Transforming work in the Digital Economy:
The impact of digital technologies on work innovation and worker engagement

KNOWLEDGE SYNTHESIS GRANT

FINAL REPORT

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August 15, 2021

EXECUTIVE SUMMARY

Background

Digital technologies have profoundly transformed how we function in society and organizations, impacting people's work and work life. They are changing organizations' spatial and temporal geography, allowing people to work from anywhere, at any time, for anyone. Although digital technologies have many positive impacts on work, they present several challenges and issues for individuals and organizations. Digital technologies will play an even more important role in individuals' daily work and organizational life in the future.

Objectives

In this report, we synthesize research focusing on the impact of digital technologies on work and worker engagement. We sought to understand: (1) how digital technologies are transforming the nature of work; (2) how digital technologies are transforming workplace practices; (3) the effect of digital technologies on social networks and relationships in the workplace; (4) how and to what extent these new work arrangements affect employee engagement and the meaningfulness individuals find in the work they do; (5) the implications of digital technologies for the future of work.

Findings

Five themes emerged in our research:

Digital technology platforms and the changing nature of work. Digital platforms, profoundly, are changing how people work, what they do for work, where they work, when they work, and for whom they work. The platforms allow producers and consumers to exchange resources and transactions through two predominant types of digital labour platforms: (1) crowd work systems for matching workers and employers and (2) work-on-demand systems that allow for the online management of traditional tasks and jobs. Platforms allow workers to be self-employed and to have greater time management autonomy enabling them to transact work arrangements and payments for work performed across time, space, and location. Digital platforms employ complex and invisible algorithms to manage and control work supply and demand dynamics and monitor and evaluate work performance.

Digital technological affordances and the transformation of workplace practices. Digital technologies shape three major work processes: (1) organizing work and hiring workers, (2) communication and collaboration within and across organizations, and (3) performing knowledge work. Digital labour platforms play roles as intermediaries and marketplaces, extending the boundaries for global competitive access to skilled labour. Digital technologies afford more accessible and flexible online communication and collaboration opportunities, facilitating timely access and greater exposure to creative and innovative thoughts and ideas. In addition, they are embedded in knowledge work practices and support the knowledge worker's need for autonomy, mobility, flexibility, and control of ambiguity and complexity. They are instrumental in shifting workplace culture and can help improve power relationships and working conditions.

Effects of digital technologies on social networks and relationships at work. There is no consistent conclusion regarding the impact of digitalization on the social structure at work. While some researchers find that digital technologies positively impact social relationships and networks and enhance employees' power in workplace social structure, other research finds that digitalization negatively impacts power dynamics at work. Researchers have applied different theoretical perspectives to explain such dualistic impacts. Some use socio-technical and affordance approaches to explain the interplay between technology and work practice. Others use structuration theory to explain the dualistic interplay between digital technologies and social structure at work. The technologies can be empowering for both employers and workers at the same time. While algorithms embedded in platforms give managers advanced powers of control and surveillance, they can also enhance the power of individual workers to respond to such oversight, reducing their impact.

Digital technologies, experiences, consequences, and management. Digital technological capabilities can be both value-enhancing and value-destroying, impacting workers' behavioural and psychological outcomes. Applying digital technologies at work may lead to information overload, challenges in time management and work productivity, and higher cognitive and time resources requirements. Digitalization can also cause adverse psychological outcomes, such as work-life imbalance, work stress, technostress, and anxiety. It may also impede group performance and affective group outcomes because digital technologies can decrease the chances and quality of social interaction and limit workers' ability to predict other's willingness to contribute to delivering expected results. Because of the persistence of digital social content online, workers may need to spend time managing their social presence.

Digital technologies and the future of work. Industry 4.0 represents the digitalized workplace's future, requiring reskilling to support work in the new era. Both educational institutions and business organizations should participate in the workforce reskilling process. Future management of platform work should move beyond just using algorithms for control to a more holistic application of platform logic for managing work and worker interactions. The Covid-19 pandemic has increased interest in the adoption and use of Artificial Intelligence (AI) and its application in machine learning, natural language processing, and robotics in the workplace. Security and privacy issues will continue to be very problematic issues in the future of work.

Key Messages

- Digital technology platforms, profoundly, are changing how people work, what they do for work, where they work, and when they work, and for whom they work .
- Everyday workplace processes and practices have changed fundamentally with the introduction and use of digital technologies.
- There is no consistent conclusion regarding the impact of digitalization on the social structure at work.
- Digital technological capabilities can be both value-enhancing and value-destroying, impacting workers' behavioural and psychological outcomes.
- Industry 4.0 represents the future of the digitalized workplace, requiring reskilling of the workforce and more focus on overall platform management.

Methodology

We applied topic modelling, an artificial intelligence-driven approach to text-mining used to identify and synthesize large sets of documents to support qualitative content analysis. We used Orange 3.27.1 (a University of Ljubljana open source initiative) to run the Latent Dirichlet Allocation model on the documents collected from broad searches of the Web of Science Core Collection and Scopus. Performing title and author searches of keywords such as digital, technology, and innovation in combination with words such as work, worker, and employment gig work, platform work, teleworking, telecommuting, work from home, and remote working yielded 9865 articles from Web of Science and 4678 from Scopus. Further screening of title and abstract for the word *digital* yielded 396 articles used for the topic modelling and 1414 articles used to validate the themes generated by the topic model. Qualitative content analysis of the articles supported the findings generated by the topic model.

REPORT

Background

Digital technologies are indispensable to people's work. By reducing the cost of acquiring information, speeding up transactions, and generating new business models, digital technologies increase productivity, efficiency, innovation and stimulate economic growth (World Bank, 2016). As instances of general-purpose technologies (GPTs) (Bresnahan & Trajtenberg, 1995; Helpman, 1998; Lipsey et al., 2005), digital technologies have profoundly impacted society, the economy, industries, markets, and many other areas of economic and social life. Digital technology advancements, leveraging high-speed networks, have created fundamental shifts in how, when, where, with whom we work. Such fundamental changes in the nature and arrangement of work are reframing the definition of employment and the relationship people have with organizations (McAfee & Brynjolfsson, 2011; Graham, Hjorth & Lehdonvirta, 2017)

Digital technologies are changing the spatial and temporal geography of organizational life, allowing people to work from anywhere, at any time, provided they can get access to an Internet connection and its related services. They allow for instantaneous connections between people in organizations and help group members collaborate efficiently and effectively (Miller, 2008). Digital nomadicity is a fashionable lifestyle where workers can work outside their traditional offices, travel globally, and have flexible schedules (Nash et al., 2018). In addition, digital technologies also change the work practices in different industries. For example, augmented reality (AR) and virtual reality (VR) can be used in social work education (Neden, 2020), while dentists can better provide dentistry care for patients by applying computer-aided design/manufacturing (CAD/CAM) (Piskin, 2021). As well, digital technologies also change the work practice in different industries. For example, while electronic health record (EHR) has been widely adopted in the medical industry, it can also be used to "research associations in medical diagnoses and consider temporal relations between events [to elucidate better] patterns of disease progression" (Chen et al., 2012, p. 1171). Digital platforms intermediate workers and customers (Dunn, 2020) and increases platform workers' job autonomy and discretion (Wood et al., 2019).

Although digital technologies have many positive impacts on people's work, they present several challenges and issues for individuals and organizations. For individuals, digital technologies require higher technical capabilities (Sellberg & Susi, 2014) and can lead to information overload (Franssila et al., 2016). People may be displaced, made obsolete, or even fully substituted by digital technologies (Ford, 2015; Freddi, 2018; Frey & Osborne, 2017). For businesses and organizations, digital technologies may impede across-group/community integrations (Monzani, et al., 2014) and cover-up conflicts within organizations (Leonardi, et al., 2013).

Digital technologies will play an even more important role in individuals' daily work and organizational life in the future. For example, the Covid-19 pandemic has accelerated the digitization and virtualization process in organizations, which requires higher technical and professional capabilities since the adoption and use of technologies such as AI can replace or even fully substitute for human workers. New management styles and techniques are needed to adopt a more technology-intense approach to organizing and managing work.

Objectives

In this report, we synthesize research focusing on the impact of digital technologies on people's work innovation and worker engagement. Specifically, the researchers attempt to understand:

(1) how digital technologies are transforming the nature of work.

(2) how digital technologies are transforming workplace practices.

(3) the effect of digital technologies on social networks and relationships in the workplace.

(4) how and to what extent these new work arrangements affect employee engagement and the meaningfulness individuals find in the work they do.

(5) the implications of digital technologies for the future of work.

The research has allowed us to generate insights along several thematic trajectories. Digital technology platforms shape work and worker engagement. These platforms afford and enable the disintermediation of work from specific locations, personnel, and time slots. Those performing work are now more fungible, opening the possibility of greater availability of workers while at the same time making it easier yet competitive for workers to secure assignments. A second theme emerging from the research considers how digital technology affordances shape and influence workplace practices. They allow for more dispersed and divergent communication and collaboration in real-time. They also facilitate better use of organizational knowledge and engender more engagement across hierarchical boundaries. The third theme highlights the positive and negative effects of digital technologies on the social aspects of work and work-life. Digital technologies hold the promise of strengthening social networks and social capital while simultaneously introducing the possibility of negative consequences such as the shift in power relationships in organizations or the loss of autonomy through panoptic surveillance made possible by digital technologies and networks. The fourth theme explores the experiences and consequences of digital technology deployment and use on work outcomes, the challenges faced, and how to manage them. Adverse behavioural and psychological effects such as information overload, technostress, social isolation, and work-life imbalance need to be addressed and managed if the positive benefits of digitalization are to accrue to organizations. The final theme focuses on the digitalized workplace's future and highlights the potential future impacts of issues such as algorithmic management over the long term. It also explores the implications of the COVID-19 pandemic on work and workplaces. The research also investigates the likely impacts of general-purpose artificial intelligence (AI) on work.

In the rest of this paper, we outline the methods used to develop the corpus used in this literature synthesis. We further articulate the review's findings using the thematic lenses to frame our analysis and synthesis of the papers, discuss research, policy, and practical implications of the study, and draw conclusions.

Methods

We applied topic modelling, an AI-driven approach to text-mining, used for identifying and synthesizing large corpora of documents, supporting a qualitative content analysis of the literature on work innovation and worker engagement precipitated the advanced digital technology deployment and use. Topic modelling allows us to go beyond manually searching and linking relevant topics at a corpus level to identify latent themes that run across the corpus as a whole and at the document level to identify relevant

articles and their relationships to the topics under investigation (DiMaggio et al., 2013). Applying this approach, a synthesis of the literature enabled us to conduct a broader survey not typically possible using conventional manual techniques. It allows for significantly more relevant voices in the discourse about how new digital technology shape work and worker engagement (Hagen, 2018; Larsen et al., 2019). It provides a more comprehensive view of the state of the literature, expanding the boundaries of inclusion beyond what is ordinarily possible using traditional means. This approach is vital to providing insights to policymakers, practitioners in organizations, and researchers.

 We used Latent Dirichlet Allocation (LDA) algorithm to run topic modelling (Hagen, 2018). Generative and probabilistic, LDA uses a three-level hierarchical Bayesian model to identify latent topics hidden in a collection of textual documents (Blei et al., 2003). It considers each article a mixture of latent topics, where each record exhibits these topics with different strengths (Blei et al., 2003; DiMaggio et al., 2013). LDA can capture words with multiple meanings (polysemy) and remove ambiguity in different uses of a term (DiMaggio et al., 2013). Using LDA makes it a better fit among other available algorithms (such as Probabilistic Latent semantic indexing, pLSI). We used Orange 3.27.1 to run the LDA model on the corpus. Orange is the University of Ljubljana open-source initiative offering a wide range of machine learning and data visualization toolkits.

Like any other automated text analysis and classification technique, we employed topic modelling as a heuristic tool to augment subject-area experts' analysis (Grimmer & Stewart, 2013). Topic modelling outcomes emerge as thematic frames that helped examine the separate layers of the underlying theoretical concepts linking digital technologies with the effects on different aspects of changing nature of work and worker engagement. The examination entailed an in-depth analysis of full-text articles to segregate conceptual linkages under the identified frames generated by topic modelling. Combining qualitative content analysis with the inductive relational approach of topic modelling allowed us to unveil novel structural patterns hidden in the textual corpora while handling large amounts of literature published in this area (DiMaggio et al., 2013).

The data collection process entailed performing broad searches to capture a comprehensive set of published articles related to the subject matter under study. We searched two leading research and science databases: Web of Science Core Collection and Scopus. Web of Science Core Collection covers scholarly research work post-1900s in various disciplines, including Sciences, Social Sciences, and Art and Humanities. Its citation indexing helps augment the search capabilities across the research work by creating an ontology for varied search terms and data. Scopus is also a multi-disciplinary database, offering a rich collection of academic articles hosting over 34,000 peer-reviewed journals in various disciplines. We limited our search to the last ten years (2010- 2020).

We first performed title and author keyword searches in both databases. Further, to conduct broad searches, various combinations of technology-related keywords (such as digital, technology and innovation) were used with work-related keywords (such as work, worker and employment). We conducted additional searches of title and author keywords to capture the concepts of gig work, platform work, teleworking, telecommuting, work from home and remote working. We also included a search string to capture articles discussing the changes in the work arrangements due to COVID-19. We used Boolean operators to formulate the search strings using different proximity operators and wild cards to incorporate variations of keywords and their combinations with each other (See Appendix 1 for the various search strings applied).

The search resulted in 9865 articles (3990 unique journals) from the Web of Science and 7315 articles (3458 unique journals) from Scopus. We removed duplicates of articles identified through Scopus that were in the list retrieved from Web of Science. The final list of additional publications for Scopus contained 4678 articles. The two lists of articles identified through Web of Science and Scopus were further pruned in a phased manner using the criteria described in Table 1 to eliminate articles not relevant to the scope of our study.

Table 1. Screening criteria to generate a corpus for topic modelling

Phase	Screening criteria		Outcomes
I	(A) Journal related to a broader set of topics on work and worker engagement or information system	Include	Corpus containing the articles identified through searches in Web of Science and Scopus, with journals of interest
	(B) Journal not centric to addressing topics on either work or digital technologies	Exclude	This resulted in a set of 3336 articles used for phase II screening.
II	(A) Title and abstract relevant to the subject matter under study	Include	Refined corpus by eliminating the articles that were not relevant to the subject matter being studied
	(B) Remaining	Exclude	
			This resulted in a set of 1810 articles used for topic modelling.
III	(A) Does title or abstract contain the word digital	Include in list 1	List 1 is used to identify frames using topic modelling that provides a holistic picture of the scholarly discussion in the subject -area under study
	(B) Remaining	Keep in list 2	
			List 2 becomes a test subject for validating the frames generated through list 1

The above screening process resulted in 396 articles in list 1, leaving 1414 in list 2. We applied topic modelling to a corpus containing 396 articles and organized them under five frames identified as relevant for the study. These frames represent the thematic structures running through the corpus and are suitable for representing the scholarly discussion in this area (Jacobi et al., 2016; Mohr & Bogdanov, 2013).

The topic modelling yielded five topics. We expanded our interpretation of the topics through scholarly discussion (Blei et al., 2003; DiMaggio et al., 2013). The topics represent "semantically coherent content" shared among the documents in the corpus (Alghamdi & Alfalqi, 2015). To assess the topics' reliability and validity, we reviewed their meaningfulness in context and the word association represented by the documents with a substantial proportion of the subject. We assessed reliability and validity by examining and comparing a random sample set of documents based on the topic's proportion, word concordances, and interpretation . We followed Hagen (2018) recommendation that when assessing a topic's reliability, "The level of agreement indicates the final model's reliability and gauges the interpretability of LDA-generated topics" (Hagen, 2018, p. 1297) (Hagen, 2018). We used valid topics to describe frames

employed for detailed content analysis and knowledge synthesis. We crafted suitable labels to expand the explicability of the topics (Grimmer & Stewart, 2013). Comparing the topics with external contemporary practitioner reports and literature in related areas can assure their validity. Each of these entails examining at least one of these aspects.

Further, since we performed the topic model in a broader set of articles, it encompasses a wide-ranging set of scholarly discussions. Hence, the identified topics through the model represent a greater degree of comprehensiveness. We argue that no prior research has provided such an overarching representation of the literature in this field. Hence, bringing together these pieces is novel and possible due to applying a machine learning data organization technique. This technique, likely, is superior to using manual processes and focusing on a limited set of leading journals (the way this type of research is often conducted). Below we provide a brief overview and summary of the thematic frames identified through topic modelling.

Results of Topic Modeling

Frames identified through topic modelling are depicted below. Table 2 includes the top ten keywords and their corresponding frequencies (also referred to as weights) in that topic. Following the table, we discuss each topic briefly and accompany the discussion with a word cloud to illustrate the resonance of the related threads in the articles that make up the corpus.

Table 2: Results of topic modelling

FRAME	TOPIC
DIGITAL PLATFORM ENVIRONMENT	platform (0.17), platforms (0.15), economy (0.15), transformation (0.13), labour (0.09), business (0.09), conducted (0.07), communication (0.06), organizational (0.04), organizations (0.03)
WORKPLACE PRACTICES	practices (0.30), opportunities (0.25), practice (0.20), current (0.15), increasingly (0.08), knowledge (0.00), challenges (0.00), value (0.00), organizations (0.00), understanding (0.00)
SOCIAL NETWORKS AND RELATIONSHIPS	social (0.24), knowledge (0.18), online (0.14), learning (0.12), education (0.09), skills (0.09), value (0.04), media (0.04), potential (0.03), changes (0.01)
WORK EXPERIENCES, CONSEQUENCES, AND CHALLENGES	management (0.11), people (0.09), training (0.09), challenges (0.08), tools (0.08), self (0.08), health (0.07), context (0.07), technological (0.06), understanding (0.05)
FUTURE OF WORK	new (0.21), development (0.12), future (0.08), organizations (0.07), professional (0.06), change (0.06), model (0.05), changes (0.05), explore (0.05), implications (0.04)

Frame 1: Digital Platform Environment

The first topic identified through the model suggests a heavy emphasis on the adoption of platform-based technologies to represent the new ways of working. Digital technologies have brought a significant shift in the ways workers interact and operate (Eden et al., 2019). The first frame derived from topic modelling

is titled 'digital platform environment'. This frame focuses on how digital technologies shape the work environment. Digital platforms characterize the "platform economy" and are central to adopting digital technologies by organizations and individuals who work in or for them. From start-ups to established businesses, platform-based approaches have been prominent in democratizing the work structure. Platform business models enable multi-sided marketplaces to exchange goods or services, introduce newer operation models, and extend flexibility to workers in several ways. The platform economy, also sometimes referred to as the gig economy, is only one way to demonstrate a shift in worker engagement. Digital technologies have impacted traditional work settings to bring a change in the use of technologies by employees. Digital transformation of organizations involves the augmentation of the organization's digital infrastructure which influences the habits of the employees.

In the literature review and synthesis, we will discuss, in more detail, additional dimensions relating to the theme "digital platform environment". The Platform model, structured as two- or multi-sided markets (Rani & Dhir, 2020), facilitates interaction between three entities - platform operator, workers and clients (Tucker, 2020). It introduces the flexibility for organizations to employ workers when needed, adding attributes such as autonomy and self-governance at work (Kahancová et al., 2020; O'Neil, 2015). At the other end, the workers may now have various options based on their availability (Nemkova et al., 2019). The findings suggest that such newer employment arrangements distinctly characteristerises autonomy at work (Gruszka & Böhm, 2020; Kahancová et al., 2020). Put differently, platform models are enablers for expanding and scaling the reach of an organization to access its workforce when needed and for administering work remotely (Bergvall-Kåreborn & Howcroft, 2014). Platform work includes performing tasks in physical space and conducting work through virtual environments (Tucker, 2020). Digital technologies are the locus of the operation of such mobilization platforms. This flexibility in scaling the workforce empowers firms in minimizing their costs while offloading risks related to being morally responsible for employee work-health standards (Bergvall-Kåreborn & Howcroft, 2014; Stewart & Stanford, 2017).

Digital technologies best support the platform models to achieve their business objectives, such as increasing producers and service offerings, competitive pricing, and greater availability and accessibility. Management of companies using platform models has undergone a shift, with the majority relying on technologies (including algorithms) to manage, allocate or surveil employee's tasks. The research looks through the lens of affordances created by digital technologies for employers while also understanding its impact on work and workers (Nemkova, Demirel and Baines (2019); Heiland, 2021; Rani & Dhir, 2020).

Also understood is that platform business models are only one manifestation of the impact of digital technologies on work arrangements. Traditional work settings have recently undergone rapid changes to take advantage of technology advances and facilitate newer digitally-enabled alternative work arrangements. Chung, Lee and Choi (2015) examine the moderating effect of organizational agility to understand the linkage between 'creative' job performance and the use of enterprise mobile applications. Habitual use and task-technology fit are key dimensions to influence job performance.

Figure 1. Represents the word distribution in the form of a word cloud for topic 1

Frame 2: Workplace Practices

Contemporary workplace practices - the way work is performed in an organization – have profoundly changed over the years with the advent and introduction of digital technologies. The second frame identified through topic modelling relates to the concept of 'practices'. The extant scholarly discussion examines the impacts of digital technologies on organizations and the everyday workplace practices of employees in socially complex environments. Digital technologies are known to enhance workplace practices by extending the capability of the user to perform a task such as in clinical practices. Wilder *et al.* (2019) explore the use case of digital voice assistant technology for health practitioners to enhance their clinical practices. Muralidhar, Bossen and O'Neill (2019) investigate the relationship between digital technologies and financial inclusion. We can further see the enhanced utility of digital technologies in the current scenario of COVID-19. For example, López Peláez *et al.* (2020) provides details on using technology to extend the reach of social work in managing misinformation and fake news.

Broadly, digital technologies have impacted the everyday practices of workers in more than one way. Chughtai (2020) studies aspects of IT work practices, including temporality, spatiality, materiality, and sociality. Wolf and Blomberg (2020) examine the role of materiality on everyday work practices in organizations. Utilizing apps alongside legacy enterprise software, they identify two tenets underpinning materiality – (1) software calculus (entails features as attributes of software programs and software/devices combos) and (2) data thinking (comprises of underlying data formats and database structures). From an organizational perspective, digital technologies give rise to newer control practices and structures within an organization. Miele and Tirabeni (2020) investigate "how these technologies are employed to share power within workplaces" by reviewing remote work practices and the use of workplace wearables.

Digital assemblage is one such example where we use several ICT technologies to perform daily work tasks. The recent commodification of web applications makes it simple for organizations to use different applications without "formally designing or collectively governing" the technologies (Sawyer et al., 2014). The evolution of practices is also a function of time and the deployment of digital technologies, the acceptance and use by employees, and other coordination mechanisms involved. Claggett and Karahanna (2018) corroborate previous research on relational and coordination mechanisms to influence the "design of coordination mechanism in digitized work processes". Tirabeni and Soderquist (2019) look through the employee engagement practices. Often, we view design as a common determinant for workers' engagement, work control, autonomy, and appropriation. Practices evolved in digitalized environments may reflect a unique appropriation dilemma, where the workers must work through the boundaries of work practices while appropriating economic value for their contributions (Scolere, 2019). 'Workplace practices' as a framework helps us synthesize the impact of the adoption of workplaces through the changes seen in practices and their implications in control and management of work.

Figure 2. Represents the word distribution in the form of a word cloud for topic 2

Frame 3: Social Networks and Relationships

Digital technologies have introduced new forms of public participation and communication and present newly found implications for the creation of social capital (Clayton & Macdonald, 2013). Social interaction with digital technologies leads to different forms of engagement. Research suggests that people belonging to different social classes, occupation statuses, and places do not derive similar benefits from technology in their everyday lives.

The frame 'social networks and relationships' identifies the effects of digital technologies on the network of relationships defined by the social fabric of the interactions among people over digital technologies. By social capital, we mean the shared norms, values, and understandings pervasive in the social networks by which people communicate and operate as a group. At work, digital technologies have layered the existing social capital with yet another form, 'digital' social capital. The use of social media within

organizations, such as enterprise social networks, offers both utilitarian value (i.e. offers utility for work purposes) and hedonic value (i.e. offers increased social interactions and enjoyment as associated with public social media networks) (Meske et al., 2019). Meske, Wilms and Stieglitz (2019) examine the influence of utilitarian and hedonic values for continued use of enterprise social media networks and further identify and assess the characteristic influence of digital infrastructure (versatility, adaptability, interconnectedness, and invisibility-in-use) on enterprise social networks (Meske et al., 2019). Examples of enterprise social networks are Confluence, IBM Connections, Jive, Slack, SharePoint, Yammer, and Microsoft Teams, among many others.

The use of digital technologies is often considered a means for social inclusion (Raya Diez, 2018). Clayton and Macdonald (2013) explore the linkage between digital technologies and social inclusion considering relative economic position. The study suggests access to information and communication technologies (ICT) alone is insufficient in providing the digital inclusion needed for members of different social classes to engage and benefit from using the technologies. Social capital affords organizational members to derive benefits from social networks by enabling individuals to draw on "economic, social and cultural resources through accepted group membership" (Clayton & Macdonald, 2013). Social capital is also significant because it refers to the ability to draw upon social networks, which allow for the reproduction of positions of power and access to further economic, social, and cultural resources through accepted group membership. Social class and associated occupational roles allow for greater or lesser profit from engagement with digital technology. Without legitimate knowledge, connections, or reasons to engage meaningfully, individuals may struggle to make appropriate use of technology within a society in which they do not dictate what is 'useful'. Online communities form a constant source of ideas and resources. Korzynski, Paniagua and Rodriguez-Montemayor (2020) propose a new construct 'online social knowledge management' to connect the concepts of knowledge creation entailing social interactions with knowledge management to enhance creativity.

Figure 3. Represents the word distribution in the form of a word cloud for topic 3

Frame 4: Work Experiences, Consequences, and Challenges

With work hours blurring into our personal lives, digital technologies positively and negatively affect the worker's wellness and personal growth. 'Work experience, consequences, and challenges,' the fourth frame, outlines the effects of digital technologies on worker's experience - both at work and at home.

Digital technologies afford improved productivity and can create flexible work schedules. However, these also can affect job satisfaction and work-life balance (Gao et al., 2020; Zaresani & Scott, 2020). Gender-based studies also highlight differences in the effects of digital technologies on different groups of people (Nagy, 2020). In recent times, digital technology is seen as a capacity-building tool for employers to quickly scale and fulfill market demands. Scholarly discussion is growing around the implications of using technologies at work and their impact on professional growth and performance (Long et al., 2018). Though it is natural to suggest that digital technologies can bridge a huge gap by performing tasks that could not be performed remotely earlier, their effects are still not understood well enough throughout the literature. Scholarly enquiry covers a wide range of topics focusing on employee well-being, including new discussions on heightened stress levels at digitalized workplaces (Carolan & De Visser, 2018; Yassaee & Mettler, 2019).

Though this new way of operating extends flexibility to workers in several ways, it has introduced more contemporary challenges not seen in the traditional work setting. These challenges include precarity in work, potential loss of meaning of the work, employer surveillance, and greater control over employee's tasks, weak labour protection laws and lowering of wages, among many others.

Figure 4. Represents the word distribution in the form of a word cloud for topic 4

Frame 5: Future of Work

The potential of digital technologies, more specifically artificial intelligence and machine learning technologies, is yet to be fully uncovered and their effects unveiled. The fifth frame, 'Future of Work', captures digital technologies' potential impact on future work and work arrangements. Some of the key ideas discussed in trying to understand the possible effects of digital technologies on future employment and jobs are; automation (Dahlan et al., 2019), digitalization of services (Saari et al., 2019), digitally-supported creations (Oldham & Da Silva, 2015), entrepreneurial arrangements (Idowu & Elbanna, 2020; Islam, 2019), and global supply chains (Rainnie & Dean, 2020).

Researchers have attempted to unveil the potential effects of digital technologies by posing questions such as whether industry 4.0 is an organizational model or mere technology. What are its impact on competence and skill level of workers, flexibility introduced through new labour markets, and effects on daily routines (Johansson et al., 2017). The fourth industrial revolution brings together physical, digital and biological worlds and profoundly impacts the social structures of society (Rotatori et al., 2021). These changes in human lives and social fabric require reskilling to secure a place in the future workforce (Rotatori et al., 2021). Kudyba (2020) examines COVID accelerated digital transformation processes in organizations to embed technologies in their operational work environment, intending to prepare organizations for the changing nature of work.

Figure 5. Represents the word distribution in the form of a word cloud for topic 5

In summary, five themes emerged from the topic modelling exercise. We discussed the essential elements of these themes and the supporting literature. In the following section, we synthesize the literature in the corpus generated by topic modelling to address the following questions:

(1) How are digital technologies, particularly digital platforms, transforming the nature of work?

(2) How are digital technological affordances transforming workplace practices?

(3) What are the effects on social networks and relationships generated by digital technologies in the workplace?

(4) How and to what extent do new work arrangements, precipitated by digital technologies, affect employee work experiences, the consequences resulting from those effects, and how are the challenges encountered managed? and

(5) What does the research literature say about the future of work?

Transforming work in the digital economy – Literature Review and Synthesis of the five themes

Theme 1: How are digital technologies, particularly digital platforms, transforming the nature of work?

Digital platforms have enabled entirely new business models (Neumeier et al., 2017) and transformed the ways people work in organizations (Vuori et al., 2019). We define digital platforms as the digital infrastructure, rules, and processes that enable resource exchange between producers and consumers (Howcroft & Bergvall-Kareborn, 2019). Enabled by advances in Information and Communication Technologies (ICT), digital platforms create new forms of work (Gandini, 2019), offering external recruiting opportunities for employers, which exploits the market-based approach to organizing work and, in turn, reduce costs (Abraham, 1990). We can categorize these digital labour platforms into two major types: 1) crowd-work systems that involve matching workers with employers, bidding for and completing work through open websites (e.g., Amazon Mechanical Turk); 2) work-on-demand systems that involve traditional and physical tasks and jobs which are organized and managed by online platforms (e.g., Uber, Lyft) (De Stefano, 2015). In addition, tasks and jobs in "crowdwork systems" include complex tasks such as web development, product design, software architecture, and microtasks such as simple categorization, tagging, and content writing (Rani & Furrer, 2021). From a broader perspective, digital platforms also provide opportunities for improving work tasks, particularly those associated with knowledge development, communication, and collaboration within and/or across organizations (e.g., enterprise social networks and enterprise mobile applications) (Sheer & Rice, 2017; Chung, Lee, & Choi, 2015).

Our research identifies a significant theme from the current literature on digital technologies and work – digital technologies create digital platforms that transform the nature of work (Mäntymäki, Baiyere, & Islam, 2019; Forman, King, & Lyytinen, 2014). Digital platforms facilitate worker engagement by enabling a wide range of new work arrangements and by precipitating changes in work relationships and the work environment (Rani & Furrer, 2021; Mäntymäki et al., 2019; Nelson, Jarrahi, & Thomson, 2017). Table 3 summarizes five dimensions related to the transformative power of digital platforms on work. First, temporal flexibility is embedded in platform-enabled work due to the digital technological capabilities of transcending time and space without limitation. Specifically, the platforms enable self-employment

mechanisms and allow for time management autonomy in which individuals have the agency to determine whether to accept or reject work opportunities, to change the time and duration of employment, and to reflexively make adjustments according to their personal needs and situations (Mäntymäki et al., 2019; Todoli-Signes, 2017). Such digital work environments endow individuals with a high level of flexibility and freedom in their work arrangements. In addition, digital technology platforms can process resource transactions (e.g., employers can publish tasks online and workers can submit works online) and economic transactions (e.g., electronic payment), which allows for a flexible payment mechanism on the digital platform-enabled workplace. Executing financial transactions means employees can get paid based on a single task or days/weeks rather than traditional fixed payment schedules (Jarrahi & Sawyer, 2015; Rani & Furrer, 2021).

Table 3. How digital technologies are changing the nature of work

Nature of work	Dimensions	Digital platform-based work	Important literature
Work relations & arrangements	• Temporal flexibility	• Self-employment mechanism e.g., control of work/employment status • Time management autonomy e.g., free working time/duration allocation • Income mechanism e.g., flexible payments based on tasks/days/weeks	Mäntymäki, Baiyere, & Islam (2019); Jarrahi, Sutherland, Nelson, & Sawyer (2020)
	• Spatial mobilization	• No spatial or geographic boundaries e.g., employer-employee match across geographic areas/industries/demographics • Information access e.g., easy/wide access to information • Device/Internet availability e.g., high availability of digital devices/Internet services	Nelson, Jarrahi, & Thomson (2017); Meske, Wilms, & Stieglitz (2019)
	• Algorithm-based administration	• Information control e.g., work-related information asymmetry, geo-tagging monitoring • Pricing mechanism e.g., platform pricing strategy determined by algorithm-based demand prediction • Rating mechanism e.g., structured rating and evaluation system	Mäntymäki, Baiyere, & Islam (2019); Rani & Furrer (2021); Nemkova et al. (2019); Heiland (2021)
Work environment	• Contextual mobilization	• A dynamic work platform where multiple jobs/tasks coexist e.g., various microtasks can be accomplished within one platform • A blending environment where personal life and professional work coexist and interact	Cousins & Robey (2005); Nelson, Jarrahi, & Thomson (2017)

		e.g., the same computer can achieve work and leisure purposes; opportunity to work under challenging life situations	
	• Social mobilization	• Online report/pay mechanism e.g., work outcome report and payment transactions are completed within platform • Online collaboration/coordination mechanism e.g., platform-enabled communications	Jarrahi & Sawyer (2015); Nelson, Jarrahi, & Thomson (2017); Sheer & Rice (2017)

Second, digital platform-based work affords spatial mobilization. There are less spatial or geographic boundaries within platform-enabled work arrangements because mobile technologies and cloud computing enable temporal and spatial freedom (Nelson et al., 2017). Individuals can get access to reliable information sources across locations enabled by the development of the Internet, social media, and other digital information technologies. The prevalent use of mobile devices, such as smartphones and tablets, and Internet services, such as 5G and WiFi, further facilitate individuals' access to information (Meske & Junglas, 2020). Third, using algorithms to organize and govern work is another vital feature of platform-enabled work (Aneesh, 2009; Rani & Furrer, 2021). Instead of relying on traditional organizational hierarchies and physical proximity (Pfeffer & Baron, 1988), digital platforms employ complex and invisible algorithms to manage and control work demand and evaluate and monitor work performance (Gandini, 2019). For example, by applying algorithms, platforms can predict work demand and adjust pricing strategies accordingly. Pre-determined structured rating systems within the platform can conduct worker performance evaluations using geo-tagging services (Mäntymäki et al., 2019; Heiland, 2021).

In addition to work relations and arrangements, digital platforms are changing work environments from two perspectives. First, a more dynamic work environment is emergent in the online work marketplace, bringing employees contextual mobilization (Nelson et al., 2017). Contextual mobilization refers to the flexible movement between the multiple social roles played by platform workers (Cousins & Robey, 2005). Enabled by digital technologies, individuals can work for multiple organizations from various geographic areas simultaneously; individuals can perform professional tasks and leisure activities by using the same digital device. In such a complex and dynamic technological environment, individuals can develop and present multiple identities through different social interactions. In addition, digital technologies such as cloud services and social media applications enable workers to communicate with each other, to collaborate and coordinate online, and to maintain social networks and infrastructure within platform-enabled work (Jarrahi & Sawyer, 2015; Nelson et al., 2017).

To summarize, digital technologies are transforming the nature of work in many ways, including workplace relations and arrangements and the work environment itself. Moreover, our research identified that their transformative power manifest in various work functions, a range of industries and many types of businesses (Stewart & Stanford, 2017). In the next section, we will report the findings regarding how digital technologies are transforming work practices.

Theme 2: How are digital technological affordances transforming workplace practices

The first subtheme falling under Theme 2 is the workplace practices that have integrated digital technologies. We identify workplace practices relating to three major work processes: market-oriented approaches to organizing work and hiring workers, communication and collaboration within and across organizations, and performance of knowledge work (e.g., Rani & Furrer, 2021; Meske, Wilms, & Stieglitz, 2019; Vuori, Helander, & Okkonen, 2019). Table 2 shows the findings regarding the technological capabilities as affordances for the three identified work processes. First, our research observed that contemporary organizations in the digital age practice a market-based approach to organizing work to increase relative competitiveness (Abraham, 1990). Enabled by advanced information technologies, such as interactive online platforms, cloud computing, algorithms and geotagging, organizations can access skilled and unskilled labour from different areas globally for various operations and tasks. Using these platforms can improve work efficiency and productivity while reducing hiring and training costs (Rani & Furrer, 2021).

The current literature employs multiple concepts to refer to this new approach of organizing work. "Digital labour platforms" are multi-sided marketplaces that facilitate exchange between service providers, clients (businesses) and workers (Farrell & Greig, 2016). Platform-based work has also been categorized under umbrella terms such as "gig economy" (Gandini, 2019) and "crowdwork" (Howcroft & Bergvall-Kareborn, 2019). The former conceptualizes platforms as a market intermediary which establishes a capital-labor relationship between a worker and a platform and mediates workers' supply and professional demand for the completion of a small task (Gandini, 2019). The latter defines crowdwork as a marketplace for the mediation of both physical as well as digital services and tasks (Howcroft & Bergvall-Kareborn, 2019). Whereas the literature uses different concepts and terms interchangeably, digital platforms functioning as intermediaries and marketplaces is consistent across various publications. De Stefano (2015) categorizes digital labour platforms as two types: work completed through open websites and demand-based work that involve more traditional and physical tasks, e.g., ridesharing, delivery services. In addition to labour platforms, we also see the emergence of "capital platforms", which facilitate the sale or rent of assets (Farrell & Greig, 2016).

Table 4. Digital technology affordances and the transformation of workplace practices

Three major functions	Examples of practice	Technological capabilities	Affordances for work & worker	Important references
Market-based approach to organizing work (i.e., platform economy, gig economy, crowdwork)	• Ridesharing and delivery services, e.g., Uber • Microtask platforms, e.g., Amazon Mechanical Turk	• Online platform • Cloud computing • Algorithm • Digital transaction • No time/place limit • Geotagging	• Match employees and employers • Complete complex tasks, e.g., web development • Complete microtasks, e.g., tagging, content writing • Bridge service producers and consumers, e.g., Uber	Rani & Furrer (2021); Mäntymäki, Baiyere, & Islam (2019); Stewart & Stanford (2017)
Communication and collaboration	• Social media apps, e.g., Messenger,	• Access to real-time information	• Effective and efficient task-related information transmission	Sheer & Rice (2017); Cavazotte,

	Examples of practice	Technological capabilities	Affordances for work & worker	Important works
	• Skype, Whatsapp • Enterprise social networks, e.g., Yammer, Jive. • Enterprise mobile applications, e.g., electronic meeting systems such as Microsoft Teams and Zoom.	• One-on-one, group, and mass communications • Rich media information transmission (e.g., texts, emoticons, images, video, and audio files) • No time/space limit • Digital data storage	• Multitasking • Remove physical, cultural, and hierarchical barriers • Emotional and social support • Internal work collaboration/relationship • External collaboration/relationship with business partners • Creativity-supporting system	Lemos, & Villadsen (2014); Matusik & Mickel (2011); Meske, Wilms, & Stieglitz (2019); Chung, Lee, & Choi (2015); Oldham & Da Silva (2015)
Knowledge work	• Mobile knowledge work, e.g., Web development, teaching, consulting, and financial planning	• Digital data storage • Cloud services • Personalized organization technologies • No time/space limit • Social network sites	• Autonomy • Asynchrony • Mobility • Co-creation • Efficient and fast knowledge flow • Independency • Keep social cohesion • Increased worker productivity	Vuori, Helander, & Okkonen (2019); Nelson, Jarrahi, & Thomson (2017); Aral, Brynjolfsson, & Van Alstyne (2012)

Industry-level practices	Examples of practice	Technological capabilities	Affordances for work & worker	Important works
Medical and clinic services	• Electronic Health Records (EHR) • Emerging technologies, e.g., digital voice assistants	• Online databases • Artificial intelligence • Digital data storage	• Improvements in medical service workflow • Productivity • Quality of care	Møller, Eriksen, Bossen (2020); Wilder et al., (2019)
Social work	• Online counselling systems • Online training sessions	• Online databases • Online network platforms • Digital communication tools	• Communication • Coordination • Training • Safety protection	Lagsten & Andersson (2018); Ley & Seelmeyer (2008); López Peláez et al. (2020)

Individual-level practices	Examples of practice	Technological capabilities	Affordances for work & worker	Important works
Daily work practices, workplace relationships	• Digital assemblages • Alliance building and collective action	• A large pool of digital tools • Accessible digital tools	• Communication with co-workers, unions, and other stakeholders • Relationship and network building and maintenance • Proactive approach to work • Increased control of power	Helmerich et al. (2021); Sawyer, Crowston, & Wigand, (2014)

Not only are digital technologies used for building new forms of work and new business models in the external work marketplace (Neumeier et al., 2017), they are also employed within organizations and across organizations to facilitate employees' workplace practices and transform the ways people work (Vuori et al., 2019). Examples of such digital applications include but are not limited to electronic communication tools (e.g., emails, instant messaging, and voice mail), electronic conferencing tools (e.g., voice/video conferencing), enterprise social networks (e.g., discussion forums, chat systems, social media), collaborative work management tools (e.g., file sharing, smart editing, and group calendars), and enterprise mobile applications (e.g., Teams and Zoom on smartphone/tablet) (Oldham & Da Silva, 2015; Chung, Lee, & Choi, 2015).

Digital technologies facilitate communication and collaboration work in organizations. The various capabilities of digital technologies function as affordances (Gibson, 1977) that enable improved workplace practices through three distinct aspects: efficiency, productivity, and use of knowledge (Vuori et al., 2019). Information and communication technologies allow efficient and timely transmission of task-relevant information, provide information for various stakeholders within and outside of the firms regardless of time and space, let workers ask for clarifications with minimal disruption, and engage in low-intensity collaboration (Sheer & Rice, 2017; Chung et al., 2015). The flexible communication and collaboration mechanisms supported by digital technologies such as one-on-one and group discussions support multitasking (Aral, Brynjolfsson, & Van Alstyne, 2012), resulting in greater individual and team productivity (Shaw, Scheufele, & Catalano, 2007). The digital communication environment, filled with rich media data such as images, videos, and emoticons, help reduce physical, cultural, and hierarchical barriers (Riemer et al., 2015), provide instrumental and emotional support for workers, which, in turn, help build and maintain good relationships with coworkers and external business partners (Sheer & Rice, 2017).

Importantly, with the help of online communication and collaboration applications, creative ideas, creative individuals, and creative processes are more accessible in organizations (Watson, 2007). Digital technology can help satisfy three key conditions for stimulating creativity and innovation: timely access and exposure to new and diverse information, full engagement in the work role, and experience of socioemotional and instrumental support (Oldham & Da Silva, 2015). Besides, collaboration through computer-mediated work systems facilitates informal communication, supporting the free exchange of creative and innovative ideas (Aragon et al., 2009). Hence, many mobile computing systems have become popular in the workplace, e.g., enterprise mobile applications (Chung et al., 2015). They are designed as

digital infrastructures to support divergent thinking and creative thinking (Avital & Te'eni, 2009) and facilitate employees' creative idea development and implementation in organizations (Oldham & Da Silva, 2015).

At the centre of innovation is knowledge work. Digitalization fosters better use of knowledge (Parida, Sjödin, Lenka, & Wincent, 2015). Our research confirms that knowledge work practices in organizations embed digital technologies. Knowledge workers are experts who create, learn, and analyze information and knowledge and then act on it (Drucker, 1999). Compared to traditional workplace practices, knowledge work contains more ambiguity and more complex interactions, demands more individual involvement, flexibility, autonomy, and mobility (Greene & Myerson, 2011; Erlich & Bichard, 2008). The digital knowledge work platforms and systems offer features such as digital data storage, cloud services, and personalized organization to meet knowledge workers' need for autonomy, mobility, flexibility, control of ambiguity and complexity, and encourage them to engage (Vuori et al., 2019; Aral et al., 2012).

In addition to integrating digital technologies into three major work processes in organizations, we also found that digital technologies impacted the work processes in at least two different industries; medical services and social work (e.g., Wilder et al., 2019; Lagsten & Andersson, 2018). Electronic health records (EHRs) are the most prominently reported digital technology used in clinical healthcare services. Their use has led to improved medical service workflow, physician productivity, and overall quality of care (Møller, Eriksen, Bossen, 2020; Wilder et al., 2019). Moreover, emergent technologies like digital voice assistants (Wilder et al., 2019) are also integrated into clinical service work practices to enhance EHR usability and improve service workers' experience and acceptance of digital transformation in a clinical setting. Another field that widely deploys digital technologies is social work. Organizations have implemented various digital tools to facilitate communication, collaboration, coordination, and decision-making activities in daily social work practice (Lagsten & Andersson, 2018). These include online counselling systems, call centres, case management platforms (Ley & Seelmeyer, 2008).

More importantly, individual workers have employed information and communication technologies in daily work practices in many other industries like real estate and global value chains (Sawyer, Crowston, & Wigand, 2014; Helmerich, Raj-Reichert, & Zajak, 2021). In particular, digital technologies have been applied in shifting workplace culture, improving power relationships in the workplace, and improving working conditions. In terms of workplace culture, digital infrastructures help change how real estate agents provide services for their clients, from being reactive to proactive. Social activities arise along with the integration of digital infrastructures; new, socially constructed service values emerge through active interactions among stakeholders (Pinch & Swedberg, 2008). Agents (e.g., real estate agents) do not just serve as information intermediaries anymore. They are an important node in the social network connecting and supporting buyer and seller (Sawyer et al., 2014). Accordingly, agents actively and flexibly employ a personalized collection of digital technologies (viewed as digital assemblages) to share information with various stakeholders, provide value-added services to buyers and sellers, and gain market power (Sawyer et al., 2014; De Landa, 2006). In addition, workers in global value chains use digital tools to improve their control of networked power (i.e., alliance-building between workers, unions or nongovernmental organizations within and across countries) (Zajak et al., 2017) and associational power (i.e., the capacity of workers to organize and act collectively) (Hodder et al., 2017), and then improve their working conditions (Helmerich et al., 2021).

In summary, digital technologies and their affordances have transformed work practices at both organizational, team, and individual levels. They enable work practices that reframe the way work is conceptualized and performed.

Theme 3: What are the effects on social networks and relationships generated by digital technologies in the workplace?

Our research finds no consistent conclusion regarding the impact of digitalization on the social structure at work. Some research suggests that the use of digital technologies at work positively impacts social relationships and networks and enhances employees' power in workplace social structure (Sheer & Rice, 2017; Meske et al., 2019; Helmerich et al., 2021). Other research found that digitalization may negatively influence the power dynamics at work (Miele & Tirabeni, 2020; Raj-Reichert, Zajak, & Helmerich, 2021). Researchers have applied different theoretical perspectives to explain the dualistic impacts of digitalization on work social structure and dynamics. For example, researchers applied a sociotechnical and affordance perspective (Gibson, 1977) to understand the interplay between technology and work practices (Leonardi, Huysman, & Steinfield, 2013). They argue that technological affordances may vary depending on how a given social actor interprets the material values of the technological artifact based on their situation and context (Nelson et al., 2017). That is, digital technological affordances evolve through relationships between the social actors, their specific uses of the technology, and the features of the technology (Sheer & Rice, 2017; Treem & Leonardi, 2013). Therefore, digital technologies can be used as a vehicle to positively connect and integrate employee-employee relationships and employee-organization relationships to facilitate positive work and worker outcomes (Nelson et al., 2017; Helmerich et al., 2021). However, digital technological affordances, like algorithmic management, can cause disconnection among workers, social isolation, and unequal social power distribution in workplace structure (Rani & Furrer, 2021; Anwar & Graham, 2021).

Researchers apply Gibson's (1977) affordance theory and Giddens' (1990) structuration theory in explaining the dualistic interplay between digital technologies and social structure at work (e.g., Miele & Tirabeni, 2019). Using Giddens's (1990) theory on structuration, researchers suggest that new technologies, as the changing conditions in the structure, can shape employment relations, power dynamics, social order, and culture in organizations. In turn, the technologies can be shaped by the changed social structure (Bala & Venkatesh, 2017; Majchrzak et al., 2000). Moreover, according to Giddens's (1991) observation of the characteristics of late modernity, many opportunities and tensions emerge in the ongoing and iterative interaction between technology and social activities. For example, the application of digital tools in health and clinical services creates opportunities for health authorities (e.g., doctors and nurses) to improve work performance and efficiency. However, applying those same tools can lead to a shift in power from authority to non-authority elements because digital information sources, like social media, allow patients to actively access health knowledge and reflexively participate in self-care and health promotion. Consequently, they can, in turn, transform the authoritative power relationship in the healthcare field (Nicolini, 2007).

We listed the significant social effects that digital technologies have caused in workplaces in Table 5. Regarding the positive social impacts, researchers suggested that integrating digital technologies into work enhances social capital and then improves worker outcomes (Sheer & Rice, 2017). Social capital referred to the actual and potential resources accumulated by an actor and mobilized through social contacts and connections (Bourdieu, 1977). Social capital is linked to productivity and organizational level

outcomes in the institutional setting because it involves instrumental and emotional support and fosters collaboration and coordination within organizations (Sheer & Rice, 2017; Williams, 2006). According to Putnam (2000), social capital includes two dimensions; strong and weak social ties (i.e., bridging capital and bonding capital). Digital technologies affordances like persistent contact and pervasive awareness could enhance both strong ties and weak ties in organizations to either strengthen the interpersonal trust and emotional support or expand network heterogeneity and diversity for new opportunities and diverse information sources (Hampton, 2016; Ellison, Gibbs, & Weber, 2015).

Digital technologies not only enhance social capital on an individual level but, more importantly, help develop organizational-level social networks. Research evidence indicates that enterprise social technologies can "increase the accuracy of people's meta-knowledge (knowledge of 'who knows what' and 'who knows whom') at work" (Leonardi, 2015, p.747), and, in turn, enable a better representation of others' social identity. The technologies portend fewer hierarchical, physical, and cultural barriers within communication and collaboration (Beck et al., 2014). Accordingly, we use many enterprise social media (also called enterprise social networks, enterprise social software) (Beck et al., 2014) in workplaces for internal communication purposes and increasing social interaction within the organization (Choudrie & Zamani, 2016). By employing the affordances view of digital technologies such as communication visibility, message transparency, and network translucence, digital social technologies could enhance metaknowledge, build a flatter and leaner structure, and lead to more innovative ideas and processes within and across organizations (Leonardi, 2014; Miele & Tirabeni, 2020). The visibility features of digital technology enable a homophily effect; namely, like-minded people can be easily identified and connected to form a community and can generate and maintain social ties (Leonardi et al., 2013; Jarrahi & Sawyer, 2015). To construct and maintain social identity within a community, individuals could employ various digital technologies strategically to project their professional image, manage their networks, and maintain social cohesion (Nelson et al., 2017).

As for the negative impact of digital technologies on work social structure and relations, the literature focuses on the themes of power relationships and dynamics in the workplace (including crowdwork and traditional offline work) (Raj-Reichert et al., 2020). Facilitated by emerging technologies such as algorithms, artificial intelligence, and wearable devices, employers can monitor production, track employees' working hours without time or place limitation, and evaluate employees' performance through rating systems (Mäntymäki et al., 2019). Smart technologies and algorithmic management may give employers and managers enhanced power in employment relationships (Raj-Reichert et al., 2020). From a broader perspective, research pinpoints the unequal power relationship in global value chains (e.g., global north vs. global south) due to the unequal distribution of access to digital tools and economic capital (Wood et al., 2019). However, as we stated earlier, based on affordance perspective and structuration theory, digital technologies can positively influence the reduction of power asymmetry and enhance employees' control over employment relationships (Nielsen et al., 2016). Individuals have the agency (i.e., free will) to appropriate the use of digital technologies at work so that digital technologies can help them escape top-down control and subvert prior organizational power dynamics (Wood et al., 2019). For example, Helmerich et al. (2021) empirically proved that workers used digital tools to improve their practice of networked power and associational power to improve their working conditions (i.e., build alliances, networks, and enhance the capability of collective action). Therefore, the dynamic interplay between technological capabilities and individual practices yields either positive or negative impacts on social relationships and individual-/organizational-level outcomes (Ellmer & Reichel, 2021).

Table 5. Effects of digital technologies on social networks and relationships at work

Dimensions	Technological Affordances	Important References
Workers' social capital accumulation	• Enhance strong tie/network strength to gain emotional and social support, trust, and reciprocity • Increase weak tie/network heterogeneity and diversity to build diverse and broadened networks and access new opportunities and information sources	Sheer & Rice (2017); Williams (2006); Elisson et al. (2015); Clayton & Macdonald (2013)
Social presence, visibility, and cohesion	• Technologies like social media enable the visibility and accessibility of digital workers to colleagues and clients. • Make communicative and interaction activities, networks, and outputs visible & keep persistent records	Leonardi et al. (2013); Nelson, Jarrahi, & Thomson (2017); Meske, Wilms, & Stieglitz (2019); Treem & Leonardi (2012)
Meta-knowledge, social identity	• Can increase the accuracy of people's meta-knowledge, i.e., knowledge of 'who knows what' and 'who knows whom' at work • Work as sociotechnical systems that provide a better knowledge of the social identity of others at work	Leonardi (2015); Leonardi (2014); Beck et al. (2014)
Power relationship, power dynamics	• Power reinforcement, i.e., technologies support the existing distribution of power relationships • Power dynamics change, i.e., technologies change social orders, power relations and social structure	Miele & Tirabeni (2020); Till (2014); Nielsen, Andersen, & Danziger (2016)

Theme 4: How and to what extent do new work arrangements, precipitated by digital technologies, affect employee work experiences, the consequences resulting from those effects, and how are the challenges encountered managed?

Under Theme 4, we identified the experiences, consequences, and challenges in managing digital technologies at work. As we stated in the last section, digital technologies have capabilities that benefit work, workers, and employers. However, these technological capabilities may also result in negative consequences that need to be controlled and managed. By maximizing the positive influences and avoiding the negative impacts, organizations could exploit the benefits of IT-work integration. We identified the specific challenges faced by workers and organizations in Table 6. Digital technologies have restraining effects on individual-level worker performance and collective-level group work processes and outcomes.

Previous literature focuses on the negative impact of digital technologies on individual worker's behavioural (e.g., work performance) and psychological outcomes (e.g., mental health, work exhaustion) (Vuori et al., 2019; Chen & Karahanna, 2018). First, while technological capabilities such as information access, autonomy, asynchrony, mobility, and co-creation can enhance worker's performance, they can also be value-destroying (Vuori et al., 2019). For example, easy and efficient access to information may

lead to information overload under malfunctioning information systems (Franssila et al., 2016), demanding workers to use more time and effort to manage information, reducing work efficiency. Although enabled with work autonomy, the asynchronous nature of digital work may precipitate challenges in time management and work productivity because employees may delay responses to co-workers and postpone the completion of tasks (Vuori et al., 2019). Moreover, employees may need to continuously learn and renew their technical skills to cope with the adoption and updates of new information systems, which demand extensive cognitive and temporal resources (Sellberg & Susi, 2014).

In addition to the behavioural outcomes, digitalization at work can also cause adverse psychological effects. Due to the easy access to the Internet and the ubiquitous use of digital devices like mobile phones, laptops, and tablets, individual workers have a perception that they are required to constantly connect to work, which may cause work-life imbalance and work stress (Chen & Karahanna, 2018). This constant pressure to engage is called "electronic leash" in the literature, which refers to the invisible but constant monitoring from management due to the task-assignment nature of the digital work environment (Brillhart, 2004). The perception of continuous connection to work has harmful effects on both workflow and employees' wellbeing. Furthermore, technostress can also be caused by "an inability to cope with the new computer technologies in a healthy manner" (Brod, 1984, p.16), which leads to anxiety towards technology and work. Technostress includes the strain of dealing with information overload, multitasking, continuous partial attention, and continuous learning about new technology and application (Wang et al., 2008). What's worse is that psychological stress can negatively impact employee behavioural outcomes, such as productivity and efficiency (Sellberg & Susi, 2014).

As for collective level group work, researchers suggest that digitalization may impede group work performance as well as affective group outcomes (Monzani, Ripoll, Peiro, & Dick, 2014). As virtual work becomes a popular form of group work at workplaces, its benefits, such as flexibility, autonomy, and innovation-friendliness, have been advocated by researchers (Oldham & Da Silva, 2015). However, as suggested by scholars, the task-oriented nature of virtual work can decrease the chances and quality of social interactions within the workgroup and the organization common in traditional face-to-face contacts (Monzani et al., 2014). The technological features such as being anonymous and geographically dispersed limit workers' ability to predict others' willingness to contribute and the work platform's ability to monitor workers' actual contributions (Kidwell & Bennett, 1993). Hence, online workgroups may be more susceptible to losing trust and motivation and a weakened sense of community (Chen, 2013). Individuals may activate social loafing practices to reduce their contributions to the group. This can negatively influence the workgroup's task-related outcomes as well as affective work outcomes (Monzani et al., 2014), such as work process satisfaction (i.e., the shared perception of how well the group worked together) and group cohesion (i.e., the willingness to belong to the group and work again in the future) (Kerr, 1983).

In addition to the within-group collaborations, digitalization may also impede across-group/community integration (Leonardi et al., 2013). Technological capabilities, like algorithms and recommendation systems, allow individuals to find like-minded people quickly and build a community. They can also lower the integration of knowledge across disparate communities (Van Alstyne & Brynjolfsson, 2005). That means the visibility and accessibility enabled by digital technologies could result in fragmented communities with limited cross-group communication and interaction. These effects may lead to ignoring conflicting perspectives and compromising knowledge work or boundary work outcomes (Leonard et al., 2013). Further, using social analytics tools, digital platforms retain and present much of individuals'

current and past behavioural data revealing their histories and social lives (Pike et al., 2013). Accordingly, workers may interact strategically online to manage their social presence and act disingenuously with relationships in the workplace (Boyd, 2004; Gibbs et al., 2013).

By recognizing the possible negative consequences of digital technology use on work, the literature has discussed how to help manage such issues and problems. Specifically, the literature highlights the essential role of IT design and proposes how to design information systems to avoid negative impacts. For example, researchers outlined for consideration the main characteristics of digital technologies as digital infrastructures: versatility, invisibility-in-use, adaptability, reflexivity, and interconnectedness (Meske et al., 2019; Pipek & Wulf, 2009). Chen and Karahanna (2018) suggested three technological capabilities that alleviate tensions raised by work interruption and exhaustion. These are immediacy of feedback, reprocessability, and rehearsability. Further, the authors pinpointed the differential effects of digital communication channels on adverse work outcomes – email interruptions are less likely to affect performance and exhaustion through interruptions than a phone call or instant messaging. In addition, researchers suggest that text-based digital communication channels are more likely to weaken community identity and lead to negative collective group work outcomes. They propose using more real-time rich media communication channels that provide more in-person contacts (Monzani et al., 2014).

Besides designing IT artifacts and digital infrastructure, research also highlights the essential role of higher-level organizational support in digital workplace management. Organizations should maintain alignment between digital platform logic and organizational logic, and alignment is an ongoing process that involves digital infrastructure work, digital strategy work, and aligning work (Rahrovani, 2020). For IT-organizational alignment, the research underscores the fit between task and technology. Specifically, organizations need to find the best match between task-related factors, including task mobility, task feedback, and technology characteristics, including system reliability, system accessibility, and system quality to facilitate job performance and creativity in organizations (Chung et al., 2015). Moreover, organizational culture, structure, and processes moderate the relationship between IT-work fit and worker outcomes (e.g., social norms) (Chung et al., 2015) by influencing employees' attitudes towards digital workplace transformation and work performance (Meske & Junglas, 2020). A work environment that enables employees to be autonomous, competent, and connected is vital for their expected work performance and their expected well-being in the workplace (Meske & Junglas, 2020).

Previous literature also mentions the strategic level organizational influences on digitalized workplace management. In particular, research advocates an agile approach to facilitate the operations and management of digital technologies in organizations (Kudyba, 2020; Chung et al., 2015). , A holistic approach is also emphasized. This comprehensive approach entails four aspects of work in developing digitalized workforce: human capital, structural capital, social capital, and relational capital (Kudyba, Fjermestad, & Davenport, 2020). Research especially paid attention to human capital development because individual differences (e.g., conscientiousness, self-efficacy, trust beliefs) are highly associated with technology use (Nelson et al., 2017; Oldham & Da Silva, 2015; Chung et al., 2015). The working environment is now highly social, autonomous and embraces individual differences (Greenbaum & Kyug, 1991). Therefore, organizational resources that support workers' learning and accumulation of technological knowledge are critical. With these learning opportunities, digital workers can develop their technological acuity, i.e., their understanding of digital infrastructures and capabilities of solving technical issues, and their habitual use of technology, which benefit individual and group level work performance (Nelson et al., 2017; Chung et al., 2015).

Table 6. Digital technologies, experiences, consequences, and management

Consequences	Technological issues	Important References
Individual work outcomes		
Negative behavioural outcomes (low efficiency, low productivity, time management issues, etc.)	• Information overload • Fragmented work settings and arrangements • Asynchronous communication, procrastination • Constant technological updates	Sheer & Rice (2017); Oldham & Da Silva (2015); Vuori, Helander, & Okkonen (2019); Nelson, Jarrahi, & Thomson (2017) Chen & Karahanna (2018); Sellberg & Susi (2014); Wang et al. (2008); Gao et al. (2020); Zaresani & Scott (2020)
Negative psychological outcomes (electronic leash, work-life imbalance, technostress, etc.)	• Easy access to information • Ubiquitous use of digital devices • Task-assignment nature • Constant technological updates	
Group work outcomes		
Negative task-related work outcomes (low productivity, low efficiency, social loafing, etc.)	• Increased use of computer-mediated communication • Reduced face-to-face contacts • Autonomy and asynchronous communication • Algorithms and recommendation systems • User-generated-content	Monzani et al. (2014); Zornoza et al. (2002); Chen (2013); Furumo & Pearson (2006). Oldham & Da Silva (2015); Leonardi et al. (2013); Van Alstyne & Brynjolfsson (2005); Pike et al. (2013); Gibbs et al. (2013)
Negative affective group outcomes (trust and motivation issues, reduced sense of community, group cohesion, etc.)	• Task-assignment nature • Behavioural data tracking and presentation • Anonymous and geographically dispersed • Reduced social inclusion • Weakened social ties • Weakened sense of community	
Individual differences in technology use	• Technological affordances are influenced by individual characteristics and situational factors	Oldham & Da Silva (2015); Nelson, Jarrahi, & Thomson (2017)
Management	**Dimensions**	**Important Works**
IT artifact design	• Key features, e.g., versatility, invisibility-in-use, adaptability, reflexivity, and interconnectedness • Technological capabilities, e.g., immediacy of feedback, reprocessability, and rehearsability • Types of digital tools	Meske et al. (2019); Pipek & Wulf (2009); Chen & Karahanna (2018); Monzani et al. (2014) Rahrovani (2020); Chung et al. (2015);
Higher-level organizational support	• IT-work/-organization alignment • Fit between task and technology • Organizational culture, structure, and processes	

	• Organizational strategy – an agile approach • Organizational strategy – a holistic approach involving human, structural, social, and relationship capital development • Recognizing individual differences	Meske & Junglas (2020); Kudyba (2020); Kudyba et al. (2020); Oldham & Da Silva (2015)

Theme 5: What does the research literature say about the future of work?

The last major theme that emerged from the literature centred on the future of the digitalized workplace. Research studies have attempted to look at the evolution of work environment, arrangements, and management during Industry 4.0. Specifically, the current literature discusses the management of the platform economy. Papers published in 2020 and 2021 dominated this theme. Some specifically considered the impact of the Covid-19 pandemic on the future of the digitalized workplace. In Table 7, we categorize the topics, dimensions, and important references under this theme.

The next great industrial revolution, called Industry 4.0, is characterized by "the proliferation of increasingly complex technologies that are bringing together the physical, digital, and biological worlds (e.g., 3D printing, robotics, and the internet of things)" (Rotatori, Lee, & Sleeva, 2021, p. 92). Through this industrial revolution, the entire production process leverages Internet-based networks (Johansson et al., 2017). In this context, this raises many issues about the future of work in organizations. The issues include; the role of technologies in changing organizational trends, social changes, and organizational discourses, the impact of the merger between the IT sector and manufacturing on work arrangements and employment conditions. Additional issues include the new organizational competencies and skills needed, changed gender patterns at work, transformation in the work environment, and human-technology/robot interaction (Johansson et al., 2017). For example, one of the significant implications of Industry 4.0 on the workforce is the reskilling required to support the future of work in the new era (Rotatori et al., 2021). Specifically, the technological changes may lead to continued globalization and sophistication of business process automation, resulting in changes in individual employees' capability and skill requirements, for example, increased human-technology interaction and collaboration (Briggs & Buchholz, 2019). Research emphasizes the importance of soft skills such as teamwork, communication, and collaboration, in addition to traditional hard skills such as science, engineering and math (Rotatori et al., 2021). These changes call for attention by educational institutions as well as business organizations to the workforce reskilling effort. Moreover, there has been a shift from formal education to lifelong learning.

Table 7. Digital technologies at work – Looking to the future

Topics	Dimensions	Important References
Industry 4.0 & Future of work	• The role of digital technologies in changing organizational discourses • The impact of IT-manufacturing merger on work • New organizational competencies and skills	Johansson et al. (2017); Rotatori et al. (2021); Dahlan

	• Individual capabilities and skills • Changed gender patterns at work • Human-technology/robot interaction	et al. (2019); Saari et al. (2019)
Management in the platform economy	• A dynamic process perspective that understands the trajectory of crowd workers overtime • A shift from "algorithmic management" to "platformic management", which conveys a broader sociotechnical premise of platforms' functions in structuring work	Idowu & Elbanna (2020); Jarrahi et al. (2020)
Impact of Covid-19 pandemic on future of work	• Management issues that need to be addressed in the post-Covid era, e.g., mixed modes of communications • Digital transformation at work is accelerated during the Covid-19 pandemic; concerns are intensified in terms of the integration of digital technologies into work, e.g., limitation of tacit knowledge transfer within/across organizations, inadequate access to social protection within platform works • A holistic approach to integrating different levels of organizational practices (e.g., strategic level micro-organization level), and a sociotechnical approach that integrates knowledge-based view and information system view, to build a more thorough knowledge of digitalized workplace • The adoption and use of Artificial Intelligence in future of work, e.g., the relationship between human labour and AI • Security and privacy issues within digitalized workplaces	Richter (2020); Kudyba (2020); Rani & Dhir (2020); Kodama (2020); Coombs (2020); Fahey & Hino (2020); Susanto et al. (2021)

As one typical type of work transformations during Industry 4.0, platform economy (i.e., gig economy, crowdwork) has attracted much research attention. Regarding future work on digital platforms, our research identified the following shifts. First, current platform work takes a static view that accounts for gig workers' status at a point in time (e.g., the precarious aspects of platform work, the flexible and autonomous nature of platform work). However, the future of platform work needs a more dynamic process perspective for understanding the trajectory of crowdworkers over time (Idowu & Elbanna, 2020). In particular, employees' responses and attitudes toward their job might be shaped by how they progress in their careers over time. Employees could adjust their practices according to contextual situations and resources (Hall & Chandler, 2005; Parker et al., 2006). Moreover, the future management of platform work might move beyond "algorithmic management" toward "platformic management" conveying a broader and sociotechnical premise of platforms' functions in structuring work (Jarrahi et al., 2020). Based on empirical investigations on the Upwork platform, the researchers extend algorithmic management to platformic management that represents a boundary resource that enables the autonomy needed by gig workers but that also helps enhance platform control. Researchers identified six functions of digital platforms: managing transactions, channelling communication, resolving conflicts, providing information, evaluating performance, and gatekeeping (Jarrahi et al., 2020). The conceptualization of platformic

management is broader than algorithmic management, and is built on the "organizing affordances" of the technology (Zammuto et al., 2007). From a sociotechnical perspective, platformic management conceptualizes a broader array of technological features than algorithms and relies on worker and client participation to a greater extent. Workers are not passive recipients of management and control and have their agency to strategically appropriate or solve issues. Further, Jarrahi et al. (2020) suggest that future work on digital platforms may need to accommodate the dynamics of interactions and alliances among various stakeholders in the platform economy.

In addition, research has paid attention to the transformations at work during and post-Covid-19 pandemic. Due to the impact of the Covid-19 pandemic, the digital transformation of work has been progressing faster than ever globally (Kodama, 2020). The global spread of the coronavirus has increased demands for crowd work and services (e.g., telework, online seminars), digital communication and collaboration systems (e.g., video conferencing tools), and social media platforms (Fahey & Hino, 2020; Rani & Dhir, 2020). The intense digital working experiences during the Covid-19 pandemic allow individuals and organizations to recognize the advantages of the future of work more quickly. These advantages include more consistent structured collaboration, greater transfer of knowledge through digital recordings, and greater utilization of analytics (Kudyba, 2020). As many digital technologies have been successfully integrated into work environments and processes during the pandemic and will continue after Covid-19, research indicates the need to address several management topics in the post-Covid era. These include the benefits and drawbacks of more mixed modes of communications (e.g., alternating between online and in-person) and the changes to organizational policies and cultures caused by remote work in the long term (Richter, 2020).

While we see the increased demand for digital technologies at work, we are also witnessing the magnified concerns relating to digital workplaces, such as the reduced spontaneous collaboration, reduced social interactions, and limitation of tacit knowledge transfer (Kudyba, 2020). Particularly for platform work, concerns are raised and exacerbated about low and unstable pay and about inadequate access to social protection within platform work environments (Rani & Dhir, 2020). Although digital transformation has been ongoing for years, the Covid-19 pandemic introduced a disruptive force that accelerated the process. Accordingly, scholars have suggested the development of the future of work should leverage the experiences of individual workers and organizations who endured the pandemic and seek to build knowledge of digitalized workplace development (Kudyba, 2020). For example, the future digital workplace should consider the sustainability of platform businesses, the improvement of business models, and the regulation of digital platforms (Rani & Dhir, 2020). Further, researchers are suggesting a new approach to the management of future work– undertaking a holistic perspective to integrate different levels of organizational practices such as the strategic level (e.g., dynamic capabilities framework, exploitation and exploration) and micro-organization level (e.g., individual practices and community practices), and a socio-technical perspective to integrate knowledge-based view (e.g., knowledge generation, integration) and information system view (IT capabilities), for a more comprehensive and thorough understanding (Kodama, 2020).

The impact of Covid-19 on the global economy also resulted in an increased interest in the adoption and use of Artificial Intelligence (AI) in workplaces. AI refers to a broad range of technologies encompassing machine learning, natural language processing, and robotics. During the Covid-19 pandemic, AI was widely deployed in healthcare to, for example, understand Covid-19 transmission and impact, as well as other fields, such as supporting chatbots in customer services and autonomous food/grocery delivery (Coombs,

2020). Accordingly, there has been a debate in the future of work discussions regarding the relationship between humans and AI; specifically, could AI replace human labor? (Coombs, 2020). As Covid-19 quarantine and social distancing experiences seem to lead to individuals' preference for AI in services, increased familiarity with AI technologies, and organizations' confidence in integrating AI in business, there has been a positive attitude toward the increasing adoption rates of AI in future work. However, by considering the limitations in big data availability and reliability, some researchers are hesitant about the value of AI at work in the future (Barber, 2020). Moreover, researchers underscored the importance of human creative tasks, social interactions, and interpretations in completing many work tasks (Coombs, 2020).

Another key issue highlighted by current literature regarding the future of work in the digital era is the security and privacy issue. To reduce the spread of the Covid-19 pandemic, governments and public health agencies adopted digital tracking technologies to trace individuals' personal digital devices to know their physical movements and interactions with other individuals (Fahey & Hino, 2020). However, there is a major divergence between the privacy-first approach and the data-first approach in the literature. Should citizens' data be protected first at the cost of extremely limited access for third parties, or should the data be collected and analyzed at the expense of individual privacy? In addition, companies and organizations are now becoming vulnerable due to threats in information security both internally and externally (e.g., threats in social media crime). Developing network security practices and computer systems have become a vital task for companies and organizations (Susanto et al., 2021). Organizations need to consider these issues better to develop and integrate the use of digital technologies at work.

Summary

This section provided a synthesis of the literature on work digitalization and the future of work. Framed reflecting five themes, we found that platform work is becoming dominant and will continue. Platforms expand the time, space, and place of work and restructure the work's content, processes, and relationships. Digitalization transforms the nature of work by providing entirely new business models and new forms of work and bringing new dimensions to work, such as temporal flexibility, spatial mobilization, algorithm-based management, contextual mobilization, and social mobilization. Digitalization significantly alters workplace practices in organizing work and hiring workers, communication and collaboration within and across organizations, and knowledge work.

Moreover, while digital technologies transform workplace practices, they also bring changes to organizations' social relationships, networks, and structures. We highlight benefits to work engagement and relationships, but we also expose the negative consequences resulting from the adoption of digital technologies. Accordingly, we summarized the impact of digitalization on worker experience and discussed the subsequent consequences and management issues raised. Lastly, we discussed the future of digitalized workplace by considering industry 4.0 and the Covid-19 pandemic and their impact on work.

Implications for research, public policy, and practice

Future research

Based on the comprehensive and systematic literature review of "digital technologies at work", we have identified five major themes where we found that digital technologies: 1) transform the nature of work; 2) have affordances that shape and transform workplace practices; 3) affect social networks and relationships in the workplace; 4) affect employee experiences, the challenges and consequences they

face, and the management of these effects at work; and 5) have implications for the future of work in the Industry 4.0 and post-Covid era. By integrating the five major themes, we suggest the following opportunities and directions for future research.

Applying Gibson's (1977) affordance perspective and Giddens's (1990) structuration theory to understand the interplay between digital technology and work

We have elaborated on the impact of digital technologies in creating new forms of work and transforming traditional ways of working within and across organizations. In particular, the literature emphasizes that digital technologies have various technological capabilities that function as affordances to help improve workplace practices (Vuori et al., 2019). However, based on Gibson's (1977) affordance theory, researchers argued that technological affordances might vary depending on how a given social actor interprets the material value of the technological artifact and that technological affordances are constituted through relationships and interplays between technology features, work practices, and situational and individual factors (Nelson et al., 2017; Treem & Leonardi, 2013). Hence, the same digital technology that can positively affect work outcomes, employment relationships, and worker engagement can cause low work productivity, low efficiency, social isolation, and unequal social power distributions in workplace structure (Rani & Furrer, 2021). Future research could adopt the affordance perspective to explore the positive and negative impacts of technological capabilities on work outcomes and worker engagement. Doing so will help develop a more complete understanding of the digitalized workplace. Future research could also take Giddens's (1990) structuration theory into account, applying it to explain the dualistic interplay between structure and agency. This way, they can develop a better understanding of the socialization processes associated with digitalization at work.

Taking a holistic and process view to understanding the impact of digital technology on work

Based on the literature review, we suggest that future research could employ a dynamic process view to understand the trajectory of digital workers (e.g., platform workers) over time. This approach contrasts with a static perspective that accounts for workers' status at a point in time (Idowu & Elbanna, 2020). Our research found that, when looked at from a static perspective, there are two main streams of research that either focus on the flexible and autonomous nature of platform work or the precarious and lack of social protection aspects of platform work. However, workers have the agency to change their responses and attitudes toward their jobs, shaped by their progress in their work over time and by the specific contextual situations and resources available (Parker et al., 2006). Therefore, taking a dynamic process view could enhance our understanding of digital platforms' work trajectories and help develop a generalizable theorization of the impact of digital technology on work performance and workplace relationships.

Further, by examining the processes and considering both individual agency and technological features, we emphasize a holistic view of research on digitalization at work. Researchers should consider different aspects such as human capital, social capital, and structural capital when developing a digitalized workforce (Kudyba et al., 2020). In this way, we could integrate different research streams covering strategies (dynamic capabilities, exploitation and exploration), micro-organizational practices (e.g., individual and community level), knowledge management (e.g., knowledge creation, dissemination and integration), and information systems (e.g., IT capabilities) (Kodama, 2020), to develop a more thorough understanding of digitalized work.

Research opportunities relating to the changing nature of work

Our research identified the changing nature of work resulting from digitalization: temporal flexibility, spatial mobilization, algorithm-based administration, contextual mobilization, and social mobilization. By integrating the characteristics of digitalized work into other aspects such as work practices and social effects, we identified more specific research opportunities for future research. Research questions could include: what are the positive and negative consequences of temporal flexibility, spatial, and social mobilization for workers and organizations? How may organizations develop and deploy "algorithm management" in a way that ensures employees' freedom and protection while enabling platform control and governance? How may employees balance their personal and professional lives and achieve behavioural and psychological outcomes in highly complex hybrid working environments? How does the nature of digitalized work affect individual work practices? How does the nature of digitalized work affect organizational structure, culture, and processes? How may IT artifacts and IT-work fit be designed to solve the issues caused by individual differences in technology use?

Research opportunities about the future of work in Industry 4.0 and the post-Covid era

We suggest future research to investigate the future of work issues in the Industry 4.0 and post-Covid context. As we enter Industry 4.0, increasingly complex technologies are embedded into work and bring together the physical, digital, and biological worlds (Rotatori et al., 2021). In this situation, a lot of work processes will execute within Internet-/machine-based networks. Consequently, there will be more human-machine interaction and integration (Johansson et al., 2017). Future research could investigate the new individual skills and capabilities and organizational competencies needed to support human-machine integration and future work. What will be the relationship between human labour and machine input? To what extent will artificial intelligence replace human labour? In addition, due to the impact of the Covid-19 pandemic, the digital transformation of work has accelerated. The increased demands of crowd work and services and the intense experiences of online communication and collaboration work during the Covid-19 pandemic allow workers and organizations to quickly become familiar with and recognize the benefits of digitalized work. However, the accelerated and intense use also leads us to think about the possible drawbacks and management issues in future work after the pandemic. Future research could examine questions such as: how to develop hybrid modes of work (online and offline communications and collaborations) in the post-Covid era? How to resolve the governance issues in platform work raised and exacerbated during pandemic (e.g., social protection and work condition of gig workers)? How to develop a sustainable platform business model? Should the privacy-first approach or data-first approach be applied in developing digitalized work? How to protect information security internally and externally?

Implications for public policy

Our research also has implications for public policy. Digital technologies enable the development of digital platforms and offer opportunities for non-specialists and non-knowledge workers in society to access the labour market and earn extra money. Policymakers (especially in developing countries) are investing in digital infrastructure and training these workers to complete tasks such as ridesharing, food delivery, and content writing, as a solution for the unemployment. However, as we advance within the context of the future of work, issues in labour markets and economies will arise. The Covid-19 pandemic has accelerated

long-standing trends such as income inequality and precarious work. There seems to be a gap in the literature regarding the management and control of digital platform work from a public policy perspective. Platform workers need social and informational support to maintain their agency. Public policymakers might need to conduct a thorough policy analysis of the impacts of digital technologies on employment and the economy. They must envision how organizations can move forward from applying algorithm-based management and control to a more platformic management involving broader socio-technical aspects of digital platforms.

The design features of digital platforms and their algorithmic management have created information and power asymmetry between platform employers and employees. Workers lack access to better-paid tasks or lack control over their work processes and working time. However, our research has found that digital technologies should have affordances that help employees regain their agency, improve their working conditions, and increase control over work-life balance (Nielsen et al., 2016). The key is to cultivate digital technology use capability (i.e., the employees need more knowledge and practice of digital technologies) (Helmerich et al., 2021). Therefore, public policymakers might not only need to make investments in digital infrastructure but, more importantly, provide education and training for platform workers in areas such as human-technology interaction, online communication and collaboration.   This training will help them accumulate new skills and capabilities in the digital economy (Briggs & Buchholz, 2019; Rotatori et al., 2021). Furthermore, public policymakers might want to promote the shift from traditional formal education to lifelong learning and foster collaborations between businesses, government, and educational institutions to improve knowledge accumulation and dissemination efficiency and effectiveness.

Implications for practice

Our systematic literature review has revealed that digital technologies have impacted various work tasks within and across firms and organizations. Specific technologies such as social media, digital communication tools, enterprise mobile applications have been recognized as powerful tools when used in work assignments such as hiring and training employees, communication and collaboration, knowledge generation, and innovation. Moreover, digital technologies are employed on an industry level and change work arrangements and environment in industries such as healthcare and clinic services and social work. However, while the technological capabilities bring benefits such as autonomy, mobility, and creativity to organizational practices and improve worker performance and work effectiveness and efficiency, they still result in issues and challenges in practice. For example, digitalization at work transforms the social relationships and structure in workplaces. It has positive impacts, such as enhancing individual-level and organizational-level social capital. It also has negative consequences, such as causing dysconnectivity among workers (Leonardi, 2015; Rani & Furrer, 2021). Our research suggests that organizations focus on the dynamic and ongoing interplay between the technological changes in the work environment and the individuals' agency, reveal the opportunities and tensions created by the interplay, and find solutions by utilizing various affordances of technologies (Giddens, 1991; Gibson, 1977). New technologies and changing conditions in the structure can shape employment dynamics. It can, in turn, be shaped by altered social structures (Bala & Venkatesh, 2017).

In addition, our research identified the challenges and issues existing in the management of digital technologies at work, such as the low work productivity and efficiency due to information overload, time management problems caused by asynchronous communication, technostress caused by constant

technological updates, and trust and motivation issues within digital communities. We suggest organizations pay attention to these identified problems to maximize the benefits of digitalization at work. Moreover, we highlighted the importance of IT artifact design and the role of higher-level organizational support in solving these issues. Building on the operational level utilization of digital technologies at work, organizations may need to plan, manage, support, and evaluate the use of digital technologies at work strategically. Specifically, organizations may need to consider the design of technological features and their fit with particular work tasks, the IT-work alignment, and organizational culture and strategy that could support the digitalized workplace.

Conclusion

Based on the Latent Dirichlet Allocation (LDA) topic modelling method, this research collected and analyzed 1810 academic papers that focus on the deployment and use of digital technologies at work. We identified five major topics from the literature, and we have provided a qualitative analysis and interpretation of the topics. Our research addressed the impact of digital technologies on work from various perspectives. In particular, we explained how digital technologies have transformed the nature of work; how digital technologies have shaped work practices; how digital technologies have created effects on the social networks and relationships at work; how digitalized work has affected employee experience, the consequences and challenges that resulted, and how they are to be managed; and how to develop the future of work in the Industry 4.0 and post-Covid era. Based on topic modelling and the systematic and comprehensive literature review carried out, our research provides implications for research by proposing a series of future research directions and research questions. We also discuss implications for public policy and practice.

Knowledge Mobilization Activities

We will share the knowledge developed in this research with policymakers, practitioners, and other researchers in one virtual and one face-to-face workshop. Given the uncertainty with the Covid-19 pandemic, the workshops will be planned for Winter 2022. Each workshop will have a maximum of 25 participants. The virtual seminar will be two hours long, while the face-to-face workshop will be 3 hours long. We will apply design-thinking ideas to engage policymakers and practitioners in generating policy and strategy options for addressing the challenges posed by applying advanced digital technologies to support work innovation and worker engagement. We will take advantage of the Sprott School's new Nicol Building and its innovation hub (slated to open in September 2021), to attract policy makers and practitioners from the public, private, and not-for-profit sectors in the National Capital Region (NCR) as well as from outside the region. With the new building and its facilities, we expect to hold both in-person and hybrid online workshops.

We will work with Sprott's research mobilization office to draw workshop participants from public sector organizations. We will target participants from public sector organizations such as Treasury Board of Canada Secretariat, Shared Services Canada, Canada Revenue Agency, Office of the Auditor General of Canada, Employment and Social Development Canada, Health Canada, Innovation SExport Development Canada, Canada Mortgage and Housing Corporation, Bank of Canada, Canada Post, Cities of Ottawa and Gatineau, The Ottawa Hospital, Canadian Blood Services, among other public sector entities. Private sector entities we expect to work with include Shopify, Mindbridge, Macadamian, Mitel, Nokia, and many other small and medium enterprises in the NCR. Sprott's Centre for Information Technology, Organizations, and People (CITOP) already has substantive contacts and relationships with many of these entities through previous work or alumni. Not-for-profit entities will include many non-government organizations headquartered in Ottawa, such as Care Canada, United Way Canada, and Connected Canadians, among others. All these organizations are wrestling with the issues related to digital technologies and their implications for work and worker engagement. Shopify, for example, on May 2020 declared that it is now a digital-by-default, work-from-anywhere organization and is putting its current headquarters in Ottawa up for sublease. Other entities like Shared Services Canada are developing co-working satellite offices across the National Capital Region and other areas of Canada.

We expect to produce two academic papers for publication. We will submit one to a highly selective international conference such as the *Academy of Management Conference*, the *International Conference on Information Systems* (ICIS) or the *Hawaii International Conference on Systems Sciences* (HICSS). We will submit a research paper to *Information and Management*, *Information Polity*, or a similar journal. These are international journals that publish research on digital technology issues and their implications. Information Polity, for example, is targeted at both academics and practitioners and is focused on policy issues and implications of emerging digital technologies on governance at various levels. We will also publish a practitioner-oriented paper in an outlet such as Conversation Canada. Working with the expertise of librarians at Carleton's MacOdrum Library, we will make the research, its bibliography, documents, other output available in open access repositories such as Carleton University Dataverse. The bibliography will be available through a web-based online reference manager that can be used free of charge.

We will also attend the SSHRC Skills and Work in the Digital Economy workshop on Tuesday September 21, 2021. As per the grant requirements, we will produce a synthesis report and a 2-page evidence brief

of the research for distribution to policymakers and other interested parties. When it is posted online by SSHRC we will notify interested parties through a variety of mediums, both online and print. We will arrange interviews through the Sprott School's and Carleton's media offices. We may also develop video vignettes for uploading to YouTube. By using these communication strategies, we will reach a diverse audience of policy, business, and civil society.

We will create a website containing the full report and other related information within Sprott and CITOP's web environment. Anyone coming to the site can download the report for free. We will publicize the links on social media such as LinkedIn and Twitter in line with Carleton University and the Sprott School's media strategy.

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APPENDIX 1

S.No.	Search Strings	Database	No. of results
1	(TI=((digital* OR innovation OR technolog* OR future OR COVID) AND (work* OR employ*))) AND (AB=(digital OR digitalization OR digitalisation OR digitization OR digitisation OR telecommuting OR tele-commuting OR gig OR ((work OR working OR job OR gig) NEAR/5 (home OR remote OR remotely OR virtual OR online)) OR telework OR tele-worker OR teleworking OR tele-working OR "work from anywhere")) Type: Articles Language: English Date of publication: 2010-2021 Date of search: 20210212	Web of Science Core Collection	1107
2	((AK=((digital* OR innovation OR technolog* OR future OR COVID) AND (work* OR employ*)))) AND (AB=(digital OR digitalization OR digitalisation OR digitization OR digitisation OR telecommuting OR tele-commuting OR gig OR ((work OR working OR job OR gig) NEAR/5 (home OR remote OR remotely OR virtual OR online)) OR telework OR tele-worker OR teleworking OR tele-working OR "work from anywhere")) Type: Articles Language: English Date of publication: 2010-2021 Date of search: 20210212	Web of Science Core Collection	1006
3	(TI=(((remote* OR gig OR platform) NEAR/10 (work* OR employ*)) OR telework* OR "tele-worker" OR "tele-working" OR "work from home" OR ((work* OR employ*) NEAR/10 (home OR remote* OR tele-commut* OR telecommut*)))) Type: Articles Language: English Date of publication: 2010-2021 Date of search: 20210212	Web of Science Core Collection	2290
4	(AK=(((remote* OR gig OR platform) NEAR/10 (work* OR employ*)) OR telework* OR "tele-worker" OR "tele-working" OR "work from home" OR ((work* OR employ*) NEAR/10 (home OR remote* OR tele-commut* OR telecommut*)))) Type: Articles Language: English Date of publication: 2010-2021 Date of search: 20210212	Web of Science Core Collection	696
5	TI/AK=((digiti* OR virtual OR tele* OR online OR internet OR web-based OR electronic OR mobile OR ICT OR "information and communication technology" OR "information technology" OR "information system" OR informatics) AND (work* OR employ* OR "future of work" OR "platform economy" OR "smart work*"))	Web of Science	6229
Total (Web of Science Core Collection)			**9835**

S.No.	Search Strings	Database	No. of results
1	((TITLE (((digital* OR innovation OR technolog* OR future OR covid) W/5 (work* OR employ*))) AND ABS ((technology OR technologies OR telecommuting OR tele-commuting OR gig OR ((work OR working OR job OR gig) W/5 (home OR remote OR remotely OR virtual OR online)) OR telework OR tele-worker OR teleworking OR tele-working OR "work from anywhere"))) OR (KEY (((digital* OR innovation OR technolog* OR future OR covid) W/5 (work* OR employ*))) AND ABS ((technology OR technologies OR telecommuting OR tele-commuting OR gig OR ((work OR working OR job OR gig) W/5 (home OR remote OR remotely OR virtual OR online)) OR telework OR tele-worker OR teleworking OR tele-working OR "work from anywhere"))) OR (TITLE (((remote* OR gig OR platform OR home OR virtual OR online) W/5 (work* OR employ*)) OR telework* OR "tele-worker" OR "tele-working" OR tele-commut* OR telecommut*)) OR (KEY (((remote* OR gig OR platform OR home OR virtual OR online) W/5 (work* OR employ*)) OR telework* OR "tele-worker" OR "tele-working" OR tele-commut* OR telecommut*))) AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English")) Type: Articles Language: English Date of publication: 2010-2021 Date of search: 20210317	Scopus	10400
	Total (Scopus)		**10400**