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SPECIAL ISSUE: DIGITAL RESILIENCE

BUILDING DIGITAL RESILIENCE AGAINST MAJOR SHOCKS

Waifong Boh
Nanyang Business School, Nanyang Technological University,
SINGAPORE {awfboh@ntu.edu.sg}

Panos Constantinides
Alliance Manchester Business School, University of Manchester,
Manchester, U.K. {panos.constantinides@manchester.ac.uk}

Balaji Padmanabhan
Muma College of Business, University of South Florida,
Tampa, FL, U.S.A. {bp@usf.edu}

Siva Viswanathan
Robert H. Smith School of Business, University of Maryland,
College Park, MD, U.S.A. {sviswan1@umd.edu}

Major shocks such as the COVID-19 pandemic create unique and exceptional challenges for different entities, including individuals, groups, and organizations. In this special issue editorial, we introduce the concept of digital resilience, which refers to the capabilities developed through the use of digital technologies to absorb major shocks, adapt to disruptions caused by the shocks, and transform to a new stable state, where entities are more prepared to deal with major shocks. The individual papers in this special issue offer compelling examples of how digital resilience is exhibited and how the process of digital resilience can unfold in response to specific major shocks. Drawing upon and extending these papers, we present an integrated framework of how digital technology can help build resilience capabilities, which is missing in past research but needed to mitigate and manage future major shocks, including financial recessions and climate change. We conclude with four important themes for future IS research.

Keywords: Digital resilience, major shocks, resilience capabilities, complex systems, and connected ecosystems

Introduction

The world stopped in March 2020. Whole countries went into lockdown, stores and factories shut down, streets emptied, and the skies were deserted. The SARS-CoV-2 virus shocked the world and caused a major pandemic that has come to be known as COVID-19. This was certainly not the first pandemic the world has experienced. There was the Plague of Athens in 430 BCE, the Black Death in 1347, and the Spanish Flu in 1918, among many more (Christakis, 2020; Snowden, 2019). There have also been two world wars and numerous regional conflicts, including the recent Russian invasion of Ukraine, as well as human-triggered technological disasters (e.g., the Deepwater Horizon oil spill in the Gulf of Mexico) that devastated humanity and our environment and disrupted everyday life.

Such ***major shocks,*** which we define as *existential threats that pose continuous and long-term risks to different entities, from individuals, groups, organizations, and institutions, and the complex systems in which such entities live and function*, are the focus of this special issue. Defined in this way, major shocks do not have simple, predictable effects. Rather, as past research on ecological and human-triggered disasters has shown, their effects depend on how various entities respond to such major effects over time (Constantinides, 2013; Kwon & Constantinides, 2018; Vogus & Sutcliffe, 2007). This naturally raises the question of *how* different entities can build the capabilities to become resilient to major shocks.

Resilience is a concept first advanced in ecology (Holling, 1973). Early work on resilience focused on resource management failures (e.g., in fisheries and animal habitats – see Armitage et al., 2007; Gunderson & Holling, 2002). The concept is discussed in prior work on averting tragedies concerning common pool resources (Hardin, 1968) through collective action and polycentric governance (Ostrom, 1990; Ostrom, 2010). Whether emphasizing "natural" evolutionary shocks (e.g., dominance of a species in a habitat) or human interventions into ecological systems (e.g., deforestation), this early work placed emphasis on the ways through which entities dependent on those ecological systems for common resources were able to achieve resilience. They did so by developing capabilities to *absorb* shocks while ensuring their survival and continued ability to function, *adapting* to the shocks by making changes to adjust to the new environment, and *transforming* their resource management practices with new innovations to avert collapse while positioning themselves to thrive in a fundamentally changed environment (Armitage et al., 2007; Gunderson & Holling, 2002). Drawing on this work, we define ***resilience*** *as the capabilities that entities develop to absorb a major shock, adapt to disruption caused by such a shock, and transform into a new stable state, where entities are more prepared to deal with future major shocks.*

Resilient entities can survive in the face of adversity and can even take advantage of opportunities from the shock to reform structures and processes in both themselves and in the complex system within which they operate (Home III & Orr, 1997). Clearly, not all entities will be resilient; some will be fragile. Fragility refers to *succumbing to disruptions in ways in which entities are left worse off than before the major shock.* For example, during the COVID-19 pandemic, supply-chain disruptions hurt retailers, digital divides negatively impacted children and schools, cybersecurity attacks damaged businesses and governments, and socioeconomic divides led to negative health outcomes (Rai, 2020). In such situations, it is incumbent on larger entities such as state or national governments and international organizations to provide appropriate digital and other resources that can help other entities build resilience. Clearly, in many cases, single entities by themselves may not be able to build the required resilience and will often require the ecosystems of entities to take action.

Resilience must be understood with respect to the specific threats and challenges of a major shock (Allenby & Fink, 2005). Each major shock will lead to cascading effects and consequences, as in the case of the COVID-19 pandemic that led to national lockdowns, movements toward greater protectionism, impacts on supply chain operations, global inflation, and disruptions to the social and work lives of various entities. While we cannot address all these effects in this editorial, we focus on the role of digital technologies, specifically the process of building digital resilience.

Digital Resilience

With the increasing reliance on digital data as a critical resource, digital technologies that can be used to collect and analyze such data have become a natural tool to help manage knowledge about emergent major shocks and build resilience. ***Digital resilience*** *refers to the capabilities developed through the use of digital technologies to absorb major shocks, adapt to disruptions, and transform to a new stable state.*

Many digital technologies may be involved in building digital resilience, including but not limited to intelligent hardware such as IoT devices and sensors, databases and digital infrastructures, and intelligent algorithms. Of course, digital technologies are not all implemented *solely* to achieve digital resilience. For example, the COVID-19 pandemic forced organizations to use numerous digital technologies to continue offering their services and products while complying with the new rules of global health (e.g., reducing contact with customers and increasing social distancing among employees). Although some digital capabilities developed in earlier digital transformation initiatives were doubtless important in building digital resilience, these capabilities were often motivated and developed to achieve *other* objectives, such as operational efficiencies and competitive advantages. These contrast with digital capabilities inspired and developed to achieve digital resilience.

The case of just-in-time supply chains can help us clarify this distinction between digital transformation and digital resilience. Prior to the COVID-19 pandemic, many industries had been adopting just-in-time supply chain strategies that prioritize short-term, flexible contracts with low-cost suppliers, usually in offshore locations, while relying on low stock inventories in home locations. During and following the pandemic, companies employing just-in-time strategies encountered huge disruptions in their supply chains due to unpredictable demand shocks, disrupted manufacturing supplies, shipping bottlenecks, and the global inflation of raw material prices. Optimizing efficiencies in supply chain management has increased the fragility of these supply chains as opposed to building resilience. In light of new geopolitical shocks such as the war between Russia and Ukraine and the looming shock of climate change, entities are now increasingly building capabilities for resilience, focused on "just-in-case"[1] fluctuations in supply and demand, price volatility, and social and environmental disruptions.

[1] https://www.mmh.com/article/ups_ceo_tome_urges_logisticians_to_take_totally_different_perspective_post

The IS literature on resilience has already emphasized the need for complex systems to build digital capabilities to respond to and recover from disturbances, maintain system properties and core practices, and rebound to an earlier state or move to a forward state (Floetgen et al., 2021; Heeks & Ospina, 2019; Park et al., 2015). Capabilities such as diversifying products and services, adapting business models, and scaling resources by quickly developing and deploying new digital technologies are thought to be critical in building resilience for different entities. At the individual level, no single entity can determine outcomes in a complex system (either their own, or a systemic outcome) since each entity's decisions affect and are affected by others' decisions and the external environment (Benbya et al., 2020; Merali, 2006). Individual entities may be able to influence or guide emergent outcomes (Prawesh & Padmanabhan, 2021) but they will still be dependent on the actions of other entities. At the same time, entities can utilize digital technologies to augment their resilience capabilities of absorbing, adapting, and transforming in a manner that increases the likelihood of desirable outcomes.

This special issue aims to advance our understanding of digital resilience by publishing path-breaking studies of how different entities respond to major shocks using digital technologies. During COVID-19, digital technologies played a major role in helping firms build resilience in multiple domains from public health to remote work to innovation. This special issue provides new theoretical and empirical insights that significantly enhance our understanding of digital resilience. Our goal in this special issue editorial is to provide an overview of these papers and lay out a research agenda to accelerate this work in further research.

The Special Issue Papers and Key Themes on Digital Resilience

The four empirical studies in this special issue each highlight the role of digital technologies in enabling resilience across different entities—from individual physicians building resilience by moving their patient consultations online, to universities reconfiguring their IT governance to respond to the changing demands of remote and hybrid teaching, to online communities of open source software developers adapting their contributions to different projects, to statewide resilience in response to major health shocks including the opioid crisis and the COVID-19 pandemic.

As evidence from the special issue papers shows, the absorb, adapt, and transform capabilities do not have to be sequentially developed but can and likely will overlap before, during, and after the shock. Further, some entities may jump from absorb to transform capabilities, while others will only develop absorb or adapt capabilities. This process will vary depending on the underlying characteristics of digital technologies as well as the organizational conditions for building digital resilience. We explore these points in detail in the next section, where we develop an integrated framework for understanding digital resilience.

The key themes of digital resilience from each of the four special issue papers are summarized in Table 1 and discussed below.

Individual Physicians Transforming their Practices During the COVID-19 Pandemic

Liu et al. (2023) examine the role and effectiveness of online healthcare communities (OHCs) in increasing *individual* physicians' resilience to the shock created by the first wave of the COVID-19 pandemic in China. A significant contribution of this study is the characterization of digital resilience. Drawing upon prior work that highlighted the need to consider different phases of the disruption caused by the major shock—the pre-disruption period, the disruption period, and the post-disruption period—Liu et al. primarily focus on the immediate and subsequent periods post-disruption and the role of OHCs in the resistance and the recovery aspects of resilience. According to their study, *resistance* focuses on the immediate period post-disruption and involves the ability to minimize the initial loss created by the disruption, whereas *recovery*, a measure of the ability to rebound quickly from the disruption, involves minimizing the amount of time taken to return to normal performance levels in the subsequent period. Thus, resistance and recovery highlight the need for explicitly taking into consideration the temporal aspect of the disruption created by the major shock., Liu et al. examine the effectiveness of OHCs in contributing to resistance by evaluating how belonging to an OHC mitigated the production loss caused by the pandemic for individual physicians; they examine the effectiveness of OHCs in enabling recovery by analyzing the extent to which physicians used an OHC to enable rapid resumption of their healthcare services. These OHC capabilities correspond to the absorb and transform capabilities of digital technologies described in the framework in Table 2.

Table 1. Special Issue Papers and Key Themes on Digital Resilience

Empirical study	Key themes
Liu et al. (2023). ***Understanding the Digital Resilience of Physicians during the COVID-19 Pandemic: An Empirical Study***: A natural experiment in a healthcare setting that matches two longitudinal datasets collected from a digital platform as well as offline (i.e., physical) channels, spanning 26 weeks before and after the first COVID-19 outbreak in China. The study distinguishes between physicians who use a digital platform to provide services, in addition to offering offline services to their patients, and physicians who provide only offline services to their patients to causally estimate the impact of using digital vs. offline services.	***Absorb shock*****:** Physicians who adopted a digital platform in addition to providing services offline to their patients were able to acquire new patients who transferred from the offline channel as well as totally new online patients who had not consulted with the physician previously. In contrast, physicians who only provided offline services were less able to absorb the shock. ***Transform to a new state:*** Physicians who were motivated to reconfigure their services by using digital platforms and providing online services were not only able to scale online consultations but also increased their number of offline consultations by transferring patients from the digital to the offline channel. ***Conditions for building resilience*** Only physicians who had high positive sentiments in their online interactions with patients and a high online reputation exhibited a strong ability to absorb the disruption.
Park et al. (2023). ***The Value of Centralized IT in Building Resilience During Crises: Evidence from U.S. Higher Education's Transition to Emergency Remote Teaching***: This study uses data about IT spending for 463 U.S. higher education institutions (HEIs) combined with student satisfaction ratings to examine how centralized IT investments help build resilience. The study posits that centralized IT helps organizations maintain satisfaction by enhancing the coordination of information and resources, streamlining the transition to the emergency operational mode, and helping to prioritize resources across the organization to provide technical support needed for service operations. The study compares how the impact of the pandemic on student ratings differs across HEIs with higher and lower centralized IT investments.	***Absorb shock*****:** HEIs with a larger investment per student in centralized IT were more successful in absorbing the shock and maintaining their student ratings. ***Adapt to disruptions:*** The study finds that HEIs that invested more in centralized IT adapted better to the transition to emergency remote teaching (ERT) as measured by student satisfaction ratings during the pandemic. ***Conditions for building resilience*** Higher levels of resilience are not driven by IT applications that are specific to unique needs in the educational sector (e.g., educational technology and research computing) but are instead related to aspects that can help facilitate the processes of making organizational changes and coordinating and supporting internal operations across an organization. Qualitative interviews with CIOs of HEIs revealed that centralized IT investments for facilitating organizational coordination and providing instructional support application and technical support rather than educational software and applications for facilitating student learning drove the success of ERT as measured by student satisfaction
Resilience in the Open Source Software Community: How Pandemic and Unemployment Shocks Influence Contributions to Others' And One's Own Projects: Using data on the contributions of over 18,000 open source software (OSS) community members, this study examines how major shocks impact developers' contributions to others' projects and their own projects. Using a large dataset comprising over 1.4 million observations, the study analyzes the changes in contribution behaviors of OSS community members in response to two different types of major shocks—the COVID-19 pandemic and the threat of unemployment.	***Absorb shock:*** The pandemic shock increased OSS community members' contributions to others' projects relative to their own projects, while the unemployment shock decreased OSS community members' contributions to others' projects relative to their own projects. Contributions to others' projects typically require an individual member to invest significantly more effort, compared to contributing to one's own project. If OSS community members maintain and/or increase their contributions to others' projects relative to their own in the face of major shocks, this would have significant implications for the resilience of the OSS community as a whole. ***Conditions for building resilience*** Depending on the type of major shock faced, motivations vary. While a pandemic leads primarily to a loss of interaction and is more likely to evoke prosocial behaviors in community members, the potential loss of employment threatens economic security, leading to a greater focus on oneself and one's own career.

Tremblay et al. (2023). ***Data is the New Protein: How the Commonwealth of Virginia Built Digital Resilience Muscle and Rebounded from Opioid and COVID Shocks:*** An in-depth, mixed methods study using interviews, participant observation, and statistical data to examine how the Commonwealth of Virginia (COVA) made use of data and analytical capabilities to respond to two challenging health crises—the opioid crisis and the COVID-19 pandemic.	***Absorb shock***: Ensuring the timely availability of data allows decision makers to intelligently sense their environment and achieve data integration across sources while also giving decision makers the tools needed to absorb shocks by balancing conflicting objectives with trade-offs between different domains (e.g. health vs. economics). ***Adapt to disruption:*** Based on data, COVA was able to adapt its practices to address both health needs (e.g., increasing hospital bed capacity and testing capacity) and economic demands (e.g., providing compensation to individuals that lost their jobs). ***Transform to a new state:*** COVA designed and implemented new data sharing agreements between agencies and private organizations that enabled deidentified data to be exchanged at scale and on demand. This provides the capabilities for organizations to share data when affected by the next major shock. ***Conditions for building resilience:*** Data exchange is very much dependent on building trust between collaborating parties and reinforcing such trust with robust governance structures and mechanisms

Higher Education Institutions and the Role of IT Governance in Building Digital Resilience

Park et al. (2023) examine the role of IT governance in enabling *organization*-level digital resilience to the disruption caused by the pandemic in the context of higher educational institutions (HEIs). While prior studies have highlighted the trade-offs between the coordination efficiency of centralization and the responsiveness enabled by decentralization and suggested that the decentralized governance of IT is better for organizations to be nimble and responsive to dynamic and uncertain environments, Park et al. (2023) find that the opposite is true in the case of the severe disruption and extreme levels of turbulence and uncertainty caused by the COVID-19 pandemic. The magnitude and unprecedented nature of the disruption forced many HEIs into a rapid emergency response mode that heightened the importance and benefits of centralized coordination, as compared to the benefits of flexibility enabled by decentralization. The empirical findings of this study highlight the need for further studies that examine the boundary conditions of these trade-offs imposed by different types of IT governance structures and their role in building digital resilience.

Open-Source Software Communities: How Member Contributions Build Collective Digital Resilience

Malgonde et al. (2023) examine *community*-level resilience with a specific focus on open-source software (OSS) communities and how they can stay resilient in the face of major natural and economic shocks through adaptations at the individual level by community members. Their findings provide interesting insights into how different types of major shocks can impact individual motivations and behaviors in different ways with significant consequences for the community at large and how communities absorb and adapt to different types of external shocks. Their study adds to the understanding of digital resilience by broadening the discourse on digital resilience beyond the effects of digital technologies through examining how major shocks can impact individuals' motivations and contributions to the creation of public digital goods. This study also emphasizes the importance of understanding the motivations behind individual behaviors and how they can change in response to different major shocks.

State Governments' Use of Data Analytics in Building Digital Resilience

The COVID-19 pandemic has unequivocally underscored the important role that governments play in ensuring the resilience of citizens. Local and national governments have responded to the pandemic with wide-ranging regulations and measures that have significant trade-offs—while saving lives and ensuring the health of the population are critically important, such measures often compromise the freedom of populations and cause significant disruptions to how people live, work, and learn. Similarly, governments must make important decisions about how they should allocate their limited resources. The pandemic greatly increased costs related to healthcare expenditures and the economic subsidies needed to compensate businesses and individuals affected by pandemic-related measures imposed by governments in many countries. The case presented by Tremblay et al. (2023) aptly illustrates how data and digital resources helped create digital resilience by allowing decision makers to make decisions that manage these trade-offs. Overall, this paper makes important contributions to the literature by fleshing out how the intelligent sensing capabilities of an entity help build digital resilience.

A Theoretical Framework for Digital Resilience Research

Building on the key themes of the special issue papers, we propose a theoretical framework that can help us understand how entities build digital resilience. This framework integrates prior IS research on resilience by elaborating on how the capabilities of absorb, adapt, and transform can be developed while leveraging different characteristics of digital technologies, as summarized in Table 2. The framework also elaborates how developing these resilience capabilities is conditioned by organizational structures, processes, and the motivations of different entities. Together, the characteristics of digital technologies and organizational conditions provide an integrated framework delineating how entities can build resilience and mitigate major shocks. We offer empirical evidence from the special issue papers and examples of how other entities have responded to major shocks.

Absorbing a Major Shock

Absorption refers to the capability to withstand shocks while preserving the original structure and operations of an entity (Martin & Sunley, 2015). This may entail minimizing the initial loss immediately after the occurrence of a shock to ensure the continued survival of the entity. There are many examples of entities that were so damaged by the COVID-19 pandemic and the associated restrictions that they eventually failed. However, other entities exhibited a greater ability to absorb major shocks and are still operational. The *absorb* capability serves to loosen the coupling between the entity and the changed environment, attempting to reduce variations through changes that enable entities to cope with major shocks.

A good example of entities' capability to absorb the COVID-19 shock pandemic can be seen in the airline industry, which was particularly hard hit by the pandemic. While some airlines were forced to declare bankruptcy, others worked hard to absorb the shock and survived the pandemic. Singapore Airlines came up with a series of creative approaches to generate alternative revenue streams. These included providing dining experiences for customers on stationary planes and flights to nowhere, which proved to be highly popular for travel-deprived individuals, home delivery of flight meals, and even flying lessons in simulators. Singapore Airlines also redeployed their cabin crew to the healthcare sector as "care ambassadors" and refitted their passenger planes to carry cargo rather than passengers.[2] While these initiatives certainly do not represent systemic changes to the airline's business model, they present an attempt to use otherwise idle resources in innovative ways to absorb the shock presented by the pandemic to ensure survival.

This idea of using idle resources or "slack" has been extensively discussed in the literature on supply chain management and is the opposite of the just-in-time strategies we discussed earlier. For example, slack in inventory and cash can potentially help organizations absorb fluctuations in inventory availability and the resource requirements caused by major shocks (Kovach et al., 2015). This slack in physical resources often goes hand in hand with the redundancy enabled by digital technologies, which we describe next.

Redundancy: Creating a Diversity of Options for Continuity

The redundancy associated with digital technologies can help entities ensure continuity while absorbing shocks (Sahebjamnia et al., 2015; Wang et al., 2010). We highlight the importance of both the redundancy *of* digital technologies and the redundancy *enabled by* digital technologies, since both played major roles in absorbing the shock caused by the COVID-19 pandemic.

As most organized activities moved online, many entities (e.g., universities with cloud e-learning systems in place) benefitted from inherent redundancies provided by cloud computing infrastructures that supported the sudden increase in the use of computational and data resources. These infrastructures are designed to be redundant and scalable, to have increased fault tolerance, and to lower the switching costs for firms, so that if one data storage or computing facility goes down in a major shock, alternate facilities can take over (Cheraghlou et al., 2016), which can be helpful during a major shock.[3] Cloud service contracts can provide significant redundant capacity for businesses, which can also be helpful in such situations.

[2] https://www.aerospace-technology.com/comment/singapore-airlines-impact-covid-19-pandemic/

[3] https://www.forbes.com/sites/forbestechcouncil/2021/01/15/how-the-pandemic-has-accelerated-cloud-adoption/?sh=5be6bb3e6621

Table 2. A Theoretical Framework for Digital Resilience Research

	Resilience capabilities		
	Absorb	**Adapt**	**Transform**
Digital technology characteristics	• **Redundancy:** *Creating diversity of options for continuity.* • **Intelligent sensing:** *Gathering and analyzing data to anticipate and withstand the shock*	• **Ubiquity and accessibility:** *Responding quickly to disruptions* • **Experimentation:** *Engaging in rapid learning, development, and implementation*	• **Reconfigurability:** *Leveraging the modularity and recombinability of digital technologies* • **Scalability:** *Leveraging the power of digital platforms*
Conditions for building resilience	• **Coordination:** *Facilitating internal operations, identifying redundant (or slack) resources, and supporting their swift utilization across entities* • **Data governance:** *Organizing structures for ensuring trust regarding the use of data between collaborating entities*	• **Organizational restructuring:** *Enacting organizational routines to leverage available technologies (e.g., moving from offline to digital activities)* • **Adaptive culture and positive mindset:** *Being open and flexible to experimenting (and failing) with new ways of working*	• **Business model innovations:** *Assessing the impact of reconfigured technologies on existing and new business opportunities* • **Ecosystem strategies:** *Building multilateral complementarities that can enable scale and stronger resilience against future shocks*

Even in cases where slack resources are not readily available, cloud infrastructures provide low switching costs and swift scalability. In this case, digital technologies enable redundancy. In the retail sector, for instance, traditional stores were able to support customer interactions through alternate digital channels (e.g., Instacart) and mobile payment apps. Likewise, universities replaced or supplemented in-person teaching with virtual or hybrid classes, as shown by Park et al. (2023). This redundancy was enabled by existing digital technologies (e.g., Zoom, MS Teams) as well as combinations of other apps for virtual classroom interaction (e.g., Miro, Kahoot!), all of which were enabled by cloud computing infrastructures.

At the same time, as Park et al. (2023) show, the capability to absorb requires processes for facilitating internal operations, identifying redundant (or slack) resources, and supporting their swift utilization across entities. Swiftly switching to an alternative operational mode is paramount to absorbing the shock. In their paper, Liu et al. (2023) show that despite the sudden drop in the number of offline consultations for all physicians, physicians who adopted the online health community (OHC) portal prior to the onset of the pandemic were able to resist the disruption and absorb the shock much better than the physicians who primarily stayed with the offline channel. While the OHC portal served as a secondary channel for physicians and their patients prior to the pandemic, this redundancy proved to be a lifeline during the pandemic, helping physicians effectively absorb the shock caused by the sudden and significant disruption in offline visits. Liu et al. also show that specific attributes of the digital channel, such as the visibility of physicians' online reputation and the positivity of their online interactions were key drivers of their ability to absorb the shock caused by the pandemic.

Intelligent Sensing: Gathering and Analyzing Data to Anticipate and Withstand the Shock

Another important attribute of digital technologies that enables organizations to build capabilities for absorbing major shocks is the intelligent sensing characteristics of digital technologies. Real-time analytics and decision-making are increasingly utilizing intelligent algorithms. As shown in the

COVA case described in Tremblay et al. (2023), intelligent sensing helped entities make informed decisions that considered important trade-offs in a highly uncertain environment, enabling targeted strategies rather than costly one-size-fits-all approaches.

The increasing analytical power of digital technologies enables entities to monitor changes in the environment and record, store, communicate, and analyze the data collected (Yoo, 2010). For example, countries like Taiwan and Singapore have made use of contact tracing apps that leverage mobile devices to collect information about the locations of individuals and their interactions with other nearby devices. Such devices and apps equip entities to collect different types of information in an unobtrusive manner, increasing the context awareness of individuals and facilitating contact tracing when the need arises (Dourish, 2001). The greater the information collection and analytical capabilities of digital technologies, the greater the specificity of information and focus it enables (Nambisan, 2017). Thus, entities can better identify novel interactions and strategies to adopt in response to emergent major shocks.

During the COVID-19 pandemic, for instance, as consumers flocked online, e-commerce faced many challenges, including having to adapt to new queries on search engines from consumers who were using online channels to buy products they would have previously purchased at a store (Guthrie et al., 2021). Google Analytics tools provided the real-time capability to sense such changing queries, allowing online retailers to change their search engine advertising strategies to adapt and respond to consumers. Given the typically tight margins of retail, such real-time sensing abilities can help firms withstand shocks.

Healthcare was also managed more effectively during the crisis, thanks to intelligent sensing. For instance, Tampa General Hospital[4] partnered with other hospitals in Florida early on in the pandemic to construct a real-time dashboard using shared data to monitor resource (beds/ICU) availability and patient volume and trends, which helped all the hospitals in the region. The University of Minnesota also launched a comprehensive hospitalization tracking dashboard that provided a real-time glimpse of how hospitalizations were trending across the U.S.[5] Hospitals and governments were better able to absorb the COVID-19 shock by using such information to proactively plan for resource needs.

Many firms also faced increased inventory costs and supply chain disruptions due to difficulties in forecasting demand as consumer behaviors changed and supply chains were disrupted. Nike, for example, faced problems related to labor shortages and the calibration of their supply and demand.[6] In pursuit of a more dynamic supply chain network, the firm relied on RFID technologies to increase inventory visibility, along with increased predictive analytics to better forecast demand and bring their products to the right places. While these examples show the importance of building intelligent sensing capabilities to effectively adapt to changing supply and demand during a major shock, the importance of robust governance structures to ensure the effective sharing and usage of data is critical. As Tremblay et al. (2023) show, barriers related to data sharing and use can only be overcome if governance structures are in place that ensure trustworthiness and relationship building between collaborating entities.

Adapting to Disruption Caused by a Major Shock

In addition to absorbing major shocks, resilience also entails the capability to adapt to adversity (Hollnagel et al., 2006). Researchers have also referred to adaptation as rebounding—i.e., to a previous or a better state (Woods, 2015). To do this, entities need to function in an environment that may be significantly different, and established operations, processes, models, or assumptions must change to adjust to the different environment. Entities can adapt by responding quickly to disruptions through ubiquitous and accessible technologies and by learning, developing, and implementing changes through experimentation.

Ubiquity & Accessibility: Responding Quickly to Disruptions

Advances in computer storage, communication hardware, and software have made digital technologies highly ubiquitous—such that the functioning of social and business systems is inseparable from the use of technology (Yoo, 2010). This ubiquity and accessibility of digital technologies—such as end-user computing devices (phones/iPads), intelligent algorithms, robotic systems, cloud-enabled enterprise systems, and data analytics—have made a significant difference in enabling organizations to adapt to major shocks.

[4] https://www.tgh.org/news/tgh-press-releases/2020/april/tampa-general-hospital-unites-with-florida-hospitals-to-share-data-in-the-fight-against-covid-19

[5] https://www.aacsb.edu/about-us/advocacy/member-spotlight/innovations-that-inspire/2021/university-of-minnesota

[6] https://www.fm-magazine.com/news/2021/jan/coronavirus-supply-chain-disruptions-kelloggs-nike-hp.html

These ubiquitous and accessible technologies are increasingly augmenting financial transactions, power grids and transportation systems, healthcare services, and supply chain and logistics networks.

For example, one medium enterprise in Singapore that distributed and installed manufacturing technology for clients found that they were able to ship the machinery to clients overseas, only to have the technology sitting on clients' shop floors because their engineers could not travel to clients' locations to help them with the installation. The company adopted augmented reality glasses—by shipping the glasses to clients, their engineers could see what the local engineers were seeing and they could give the clients' engineers detailed instructions to help them to install the technology.

Similar examples have shown up in other sectors as well. In the social services sector, for instance, the Greater Boston Food Bank[7] used widespread access to devices and technology to switch to contactless service and curbside pickups to continue battling (increased) food insecurity during the COVID-19 pandemic. To combat the fear of exposure to the virus, the food bank used robots to clean and sanitize potentially exposed spaces. These initiatives highlight that the ubiquity and accessibility of technology during the crisis were critical to enabling adaptation to disruptions.

Although digital technologies and tools are often easily accessible, organizations must be prepared to make internal organizational changes to tap these digital technologies. To leverage the widespread availability of digital technologies to quickly convert their usual offline activities to online activities, organizations need to make changes to multiple aspects of their internal processes and staff capabilities and make quick pivots in their business. This suggests that firms that are better equipped to make rapid adaptations and more digitally prepared may be better able to make the adaptations needed to leverage digital technologies. For example, American Eagle Outfitters acquired a digital fulfillment operator to enable them to take greater control of their supply chain.[8] The digital fulfillment operator supplements their digital capabilities with robots that aid them in fulfilling shipping orders for digital apparel and lifestyle brands. Such capabilities are critical because retailers are increasingly using online platforms that prioritize rapid home delivery and low-cost shipping. This example shows that while digital technologies are ubiquitous and the organizational adoption of such technologies were often necessary during the pandemic, organizations need to acquire wider capabilities to effectively leverage these digital technologies.

Experimentation: Engaging in Rapid Learning, Development, and Implementation

In adapting to the disruptions caused by a major shock, entities engage in experimentation with new services and products through agile methods such as DevOps and SCRUM (Abrahamsson et al., 2017). The uncertainty caused by the major shock coupled with the need to adopt new technologies suggests that organizations are faced with multiple possibilities and options during a shock and often do not have a clear idea of the path forward that can best help them adapt to and recover from the shock. As digital technologies can enable the rapid development of new product ideas and business models through new cycles of experimentation, the options facing organizations become much less bounded (Yoo et al., 2010). For example, in the face of quickly changing consumer behaviors during the pandemic (Sheth, 2020), online platforms with built-in A/B testing capabilities enabled rapid, real-time experimentation to help firms remain adaptable (Kohavi et al., 2020). Another interesting example is how the Mosaic Youth Theater of Detroit embraced the idea of "small experiments with rapid intent" to explore different ways of delivering the same training, coaching, and mentoring services through online channels. The lessons learned from these experiments are changing the way that Mosaic offers its services to budding artists in the post-pandemic world as well.

While digital technologies can be rapidly adopted and changed, entities need to have an adaptive culture and a positive mindset to engage in experimentation. For example, Liu et al. (2023) show that physicians who were able to adapt to the COVID-19 disruption had more positive sentiments about the changes needed to provide medical services both on digital platforms and in face-to-face consultations. Their adaptive mindset and personal resilience in the face of the COVID-19 shock allowed them to experiment with new ways of working.

Transforming to a New Stable State

A major shock can cause individuals to recognize the significance and importance of the changes that are needed to bring about a new post-shock reality. Such deep and revolutionary changes cannot always be achieved through short-term adjustments and the quick fixes that organizations use to adapt to a shock. Rather, these changes often require

[7] https://www.mckinsey.com/featured-insights/food-security/digital-transformation-comes-to-food-banks

[8] https://www.wsj.com/articles/american-eagle-outfitters-to-buy-quiet-logistics-for-350-million-11635850920?mod=djemlogistics_h

fundamental transformations (O'Brien, 2012; Pelling, 2010) that entail the development of new capabilities, changing organizational structures (Fjeldstad & Snow, 2018), or even new business models (Teece, 2018).

The 2010 Deepwater Horizon Oil Spill in the Gulf of Mexico was an ecological disaster that served as a wake-up call for the industry. Since then, the industry has transformed itself by using a plethora of digital technologies to avert such disasters. These technologies provide the mitigation, detection, characterization, and quick remediation of oil spills and gas releases. For example, the oil and gas industry has adopted "AI Digital Twin" technologies—a digital representation of the entire process that enables real-time analytics of the health of assets while enabling "what if" scenario planning to detect flaws before issues arise. In addition, the use of IoT technologies, more sophisticated predictive modeling of oil spills and ocean currents, remote sensing technologies, real-time analytics from sensors, and pattern recognition of normal and abnormal behaviors from different equipment have dramatically improved the industry's resilience to such major shocks.

Reconfigurability: Leveraging the Modularity and Recombinability of Digital Technologies

The set of emerging digital technologies used in the oil and gas industry can be characterized as modular and recombinable. Modularity refers to systems that are designed to be composed of distinct and relatively self-sufficient units loosely coupled through well-defined interfaces (Baldwin & Clarke, 2000). Modularity is often desirable because highly integrated and coupled system designs are hard to understand and change, whereas modular systems are easier to amend, and functional modifications can thus take place more easily (Yoo et al., 2010). Various modules of digital technologies can thus be readily recombined to generate systems and objects with new functionalities (Arthur, 2009). Changes in the environment require organizations to adapt existing technologies in new ways or quickly repurpose and combine existing technologies to help the organizations recover and rebound from a major shock. The reconfigurability of digital technologies is thus critical for building digital resilience.

Continuing with an earlier example, the Greater Boston Food Bank was motivated by the crisis to transform into a "digital first" organization (Baskerville et al., 2020), by leveraging the existing technologies it had (predictive analytics, warehousing technology, mobile devices, collaboration technologies) and implementing some new ones to create a digital-first experience for all their stakeholders (food recipients, donors, distributors, and government programs and agencies). This required them to rethink the entire experience from the perspective of each stakeholder and design new solutions combining old components with new ideas.

The reconfigurability of digital technologies may be a boon, or bane, as rapid changes to digital technologies can be made with deep learning and reflections or in quick iterations without much thought. Organizations need to reflect on the key learnings in each phase of their adaptation and transformation process to understand how digital technologies should be adapted to help them prepare for the next shock. This requires organizations to be able to evaluate their options while understanding the trade-offs involving the reconfigurability of digital technologies in the context of new and existing business models.

Scalability: Leveraging the Power of Digital Platforms

While the ability to rapidly learn through experimentation, accompanied by the ease of reconfigurability of digital technologies, can enable organizations to quickly identify ways to adapt to external shocks, successful new configurations would need to be scaled quickly to meet the needs of a "new normal." Moving beyond experimentation and pivoting to a new configuration could lead to sudden surges in demand, access to new markets, and the influx of new customers with different needs. The scalability of digital technologies can enable firms to handle such sudden surges in demand. However, sudden increases in demand could have ripple effects, impacting other processes such as security as well as performance metrics such as speed of response.

Digital platforms provide digital resources to enable value-creating interactions between different entities while leveraging demand-side economies of scale (Constantinides et al., 2018; Parker et al., 2017). During the pandemic, several restaurants were forced to discontinue in-person dining. However, the availability of platforms such as DoorDash and Uber Eats enabled these restaurants to quickly switch to take-out orders, which enabled them to continue their operations at scale and gain access to new markets. Other platforms such as Marketboomer and Fairmarkit have enabled different entities to scale quickly, without compromising key performance indicators. Both Marketboomer and Fairmarkit incentivize buyers to bring their own existing suppliers to their sourcing and procurement marketplaces. Suppliers have a better platform for interacting with existing and potentially new customers (e.g., managing schedules, payments, records), while buyers benefit from the competition among suppliers across different verticals, decreasing their search and transaction costs. Digital platforms can accelerate indirect network effects and help entities scale and expand their deployment as they identify solutions and approaches that work. This helps entities transform by injecting new capabilities that may help them cope with the new environment.

The pandemic accelerated the transformation of higher education toward remote, online educational offers by universities. [9] This transformation has been in the making for the last two decades, as it reflects the complex landscape posed by a generative digital transformation of business activities. Platforms like Coursera, edX and Udemy have started offering massive open online courses (MOOC) that are designed to scale on demand to address the growing skills gap in emerging technologies; such platforms recruit instructors on demand, based on their expertise in specific topics. A current strategy of MOOC providers is to partner with universities rather than competing with them by helping them outsource their online degrees, thereby gaining the trust of learners. Universities can choose how much of the total student experience to outsource to these providers, from marketing and recruitment, admissions, online course management, and curriculum design to course instruction and assessment. Evidently, just like other entities, universities are facing significant disruptions at scale, which requires partnerships across the higher education ecosystem. The scalability of digital platforms will likely play a key role in shaping the future of higher education.

Implications for Research, Policy, and Practice

The proposed framework inspires a set of themes for future research, which we discuss in this section. In so doing, we build on our theoretical framework but extend the focus into broader areas where research, policy, and practice might be productively pursued for further research into digital resilience. We refer to these themes as: (1) the development of public-private ecosystems to build resilience across entities, (2) the design and implementation of governance structures for collective action against major shocks, (3) policy reforms to address digital inequalities, and (4) the temporality of resilience capabilities. Table 3 summarizes these themes.

The Development of Public-Private Ecosystems to Build Resilience across Entities

The looming global recession, inflation, and constrained access to affordable raw materials are creating a tsunami of shocks for both private and public sectors, which are struggling to find ways to circumvent high costs while ensuring the sustainability of everyday operations. This tsunami of shocks is being compounded by the devastating effects of climate change, which are creating a stranglehold on access to resources for some entities and causing waves of economic migration to (yet) unaffected areas. On top of this, the COVID-19 pandemic not only surfaced the challenges faced by the global health system, including shortages in basic medical supplies for developing countries, but also revealed a complex ecology of pathogens that can break free at any given point, reproduce, and thrive exactly because of our interconnected social and business lives. Furthermore, supply chain fragility has been revealed as a significant issue, exacerbated by factory closures, worker shortages, and higher energy costs. These problems present an urgent need to design and develop public-private partnerships that can help us collectively build resilient supply chains and improve our responsiveness to the next crisis.

All these emergent major shocks require national, state, and international governments to work together with private-sector firms to build resilience through *public-private ecosystems* that go beyond a single government or group of companies to encompass a wider set of public and private sector entities. For public-private ecosystems to work together to build collective resilience, this requires data sharing and co-investment in digital technologies. As noted by Tremblay et al. (2023), such partnerships require building trust and relationships and the conscious building of capabilities. Hence, there is greater scope to examine how digital infrastructure and technologies can enable better coordination in public-private ecosystems and how to facilitate digital resilience in such partnerships. Further research should more explicitly examine the role of digital technologies in public-private ecosystems. Some relevant research questions include: *How can potentially conflicting objectives (i.e., private vs public good) be jointly pursued while building digital resilience for diverse entities? How can digital technologies be deployed to support and sustain the development of public-private ecosystems for digital resilience?*

[9] https://hbr.org/2020/09/the-pandemic-pushed-universities-online-the-change-was-long-overdue

Table 3. Themes for Further Research, Policy, and Practice

Theme	**Relevance**	**Possible research questions**
The development of public-private ecosystems to build resilience across entities	Emergent environmental, health, and business shocks (e.g., climate change, global inflation) require national governments, nongovernmental organizations (NGOs), and private sector firms to work together to build collective resilience. This requires data sharing and co-investment in digital technologies. To ensure the rapid provision of goods and services in anticipation of future external shocks, public entities may need to build digital infrastructures and develop mechanisms that enable better coordination with private entities.	• How can potentially conflicting objectives be jointly pursued while building digital resilience for diverse entities? • How can digital technologies be deployed to support and sustain the development of public-private ecosystems for digital resilience?
The design and implementation of governance and regulatory structures for creating digital resilience to enable collective action against major shocks	Digital tools and platforms enable rapid experimentation to drive digital transformation and innovation, helping entities to adapt and transform. Such tools and platforms, however, give much power to platform providers. In addition, data is also often controlled by a powerful few, who use such data to innovate new services and products but also to prepare for the next major shock. Centralization and digital platforms tend to concentrate power, which may pose a threat to resilience if such power is not appropriately governed. More adaptive governance structures are needed for digital resilience to enable collective action against major shocks.	• What are appropriate governance and regulatory structures with which to counter major shocks while balancing the needs of different stakeholders?
The need to institute reforms and mechanisms to address digital inequalities	There are significant digital inequalities between entities in relation to access to digital technologies such as connectivity and mobile devices but also in relation to entities' capabilities to gain benefits from their use of technology. These digital inequalities become accentuated during major shocks, with significant negative implications for building health and economic resilience.	• How can existing policies be reformed and mechanisms introduced to reduce digital inequalities and help entities to build resilience?

The temporality of resilience capabilities	Capabilities enabled by digital technology can help entities become more resilient but they must exist prior to the major shock. Preparation is important. Building capabilities to withstand major shocks is an important and potentially expensive effort. Like cybersecurity and disaster recovery planning, strategizing how exactly this needs to be done also must be a priority.	• How can entities *prepare* to build digital resilience to major shocks? • How do the absorb, adapt, and transform capabilities play out in time to respond to major shocks?

The Design and Implementation of Governance and Regulatory Structures for Collective Action against Major Shocks

Digital tools and platforms helped entities ranging from individuals to large and small businesses adapt and transform themselves in response to the COVID-19 pandemic, leading to rapid experimentation and the adoption of digital technologies and platforms. Such platforms, however, tend to concentrate much power in the hands of a few powerful providers. As shown by Park et al. (2023), in the case of severe disruption and extreme uncertainty resulting from the COVID-19 pandemic, the requirement for a rapid emergency response mode creates a greater need for centralized coordination. Such centralization of power may pose a threat to resilience if such powers are not adequately governed and regulated. Equally, power concentration can exclude alternative viewpoints engendering polarization and "ideological groupthink" (Kitchens et al., 2020).

The need for effective governance of common pools of resources to build resilience for heterogeneous collections of entities (Ostrom, 1990; Ostrom, 2010) also highlights important inequalities that need to be tackled for us to achieve resilience, yet there are immense challenges given the multitude of entities involved and their diverse interests and resource constraints (Constantinides & Barrett, 2015). For example, as shown by the COVID-19 pandemic, the development of new vaccines to contain the spread of infectious and deadly diseases is infused with value conflicts. There are critical inequalities regarding the access and availability of vaccines across the globe, which has caused stark criticism of patent protection and ownership rights when the greater public health good is negatively impacted.[10] While patents and ownership are important incentives for driving innovation in new drug development, they can also limit inclusive access across the globe.

In addition, data about critical trends in anticipating and containing major shocks are also often controlled by a powerful few that may exclude smaller entities from opportunities to plan and prepare for such shocks. In the case of the COVID-19 pandemic, the exact disease prevalence, including how specific variants were spreading, was often available to only select governmental agencies in real time. Similarly, supply chain visibility, including the availability of specific goods was restricted to the few who manufactured and distributed products or institutions that oversaw these processes. In financial markets, a handful of entities that facilitate order entry and execution have an early window into potentially large market collapses, such as recently seen in the crypto markets worldwide. Today there is a movement aligned with the growth of blockchain ecosystems where individuals might directly control and monetize their data and social capital by mechanisms such as individual tokens and self-sovereign identity.[11] If such ideas grow to include other types of data, then we may see a future where blockchain-based solutions for real-time data access can address some of these inequalities.

In addition to governance mechanisms, regulatory changes are also essential to ensure that entities adopt technologies and processes that can improve their resilience to future shocks. For instance, the Deepwater Horizon disaster sparked a series of regulatory actions and reforms designed to have a more lasting impact on the safety of future operations, including a major agency reorganization and ultimately new safety and environmental requirements.[12] The years following the disaster saw improved regulatory oversight designed to better balance environmental and safety concerns with energy development, including new certification requirements, new requirements for systems, additional inspection and testing, etc. There was also a significant reorganization of regulatory agencies and the creation of new agencies such as the Bureau of Safety and Environmental Enforcement (BSEE), which is responsible for safety and environmental enforcement. These

[10] https://www.nature.com/articles/d41586-021-01242-1

[11] https://www.theatlantic.com/ideas/archive/2021/11/financialization-everything-investment-system-token/620804/

[12] https://eelp.law.harvard.edu/2020/05/deepwater-horizon-ten-years-later-reviewing-agency-and-regulatory-reforms/

coordinated efforts at regulatory reforms have significantly contributed to building resilience for the industry. However, as Vizcara (2020) notes, constant vigilance is required for regulatory oversight, based on new technologies, operations, and developments in the industry.

Further research could more explicitly examine the role of digital technologies in designing governance structures and the role of regulatory reforms for collective action against major shocks, including the governance and regulations related to digital ecosystems. A relevant research question is: *What are appropriate governance structures and regulatory mechanisms with which to counter major shocks while balancing the needs of the different stakeholders?*

Reforms to Address Digital Inequalities

The COVID-19 pandemic exposed significant digital inequalities between entities in relation to access to digital technologies such as the internet and mobile devices, but also in relation to entities' capabilities to gain benefits from their use of technology (Beaunoyer et al., 2020). Such capabilities include the "knowledge, motivation, and competence to access, process, engage, and understand the information needed to obtain benefits from the use of digital technologies, such as computers, Internet, mobiles devices and applications" (Beaunoyer et al., 2020, p. 1). As many studies have shown, such digital inequalities are deeply embedded in social, economic, and cultural contexts and have significant, negative implications for building health (including mental health) and economic resilience (Brooks et al., 2020; Fernandes, 2020).

Many of the points we raised earlier around the importance of developing public-private ecosystems and designing governance structures for collective action lay the groundwork for policy reform and mechanisms to address digital inequalities. For example, it has previously been proposed that cities should be allowed to provide their own broadband and provide devices to children.[13] Such policy proposals require not only strong collaborations between the public and private sectors but also a deeper engagement with market competition frameworks around the supply of basic utilities. Even if access were provided in an equitable manner to all groups in society the use of these resources could widely vary as well due to knowledge and access to other resources. For instance, as the world moved online it was easier to find advanced tutors who could coach students online, yet doing so required access to other (financial) resources, which are unevenly distributed. Given our understanding of how these issues can play out, what policies might be needed to level the playing field such that future major shocks are not accompanied by digital inequities of the kind we saw during the COVID-19 pandemic?

More generally, further research could more explicitly examine: *How can existing policies be reformed and mechanisms introduced to reduce digital inequalities and help entities build resilience?*

The Temporality of Resilience Capabilities

While digital technology characteristics can enable entities to build digital resilience to major shocks, these characteristics must exist prior to the shock in order for entities to absorb, adapt, and transform. This suggests a "prepare" phase that most entities need, as illustrated in Figure 1. In (cyber)security, organizations routinely plan for this phase through actions like disaster recovery and business continuity planning. The special issue papers, as well as the additional examples we discuss above, show the need for similar planning to build digital resilience capabilities to withstand major shocks.

Currently, there is little guidance on how, exactly entities can prepare (e.g., a blueprint similar to disaster recovery and business continuity [DRBC] planning might look like) to build resilience to major shocks. We suggest that this process is likely to be ongoing. Preparation for the "next" shock(s) that might arise will likely focus on leveraging the digital technology characteristics and conditions for building resilience, as summarized in Table 2. The preparation phase may need to become an explicit component of the ongoing process of building digital resilience for most entities.

As Figure 1 suggests, the absorb, adapt, and transform capabilities do not have to be sequentially developed but can and likely will overlap during and after the shock. In extreme cases, these may be developed simultaneously, with absorb capabilities being deployed to ensure immediate survival and collective adaptations and transformations to the new reality taking place post-shock. For instance, the sensing capabilities provided by Google Analytics to understand evolving customer trends during the COVID-19 pandemic in conjunction with the availability of alternate digital channels to sell directly to consumers can simultaneously help organizations both absorb and adapt to major shocks.

[13] https://www.forbes.com/sites/washingtonbytes/2020/05/07/three-policies-to-address-the-digital-divide/?sh=866343c60145; https://obamawhitehouse.archives.gov/sites/default/files/wh_digital_divide_issue_brief.pdf

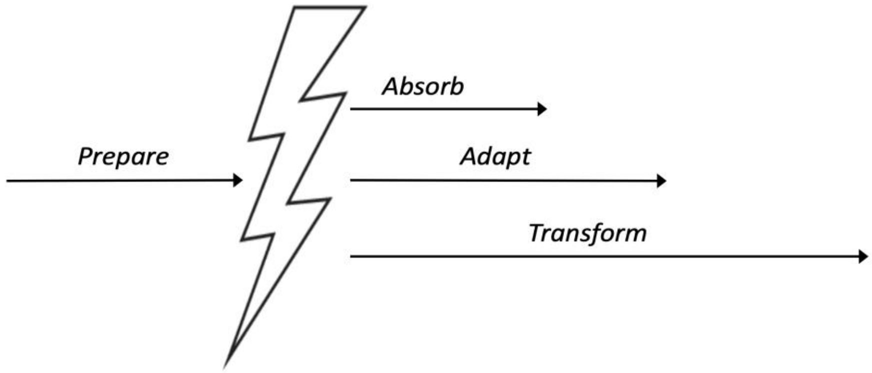

Figure 1. The Temporality of Resilience Capabilities

Further research could more explicitly examine the temporality of resilience capabilities. Some relevant research questions include: *How can entities prepare to build digital resilience to major shocks? How do the absorb, adapt, and transform capabilities play out in time to respond to major shocks?*

Conclusion

Given the experience of the COVID-19 pandemic, preparing for the next major shock is a significant imperative for all entities. In a highly interconnected world characterized by complex systems, a single entity cannot, in most cases, directly control its outcomes as entities are dependent on the actions of others. Yet there are things that can be done to increase the chances of not just surviving but thriving as well. The characteristics of digital technology present significant opportunities for entities to develop the resilience capabilities of absorbing, adapting, and transforming to a new stable state.

This editorial, along with the papers in this special issue, offers some important ideas that can help entities start to proactively plan for the next major shock, which could hit at any point. Unlike digital transformation initiatives, digital resilience initiatives require entities to consider and embrace important trade-offs regarding short vs. long-term planning horizons, efficiency vs. flexibility and independence vs. interdependence. This special issue shows a path forward, driven by building and developing specific capabilities enabled by digital technology.

While this editorial emphasizes redundancy and intelligent sensing (for absorbing the shock); ubiquity, access, and experimentation (for adapting); and reconfigurability and scalability (for transforming), we are not suggesting that these digital technology characteristics are the only ones that can help build resilience capabilities. Indeed, we expect future research to add to these and explore specific major shocks for which entities can more easily design mitigation strategies.

In closing, we caution against thinking of technology as a panacea to develop resilience. As we show, what happens outside of the technology arena is equally important, and this means building a deeper understanding of how people, processes, and culture collectively act to shape the future of various entities during the next major shock. We are confident that future research will build on the themes presented in this special issue to push the boundaries of both theory and practice.

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About the Authors

Wai Fong Boh is the President's Chair and a professor of information systems at Nanyang Technological University (NTU) in Singapore. She is currently the deputy dean of Nanyang Business School (NBS), director of the Information Management Research Centre at NBS, and she serves as a co-director for both Singapore Agri-Food Innovation Lab (SAIL) and NTU Centre in Computational Technologies for Finance (CCTF). She received her Ph.D. from the Tepper School of Business at the Carnegie Mellon University. Her research interests are in the areas of knowledge and innovation management, entrepreneurship, and blockchain.

Panos Constantinides is a professor of digital innovation and the digital learning lead for Executive Education at Alliance Manchester Business School. Previously, he held positions at the Warwick Business School (WBS), Lancaster University's Management School (LUMS), and the Judge Business School at the University of Cambridge, where he earned his Ph.D. He is a Fellow of the Cambridge Digital Innovation Centre and leads the Digital Transformation Research Group at Alliance Manchester Business School. His research focuses on the transformative potential of digital technology, including digital platforms, infrastructures and artificial intelligence.

Balaji Padmanabhan is a professor of information systems and the Anderson Professor of Global Management at USF's Muma College of Business. He is also the director of USF's Center for Analytics & Creativity where he leads programs, industry collaborations, community engagement and research initiatives. He has a bachelor's degree in computer science from the Indian Institute of Technology and a Ph.D. from New York University's Stern School of Business. His research addresses key issues at the intersection of machine learning and artificial intelligence and applications in business and society.

Siva Viswanathan is the Dean's Professor of Information Systems and Digital Innovation at the Robert H. Smith School of Business, University of Maryland, College Park. He received a PhD in information systems from the Stern School of Business, New York University. His research focuses on understanding the implications of emerging technological innovations including ML & AI, for platform design and strategy, consumer behaviors, and societal welfare. Prof. Viswanathan has published in top journals in Information Systems, Marketing, and Management.