts, which implies interdependencies and mutually expected behaviour. Apart from contractual aspects such as pay, duration, and working times, we highlight four elements with a clear link to process disturbances: allocation, training, leadership, and labour relations (Ingemansson, 2004; Ito et al., 2021)

(1) By allocating 'the right man to the right job at the right time', chances improve that the employee's regulation capacity will enable him to prevent or cope with production disturbances.
(2) Adequately trained personnel will reduce the risk of disturbances and improve the capacity to tackle disturbances.
(3) Leadership styles that encourage employees to conform to established standards of job performance may contribute to the attenuation of disturbances and amplification of regulation capacity.
(4) Employee representation and participation could contribute to the development of procedures that incorporate tacit knowledge on (expected) production disturbances, to increased employee autonomy resulting in augmented regulation capacity, and to arrangements for flexible deployment of employees (Huys et al, 2013).

Technology

Technology can be used to perform certain tasks related to the transformation process, resulting in a division of work between people and technology, thus contributing to the level of task interdependency and the need for coordination. Moreover, the deployment of technology may lead to more or less rigid routines and standardised procedures (Kuipers et al., 2020). In cases where the specific technology implies an exhaustive set of rules, it will likely be more difficult to deal with production disturbances, which are essentially events that deviate from the norm. Standardised procedures or physical restraints (e.g., limited access to information) are mechanisms that limit the employee's operational regulation capacity (Trusson et al., 2018). Finally, the mere possibility of technology deficiencies may evidently cause production disturbances. While upcoming technologies hold the promise to offer the shopfloor employee more autonomy to tackle (risks for) disturbances locally (Rauch et al., 2019), Butollo et al. (2018), in contradiction to this observation, notice a tendency towards greater standardisation and top-down control of work. Similar technologies could be used to increase or decrease local regulation capacity, depending on how they are designed and implemented as an integral part of the infrastructural conditions. For example, based on a systematic literature review on smart glasses at work, Bal et al. (2021) found contrasting results regarding job demands and regulation capacity, depending on whether the technology was deployed in a supportive or directive way. The impact of technology can only be understood when considering the dynamic interactions between people, organisations, and the technologies they use (Majchrzak & Markus, 2012).

Case studies

We illustrate the importance of a combined approach of the three infrastructural conditions with insights from our previous research on virtual teams in private and public companies in Belgium (Vereycken & Ramioul, 2019), complemented with a recent case study about ongoing workplace innovation in a Belgian machine production factory.

Virtual teams

A virtual team is a collection of at least two people working together for a common goal that needs completion through interdependent work, in which at least one of the team members works at a different location or organisation, or at a different time, so that communication and coordination are predom-

inantly based on electronic communication media (Hertel et al., 2005). The increased complexity of coordinating virtual teams as compared to colocated teams (Schaubroeck & Yu, 2017) becomes an even greater challenge when many people are obliged to work from home during a pandemic disruption (Waizenegger et al., 2020).

Vereycken and Ramioul (2019) analysed eight virtual teams in five different companies, mainly focusing on the division of work and (virtual teamwork enabling) technology. Clear differences in the division of work were found between the virtual teams studied. Four teams did not seem to have any specific difficulties absorbing the additional coordination complexity induced by remote collaboration. Task interdependencies within these teams were limited, resulting in high levels of regulation capacity for the team members to organise their work and solve any occurring disturbances. Moreover, the technology used in these teams did not prescribe or restrain team members' actions, but rather supported remote collaboration with communication tools and knowledge-sharing platforms, which the team members were free to use according to their insights.

Conversely, the other four teams kept being confronted with severe coordination challenges, which were likely related to changes in the team's division of work introduced during the implementation process. In two teams, support, preparation, regulation, and production tasks were decoupled and assigned to different jobs. These changes implied an increase in task interdependencies and less autonomy, thus resulting in backlog and delays. In all four teams, team members' regulation capacity decreased and shifted towards the team leader and to the technology. The four teams heavily relied on centralised information systems, such as ticketing systems, that manage information and strictly organise the workflow. Although the technology was expected to secure the team's coordination, Vereycken and Ramioul (2019) observed multiple examples of technical systems obstructing rather than supporting the team's coordination. Technical errors were a frequently observed liability. Multiple examples were found where team members were unable to solve problems due to the inflexibility of the technology. Finally, coordination by technology often interfered with the team leader's coordination efforts. Team leaders had less of an overview of the team's actions, experienced difficulties in remaining on top of things, and faced a general decrease in regulation capacity.

Machine production

This section contains a preliminary description of a case of a machine production company, based on site visits, interviews, and production data

analysis. The case study is part of the Paradigms 4.0 research project (Dessers et al., 2020). In the production department of the company, the number of hierarchical levels was reduced, which created several options for line managers and workers to manage work schedules, hire newcomers, and organise the team. The line managers and workers were supported by a new team of process engineers which only offers support when the line manager indicates production disturbances that cannot be managed locally. A tablet-based technology was developed in-house to allow workers and their line managers to report production disturbances (including faulty work instructions and design errors) directly to the right support worker in the back office. The technology increased the workers' and line managers' regulation capacity to solve production disturbances. By connecting the production department and the back office in real-time all workers could monitor how and when their production disturbances were being solved. Only the worker reporting the production disturbance could decide that the problem was solved.

Moreover, the support department was reorganised mainly into two teams in which engineering, marketing, sales, and warehousing experts worked together on particular projects, with less risk for production disturbances related to coordination issues. As a result, the company saw its lead times reduced, and its delivery reliability and product quality improved. The quality of working life of the employees in the production department improved due to the increased level of regulation capacity, although people in the support department sometimes experienced higher levels of stress due to the expectation to react swiftly to reported production disturbances. The company also revised its way of remuneration (which is an HRM intervention), with a salary partially based on the employee's skill level, which encourages employees to acquire additional skills.

Discussion

The virtual teams and machine production case studies illustrate the importance of a combined approach targeting the three infrastructural conditions. The virtual teams case studies clarify that the implementation of technologies, although meant to improve coordination, can equally hinder a team's functioning because of the additional interdependencies they generate. Vereycken and Ramioul (2019) explain that decreasing coordination requirements is more likely to facilitate remote collaboration. They also found that organisations tend to overestimate the ability of technology to achieve effective coordination. While the virtual teams story illustrates how differences in the division of work and technology implementation relate to the capacity of employees to avoid or solve possible production disturbances, our second case study shows

how a machine production company applied combined interventions in the domains of work organisation, HRM, and supportive technology, with the explicit aim of tackling possible production disturbances and increasing the regulation capacity of its employees and teams. Additional case studies can be found in *The Palgrave Handbook of Workplace Innovation* (McMurray et al., 2021; see, e.g., the 51 cases from the Eurofound study in Oeij, Preenen, and Dhondt's Chapter 11).

A research agenda for workplace innovation

As the case studies show, a focus on production disturbances could be a fruitful route for further developing the research on workplace innovation. Within that route, we suggest the following research topics:

- *Effectiveness of specific workplace innovation approaches with different types of technology*. Meylemans and Ramioul (2020) make a distinction between: (1) measurement technology (for registering and analysing data, mainly for control and optimisation); (2) automation technology (for mechanising or digitising manual tasks); and (3) interaction technology (for enabling interaction among people and between people and machines). The case studies in this chapter focused on interaction technology, which is mainly related to coordination and communication connected to production disturbances. In other settings, disturbances could be primarily related to, for example, technical failures or to skill-related issues. The specific relation between the division of work, HRM, technology, and production disturbances may depend on the type of technology.
- *Options to design technology in support of workplace innovation.* While one of the conclusions of the research on virtual teams was that organisations tend to overestimate the ability of technology to achieve effective coordination, the case study on the machine production company indicates that building a dedicated technology solution as part of a workplace innovation approach actually can connect people across organisational boundaries. Further research may focus on the impact that (implicit) technological design choices have on employees' and teams' regulation capacity, and how technology design could be improved or adapted to provide better options for improving regulation capacity.
- *Quality of working life of everyone involved.* While advocates of workplace innovation tend to consider improving organisational performance and quality of working life as two sides of the same coin, the case study on the machine production company shows that the downside of improving

regulation capacity for some is an increased workload (and thus growing regulation needs) for others. The focus on production disturbances may help to assess the potential impact of workplace innovation practices on all employees involved.

- *Key aspects of the division of work and HRM concerning digital technologies.* Not every aspect is likely to be of equal importance when organisations journey through a digital transformation. For example, specific tacit and codified skills could be of importance for preventing and managing production disturbances. While codified skills are typically related to HRM (i.e., recruiting, training), the opportunity to acquire the necessary tacit skills is more likely to be related to the division of work (and the resulting job autonomy and learning opportunities). Production disturbances offer a concrete point of departure to identify relevant aspects, although it should be clear that to ensure the quality of working life, requirements and constraints other than just a smoothly running transformation process also need to be considered, such as sufficient job control.
- *Implications for workplace innovation during, and in the aftermath of, a pandemic disruption.* The COVID-19 pandemic has caused a whole range of additional production disturbances (Kumar et al., 2020) for which specific workplace innovation practices could be developed and evaluated.

A workplace innovation approach could help companies establish a fit between technological choices, work organisation, and HRM practices, necessary to exploit the opportunities offered by new technologies and to prevent and tackle production disturbances related to digital transformation and pandemic disruption.

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4 Augmented telework with avatar technology: impact on workplace and required actions

Kentaro Watanabe

Promoting well-being in workplaces is a global agenda (ILO, n.d.; United Nations, n.d.). While digital technologies attract more attention as a strong enabler to achieve this goal, a new workstyle to increase employees' well-being is also needed (Howaldt et al., 2017; Oeij et al., 2019). Telework (or telecommuting) has been considered an effective approach to bring flexibility at work and improve work–life balance (Kurland & Bailey, 1999; Allen et al., 2015). Although its actual benefits and drawbacks are not necessarily established (Allen et al., 2015), it has been accepted as a common business practice in several countries (Allen et al., 2015; Milasi et al., 2020). Furthermore, since the pandemic of COVID-19, telework has become an essential approach for continuing business activities and protecting employees from infection risks (ILO, 2020). Some surveys on telework under the pandemic report that the respondents have a strong willingness to continue teleworking beyond the end of the pandemic (Japan Productivity Center, 2020; Moens et al., 2022), which implies that telework could be more widely accepted as a basic workstyle.

Currently, telework is applied to limited types of work such as office work and some professional jobs. One of the reasons is the limitation of available technologies, such as e-mail, shared file storage and video conferencing systems. These technologies can facilitate only limited modes of communication, which hinders telework application to workplaces that require frequent, close human interactions. As a result, workers in such workplaces, including hospitality services, were not able to benefit from teleworking and confronted the higher risk of infection and job loss.

Toward this challenge, Human Augmentation Research Center (National Institute of Advanced Industrial Science and Technology (AIST)) proposed the concept "augmented telework" that brings a telework opportunity to work-

places with frequent human-to-human interactions utilising human augmentation technologies, including virtual reality (VR), multi-modal sensing and interfaces, and an avatar (Watanabe et al., 2020). Avatar technology, an artificial double that is controlled remotely, is a promising technology that enables its users to interact with customers and/or other employees at a remote site. The industrial application of avatar technology is still emerging, but several companies, including start-ups, have already started experimental trials and even actual business operations of avatar technologies. This technology has a significant potential impact on workstyles and customer–employee relationships. It may even change the workplace concept, but the research on avatar technology mainly focuses on technology development and human interactions in experimental settings (Kasahara & Rekimoto, 2014; Tobita, 2017). The impact of augmented telework with avatar technology on workstyle, required skills, and well-being has remained under-studied.

Workplace innovation (WPI) is an effective approach for embedding such a new technology in workplaces considering how augmented telework impacts on these aspects for employees. WPI refers to a non-technological innovation to increase both organisational performance and quality of work (Pot et al., 2017, Oeij et al., 2019). WPI also supports technology adoption by employees (Oeij et al., 2019). Hence, it is important to clarify required actions for WPI to integrate avatar technologies into workplaces effectively.

This chapter introduces a case study on industrial application cases of avatar technologies. I present two cases with different types of avatars and elaborate on the potential impact of avatars on workplaces and required actions for WPI. In the following sections, I first introduce the current state of telework concerning COVID-19 and WPI, and the concept of augmented telework realised by human augmentation technologies. I specifically explain the avatar's features as a means of augmented telework. I then illustrate two industrial cases of avatar applications in workplaces. In the first case, a spin-off start-up company solely operates one application, and in the second, the other application is organised through the collaboration between a start-up company of artificial intelligence (AI) and a robotics industry firm. Finally, I introduce the interview study findings and discuss the implications of augmented telework with avatar technologies, and requirements for WPI.

Telework, augmented telework and avatar technology

Telework before and after COVID-19

Telework has been gradually accepted in response to the diffusion of information technology available at home, such as laptops, PCs, mobile phones, and the internet. According to Fonner and Roloff (2010, p. 336), telework refers to a "work arrangement in which employees perform their regular work at a site other than the ordinary workplace, supported by technological connections." Telework has been expected to bring flexibility and autonomy at work, which promotes job satisfaction and work engagement (Allen et al., 2015). Several studies show its positive impact on employees. For example, workers with a moderate frequency of teleworking reported higher job satisfaction (Golden & Veiga, 2005).

Meanwhile, there are also some negative impacts reported concerning telework. For example, isolation from colleagues and work intensification through teleworking are considered common challenges of telework (Kelliher & Anderson, 2010; Allen et al., 2015). In addition, the spatial–temporal boundary between workplace and home becomes blurred when teleworking at home. Work–family conflict, a conflict between roles as a worker and as a family member, is another challenge of teleworking in such a situation (Ashforth et al., 2000; Clark, 2000). This role conflict causes difficulty in adapting oneself to the change of role from work to family, and vice versa. Despite these difficulties, telework has already been accepted as a common workstyle in several countries, such as the US and Northern European countries (Allen et al., 2015; Milasi et al., 2020).

When COVID-19 became a pandemic, the acute shift to telework occurred globally (ILO, 2020). Telework has been considered an effective means to keep business continuity during a large-scale disaster (Heng et al., 2012) and has been adopted by many companies and organisations responding to the pandemic (ILO, 2020). Furthermore, several surveys show that many workers experiencing telework would like to continue teleworking (Japan Productivity Center, 2020; Moens et al., 2022), which implies that the global shift to telework would continue even after the pandemic ceases. Meanwhile, the telework-related problems reported in the existing studies have become more evident as the teleworking population grows (ILO, 2020). To overcome these challenges, organisational support with employee participation is considered effective (Allen et al., 2015), as is also emphasised in the literature on WPI (Dhondt et al., 2017).

Human augmentation and augmented telework

Telework has been mainly applied to office work and limited types of professional work such as information system development and financial services (Bailey & Kurland, 2002). Other types of workers doing work which requires frequent physical encounters and interactions, such as hospitality service workers, cannot benefit from telework by means of conventional information and communications technology (ICT) (Milasi et al., 2020; Japan Productivity Center, 2020). Accordingly, they confronted a higher risk of infection, and job loss caused by business contraction or termination. Although vaccination against COVID-19 started at the end of 2020, some professionals estimated that it would still require a longer period to overcome the severe impact of this pandemic (Scudellari, 2020; Charumilind et al., 2021).

Meanwhile, the recent advancement of digital technology is broadening the application targets of telework. The existing research shows a growing expectation toward human augmentation technology which applies to frontline employees at workplaces in service industries (Larivière et al., 2017; De Keyser et al., 2019; Garry & Harwood, 2019). According to Gartner Glossary, human augmentation refers to "creating cognitive and physical improvements as an integral part of the human body" (Gartner, n.d.). Some human augmentation technologies are applicable to realise human-to-human interactions at a remote site. Human Augmentation Research Center, AIST, suggested a concept of "augmented telework" to apply human augmentation technologies to employees at workplaces that require human-to-human interactions, such as in retail, restaurant and event operation (Watanabe et al., 2020), as shown in Table 4.1. In this chapter, I specifically focus on avatar technologies' potential impact and application.

Avatar technology and its application

Avatar originally refers to "a god who appears on earth as a person" in Hinduism (Cambridge University Press, n.d.). Currently, this term often means a person represented in a virtual environment which can be controlled by that person. While an avatar is commonly used in computer games and virtual communities such as Second Life, Avatar is more familiar in Japan as a virtual character on the online video-sharing platforms, often called Virtual YouTuber (or VTuber), to communicate with an audience (Nagata, 2018). In addition, virtual avatars are also utilised for concierge and hospitality services (Choi et al., 2020).

Table 4.1 Current telework and augmented telework

	Current	Augmented telework
Major tasks	Desk work (documentation, etc.), business meetings	Tasks involving dialogues, gestures and sharing space with others
Characteristics	• External access to intranet systems • Verbal/video communication	• Estimation of physical and mental status by multiple sources • Utilisation of remote devices • Shared experience in virtual environments
Major technologies	• Video conference system • E-mail • Online storage • Business management system	• Multi-modal interface • Virtual reality • Avatar technology
Major industries	Headquarters function, software development, information service	+ hospitality, fitness, education (requires skill practices), entertainment, tourism

Source: Adapted from Watanabe et al. (2020, p. 7).

The other type of avatar is the avatar robot. While robots moving autonomously attract more attention as new 'co-workers' at the workplace (Van Doorn et al., 2016), the avatar robot is gradually gaining interest as a means to interact with people or things physically and remotely. One typical example of an avatar robot application, which illustrates its social benefit, is a café service operated by physically impaired people. In this experimental café service, those who cannot leave their beds operate avatar robots remotely to serve customers as café staff (BBC, 2018). This type of service demonstrates the potential of avatar robots to open up opportunities for people who cannot work for various reasons. The avatar robot concept is expected to become more common after the pandemic because this technology is effective for remote, physical interactions with others.

Based on the case study, this chapter illustrates how avatar technologies could contribute to workplaces. Furthermore, for better adoption of avatar technologies for decent work, concrete WPI actions are also explored.

Table 4.2 Case description

	Case 1	Case 2
Company	Avatarin: a spin-off company of avatar technology	Company B: an AI start-up Company C: a robot technology company
Technology	Movable communication avatar robot	Virtual avatar and humanoid with AI/human control
Representative application case	Avatar bookstore	Fever monitoring service
Application targets	Department store, bookstore, museum, aquarium, local shopping avenue	Front desk, office security
Number of interviewees	3	1 (from Company B) 3 (from Company C)

Case study

I conducted a semi-structured group interview about two application cases in Japan in 2020. Unfortunately, industrial cases of avatar technologies were still few. The cases in this study, therefore, were selected in an opportunistic manner. However, their technologies and applications are different, which is meaningful in order to have a broader view of avatar technologies' impact on workplaces.

The interviewees held senior or middle management positions in the companies, which develop and implement avatars. Table 4.2 shows the case description and the number of interviewees. The interview periods were approximately 90 minutes each. The main questions in the interview include technological features, application targets, change in work and the workplace, and challenges in implementation. The interview notes as the main data source were transcribed on a PC and thematically analysed. In addition to the interview result, the website, documents and videos accessible on the internet were supplementally used to understand the cases better.

The brief introduction to the two cases is as follows.

Case 1: Avatarin Inc.

Avatarin is a spin-off start-up company from a large airline company. Avatarin has developed a movable communication avatar robot. This avatar robot has a monitor, camera, microphone and speaker on the pole and base, and moves freely on the floor. It is remotely controlled from the web interface through its own cloud platform.

The developed avatar robot has already been commercialised and applied to various service workplaces, such as a department store, a bookstore, a museum, an aquarium and a local shopping avenue. It is also implemented at a private residence. The main usage of the robot at service workplaces is that a customer controls the robot, which is set in the workplace and interacts with the staff and environment. In the application case of a bookstore (hereafter, avatar bookstore), a customer logged in to an avatar robot placed at a bookstore, and a book concierge served the customer through the avatar. Avatarin aims to make its avatar robots 'infrastructure' of society, where avatar robots are available to access stores and services without physically visiting.

Case 2: company B and company C

Company B is an AI start-up company. Its strength lies in natural language processing such as speech dialogue and chatbot technologies. These technologies are applied to, for example, a virtual front desk service. A unique business activity of company B is that it holds a branch in a local city providing remote operator services. It switches the control of its front desk service from AI to a human operator when AI does not sufficiently respond to users adequately. The switch of AI–human operations realises both efficiency and accuracy in serving customers. Also, human operations, after the switch of control, can be used as data for AI.

Company B also collaborated with company C, a robot technology company, and developed an avatar robot for monitoring office workers with fever in order to avoid spreading infection at the office (hereafter, fever monitoring robot or fever monitoring service). A humanoid robot developed by company C was used to check workers' temperature and block any person with a fever. When an automatic operation did not properly work, a human operator interacted with the person through the humanoid.

Findings

Through the interviews, the following findings were obtained.

Distributed locations, concentrated interactions

In both cases, avatars need a physical space to interact with customers (or employees) while employees (or customers) operated them from distributed places. For example, the staff of the avatar bookstore are located in the specific workplace (existing bookstore) and meet and serve customers located remotely through installed robots. In the fever monitoring service, a person with a fever is automatically detected, and teleoperators control the robot and communicate with her/him remotely. Subsequently, the interviewees concluded that the risk to staff and cost for sanitisation were reduced. On the contrary, customer touchpoints are concentrated at the office entrance where the monitoring service is provided. A physical location where avatars are installed tends to have more direct touchpoints and interactions, which would be a characteristic of avatar-mediated services. This is significant for the application cases of avatar robots because they require substantial investment.

Novel interaction with customers

According to the interview result, a physically embodied avatar robot shows the 'presence' of a person behind it, and people in front of an avatar accept it as an agent. One interviewee in case 1 introduced a scene where a person passing by nodded at an avatar robot in a mixed environment of humans and avatars. Another interesting behavioural change the interviewee mentioned is that people in front of an avatar tend to naturally communicate with hand gestures to lead or call avatars. Moreover, the physical features of avatar robots enable different types of interactions that do not occur in ordinary human-to-human interactions. For example, the interviewee in case 1 described an interesting story in the avatar bookstore. At the store's closing time, a book concierge carried the customer-operated avatar to the concierge's recommended book. The situation where an employee carries a customer in a bookstore does not usually happen in ordinary customer-employee interactions.

The interviewee also stated from her/his experience that the communication through an avatar tends to be longer than ordinary human-to-human communications. The interviewee gave a speculative reason that avatar-mediated communication might cut off disturbing information and let the users focus

on communication. In the case of the avatar bookstore, a concierge can spend more time with a customer, increasing the value of her/his knowledge of books.

Beyond manual operation and control

The avatar enables an employee to serve customers who are not physically co-located, as shown in the avatar bookstore. This is an innovative shift for hospitality services to overcome the spatial–temporal barrier. However, an avatar basically requires a constant human operation, which means that a human operator needs to continually focus on controlling an avatar. Concerning this point, the interviewee from company C indicated that the combination of AI and human control is essential for avatar operation. In the case of the fever monitoring service, the procedure for temperature measurement is automatically conducted. It is only when a person with a fever appears that a human operator takes control and interacts with her/him. The same approach was taken in company B's virtual front desk service. As previously mentioned, the data from human operation can be used to improve AI. The human roles here are (1) to take care of irregular situations which AI cannot handle, and (2) to enhance the capability of AI.

Discussion

Impact on workplace and required WPI approaches

These case studies are still preliminary but imply a substantial impact on workplaces. This section discusses the impact of avatars and required WPI approaches from the following three aspects: workstyle, skill development, and well-being.

Workstyle

One of the most important benefits of an avatar, especially during the COVID-19 pandemic, is remote interaction with customers. This is especially meaningful for activities with a high risk of infection, such as fever monitoring. It is meant to separate customers physically from employees because the risk of infection from customers is less predictable and controllable than among employees in the same organisation.

Meanwhile, the physical interaction with customers has been considered an essential value source in hospitality services (Solnet et al., 2019). This

is not easily replaceable, and the concept of augmented telework does not intend to replace every human-to-human interaction (Watanabe et al., 2020). Nevertheless, remote interaction through an avatar could enable new types of services. Knowledge-based, one-to-one and/or high-added-value services could be more effective and productive by accessing customers at various locations. AI could also increase productivity by learning from human operations and taking routine procedures away from the human role. This role shift between human and AI in avatar applications will be discussed in the following sections.

Utilising avatars in the pandemic situation, a more distributed workstyle, in which ultimately every employee and customer remotely interacts with one another, would be safer with regard to the infection risk. This approach is more feasible when the avatar is virtual and accessible from displays of PCs and smartphones. Still, when it comes to avatar robots, they have to be implemented in an environment where interactions occur. Physical interactions and environment have more substantial meaning for the work through avatar robots. Therefore, a holistic approach to designing avatar robots, work processes and a workplace as a whole is needed for augmented teleworking (Oeij et al., 2019; Watanabe et al., 2021).

The other important implication of the fever monitoring service is teleworking from the rural area to fulfil the needs in the urban area. Even if people leave cities under the pandemic, various demands for interactive services will remain. The case implies that augmented teleworkers living in rural areas might fulfil these needs. An important point is how to create meaningful work for local workers. Job design to make their work more interactive and to let them grow their skills will be important.

Skill development

The case of the avatar bookstore implies that interaction through an avatar is fundamentally different from face-to-face interaction. Carrying an avatar to a place may be an exceptional case, but employee-customer cooperative behaviours through avatars could generate new types of experiences at workplaces. For example, Kasahara & Rekimoto (2014) propose a mechanism to co-experience what the remote person feels through the device attached to the person. Avatar-mediated hospitality would require a different type of skill set, which will be a new issue for the skill development of augmented teleworkers. The interviewee mentioned the employee's 'natural' behaviour toward avatars, such as hand gestures. This is very interesting, but when avatar-mediated

services become more common, gestures of hospitality will also be refined, and a new "best practice" will be developed.

The process of skill development for avatar-mediated services will be a co-creative one with customers, and such experiences will also be mutually learned among stakeholders. For better utilisation of new technologies with a non-technological approach, as WPI emphasises (Pot et al., 2017; Oeij et al., 2019), it is important to create opportunities for mutual learning among employees. For example, formal or informal meetings to share workplace experiences will effectively facilitate mutual learning (Hvid & Scheller, 2017). In addition, bricolage at work will be a good source to figure out excellent service practices (Saari et al., 2015), and this learning should be shared among employees for improving work practices. Japanese companies are traditionally keen on improvement activities at workplaces, and these activities are applicable for better technology adoption (Watanabe et al., 2021).

Well-being

Working through an avatar is effective for workplace well-being from the aspect of infection risks. Moreover, avatar technology broadens the options to participate in work, including working from home and allowing physically impaired people to participate (BBC, 2018). Meanwhile, the existing literature on telework also revealed its negative consequence to teleworkers' well-being (Ashforth et al., 2000; Kelliher & Anderson, 2010). Although the case study in this chapter does not show such negative consequences, some negative impact, such as feeling isolated from coworkers, could occur when avatar-mediated work has become a regular work practice, depending on the type of workplace. Toward this challenge, the existing approaches to avoid negative impacts of telework, such as sufficient support by supervisors, will be beneficial (Allen et al., 2015). To avoid accidents such as a collision between an avatar robot and an employee or a customer, risk management also needs to be considered.

Co-evolution between human and technology: starting from manual control

A recent discussion on a desirable relationship with AI indicates the possibility of 'co-evolution' between human and technology (Döppner et al., 2019). After the shock of AlphaGo and other types of AI for board games, professional board game players have started to learn from AI and are developing new strategies which have not been explored beyond human heuristics (Kobayashi, 2017). Even in a business setting, case 2 shows how the roles of human and AI can be reorganised through a continuous operation. While urban experi-

ments of autonomous, intelligent technologies are prevailing (Macrorie et al., 2021), it could be an effective strategy to autonomise social robots based on the analysis of human operation for human-centric technology development which fits to local needs. To promote such approaches, it is important to take workplace-centred thinking to highlight human values such as work engagement and well-being and to make digital technologies more supportive of human activities.

Conclusion

This chapter provides a preliminary observation of avatar technology's impact on workplaces from Japan's experimental industrial cases. Avatar-mediated services demonstrated by the case companies have already realised novel experiences for customers with less infection risk by shifting from face-to-face to remote interactions. Accordingly, employees working with avatar technology can increase their well-being, especially under the influence of COVID-19 and other types of infections, but they also need to explore a new style of hospitality and the associated skill sets. Co-creation with customers will be a key to success in avatar-mediated services. In addition, sufficient supports are needed to adopt new technologies at workplaces, such as nurturing an innovative environment to share experiences, knowledge and ideas among employees, and adequate job design.

The case studies in this chapter also imply the importance of co-evolution of an avatar, as an emerging technology, and employees. Augmented telework using avatars should be designed, responding to fundamental questions such as what meaningful work for augmented teleworkers is and how the divisions of roles between human and technology should be determined. Autonomisation of avatar technologies starting from understanding human operation will be a constructive approach to answer these questions, and meaningful for the current trend in technology development such as AI and robotics.

This chapter is limited to the potential impact of avatars on workplaces and further research is needed on this topic. Furthermore, the argument in this chapter is based on a limited number of group interviews only with avatar developers. A more profound study of industrial cases, including various stakeholders, should be conducted. The business cases of avatar applications are still few but are growing in response to the needs for telework in human-to-human services and other industries. I hope this study brings further discussion from the aspect of WPI for better utilisation of avatar technologies in workplaces.

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