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Conceptualizing Digital Resilience: An Intellectual Capital Perspective

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Conceptualizing Digital Resilience: An Intellectual Capital Perspective

Completed Research Paper

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Abstract

In the current era of digital transformations, numerous organizations integrate information and communication technologies (ICTs) into their core operations. However, such transformations can lead to novel risks that have to be governed in the face of disruptions. The emergence of a new risk landscape has given rise to new concepts aimed at safeguarding ICT-based operations. One of these is digital resilience (DR), a complex concept that has recently received attention from academia and regulatory bodies. However, prior work has often studied it inconsistently and offered different suggestions on how to build DR. To foster a comprehensive understanding of DR within information systems (IS), we have conducted a systematic literature review and conceptualized the problem by drawing on intellectual capital (IC) theory. We contribute to research and organizational practice by offering a novel framework with three main sub-capabilities and a comprehensive range of supporting micro-foundation, which unveils areas for future research.

Keywords: Digital Resilience, Intellectual Capital, Dynamic Capabilities, Systematic Literature Review

Introduction

The current age of digital transformation means that organizations are increasingly integrating new information and communication technologies (ICTs) into their operations, products, and services (Matt et al. 2015; Verhoef et al. 2021). While digital transformation can bring many benefits, such as increased efficiency, innovation, and competitiveness (Henriette et al. 2015), it also comes with new risks (Yucel 2018). When ICTs are becoming more and more intertwined within organizations' core processes, any major disruption affecting organizations' ICTs can influence the organization as a whole (Salovaara et al. 2019). Such risks become of even greater relevance in the face of unexpected and unprecedented disruptions that can overwhelm an individual or an organization (Gkeredakis et al. 2021).

The need to focus on this new risk landscape has been addressed by regulatory bodies, such as the European Union (EU Commission 2020), which introduced the digital operational resilience act (DORA) to safeguard ICT-based operations (i.e., digital operations) of financial institutions (Neumannova et al. 2023a).

Additionally, academic journals and publications are increasingly paying attention to digital resilience (DR), with articles and special issues devoted to this topic (e.g. Boh et al. 2023). Recent research argues that DR is not just about preventing digital disruptions, but also about preparing for and responding to them effectively. Prior initiatives and studies, however, have approached the subject one-sided and placed an emphasis on preparation as opposed to the adjustment to the disruption. In addition, policy makers mainly seem to understand resilience through ICT security principles, which can be more easily audited (such as the already noted DORA) (Neumannova et al. 2023a).

Academic research on DR has been fruitful with publications studying DR across different levels of analyses (e.g., Kohn 2020b; Schemmer et al. 2021) or offering varying reasons for its importance (e.g., Fleron et al. 2021; Tim et al. 2021). This, however, has led to inconsistent conceptualizations of the term DR (Magutshwa and Radianti 2022). The current body of knowledge on DR is, therefore, lacking common themes (Kohn 2020b, Kohn 2023) or efforts aimed to synthesize information into more comprehensive concepts (Weber et al. 2021) that can uncover patterns or trends for future research. Prior attempts to consolidate the emerging views on DR within the information systems (IS) literature have underlined its socio-technical aspects (Kohn 2020b; Weber et al. 2021), however, have not explicated it across the entire organization (Schemmer et al. 2021) or have exclusively focused on specific attributes, such as its operationalization (Kohn 2023). We postulate, in order to capture the intertwined effect of ICTs within digitally enabled or supported operations on the resilience of the organization as a whole, a theoretical framework capturing the entire organization needs to be applied.

With this study, we thus seek to develop a novel theoretical framework and understanding of DR that aligns with the realities of the digital transformation era, comprising and balancing all the essential capabilities needed to conceptualize it. To do so, we focus on the micro-foundations of DR, which are generally attributed to knowledge resources, or intellectual capital (IC) (Farzaneh et al. 2022; Singh and Rao 2016). Viewing micro-foundations based on IC elements could foster their understanding from human, structural as well as relational perspectives. Therefore, and to advance further impactful research on DR, it is relevant to align on what DR is and postulate the micro-foundations needed to achieve it. Our goal is to define DR by utilizing existing research to create a foundation from which we can ask the fundamental first research question: *What is digital resilience?* Next, we ask *how intellectual capital may contribute to digital resilience.* Finally, we ask *what promising future research areas for digital resilience* could be.

To answer these research questions, we have conducted a systematic literature review (SLR) aimed at discovering all relevant elements of IC that lead to the development of DR capabilities. We have combined SLR steps postulated by vom Brocke et al. (2015) and Webster and Watson (2002) for increased creditability and transparency, and focused on the Senior Scholar's list of premier journals in the IS field and top IS conferences which is in line with prior research (Kohn 2020b; Weber et al. 2021). We have queried AISel, EBSCO, SCOPUS and ScienceDirect databases for our research.

With this research we aim to consolidate prior perspectives on DR among IS scholars, foster an increased academic focus on this phenomenon, and conceptualize the micro-foundations needed to achieve it. Our study contributes by showing that DR is a complex phenomenon that needs to be understood across varying levels of analyses. Furthermore, we uncover that DR is built on three sub-capabilities fostered from diverse IC elements, which can be interpreted as their distinct micro-foundations. Finally, we expand extant research on DR by connecting the distinct micro-foundations to established DR sub-capabilities (i.e., Boh et al. 2023) and by aligning the diverging definitions of DR (i.e., Kohn 2023).

Resilience in the IS Literature

Resilience as a concept has been studied across many research domains for the past decades (Bhamra et al. 2011; Linnenluecke 2017). In general terms, resilience is best attributed to the ability of “*an element to return to a stable state after a disruption*” (Bhamra et al. 2011, p. 5376). In a similar manner, the most comprehensive definition of resilience within the IS literature understands it as “*the ability/power to recover form and position elastically*” (Müller et al. 2013, p. 4). One can thus imply organizations have to possess adequate resources, including intangible ones, to portray such “elasticity” (Daou et al. 2019).

Nevertheless, as resilience within the IS literature has been studied from diverse angles and standpoints, it is presently arduous to propose such implications (Weber et al. 2021). To date, there have been few attempts to streamline the dispersed research on resilience and propose generalized standpoints. For instance,

Weber et al. (2021) aimed to structure the resilience view into socio-technical and temporal components and Kohn (2020b) aimed to synthesis aspects of digital resilience connected to individuals. Boh et al. (2023), through applying a temporal perspective, postulated three main resilience capabilities of absorb, adapt, and transform built from socio-technical components. Following the work of McManus et al. (2007), Sarkar et al. (2021) and Sarkar et al. (2017) proposed that resilience is built from six overall capabilities whose micro-foundations are connected to organizations' intangible assets. Similar capabilities can be viewed in the research of Heeks and Ospina (2019), Schemmer et al. (2021) as well as Erol et al. (2010), who respectively added the increased focus on IS through redundancy, rapidity or robustness. Moreover, Heeks and Ospina (2019) proposed resilience should be conceptualized from three levels: the resilience of IS input systems (individuals), the resilience of IS (systems), and the resilience of IS output systems (organizations) (i.e., units relying on digital technologies). This has been further postulated by Kohn (2023) who aimed to unify different approaches used to operationalize resilience and Schemmer et al. (2021), who have underlined how the combined resilience of each unit relying on digital technologies leads to what they define as digital resilience.

What is Digital Resilience?

The increased number of digital transformations across organizations have led to higher number of digital operations with the strategic goal to improve core business value propositions (Gabryelczyk 2020). However, the ICTs used to transform operations into digital formats can lead to possible new vulnerabilities organizations need to account for. The notion to secure or leverage ICTs to gain resilience has already been studied across research domains, however, many researchers have not accounted for the intertwined effect of ICTs across different levels of units relying on digital technologies (Heeks and Ospina 2019; Schemmer et al. 2021). Thus, extant research introduced a novel concept, which views the resilience of organizations and their digital operations holistically – digital resilience (DR) (Boh et al. 2020). DR has to date been studied from diverse standpoints and theoretical lenses, which have inherently led to the fuzzy understanding of this phenomenon. For instance, one stream of research understands it as the overall resilience of organizations leveraging ICTs across their operations (which follows the main view of DR) (Boh et al. 2023; Schemmer et al. 2021), other research uses the same term to address the resilience of individuals (both within organizational and personal context) (Al-Abdulghani et al. 2021; Kohn 2020b), whereas yet another sees it as the resilience of communities working with/impacted by ICTs (Floetgen et al. 2021; Heeks and Ospina 2019). Furthermore, there is a difference when focusing on DR of for-profit and public organizations (Boh et al. 2023). Kohn (2023) has compared varying definitions pertaining to DR. However, her propositions have been aimed at streamlining the operational side as opposed to unifying conceptual divergences. To foster comparison among the definitions pertaining to organizations and promote conceptual convergence, we have identified a number of sources pertaining to for-profit organizations and showcase them in Table 1.

By reviewing prior conceptualizations (see Table 1), we were able to synthesize a common definition of **digital resilience** that comprises four dimensions: (1) *the unit relying on digital technologies that needs to be resilient*, (2) *the triggering disruption that requires the unit relying on digital technologies to be resilient*, (3) *the dynamic capabilities and/or micro-foundations that enable digital resilience*, and (4) *the required time-frame of organizational adaptations*. The two most important aspects of DR are the leveraging of units relying on digital technologies across diverse levels and the required swiftness to overcome disruptions. These aspects differentiate DR from similar resilience concepts in the IS literature. Table 2 offers examples of definitions pertaining to cyber security, anti-fragility or even robustness that are closely linked to DR. However, when compared with Table 1, these definitions either discuss the resilience of one unit relying on digital technologies or do not account for the time-frame of organizational changes. Furthermore, they discuss the planning aspects or define organizations only with the focus on system mechanisms that should pro-actively manage vulnerabilities. Consequently, all of these articles do not view resilience as a capability, but rather as a mechanism or a plan that needs to be executed in the light of disruptions. Nevertheless, among the definitions in Table 1 and Table 2 a common ground is visible – the dispersed connection to disruptive events, and the attributes needed to overcome them. Considering these notions, we provide the unified view on DR as ***“the capability of [unit relying on digital technologies] to swiftly apply [micro-foundations] to overcome [internal or external driven] disruptions”***.

Two conditions should be noted: DR definitions are interlinked with (1) differing disruption triggers, and (2) varying micro-foundations. The definitions in Table 1 addressed the triggering disruptions both from an internal perspective (i.e., introduction of new ICT) or from an external one, where natural disasters as well as cyber threats have been discussed. Secondly, the variables of interest in Table 1 might require a specific capability micro-foundation to ensure a higher level of DR is present. Furthermore, Table 1 showcases that the variables of interest appear to be of intangible basis which extant literature connects to the intellectual capital of organizations (Attar et al. 2019). An intellectual capital perspective could help collate the dispersed knowledge of DR capability micro-foundations and shed light into which specific intellectual capital configurations are needed to display higher levels of DR.

Source	Concept	Unit	Definition	Variables of Interest
<i>Boh et al. (2023)</i>	Digital Resilience	Firm	The capabilities developed through the use of digital technologies to absorb major shocks, adapt to disruptions, and transform to a new stable state.	<i>Redundancy, intelligent sensing, ubiquity and accessibility, experimentation, reconfigurability, scalability</i>
<i>Boh et al. (2020); Kohn (2023)</i>	Digital Resilience	Firm	The phenomena of designing, deploying, and using IS to quickly recover from or adjust to major disruptions from external shocks.	<i>n/a</i>
<i>Erol et al. (2010)</i>	Enterprise Resilience	Firm	The capability of an enterprise to connect systems, people, processes and information in a way that allows enterprise to become more connected and responsive to the dynamics of its environment, stakeholders and competitors.	<i>Adaptability, agility, flexibility, and connectivity</i>
<i>Magutshwa and Radiani (2022)</i>	Digital Resilience	Firm	The quick regaining of essential capabilities to perform critical missions during crisis and smoothly return to fully stable operations.	<i>Adaptation, innovation, agility, flexibility, and exaptation</i>
<i>Sarkar et al. (2020)</i>	Information Systems (IS) Resilience	Firm	The function of an organization's overall situation awareness related to IS, management of IS vulnerabilities, and adaptive capacity, risk intelligence, flexibility and agility of IS in a complex, dynamic, and interconnected environment.	<i>Management of IS vulnerabilities, adaptive capacity, risk intelligence, flexibility and agility</i>
<i>Schemmer et al. (2021)</i>	Digital Resilience	Firm	The property of an IS to increase the resilience of IS output systems while satisfying a sufficient resilience on sub-systems.	<i>Vulnerability, flexibility, adaptability, and agility</i>

Table 1 Definitions of DR pertaining to organizations in the IS Literature

Source	Related concepts	Unit	Definition	Difference to DR
<i>Baham et al. (2017a)</i>	Disaster Recovery	Firm	Creating and executing a plan for how an organization will resume partially or completely interrupted IT, organizational, or business critical functions within a predetermined time after a disaster or disruption has occurred.	Sees resilience as a mechanism.
<i>Björck et al. (2015); Gerlach et al. (2022)</i>	Cyber-Security	System	The protection of the confidentiality, integrity, and availability of computer systems, networks, data, and information.	Sees resilience as a mechanism.
<i>Desouza and Xie (2021)</i>	Organizational (IS) Robustness	Firm	Underlying system mechanisms to proactively and agilely respond to predictable and unpredictable crises.	Sees resilience as a mechanism.
<i>Gorgeon (2015)</i>	Anti-fragility	Firm	An alternative means of apprehending the fragility of Information Systems and a novel way of dealing with risk, uncertainty, and the unknown.	Sees resilience as a mechanism.

Table 2 Example of concepts defined in a similar manner to DR

Intellectual Capital Perspective for DR

Intellectual capital (IC) is a concept that represents organization-specific knowledge-based resources (Attar et al. 2019). While initially introduced as a concept driven by practitioners, it has gained significant academic recognition in recent decades (Bollen et al. 2005). Generally, IC is understood as the “*combination of intangible assets that allows the company to operate*” (Brooking 1996, p.25). Conceptually, IC is related to organizational learning and knowledge management, which can foster the development of dynamic capabilities (Farzaneh et al. 2022; Singh and Rao 2016). To date, researchers connecting IC and dynamic capabilities have underlined their intertwined notions (Farzaneh et al. 2022; Wu et al. 2007) or addressed IC as foundational blocks leading to the development of dynamic capabilities (Eisenhardt and Martin 2000; Singh and Rao 2016). Expanding on this notion, Bojesson and Fundin (2020) addressed the elements of intellectual capital as the micro-foundations of dynamic capabilities and postulated their conceptual similarities. This is comparable to Teece’s (2007) view on utilizing intangible resources to foster dynamic capabilities. We, therefore, imply IC comprises the organizations’ specific knowledge resources that can develop into a dynamic capability aimed to overcome disruptive events (i.e., DR) (Cheng et al. 2023; Singh and Rao 2016).

Conceptually, IC is a complex source of intangible assets which can be connected to three areas: human capital, structural capital, and relational (customer) capital (Bollen et al. 2005; Cao and Wang 2015). These three, nevertheless, need to be seen as intertwined systems where one source of capital influences the other (Attar et al. 2019). Firstly, human capital arises from the capabilities of employees. These elements can range from employees’ knowledge, experiences, innovativeness, to commitment, attitudes or competences (Bollen et al. 2005; Cao and Wang 2015). Specifically, prior knowledge, experience and abilities pertaining to industries, adverse events or technologies have been identified as inherent sources of dynamic capabilities from an individual perspective (Singh and Rao 2016; Teece 2007) and have been further attributed as variables of interest for DR (e.g., Kohn 2020b; Sarkar and Traubinger 2021). Secondly, structural capital refers to the interaction of human capital with the organization (Attar et al. 2019). It consists of the organizational structures or processes which support employees or management in

completing their tasks. Additionally, it consists of organizational infrastructures such as hardware, software or databases (Bollen et al. 2005; Cheng et al. 2023). In particular, the knowledge base, learning or utilization of IT has been attributed as an enabling factor for the presence of dynamic capabilities due to their creation of organizational wide knowledge (Kang and Snell 2009). Moreover, in connection to DR, type of infrastructure applied to govern organizations' knowledge or information is said to differentiate between resilience capable structures from less capable ones (Cheng et al. 2023). On a final note, relational (customer) capital refers to the capabilities and knowledge shared between the organization and its external stakeholders, especially with customers or suppliers (Bollen et al. 2005; Bontis 1998; Cao and Wang 2015). However, its contribution to the development of dynamic capabilities is yet to be postulated by academics. For instance, Singh and Rao (2016) have found no significant relationship between relational capital and the alliance management capabilities, which questions the effect of relational capital towards the development of DR. Furthermore, it appears only few DR articles discuss the knowledge shared between organizations and their customers/partners and its effect on resilience. These articles mainly discuss the choice of robust partners (Sarkar and Traubinger 2021), or the collaboration to foster trust (Marotta and Pearlson 2019) as elements leading to resilience capabilities.

Overall, we understand DR as the main capability enabling contemporary organizations in today's digitalized environment to withstand unforeseen events, which rests on IC elements stemming from the organization's knowledge base resources. This expands the research of Cheng et al. (2023), Singh and Rao (2016), as well as Teece (2007), who portrayed knowledge management as a micro-foundation that helps with the management of threats. Thus, each element of IC explicated above in relation to resilience within the IS literature can be understood as a possible micro-foundation of DR. Nevertheless, while previous researchers have examined various elements of human, structural, or relational capital that could be essential for the development of DR, categorizing them as micro-foundations proves challenging due to the fragmented research focus on DR. Our aim is to summarize which elements of IC have been discussed in prior literature in relation to DR as micro-foundations and connect those to DR capability.

Literature Review

Systematic literature reviews (SLRs) are a widely accepted review method among top IS journals (Okoli 2015; Webster and Watson 2002). SLRs are best suited to streamline the knowledge and understanding of complex concepts, and aims to uncover common research themes (Webster and Watson 2002). Following both Kohn (2020b) as well as Weber et al. (2021), who performed an earlier SLR of the resilience literature within IS, we apply the literature search steps of vom Brocke et al. (2015) and consider only top IS journals and conferences. We implement this to ensure the adequate information sourcing and applicability of our findings. We have only focused on the Senior Scholar's list of premier journals in the IS field and added the top 5 AIS conferences which is in line with prior research (Kohn 2020b; Weber et al. 2021).

The first step of an SLR is to identify applicable articles through querying databases. Following prior researchers, we have utilized both AIS electronic library (JAIS, MISQ and IS Conferences), EBSCO Business Premier (DSS, EJIS, ISJ, ISR, and JMIS journals), SCOPUS (JIT journal), and ScienceDirect (I&M, I&O and JSIS journal) to gain access to the Senior Scholar's list of premier journals in the IS field and IS conferences. In each of the databases we have searched for the term "*resilien**" in the abstract to account for all the concepts defined in the similar manner to DR and which could comprise relevant information (as identified in Table 2). Altogether, we have uncovered 136 articles in AISel, 16 articles in EBSCO, six articles in SCOPUS and eight articles in ScienceDirect, which we then screened for eligibility. We first looked through titles, and then searched through abstracts. We have examined the identified articles to ensure they addressed resilience as main theme of their research, explicated the incident trigger for resilience, delineated the unit relying on digital technologies that needs to be resilient, and addressed resilience micro-foundations in their research. We have disregarded papers which addressed resilience of communities, resilience of ecosystems and e-governments, and the resilience of individuals not in the context of organizations (i.e., as employees), as those have not been the focus of our research. As a last step we have disregarded non-English papers, short papers, emergent research forums, research in progress papers, literature reviews, editorials, as well as comments papers (Kohn 2023; Weber et al. 2021). Additionally, to avoid duplication, we have only focused on the newest version of an article, if a previous version has been published in conference proceedings or a journal (Kohn 2023). With all the criteria in mind, we have first screened titles, which resulted in 60 identified articles. Each of these articles have been further screened

within their abstract, which led to **40** articles chosen for qualitative appraisal. Next, we have analysed the articles based on the qualitative criteria and ended with **21** articles. As a last step, we have performed backward and forward search of the selected articles and added **two** articles. Overall, we have identified **23** articles spread among **nine** different outlets (please see Table 3).

Premier Journals in IS

DSS	I&M	JIT	JMIS	MISQ
1	3	2	1	4

IS Conferences

AMCIS	HICSS	ICIS	PACIS
4	4	2	2

Table 3 List of selected studies per each outlet

Literature Analysis and Synthesis

To fully analyse the identified articles, we have adhered to the steps outlines by Webster and Watson (2002) and used a morphology box to analyse and synthesise our selected articles. Based on Bollen et al.'s (2005) review and discussion of diverse IC frames, we find that Lynn's (1998) division of IC elements into human, structural, and relational capital (see Table 4) is the most appropriate in relation to the micro-foundations discussed in relation to DR. To analyse the literature, we have applied the steps of directed content analysis to postulate and correctly position articles based on our theoretical frame (Hsieh and Shannon 2005). Content analysis steps have been used to conceptualize fragmented concepts, and have been applied by scholars aiming to understand the topic of resilience (Conz and Magnani 2020). First, we have read the article numerous times to familiarize ourselves with the topic and content of the article, before we proceeded with the coding and sorting of the article into the predetermined categories. Second, we have identified all possible IC elements discussed, which we then, in the last step, sorted into categories, however, being mindful in case a new coding category emerged. In order to introduce a new coding category, we have first consulted Bollen et al. (2005) and looked if there is a coding category from other IC theoretical frames, which would fit better. This is especially relevant in directed content analysis if the end goal is to categorize all instances of a particular phenomenon – in our case micro-foundations of DR sub-capabilities (Hsieh and Shannon 2005). For the purpose of this paper, we have followed Weber et al. (2021) and assigned one main researcher, supported by a second one, to sort the articles into each of the categories and foster consistency.

Human Capital	Structural Capital	Relational Capital
<i>Implicit knowledge, Skills, Number of links to other nodes</i>	<i>Organizational routines, Supportive culture, Information systems, Efficiency, Transaction times, Procedural innovativeness, Access to information for codification into knowledge, Infrastructural activa (methods, technologies, processes)</i>	<i>Knowledge of marketing channels, Knowledge of customer relationships, Market orientation, Relations with other organization</i>

Table 4 Theoretical framing of intellectual capital based on Bollen et al. (2005) and Lynn (1998)

As noted above, we have identified 12 conference proceedings papers, and 11 journal articles. Methodologically, only five of the 23 identified articles worked on theory development. The rest applied empirical methods to study digital resilience. Nine articles focused on case studies, seven worked with surveys, one study has applied a Q-method approach, and one focused on a novel version of action research.

Next, we have looked for the disruptive triggers, which appeared to be of two natures – technological and environmental. Out of the selected articles, six were focused on the effect of technological disruptions and 17 discussed the impact of environmental disruptions. The articles discussing environmental disruptions explicated the effect of earthquakes (Sarkar and Traubinger 2021; Sarkar et al. 2021; Zobel 2011), pandemics (Cheng et al. 2023; Liu et al. 2023; Magutshwa and Radianti 2022; Park et al. 2023; Sarkar and Traubinger 2021; Schaffer et al. 2021), or other unspecified natural disruptions (Baskerville and Pries-Heje 2021; Boh et al. 2023; Morisse and Prigge 2017; Park et al. 2015; Sarkar et al. 2020; Teoh and Zadeh 2013). Within technological disruptions, the articles can be divided into two areas. Those that have discussed the impact of introducing new technologies, and those that have focused on cyber threats. Articles addressing the introduction of new technologies discussed the implementation of new ERP systems (Ignatiadis and Nandhakumar 2007) or the introduction of novel software for the purposes of patient-doctor communication (Cho et al. 2007). The second area of articles contextualized data security in relation to organizational culture (Marotta and Pearson 2019), security software selection (Gerlach et al. 2022; Llansó and McNeil 2021), or individuals’ coping response (Kohn 2020a).

Intellectual Capital Elements

As a next step in our analysis, we divided the articles based on the coding categories outlined in Table 4. Overall, we have identified 13 articles discussing elements pertaining to human capital, 19 articles explicated elements of structural capital, and nine articles touched the elements of relational capital (please see Table 5). Albeit we found evidence for most IC elements denoted by Lynn, our findings further indicate lacking evidence for: *number of links to other nodes* (human capital), *efficiency* and *transaction times* (structural capital).

<p>Human Capital</p>	<p>Implicit knowledge: <i>situation experience</i> (Cheng et al. 2023; Park et al. 2015; Sarkar et al. 2021), <i>knowledge</i> (Baham et al. 2017b; Morisse and Prigge 2017), <i>people knowledge</i> (Baskerville and Pries-Heje 2021)</p> <p>Skills: <i>management commitment</i> (Benitez et al. 2023; Sarkar and Traubinger 2021; Sarkar et al. 2020; Sarkar et al. 2021; Schaffer et al. 2021), <i>managerial mindfulness</i> (Magutshwa and Radianti 2022; Teoh and Zadeh 2013), <i>coping ability</i> (Kohn 2020a; Liu et al. 2023), <i>innovative responses</i> (Cheng et al. 2023; Magutshwa and Radianti 2022)</p> <p>Number of links to other nodes (not discussed)</p>
<p>Structural Capital</p>	<p>Information systems: <i>modularity</i> (Boh et al. 2023; Cheng et al. 2023; Morisse and Prigge 2017), <i>redundancy</i> (Boh et al. 2023; Morisse and Prigge 2017; Zobel 2011), <i>secureness</i> (Llansó and McNeil 2021; Morisse and Prigge 2017; Schaffer et al. 2021), <i>network connectivity</i> (Cheng et al. 2023; Cho et al. 2007; Morisse and Prigge 2017), <i>scalability</i> (Boh et al. 2023; Cheng et al. 2023), <i>intelligent sensing</i> (Boh et al. 2023), <i>robustness</i> (Morisse and Prigge 2017), <i>reusability</i> (Cheng et al. 2023), <i>standardization</i> (Morisse and Prigge 2017), <i>ubiquity</i> (Boh et al. 2023), <i>diversity</i> (Morisse and Prigge 2017), <i>compatibility</i> (Cheng et al. 2023)</p> <p>Access to information for codification into knowledge: <i>communication</i> (Cho et al. 2007; Sarkar et al. 2020; Sarkar et al. 2021), <i>learning</i> (Cho et al. 2007; Park et al. 2023; Teoh and Zadeh 2013), <i>risk assessment</i> (Gerlach et al. 2022; Magutshwa and Radianti 2022; Teoh and Zadeh 2013), <i>critical service identification</i> (Park et al. 2023; Sarkar and Traubinger 2021; Sarkar et al. 2020; Teoh and Zadeh 2013)</p> <p>Infrastructural activa: <i>agile methods</i> (Baham et al. 2017b; Baskerville and Pries-Heje 2021; Boh et al. 2023), <i>governance</i> (Boh et al. 2023; Lin et al. 2023; Morisse and Prigge 2017; Park et al. 2023), <i>continuous testing</i> (Baham et al. 2017b; Sarkar et al. 2020), <i>technology adaptations</i> (Magutshwa and Radianti 2022)</p> <p>Organizational routines: <i>flexible planning</i> (Benitez et al. 2023; Cheng et al. 2023; Sarkar et al. 2020; Sarkar et al. 2021), <i>long-term planning</i> (Morisse and Prigge 2017; Sarkar and Traubinger 2021; Sarkar et al. 2021), <i>flexible routines</i> (Boh et al. 2023; Ignatiadis and Nandhakumar 2007; Teoh and Zadeh 2013)</p>

	<p>Supportive culture (Boh et al. 2023; Morisse and Prigge 2017; Sarkar et al. 2020; Sarkar et al. 2021; Schaffer et al. 2021)</p> <p>Procedural innovativeness (Boh et al. 2023; Cho et al. 2007; Schaffer et al. 2021)</p> <p>Efficiency (not discussed)</p> <p>Transaction times (not discussed)</p>
Relational Capital	<p>Relations with other organizations (Boh et al. 2023; Cho et al. 2007; Sarkar and Traubinger 2021; Sarkar et al. 2021; Schaffer et al. 2021)</p> <p>Knowledge of marketing channels (Lin et al. 2023; Sarkar et al. 2020; Sarkar et al. 2021; Schaffer et al. 2021)</p> <p>Knowledge of customer relationships (Baskerville and Pries-Heje 2021; Schaffer et al. 2021)</p> <p>Market orientation (Liu et al. 2023)</p>
<p>Table 5 Varying levels of evidence for each type of IC element</p>	

Human Capital

In relation to human capital, we found numerous articles discussed specific types of *implicit knowledge* as well as *skills*. Within *implicit knowledge*, experience plays a significant role in achieving higher levels of resilience. For instance, Park et al. (2015), Sarkar et al. (2021) and Cheng et al. (2023) have discussed how disaster or past experience ensure greater levels of resilience, whereas Morisse and Prigge (2017), Baham et al. (2017b) purport knowledge generated through learning and experience is of high relevance to overcome disruptive situations. Additionally, Morisse and Prigge (2017) state both knowledge and experience lead to the skills employees need to aid organizations to adapt to disruptive events. Each article further denotes the importance of both, situation experience as well as knowledge, in order to withstand the disruption.

When delving into *skills*, management commitment appears to be among the most discussed abilities. Sarkar and Traubinger (2021), Sarkar et al. (2020), and Sarkar et al. (2021) have highlighted management commitment enables companies to engage in information systems resilience planning, whereas Benitez et al. (2023) underlined the effect of management commitment on adaptive notions. Schaffer et al. (2021), on the other note, stated effective and encouraging leadership is a motivational attribute enabling resilience.

While certain elements of human capital are discussed in several articles, we found that other areas received less attention in our sample. For instance, Baskerville and Pries-Heje (2021) uncovered the knowledge of people in the team or colleagues differentiates resilient teams from less resilient ones and Kohn (2020a) portrayed employees coping ability enables organizations to increase their resilience. Cheng et al. (2023) underline employees' creative responses enable organizations to deal with unexpected disruption which, according to Magutshwa and Radianti (2022), creates viable follow-up solutions. Following this line of thought, Teoh and Zadeh (2013) discussed how managerial mindfulness enables an early detection of vulnerabilities. Nevertheless, managerial mindfulness can further enable organizations' adaptive capacities during disruptive events (Magutshwa and Radianti 2022).

Structural Capital

Within structural capital, the articles have underlined several attributes of *information systems* in order to display resilience. Modularity enables adaptations due to easier changes to self-sufficient digital units (Boh et al. 2023; Cheng et al. 2023; Morisse and Prigge 2017). Redundancy enhances the ability to absorb the disruptive event though the availability of diverse options (Boh et al. 2023; Zobel 2011) and enhances the adaptive speed through extra resources (Morisse and Prigge 2017). Secureness of transmitted data enables higher levels of resiliency (Llansó and McNeil 2021; Morisse and Prigge 2017; Schaffer et al. 2021).

Access to information for codification into knowledge appears to be discussed among numerous analysed papers. Communication enables timely information transmission in order to gain awareness of the disruption (Cho et al. 2007; Sarkar et al. 2020; Sarkar et al. 2021), whereas learning can enable better adoption of the novel solutions (Cho et al. 2007; Park et al. 2023) or increase positive adjustment to

disruptions (Teoh and Zadeh 2013). Continuous risk assessment increases the secureness of the solutions (Magutshwa and Radianti 2022) and provides knowledge to assess situations to decision makers (Gerlach et al. 2022; Lin et al. 2023; Teoh and Zadeh 2013). Critical service identification enables organizations to possess understanding of key processes to withstand disruptions (Park et al. 2023; Sarkar and Traubinger 2021; Sarkar et al. 2020; Teoh and Zadeh 2013).

When delving into the types of *infrastructural activa* (i.e., the methods, technologies, and processes within organizations), the articles predominantly discussed the impact of agile methods or diverse governance frameworks. Agile methods enable easier adaptations of services or products in an uncertain environment (Baskerville and Pries-Heje 2021; Boh et al. 2023) or lead to optimized communications (Baham et al. 2017b). Governance frameworks have been attributed to better connectivity within a supply-chain context (Lin et al. 2023), lessened risk exposure (Boh et al. 2023; Morisse and Prigge 2017), and better resource prioritization (Park et al. 2023) in order to maintain operations when disruption strikes. The articles further stipulated organizations' routines should be flexible so that they can leverage technologies to quickly adapt to disruptive events (Boh et al. 2023; Ignatiadis and Nandhakumar 2007; Teoh and Zadeh 2013). Additionally, the articles denoted the routines connected to contingency planning could be two-fold. On one side flexible (scenario-based), which are adjusted to extant situations (Benitez et al. 2023; Cheng et al. 2023; Sarkar et al. 2020; Sarkar et al. 2021), on the other long-term focused, which leads to better disaster management (Morisse and Prigge 2017; Sarkar and Traubinger 2021; Sarkar et al. 2021).

Moreover, *supportive culture* plays a significant role in building resilience capabilities. The identified articles discussed culture, which stands on the principles of innovativeness, ensures that organizations can better predict changes (Morisse and Prigge 2017) or adapt to disruptions (Boh et al. 2023). Further articles argued that the focus on resilience needs to be part of an organizational strategy culture for it to have an organization-wide effect (Sarkar et al. 2020; Sarkar et al. 2021; Schaffer et al. 2021).

Procedural innovativeness is discussed through business model innovations (Boh et al. 2023; Schaffer et al. 2021) or through the adoption of telehealth innovations (Cho et al. 2007), which allow organizations to adjust to disruptive triggers.

Two elements of structural capital (*information systems* and *infrastructural activa*) appear to find evidence within single or dual articles. In order to achieve higher levels of resilience, *information systems* should enable intelligent sensing and ubiquity (which leads to quick responses) (Boh et al. 2023), be robust, standardized or diversified (Morisse and Prigge 2017), or be reusable and compatible (Cheng et al. 2023). Furthermore, network connectivity can lead to flexibility of an organization (Cheng et al. 2023) as well as the creation of novel services through the information shared within the network (Morisse and Prigge 2017). Scalability of digital platforms ensures easier adaptations by simple removals or additions of new functions (Cheng et al. 2023) and enables future transformations (Boh et al. 2023). As for *infrastructural activa*, continuous testing prepares organizations for disruptive events (Sarkar et al. 2020) or, through agile methods, enables the organization to adapt to changes (Baham et al. 2017b). Technology adaptations further enable creations of crisis-driven innovations needed to overcome disruptions (Magutshwa and Radianti 2022).

Relational Capital

Interestingly, the most discussed elements of relational capital are *relations with other organizations* and the *knowledge of marketing channels*. *Relations with other organizations* ensure the robustness of selected partners (Sarkar and Traubinger 2021; Sarkar et al. 2021), lead to novel adaptations (Schaffer et al. 2021), and help in the recognition of threats (Cho et al. 2007). They also ensure the building of complementarities (Boh et al. 2023), which help organizations to prepare for disruptions, and have the ability to adapt and transform to the newly established situation. *Knowledge of marketing channels* enables responses to changes through tacit knowledge exchange (Lin et al. 2023; Sarkar et al. 2020; Sarkar et al. 2021) or the reach to new market segments (Schaffer et al. 2021)

Only three of the four relational capital elements find marginal support within the selected literature. For instance, *knowledge of customer relationships* enables organizations to expand during crisis (Baskerville and Pries-Heje 2021) or develop new services enabling their transformative aspects (Schaffer et al. 2021). *Market orientation* has been discussed within one article and is attributed to the ability to absorb undesirable outcomes caused by disruptions (Liu et al. 2023). Liu et al. (2023) showcase how the switch

towards online market presence while retaining offline presence enabled physicians to preserve operations in the immediate period after a disruption.

Mapping IC Elements to DR Capabilities

Our findings indicate that IC elements can be connected to specific capabilities discussed in relation to resilience. Based on a modified conceptualization of DR capabilities from Boh et al. (2023), we have structured our findings in relation to three sub-capabilities: **absorb** (the capability to withstand shocks in the short-term while preserving the original structure and business model of an entity), **rebound** (the capability to withstand shocks in the mid-term while adapting to diversity) and **transform** (the capability to withstand shocks in the long-term while developing new capabilities, changing organizational structures or business models). In relation to Boh et al. (2023), we have differentiated between these capabilities more clearly by allowing for operational changes in absorption (but not business model related) and explicitly stating for which time frame each capability applies. Additionally, we refer to the term rebound as sub-capability, as opposed to absorb, which accentuates the difference between the rebound and transform stages in a greater depth. Previous research has seen the adapt and transform capabilities as unilateral (Sarkar et al., 2020), which we wanted to avoid in this conceptualization. These sub-capabilities clearly serve different purposes whilst possibly resting on partially similar foundations. Table 6 denotes our main findings and indeed shows that certain types of IC elements can be connected to multiple sub-capabilities, nevertheless, with varying levels of evidence across the articles in our sample.

	Human Capital	Structural Capital	Relational Capital
Absorb	<p>Implicit knowledge: <i>situation experience</i> (Cheng et al. 2023; Park et al. 2015; Sarkar et al. 2021), <i>knowledge</i> (Baham et al. 2017b; Morisse and Prigge 2017)</p> <p>Skills: <i>managerial mindfulness</i> (Teoh and Zadeh 2013)</p>	<p>Access to information for codification into knowledge: <i>communication</i> (Cho et al. 2007; Sarkar et al. 2020; Sarkar et al. 2021)), <i>risk assessments</i> (Gerlach et al. 2022; Lin et al. 2023; Teoh and Zadeh 2013), <i>critical services identification</i> (Park et al. 2023; Sarkar and Traubinger 2021; Sarkar et al. 2020; Teoh and Zadeh 2013)</p> <p>Organizational routines: <i>flexible planning</i> (Benitez et al. 2023; Cheng et al. 2023; Sarkar et al. 2020; Sarkar et al. 2021), <i>long-term planning</i> (Morisse and Prigge 2017; Sarkar and Traubinger 2021; Sarkar et al. 2021)</p> <p>Infrastructural activa: <i>governance</i> (Boh et al. 2023; Lin et al. 2023; Morisse and Prigge 2017; Park et al. 2023), <i>continuous testing</i> (Sarkar et al. 2020)</p> <p>Information systems: <i>redundancy</i> (Boh et al. 2023; Zobel 2011)</p> <p>Supportive culture (Morisse and Prigge 2017)</p>	<p>Knowledge of marketing channels (Sarkar et al. 2020; Sarkar et al. 2021)</p> <p>Relations with other organizations (Cho et al. 2007; Sarkar and Traubinger 2021)</p> <p>Market orientation (Liu et al. 2023)</p>
Rebound	<p>Skills: <i>coping ability</i> (Kohn 2020a), <i>managerial mindfulness</i> (Magutshwa and Radiani 2022), <i>managerial</i></p>	<p>Information systems: <i>modularity</i> (Boh et al. 2023; Cheng et al. 2023; Morisse and Prigge 2017), <i>redundancy</i> (Morisse and Prigge 2017), <i>network connectivity</i> (Cheng et al. 2023), <i>scalability</i> (Cheng et al. 2023), <i>ubiquity</i> (Boh et al. 2023)</p> <p>Infrastructural activa: <i>agile methods</i> (Baham et al. 2017b; Boh et al. 2023), <i>continuous testing</i> (Baham et al. 2017b)</p>	<p>Relations with other organizations (Schaffer et al. 2021)</p> <p>Knowledge of marketing channels (Lin et al. 2023)</p>

	commitment (Benitez et al. 2023) Implicit knowledge (Morisse and Prigge 2017)	Access to information for codification into knowledge: <i>learning</i> (Morisse and Prigge 2017; Teoh and Zadeh 2013) Organizational routines: <i>flexible routines</i> (Boh et al. 2023; Teoh and Zadeh 2013) Supportive culture (Boh et al. 2023) Procedural innovativeness (Cho et al. 2007)	
Transform	Skills: <i>innovative responses</i> (Magutshwa and Radianti 2022)	Information systems: <i>scalability</i> (Boh et al. 2023), <i>network connectivity</i> (Morisse and Prigge 2017) Infrastructural activa: <i>agile methods</i> (Baskerville and Pries-Heje 2021), <i>technology adaptations</i> (Magutshwa and Radianti 2022) Procedural innovativeness (Boh et al. 2023)	Knowledge of marketing channels (Schaffer et al. 2021) Knowledge of customer relationships (Schaffer et al. 2021) Relations with other organizations (Boh et al. 2023)

Table 6 DR sub-capabilities with micro-foundations building on Boh et al. (2023)

Discussion and Future Research Directions

Our findings contribute to unifying the view on digital resilience (DR) as a dynamic capability which is fostered through dynamic absorb, rebound and transform sub-capabilities. Based on our SLR, we have identified and uncovered micro-foundations from an intellectual capital (IC) perspective, which serve as building blocks of DR sub-capabilities. Our findings reveal that IC elements can be viewed as micro-foundations strengthening DR across these three sub-capabilities. This study’s contribution lies in denoting which micro-foundations are needed to portray specific DR sub-capabilities, however, with varying levels of evidence across the identified articles. We have demonstrated that certain micro-foundations arising from human, structural, and relational capital can serve as building blocks for multiple sub-capabilities. What is more, some of these micro-foundations (e.g., *supportive culture* or *procedural innovativeness*), in relation to sub-capabilities, are studied only by a small number of articles, which deserves particular attention. We have further explicated elements of structural capital which propose contrasting findings. For instance, organizational routines can be focused on long-term or flexible planning with high levels of evidence for both in relation to absorb sub-capability, which should be of interest to academics. Considering all of these, we contribute to future research by explicating and proposing research areas which are in need of greater evidence or appear to showcase conflicting findings.

From the human capital side, managerial mindfulness is argued to enable increased awareness as well as improvised responses, which can enable organizations to both absorb as well as rebound to disruptive events. A similar distinction has been proposed by Butler and Gray (2006) and Salovaara et al. (2019), who connect managerial mindfulness to resilient practices. However, as the number of articles discussing the effect of managerial mindfulness is limited, future research could uncover under which conditions mindfulness creates greater levels of DR through either absorb or rebound capabilities. Secondly, structural capital offers varying levels of evidence for information systems (redundancy, network connectivity, and scalability), supportive culture, and procedural innovativeness. Albeit redundancy seems to be more discussed in relation to absorb capability, Morisse and Prigge (2017) argue it leads to greater resource availability, which enhances the ability to rebound. Network connectivity, and scalability, on a different note, show varying evidence in relation to rebound and transform capabilities. When looking at supportive culture, Morisse and Prigge (2017) argued culture built on knowledge and information sharing is relevant to foster absorb capabilities, whereas Boh et al. (2023) denoted flexible culture open to experimenting leads to rebound capabilities of DR. Marotta and Pearlson (2019) postulated cyber-security culture builds trust, which is needed to absorb, rebound and transform to disruptions, and Coldwell (2010) connected bricolage culture to better information flow as well as swifter adaptations in relation to resilience. Future research

could be promising in two areas. On the one hand, it remains unclear whether redundancy does indeed enable organizations to rebound during crisis situations, and how scalability and network connectivity may support rebounding and the development of new capabilities to achieve higher levels of DR. On the other, a deeper investigation and understanding of the types of cultures that enable the building of DR and how it connects with specific DR sub-capabilities is currently missing and would benefit both research and practice alike.

Elements of relational capital appear to be dispersed across the identified articles. Albeit we have identified the importance of knowing marketing channels and having relations with other organizations in order to achieve absorb capability, the influence of relational capital elements for the rebound and transform capabilities is yet to be fully uncovered. The literature indicates relationships with suppliers or external partners enable wider information scouring and leads to the uptake of innovative practices (An et al. 2018; Feyereisen et al. 2017). Specifically, the supply chain management discipline purports tight networks with partners or customers increased the number of innovative products (Fredberg and Piller 2011) or inter-firm collaboration (Kim et al. 2010), which could enable both the rebound or transform capabilities of DR (Schaffer et al. 2021). We encourage future research to further investigate and uncover which DR sub-capabilities can be better fostered through specific elements of relational capital.

On a separate note, we would like to bring awareness to an interesting aspect when analysing organizational routines – contingency planning. Across the articles we have uncovered profound evidence for the benefits of both long-term planning (i.e., business continuity or disaster recovery plans) as well as flexible planning (situation-based). Only two noted exceptions (Sarkar et al. 2020; Sarkar et al. 2021) consider that these different types of planning techniques are connected to two types of managers. Additionally, Sarkar et al. (2017) partially reflect the role of different types of organizations. For instance, younger and resource constrained firms are not known to possess business continuity or disaster recovery plans and are more prone to focus on improvisation tactics (Järveläinen et al. 2022), which have been connected to heuristics (Neumannova et al. 2023b) or bricolage (Tsilika et al. 2020; Yu et al. 2020). However, our literature analysis did not produce a single article discussing this distinction. Future research could explicate the conditions or leading causes of different contingency planning processes from individual, systems or organizational perspectives.

What is more, we have uncovered information systems modularity has so-far only been connected to the rebound capability, albeit its effect on mitigating risks connected to technology adoptions or increased information flow has been postulated (Gopalakrishnan et al. 2022) indicating its importance to both absorb and transform capabilities of DR.

Limitations and Conclusion

In this paper, we have provided a unified view on digital resilience from an organizational perspective guided by intellectual capital theory. We have conducted a systematic literature review to investigate underlying capabilities and interlinked micro-foundations. We present digital resilience as a multi-staged concept resting on three dynamic sub-capabilities (absorb, rebound, and transform) needed at different times and rooted in distinct micro-foundations, derived from elements of intellectual capital theory. For instance, the absorb sub-capability is firstly built on human capital comprising situation experience, knowledge generated through learning and managerial mindfulness. Secondly, it also requires structural capital covering access to information which can be codified into knowledge connected to communication, risks and critical services identification, established organizational routines in relation to flexible and long-term planning, infrastructural activa standing on governance practices and the process of continuous testing, redundancy of information systems, and a supportive culture to accommodate change and limit resistance. Thirdly, the absorb sub-capability requires relational capital forged through knowledge of marketing channels enabled by tacit knowledge exchange, relations with other organizations which aid in recognizing threats, and market orientation where focus on numerous markets ensures absorption of threats in the immediate period after a disruption. These elements collectively form micro-foundations established in literature on supporting the initial absorption sub-capability of digital resilience. Similarly, both the rebound and transform sub-capabilities also draw from various intellectual capital elements to foster higher levels of digital resilience, as elaborated in the findings and discussion sections.

Additionally, we also present evidence of certain micro-foundations supporting multiple sub-capabilities of digital resilience, and discussed others that would deserve a more holistic analysis emphasizing their value for more than one sub-capability. These shared micro-foundations hold particular importance in enhancing overall understanding of digital resilience and, therefore, warrant special attention. For example, managerial mindfulness finds diverging support in relation to absorb and rebounding sub-capabilities; additional research is necessary to understand under which conditions managerial mindfulness is effective for either of the sub-capabilities.

Despite the substantial body of literature on digital resilience illustrated above, there exists a noticeable gap that has not been adequately explored. We discussed that several key questions and avenues remain under-addressed within the existing research. One such question is connected to the routines implemented to generate contingency plans. Our findings suggest there is a difference in the planning methods applied among different types of organizations where the scrutiny should be placed on younger and resource constrained firms. In particular, a special attention should be paid to the value of improvisation, heuristics or even bricolage tactics which are yet to be explicitly discussed and connected to the sub-capabilities of digital resilience fostered through structural capital elements.

Our findings are not without limitations. First, our sampling is limited due to the journal and conference publications selected for this review. The concept matrix, which is the core part of this paper, stands primarily on the shoulders of top IS journals and conference proceedings. Were we to encompass a greater number of journals or even non-academic outlets, certain ambiguities could be addressed or would not even manifest. Next, given the rapidly emerging body of research on digital resilience, our findings are limited to the publications available at the time of research. However, we view this limitation as an opportunity to guide future researchers aiming to explicate the phenomenon of digital resilience.

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