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Bridging technostress and continuous learning in knowledge-intensive organizations: A socio-technical systems approach for the future of healthy working life

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Abstract: We present an interdisciplinary exploration of technostress in knowledge-intensive organizations, including both business and healthcare settings, and its impact on a healthy working life. Technostress, a contemporary form of stress induced by information and communication technology, is associated with reduced job satisfaction, diminished organizational commitment, and adverse patient care outcomes. This article aims to construct an innovative framework, called The Integrated Technostress Resilience Framework, designed to mitigate technostress and promote continuous learning within dynamic organizational contexts. In this perspective article we incorporate a socio-technical systems approach to emphasize the complex interplay between technological and social factors in organizational settings. The proposed framework is expected to provide valuable insights into the role of transparency in digital technology utilization, with the aim of mitigating technostress. Furthermore, it seeks to extend information systems theory, particularly the Technology Acceptance Model, by offering a more nuanced understanding of technology adoption and use. Our conclusion includes considerations for the design and implementation of information systems aimed at fostering resilience and adaptability in organizations undergoing rapid technological change.

Keywords: digital transformation; information system theory; learning systems; organization design; Technology Acceptance Model (TAM); socio-economic impacts

1. Introduction

This theoretical article delves into the intricate relationships between technological disruptions, working life, and organizations in the field of nursing science and business studies. To provide a broader and more holistic view, we have incorporated economic considerations into our framework. This interdisciplinary approach has allowed us to scrutinize various facets of this complex subject, thereby developing a comprehensive understanding of the potential impacts of cutting-edge digital technologies such as artificial intelligence (AI) and automation on work environments. The buzz around workplace automation has surged exponentially due to Industry 4.0 (and 5.0) in general, and, over the past year, owing to the rise of large language models such as ChatGPT in particular. Given this rapid technological advancement, how can we keep pace with these mind-blowing developments, and what implications do they hold for our human cognition in the workplace? Thus, the primary objective of the paper is to explore the impact of technostress on Knowledge-

Intensive Organizations (KIOs), healthcare, and other sectors.

2. Understanding technostress and its impact on employees in organizations

2.1. Technostress and digital transformation

Digitization, digitalization, and digital transformation touch numerous aspects of contemporary life and are not confined to specific sectors. We categorize these concepts at different taxonomical levels. Digitization is the technical change process occurring within organizational boundaries to create user value and efficiencies, arising from the conversion of information from analog to digital format (Ritter and Pedersen, 2020). Previous publications have detailed the transition to digitalized work and its resultant technostress during the COVID-19 pandemic. One notable study highlighted the escalating issue of technostress among educators, particularly in under-resourced schools. It emphasized the critical need for balanced technology integration in educational settings. This study also pointed out that technostress disproportionately affects those with limited technological proficiency (Khlaif et al., 2023). Furthermore, research conducted in Spain investigated technostress among teleworkers, revealing significant impacts on this demographic, including students. The findings indicate that elevated levels of technostress adversely affect teleworkers' performance, their satisfaction with digital platforms, and their overall anxiety levels. Moreover, the study concluded that increased technostress correlates with heightened anxiety, which consequently diminishes job satisfaction and performance (Fernández-Fernández et al., 2023).

In this context, Vallo Hult et al. (2023) underscore the nuanced pedagogical strategies emerging from remote teaching. They reveal how digital platforms, while initially perceived as restrictive for socialization and engagement, have evolved to enable more inclusive and interactive learning environments, thus contributing positively to the digital transformation process in education. Digital transformation is a complex change process occurring across organizational and technical structures within industrial networks, aimed at achieving new value-creation goals. This change process is fueled by multiple investments, changes, and developments undertaken by various actors across the industrial network (Henriette et al., 2015).

However, the terms “digitization” and “digitalization” are often used interchangeably in a broad range of literature (Brennen and Kreiss, 2016; Henriette et al., 2015; Morakanyane et al., 2017; Ritter and Pedersen, 2020). Digitization is to digitalization what digitalization is to digital transformation: each is a nested change process within the other, but each subsequent process is more complex and encompassing than the previous one. Digital transformation represents the transition from using digital technology in work processes to performing tasks digitally (Brennen and Kreiss, 2016; Gobble, 2018).

2.2. Digitalization and work-life balance

People experience stress due to the pervasive role of technology in both their personal and professional lives (Villadsen, 2017). While these technologies are touted

as tools to enhance working life balance and professional competence, they often lead to stress, work intensification, and a culture of constant connectivity that limits individual autonomy (Khlaif et al., 2023; Villadsen, 2017). In the workplace, the ability to avoid technology is often limited, and the relationship between Information and Communication Technology (ICT) and working life balance can be complex, shaped by cultural and local factors (Barayev et al., 2021; Kusairi et al., 2023).

Factors contributing to employee stress, such as work overload, disruption of working life balance, job insecurity, and complexity (Malik et al., 2021), are associated with negative organizational consequences. These consequences are important to policymakers, politicians, and leaders because they may have societal implications. According to Stich et al. (2017), there is a 'misfit' between how people want to use ICT and how they actually utilize it. Individuals may experience occupational stress because of this. Digitalization is critical to the development of sustainable societies and is intertwined with several of Agenda 2030's Sustainable Development Goals (SDG). As a result, the Swedish government has embarked on an ambitious digitalization strategy in order to establish itself as a world leader (Eriksson, 2017).

The widespread adoption of ICT, along with the digitization of both public and private spheres, has resulted in a technological boom. Bordi et al. (2018) found that users may perceive ICT as demanding and stressful. Stress related to technology is commonly termed 'technostress'. Technostress is defined as "stress experienced by end-users in organizations because of their use of ICT" (Ragu-Nathan et al., 2008). It is often associated with the occurrence of psychological and behavioral disorders in the workplace (Cadieux et al., 2021; Camarena and Fusi, 2022). Failure to provide adequate training to staff prior to the implementation of new information systems can lead to stress (Heponiemi et al., 2021). In the context of public value, failing to manage technostress effectively individual well-being. It also undermines the organization's ability to deliver socially valued outcomes, thereby affecting its operational capacity and legitimacy in the authorizing environment (Van Gestel et al., 2024).

Moreover, research in healthcare organizations (Califf et al., 2020; Kaihlanen et al., 2021) has shown that staff face significant stress during the digitization process. In addition to basic tasks like bedside nursing, medical counseling, and therapies, technologies such as electronic health records are an integral part of healthcare professionals' daily work. Moore et al. (2020) conducted a systematic review on the impact of health information technology on nurses' time. They found that information systems led to increased time spent with patients. However, another systematic review showed that while health information technology increased the time spent on nursing documentation, it also led to a redistribution of time that improved communication with patients (Moore and Tolley, 2020). Despite the value that information systems offer to end-users and stakeholders, previous research has identified challenges such as negative attitudes (Baudin, 2020) and resistant behavior (Nilsen et al., 2016) among healthcare staff. Studies have demonstrated that factors like age, gender, education, and computer confidence influence technostress (Ragu-Nathan et al., 2008).

3. The complex dynamics of KIO in the digital age

KIO where the majority of work is intellectual in nature and where a well-educated, qualified workforce predominates (Alvesson, 2004; Mutlu, 2020). Primarily driven by technology, KIOs produce innovative products and/or services, using knowledge as their main resource. In KIOs, there exists a discernible relationship between the intrinsic characteristics of the work environment and the phenomenon of technostress. Recent empirical research by Shen and Kuang (2022) has indicated a positive correlation between technostress and the propensity for knowledge concealment among employees. Specifically, individuals experiencing elevated levels of technostress are more inclined to withhold knowledge. Learning goal orientation negatively moderated the relationship between technostress and intra-team knowledge sharing (Song et al., 2023). Technostress, work–family conflict, and perceived organizational support combined explained variance in workplace flourishing (Harunavamwe and Ward, 2022). This aligns with socio-technical systems (Bockschecker et al., 2018) and the knowledge-based view of organizations. The knowledge-based view is a management concept focused on organizational learning. It provides strategies to gain a competitive edge by increasing employee involvement in both operational goals and long-term transformational objectives. From the perspective of socio-technical theory, “development of information systems is not a purely technical issue, but an organizational issue which is fundamentally concerned with the process of change” (Leitch and Warren, 2010). Organizational strategies aimed at mitigating techno-overload can encompass the allocation of requisite resources and supportive measures to enable employees to manage their tasks proficiently. Such interventions may involve the deployment of supplemental personnel, targeted training programs, and the provision of specialized tools for workload management (Bahri et al., 2019; Sarabadani et al., 2020). However, economic evaluation is a crucial analytical tool for making informed decisions. It provides comprehensive information about the workplaces involved (Rezaghali, 2016b, 2019) and subsequently aids in implementing profitable intervention programs to mitigate techno-overload.

3.1. The complex interrelationships between the individual and the organization

The digital revolution impacts entire organizations, redefining their strategies, entrepreneurial processes, and governance mechanisms or structures (Fremont et al., 2019). Consequently, future research on digital transformation and the implementation of new technologies must be interdisciplinary to create value for both employees and employers. While much recent research has zoomed in on individual-level factors, less attention has been given to the intricate interrelationships between individuals and organizations.

In both public and private KIOs, the introduction of ICT has yielded multiple benefits for individual employees, such as the automation of mundane tasks, as well as organizational advantages like reduced cycle times and cost savings (Carayon and Hoonakker, 2019). However, it is also acknowledged that technostress is a ubiquitous phenomenon across organizations worldwide, despite the widespread use of ICT.

Thus, ICT emerges as a double-edged sword, offering both individual and organizational benefits while also creating detrimental effects. In other words, technology can be both a friend and a foe (Carroll et al., 2015; Mills, 2019). Similarly, Osarenkhoe and Fjellström (2021) argued that while digitalization relies on universally accessible technology, its effectiveness is limited by a firm's ability to capitalize on its benefits—the oxymoron of digitalization. This dualistic view extends to care seekers as well. While initiatives to enhance access to care through digitalization have been undertaken, these efforts might inadvertently widen the access gap in socioeconomically disadvantaged communities (Blix and Levay, 2018; Hung et al., 2023).

Numerous studies point to the complexities of using ICT at work. For example, research on telenurses' working life at Swedish Healthcare Direct highlights these complexities (Björkman and Salzmänn-Erikson, 2019). Challenges faced by nurses in effectively using ICT include limited engagement, increased documentation effort, and information overload (Thielmann et al., 2023). Given these challenges, the importance of research on technostress is unquestionable and could even lead to a new generation of stress-sensitive adaptive enterprise systems (Adam et al., 2014). Such intricate interactions between humans, machines, and the work environment are encapsulated in studies of 'socio-technical systems.' Our prior investigation revealed a market-driven, science fiction-based approach to the design of nursing robots, rather than an approach rooted in nursing values—a disconnect between development and users (Salzmänn-Erikson and Eriksson, 2018).

3.2. Individual-level impacts

Technostress manifests itself in various ways at the individual level, affecting employee well-being and job satisfaction (Camarena and Fusi, 2022; Harunavamwe and Ward, 2022; Mehmood et al., 2023). Additionally, the phenomenon is correlated with knowledge hiding behaviors (Shen and Kuang, 2022), which not only hamper personal growth but also disrupt the knowledge-sharing culture within organizations. This can lead to a decline in innovation and creativity, two vital components for organizational success in the knowledge economy.

3.3. Organizational-level impacts

The repercussions of technostress extend to the organizational level, impacting factors such as employee turnover, productivity, and overall organizational climate. Organizations that fail to address the issue of technostress may face elevated absenteeism rates and reduced productivity, as employees struggle to maintain a healthy work-life balance (Bahri et al., 2019; Sarabadani et al., 2020). Furthermore, techno-overload can lead to decreased operational efficiency, negating some of the initial benefits garnered through digital transformation.

3.4. Harmonizing individual and organizational goals

Understanding the interconnectedness of individual experiences of technostress and broader organizational objectives is crucial. Organizations can implement targeted interventions to alleviate technostress, such as providing digital literacy training,

establishing protocols for technology use, and promoting a supportive work environment (Song et al., 2023). By doing so, organizations can not only improve individual employee well-being but also enhance human capital performance and organizational production, thereby achieving a harmonious balance between technological advancement and human factors.

4. Healthcare 4.0 as a socio-technical system

The importance of a socio-technical systems approach is underscored, advocating for an integrated focus on both the social and technical aspects of system design. This ensures that technology acts as an enabler rather than a hindrance in work environments (Cresswell et al., 2013). In line with Cresswell et al. (2013), the socio-technical systems approach in Healthcare 4.0 emphasizes the need for an integrated focus on both social and technical aspects. This is particularly relevant for mitigating technostress among healthcare professionals. Given these complexities, the imperative for well-designed and successfully implemented technological solutions in healthcare settings becomes even more pressing. This is particularly crucial in specialized fields like geriatric care, which are expected to face numerous challenges related to technological innovations in the coming years. Moreover, nursing staff will need to continually update both their infrastructure and digital literacy skills to adapt to these rapid changes (Salzmann-Erikson and Eriksson, 2017).

Thus, healthcare staff, especially in specialized fields like geriatric care, are expected to continually update both their infrastructure and their skills in digital literacy. This often places them at risk of experiencing technostress, which Konttila et al. (2019) have argued can lead to a decrease in competency levels. As a result, interdisciplinary collaboration in Healthcare 4.0 research is not just beneficial but essential. This holistic approach combines expertise from different fields, providing a broader view that ensures technological advancements address needs of both healthcare professionals and patients. Healthcare 4.0 encompasses opportunities to reduce costs, monitor patients' vital parameters, improve diagnostics, foster collaboration, and support training and education (Tortorella et al., 2020).

By employing a socio-technical approach, healthcare organizations can create an environment where technology serves as an enabler rather than a hindrance, thereby reducing the incidence of technostress. This involves not only technological solutions but also supportive organizational structures and upskilling programs for staff.

Interdisciplinary collaboration

The need for interdisciplinary collaboration, as advocated by Tortorella et al. (2020), further supports this notion by ensuring that technological advancements are aligned with the actual needs and capabilities of healthcare professionals, thereby reducing the disconnect that often leads to technostress. Healthcare staff are required to use electronic hardware and software in their daily work (Heponiemi et al., 2021; Rai, 2022). Digital transformation has also changed the ways healthcare staff interact with patients, shifting from hospital examination rooms to digital environments (Eriksson and Salzmann-Erikson, 2013). Although digital transformation can reduce workloads and enhance the quality of patient care and safety, there is a risk that the

users lack the necessary skills or competencies (Konttila et al., 2019). In health informatics, these competencies are considered crucial among healthcare staff, yet informatics competency among nurses has been reported to be low.

The lack of competency and the feeling of inadequacy in fulfilling work obligations can lead to work-related stress. Such gaps in informatics competencies and work-related stress have received limited attention in research. Few authors (Frennert, 2019; Rantanen et al., 2021) have reported that the intention to implement digitalized services in public organizations is associated with improvements in quality of life, independence, and value creation for end-users. However, these initiatives often fail because stakeholders do not consider the entire system of implementation.

5. The powerful synergizing triologue: Value in digital transformation

In a state-of-the-art review of digitalization within socio-technical systems, Bockshecker et al. (2018) defined inter-organizational collaboration as the most studied phenomenon. Other notable aspects related to digital transformation within socio-technical systems include enhanced communication between organizations and their stakeholders (Schmidt and Pröpper, 2017), increased organizational flexibility (Schmidt and Pröpper, 2017), increased organizational flexibility (Nastjuk et al., 2016), the seamless flow of information between services (Deng and Christodoulidou, 2015), and heightened co-creation of value (Bockshecker et al., 2018). Understanding the nuanced effects of technostress within these networks can illuminate pathways for more efficient and compassionate healthcare delivery.

Also pertinent to our article is the business studies perspective, which views the phenomenon under discussion as a complex change process occurring in industrial networks. Our focus is on organizations that interact and co-create value within these networks, examining the changes and effects that digital transformation brings. This emphasis on interacting organizations that co-create value is incredibly relevant to nursing as well. In healthcare, nursing units and departments are not isolated entities; they are part of a complex network that includes medical teams, administrative staff, and even the patients themselves (Olsson et al., 2020; Smith, 2011). Understanding the changes and impacts of digital transformation within this network can contribute to more effective, efficient, and compassionate nursing care, aligning with both industrial and healthcare values.

Similarly, the field of economics provides invaluable insights into these complex change processes within industrial networks. Economics studies how individuals, firms, and societies allocate scarce resources to various users in ever-changing situations, often represented by intricate diagrams of supply and demand. This economic perspective aligns with our argument that technostress as a result of digital transformation has direct and indirect socio-economic impacts, necessitating a multi-disciplinary approach to its study and mitigation. In the context of digital transformation, economics can shed light on how resources such as time, expertise, and technology can be optimally allocated for achieving sustainable economic growth and maximizing societal welfare. Like nursing and business, economics focuses on optimizing interactions within a network—whether they be markets, healthcare

system, or industrial cluster—to create value in the most effective manner.

5.1. The dark side of ICT: Exploring technostress across organizational borders

While the remarkable advances in the field of ICT have led to significant societal benefits, there is growing evidence pointing to its “dark side” for both individual users and organizations (Tarafdar et al., 2013). In line with this, Platt et al. (2020) review on adapting to new health systems revealed that research has predominantly focused on technical solutions, with fewer studies examining the role of interpersonal interactions in complex health-promoting ecosystems (Björkman and Salzmänn-Erikson, 2019). Our integrated framework (**Figure 1**), therefore, aims to enable an organizational design that emphasizes learning, focusing on multiple stakeholders and knowledge domains in the pursuit of continuous improvement. Specifically, we compare technostress in healthcare settings and businesses.

Organizations and individuals find themselves at various stages of their learning journey. Some have developed advanced systems for continuous improvement in care, while others are just beginning. We argue that one source of technostress is the current knowledge gap affecting healthcare providers and patients. To fully understand the ramifications of the negative aspects of ICT, it is essential to explore not just the technological factors but also the economic repercussions on occupational health and well-being.

5.2. Balancing the socio-economic impacts of ICT in healthcare and KIOs: A health economics perspective

A work environmental study in the Swedish company Sandvik Materials Technology (Rezagholi, 2016a, 2018) revealed that deficiencies in the psychosocial work environment had the most significant socio-economic impacts. These impacts were particularly notable in terms of unproductive working hours, reduced work ability, and diminished work interest, especially among female workers. Given that the nursing sector, predominantly composed of female workers, faces similar challenges, which are particularly relevant as we discuss the effects of technostress in healthcare settings. However, existing research focusing specifically on technostress and its consequences among nurses or healthcare staff is noticeably limited. Some studies indicate that insufficient or inadequate training before the implementation of new electronic health record systems may jeopardize nurses’ well-being (Heponiemi et al., 2021). This gap in evidence underscores the need for further health economics research, particularly in healthcare contexts dominated by female workers.

In addition to these concerns, stressors such as unclear expectations, high job requirements, instability, job insecurity, and conflicts tend to exacerbate workers’ situations more than other psychosocial risk factors (Rezagholi, 2016a; Rezagholi and Bantekas, 2015). These stressors often arise and intensify due to ongoing or significant changes in work organization and technology. A recent study by Mehmood (2023) echoed the findings of Rezagholi (2016a) and Rezagholi and Bantekas (2015), highlighting the role of technology-induced stress factors like role overload and ambiguity in affecting job performance. This adds another layer to the complex

interplay of factors contributing to employee well-being and productivity.

Nevertheless, ICT also brings about favorable socio-economic outcomes, especially when KIOs offer high-quality services at reduced costs. ICT has a dual impact: while it can lead to negative outcomes like unemployment and health issues among KIO employees, it can also drive positive effects like cost efficiencies and improvements in total factor productivity. Given this duality, a nuanced approach by health policymakers is essential for effectively counteracting technostress-related disorders. This approach should include comprehensive occupational health economic assessments that consider both the positive and negative socio-economic impacts of ICT. Implementing and integrating workplace health promotion programs have proven to yield considerable socio-economic benefits, particularly in enhancing overall labor effectiveness by mitigating work impairments and reducing lost work hours and productivity losses (Rezaghali, 2018). Considering that elevated levels of technostress among tele-nurses could lead to additional human and socio-economic costs—especially when patients are also affected—this occupational group has been prioritized for health-economic analysis.

5.3. Exploring the interplay of technological, human, and relational aspects in addressing technostress.

The ambition to utilize ICT to alleviate workload stress has paradoxically introduced more complex issues related to technostress (Ayyagari et al., 2011; Tarafdar et al., 2010). This situation calls for a better theoretical understanding of technostress, which will aid in the development of effective organizational interventions. Understanding stress at the individual level is vital, as stress originates and manifests within individual cognitive processes—encompassing perception, emotions, and thoughts. Our work takes its theoretical position from the Resources-Experiences-Demands (RED) model, which looks at technostress at the personal, organizational and societal levels (Atanasoff and Venable, 2017). Tarafdar et al. (2010) described five technostress conditions: techno-overload; techno-invasion; techno-complexity; techno-insecurity; and techno-uncertainty. Work-related technostress, its causes, strains, inhibitors, and impact were illustrated in the work of Nisafani et al. (2020).

6. The integrated technostress resilience framework

It is essential to recognize work-related stress as a phenomenon emerging from the interaction between the individual and their work environment. Therefore, while individual-level measurements are necessary, they are not sufficient for understanding the multi-dimensional nature of technostress in an organizational context. In nursing science (Fawcett, 1984), where individuals are often seen as inseparable from their environment, this perspective gains added complexity. This holistic view allows for an in-depth understanding of how external factors like technology influence stress levels and overall well-being. Given the intricate socio-technical aspects of technostress, we advocate for an interdisciplinary approach to its study.

Our integrated framework, The Integrated Technostress Resilience Framework (**Figure 1**), aims for an organizational design centered on multi-stakeholder involvement and diverse knowledge domains, striving for continuous improvement. This framework arises from a rigorously operationalized literature review and aims to

fill existing gaps in socio-technical systems theory. It serves multiple purposes: theoretical development, empirical testing in real-world settings, and informing research design choices. **Figure 1** illustrates the features of a healthcare system characterized by continuous learning, including science and informatics, digital capture of care experiences, patient-clinician partnerships, value-aligned incentives, full transparency, a leadership-driven culture of learning, and supportive system competencies.

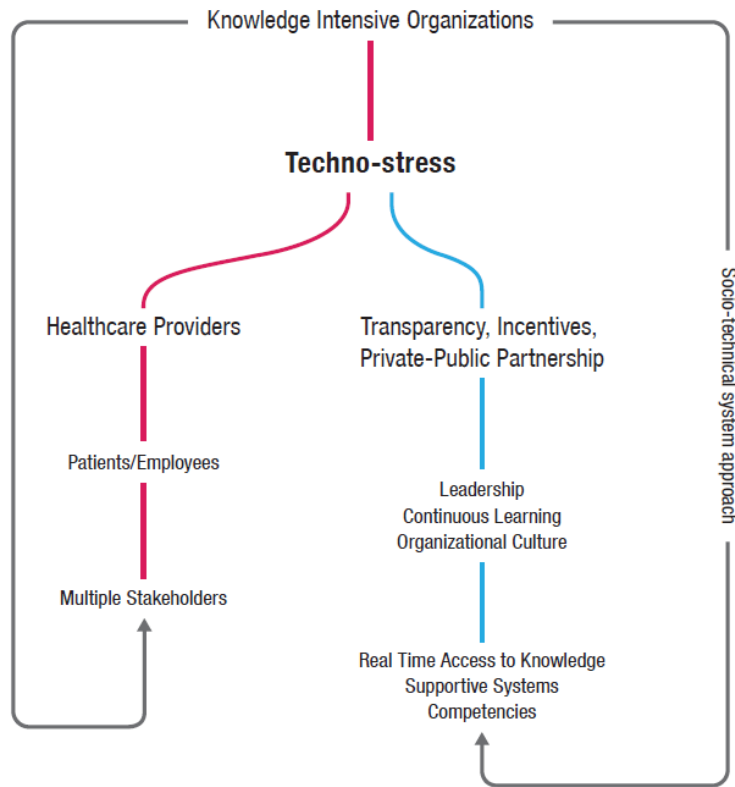


Figure 1. The integrated technostress resilience framework.

6.1. Technostress framework and technology acceptance

The parsimony of the Technology Acceptance Model (TAM), combined with its predictive power, makes it easy to apply to different situations. However, as Venkatesh and Davis (2000) and Rahimi et al. (2018) have suggested, while parsimony is TAM's strength, it is also its key limitation. The original TAM is predictive, but its generality does not provide sufficient understanding from the standpoint of providing system designers and organization systems managers (Gao and Bai, 2014). Furthermore, attempts to expand TAM so as to adapt it to the constantly changing IT environments have led to a state of theoretical chaos and confusion (Benbasat and Barki, 2007). The holistic and integrated approach operationalized will enrich information system theory.

We seek to contribute to the development of information systems theory, such as the TAM (Davis, 1989; Davis, Bagozzi et al., 1989). Our framework, The Integrated Technostress Resilience Framework (see **Figure 1**), focuses on improving information system openness and addressing the challenges posed by technostress in modern companies and KIOs similarly relies on socio-technical resources that allow KIOs to

effectively identify, collect, process, disseminate and make heterogeneous data sources transparent within and across organizational boundaries. The ability to adapt to new technology is highly individual, and support may vary in quality across organizations.

Technostress exists in many different organizations and contexts in society (Scaramuzzino and Barfoed, 2021). Importantly, an interplay of technological, human, and relational aspects underpins this value creation process (Božič and Dimovski, 2019). It is emphasized in The Integrated Technostress Resilience Framework (see **Figure 1**) the need for coordination across multiple stakeholders—patients, employees, leadership, and systems—to address this technostress. In similarity to Božič and Dimovski we argue that this value-creation process, driven by transparency, incentives, and leadership, highlights the importance of fostering continuous learning and real-time access to knowledge. These changes have created a need for more research that fosters our understanding of needs across touchpoints within the organization. Such research efforts will have significant implications for increased retention of employees, and higher levels of engagement and commitment.

6.2. Human, Technology and Organization (HTO): The subsystems of the work system

To produce innovative goods and services, both private and public KIOs are rapidly adopting digital technologies like machine learning and Big Data Analytics (Karatas et al., 2022). Concurrently, the world faces pressing societal challenges, such as demographic shifts, climate change, and social, economic, and political instability, as well as inequality and technostress (Bondanini et al., 2020). These issues profoundly impact societal health, inclusion, and freedom. Leveraging the potential of digital technology has become essential for driving innovation in knowledge-intensive sectors, including healthcare, professional services, private enterprises, and education.

On one hand, digital technologies like machine learning and augmented/virtual reality (AR/VR) offer unprecedented opportunities for creating new goods and services (Möller et al., 2008; Neely, 2014). On the other hand, the integration of automation, robotization, and artificial intelligence in the workplace raises concerns about individual well-being, work-life balance, privacy, and social justice, as well as issues related to diversity, equity, and inclusion (Galinsky and Matos, 2011; Mitchell and Kan, 2019).

Work system performance, in terms of productivity, efficiency, and quality, is continually challenged (Shanafelt et al., 2015). The rapid pace of technological advancements, including the swift adoption of digital solutions connecting various departments within and beyond a work system, opens new avenues for business opportunities and operational organization (Bray et al., 2013; Ekholm, 2017).

However, successfully navigating this landscape requires appropriate organizational structures, work processes, and a workforce prepared to deploy, manage, and engage with these technologies (Cancela et al., 2021; Toniolo-Barrios and Pitt, 2021). While new technologies may offer the flexibility to work independent of time or location, they can also introduce increasing complexity into the workplace (Kumar et al., 2021). Moreover, there is an escalating need for organizations to pursue

ecological, economic, and social sustainability. Weber et al. (2024) highlight that digital entrepreneurship, when used as a bridge between technological innovation and social sustainability, can foster significant organizational and societal benefits.

6.3. Use of socio-technical perspective to harmonize interactions and design work systems

To effectively navigate the increasing complexity in work systems, a systemic or holistic view is crucial for understanding the risks and challenges faced by individuals, teams, or entire operational activities (Checkland, 1981; Karlton, 2011; Von Bertalanffy, 1968). One such framework is Humans, Technology, and Organization (HTO) (Eklund, 2003). The HTO model is built on human work activities within a system composed of individuals, technology, and organizational structures. This focus provides insights into the work environment, required skill sets, and team interactions (Berglund and Karlton, 2007; Nolim Solman, 2002). This closely aligns with the Integrated Technostress Resilience Framework (see **Figure 1**), which also emphasizes the complex interplay between healthcare providers, transparency, incentives, and leadership in mitigating technostress. We argue that this approach is invaluable for continuously improving working conditions with the aim of enhancing system performance, well-being, and occupational safety and health (OSH)—factors often seen today as elements of social and economic sustainability.

However, adopting a systems perspective necessitates not just an understanding of the individual components—here, H, T, and O—but also their interactions. This approach highlights the importance of recognizing how alterations in one component can ripple through and affect the entire system. This perspective is rooted in socio-technical theory, which considers work systems as an interplay between a social system, involving people, and a technical system (Bockshecker et al., 2018; Carayon and Hoonakker, 2019).

HTO serves as a generic concept applicable to a wide range of operations. Like socio-technical systems, it is multidisciplinary and incorporates knowledge from fields such as information systems, nursing/health science, and social and behavioral sciences. This framework places an emphasis on both individual and overall work system design and improvement. Utilizing socio-technical theoretical perspectives can therefore facilitate a broader application of the HTO concept in evaluating, visualizing, and evolving work systems, ultimately benefiting both individuals and organizations.

HTO often bridges the gap between theory and practice and involves interactions across multiple knowledge domains (Ooms and Piepenbrink, 2021; Shnurenko et al., 2022). For example, the interaction between H (Human) and T (Technology) concerns the design of the human-machine interface (HMI), which encompasses both cognitive and physical ergonomics. The interaction between H and O focuses on practical organizational models in areas like organizational theory and work psychology (Porras and Roberston, 1992; Robbins, 1990). Lastly, the interaction between T and O has influenced the socio-technical tradition and can be found in disciplines like computer science and information systems (Eklund, 2003; Karlton, 2011). The underlying philosophy of HTO is to iteratively design technology and organizational structures while considering the needs, abilities, and limitations of human beings, rather than

starting with technology and then retrofitting humans and organizations to accommodate it.

6.4. Real-world applications of the framework

To implement the framework in real-world scenarios, organizations should begin by conducting an internal assessment to determine key stressors related to technology implementation and use. In a healthcare setting, the framework can be implemented by first assessing the specific technological stressors that nurses face, for example introduction of electronic health records or decision-support systems for telenurse. Hospitals can provide ongoing, role-specific training for nurses to build digital literacy. In doing so, new technologies can be introduced without feeling of being technologically overwhelmed. Wards managers within hospitals can promote open-door policy where nurses can communicate their challenge with technology. Another way to meet the challenges is to establish a dedicated support system, such as on-site IT assistant personnel or ‘digital champions’ within nursing teams. Future empirical research could focus on evaluating the effectiveness of specific interventions outlined in the framework across different types of healthcare wards. For example, studies could investigate how digital literacy training, leadership’s role in reducing technostress, and flexible work policies affect nurses in technologically advanced environments, such as Intensive Care Units (ICUs), versus wards less accustomed to frequent technology use, like psychiatric units. Research could also explore how the implementation of these interventions impacts nurse well-being, job performance, patient safety, and quality in care. Longitudinal studies could assess the long-term effects of technostress mitigation strategies on nurse retention and patient outcomes, comparing results across wards with different technological demands.

7. Conclusion and implications

In this article, interdisciplinary collaboration among nursing science, business studies, and economics has led to a comprehensive understanding of the effects of rapidly evolving technology on working life and organizations. We conclude that our framework, The Integrated Technostress Resilience Framework (see **Figure 1**), focuses on improving information system openness and addressing the challenges posed by technostress in modern companies and KIOs. By doing so, we offer valuable insights that will guide the design and implementation of more effective information systems, ultimately leading to more resilient and adaptive organizations in the face of rapid technological change, which also have economic benefits and values. Future research should consider empirical validation of the proposed Integrated Technostress Resilience Framework. Potential avenues include testing the framework in real-world organizational settings, particularly within knowledge-intensive sectors such as healthcare settings. Case studies could be employed to examine the framework’s applicability in mitigating technostress, fostering continuous learning, and promoting resilience.

As technostress continues to affect both organizations and various contexts, it is crucial to develop a better theoretical understanding of this phenomenon, with a focus on individual cognitive processes and the interaction between individuals and their

work environment. The (HTO) perspective provides a holistic and systemic approach to addressing the complexities of work systems, emphasizing the importance of harmonizing interactions and designing work systems that consider human capabilities and limitations.

By improving information system transparency and addressing technostress-related issues, the framework aims to offer valuable insights for the design and implementation of more effective information systems, ultimately leading to more resilient and adaptive organizations amidst rapid technological change. Addressing technostress and promoting continuous learning in KIOs requires a multi-faceted approach that includes policy implementation, managerial support, and a theoretical understanding of the socio-technical dynamics at play.

From a policy perspective, organizations can implement policies and guidelines that promote the responsible and effective use of technology, ensuring that employees have the necessary resources and support to manage technostress. This can include providing training and education on technology use, establishing clear expectations and boundaries for technology use, and creating a supportive work culture that values working life balance and well-being.

From a managerial perspective, managers play a crucial role in mitigating technostress and fostering continuous learning. They can provide support and resources to employees, such as training and development opportunities, flexible work arrangements, and regular communication channels to address concerns and provide feedback. Managers can also create a positive work environment that encourages collaboration, knowledge sharing, and innovation.

From an economic perspective, digital transformation has brought both costs and benefits at societal level. However, the socio-economic costs of digital transformation such as sick absenteeism and presenteeism may significantly be reduced while the socio-economic benefits of it such as labour productivity and societal sustainability and welfare may significantly be increased in mitigating technostress among workers in KIOs.

From a theoretical perspective, bridging technostress and continuous learning in knowledge-intensive organizations requires a socio-technical systems approach. This approach recognizes the interplay between technological and social factors in organizational settings. It considers the individual, organizational, and societal levels of technostress and explores the resources, experiences, and demands that contribute to technostress. By integrating theories such as the e.g., RED model, implementation theories, and situated cognition, a comprehensive understanding of technostress and its impact on continuous learning can be achieved.

The connection between policy, managerial, and theoretical implications for addressing technostress and promoting continuous learning in KIOs lies in the need to mitigate the negative impact of technostress on employees and organizations, while also promoting a healthy working environment and facilitating continuous learning.

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