Digital Innovation of Healthcare Services in Times of Crisis and Beyond

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Abstract

The COVID-19 pandemic has created a worldwide state of emergency, triggering extensive digital innovation within healthcare institutions to recover from the disrupted services caused by the pandemic. The purpose of this research is to explore the phenomena of digital innovation during these extraordinary conditions and to understand the impacts during the pandemic and beyond. To do so, we conducted a systematic literature review by analyzing 130 research articles across research disciplines that were published during the pandemic. We found that the innovation processes were highly iterative and focused on rapid diffusion to address the urgent need for stabilizing and recovering disrupted services. This short-term perspective may result in adverse impacts beyond the pandemic, such as increased inequity. Moreover, we found that some environmental factors were highly adaptive to the pandemic, whereas others were less so. We suggest that organizations should focus on the latter when building resilience to future pandemics.

Keywords: Digital innovation, healthcare services, crisis, COVID-19 pandemic, tensions

1. Introduction

The healthcare sector worldwide has recently experienced extreme challenges due to the COVID-19 pandemic [42]. A common definition of crisis is "a low-probability, high-impact situation that is perceived by critical stakeholders to threaten the viability of the organization" [52, p. 66]. This definition translates well to the COVID-19 pandemic, where the surge of hospitalized COVID-19 patients and government mandates of social distancing caused disruptions in both in- and out-patient care [28; 35]. Additionally, the COVID-19 pandemic has impacted the wider economic and societal systems, creating ethical dilemmas, such as the provision of healthcare to all patients during crisis (health equity) and public health versus economic well-being [6; 28].

Whereas the World Health Organization (WHO) formally declared COVID-19 a global pandemic [28], others have labeled the crisis a "digital health pandemic" [42]. This illustrates the pivotal role of technological innovations as an effective approach to tackling the pandemic [33]. Existing technologies have been reactualized, and healthcare organizations have accelerated the adoption of such technologies in response to the crisis [7]. Here, relevant technologies include telemedicine and mobile health (mHealth) because of their suitability for social distancing and reducing pressure on the healthcare system [40].

Adoption of such existing technological solutions that significantly change the provision of a service is termed *digital innovation* [36]. Digital innovation is a foundational concept in information system (IS) research [23; 69] and also includes outcomes of products, processes, and business models that lead to significant organizational change [16; 23; 46]. Digital innovation is possible when human actors have the ability to combine knowledge of technological possibilities and unmet organizational or societal needs [23]. In a crisis, such as the COVID-19 pandemic, these organizational needs relate to the recovery of disrupted systems back into alignment [68]. Specifically, the healthcare sector has approached the COVID-19 crisis through digital innovation [47].

The concept of digital innovation in a "normal" setting is an established stream of research within the IS community. Digital innovation during times of crisis, such as the COVID-19 pandemic, however, is underexplored in the stream of digital innovation literature [4]. This gap raises several important questions, such as "does digital innovation unfold differently during a crisis than in a 'normal' setting," "does digital innovation need to be managed differently during a crisis," and "how are digital innovation impacting patients, organizations, and the society during the crisis and beyond?" These questions motivated this study and our two-fold research objectives: 1) to explore digital innovation in healthcare services in times of crisis and 2) to

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understand the impacts of digital innovation in healthcare services in times of crisis.

In addressing the research objectives, we performed a systematic literature review of research articles across research disciplines published during the pandemic.

This paper is structured as follows: First, we present the background literature on digital innovation, the review method, and the results. Then, we discuss our findings from the literature review against the existing literature. Finally, we present our conclusions of the research objectives and suggest implications for both research and practice.

2. Digital innovation

In this section, we present relevant literature on the concept of digital innovation within the context of healthcare services in times of crisis.

Digital innovation is a foundational concept in IS research [23], and several definitions of the concept exists [e.g., 16; 30; 69]. In this paper, we adopt the perspective of Fichman et al. [23] and define digital innovation as "product, process, or business model that is perceived as new, requires some significant changes on the part of adopters, and is embodied in or enabled by IT" [23, p. 330]. This definition is broad compared to others [e.g., 69] and covers several important elements. In this research, we depart from Kohli and Melville [36] and focus on the following elements of digital innovation: 1) digital innovation outcomes [30; 36]; 2) digital innovation process [23]; 3) digital innovation management [46]; and 4) digital innovation environment [36]. The IT artifact is a critical element in digital innovation [23], and therefore an integral part of all of the elements in the definition.

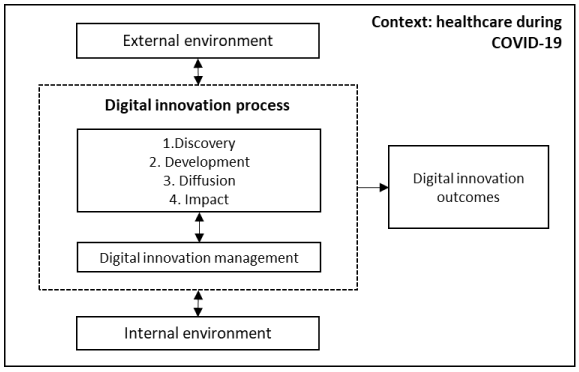

Figure 1. Conceptual research model.

In the following, we elaborate on the four key elements that form our theoretical framework (presented in Figure 1). We use this research model as our analytical lens.

2.1. Digital innovation outcomes

The existing literature covers various types of digital innovations, including services, products, processes, and business models [23; 36], where digital innovation types may overlap and blur boundaries [23]. The different digital innovation outcomes are briefly presented below.

- Digital service innovation outcome – Significantly new services embodied in or enabled by IT [23, p. 334]
- Digital product innovation outcome – Significantly new products embodied in or enabled by IT [23, p. 334]
- Digital process innovation outcome – Significantly new ways of doing things in an organizational setting embodied in or enabled by IT [23, p. 334]
- Digital business model outcome – Significantly new ways of creating and capturing business value embodied in or enabled by IT [23, p. 335]

The aim of managing a crisis is to respond appropriately by adjusting and recovering disrupted services and processes into alignment [68]. Thus, the main objective for healthcare organizations during a crisis, such as the COVID-19 pandemic, is to stabilize the situation and continue to provide healthcare services to citizens [47]. Hence, the crisis may become a trigger for healthcare service innovation, where the main objective is repurposing existing technologies to recover disrupted services [47], rather than inventing new products, processes, or business models.

2.2. Digital innovation process

The existing literature has described the digital innovation process through various stages, practices, and activities [16; 23; 30; 36]. In this study, we follow Fichman et al. [23], who categorized the digital innovation process into four general stages:

- Discovery – new ideas are discovered for potential development
- Development – an idea is developed into a usable innovation
- Diffusion – the innovation is spread across a population of potential users
- Impact – effects that digital innovations, once diffused, have on individuals, organizations, markets, and society

Although these stages are specified, they may not occur sequentially but may rather overlap and/or be iterative [23; 46].

2.3. Digital innovation management

Digital innovation requires significant organizational changes [23], involving dynamic stakeholders with diverse goals and capabilities [46]. Thus, digital innovation needs to be actively managed throughout the various stages of the innovation process. Nambisan et al. [46] more specifically defined digital innovation management as "the practices, processes, and principles that underlie the effective orchestration of digital innovation" [46, p. 224]. This definition captures a range of innovation outcomes (including digital service innovation outcomes), a broad set of digital tools and infrastructures (including health technologies, such as telemedicine and mHealth), and the possibility that the innovation outcomes may be diffused, integrated, or adapted to specific use contexts [46] (including healthcare organizations in times of crisis).

In the following sections, we adopt this broad understanding of digital innovation management.

2.4. Digital innovation environment

Digital innovation, including processes and management, always occurs in specific contexts (i.e., healthcare in this research). Thus, the intention of digital innovation is to provide appropriate and context-specific value [30; 46]. Here, the environment in which the digital innovation is embedded shapes the digital innovation process and outcome [36]. Environmental factors can be internal (e.g., organizational culture, strategies, practices) and external (e.g., the surroundings in which the organization is embedded) [36].

3. Method

To identify and synthesize the relevant literature addressing the research objectives, we followed the guide for conducting systematic literature review by Okoli [49]. This guide comprises the following four general phases: planning, selection, extraction, and execution.

The purpose of the **planning phase** is to identify the purpose of the review and to draft a protocol [49]. Based on the current literature on digital innovation and extensive discussions, we drafted a protocol. It included several inclusion and exclusion criteria for relevancy, time (i.e., 2020-2022), language (i.e., only English language), and availability (i.e., only accessible research). An example of inclusion criteria for relevancy was that the described innovations needed to include significant changes in product, process, business models, or services for patient treatment or follow-up services and that the innovation was triggered by the current COVID-19 pandemic. Conversely, an example of exclusion criteria for relevancy included support functions (e.g., laboratory, and radiology), healthcare training, epidemiology, pharmacology, and administrative support functions.

The purpose of the **selection phase** was to apply the practical screening criteria and perform a literature search [49]. Based on the protocol, we developed the following search string: "Innovation" AND ("technolog*" OR "digital") AND ("healthcare" OR "health care") AND ("crisis" OR "epidem*" OR "pandem*" OR "covid*" OR "corona*"). The search string was executed at ISI Web of Science, ProQuest, and Scopus (includes PubMed/Medline). These databases were selected to ensure multidisciplinary research involved in research on digital innovation in healthcare during the COVID-19 pandemic (e.g., IS research, engineering, medicine, and health informatics). The process of selecting the relevant articles was done through several sequences and included a screening process (title and abstracts) and an assessment of eligibility (full-text assessment). The search was limited to research after the start of the COVID-19 pandemic (i.e., 2020–2022). The search ended May 15, 2022. The selection process is described in detail in Figure 2.

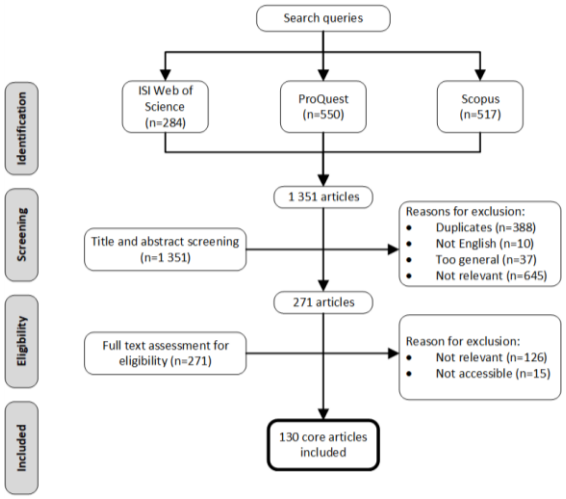

Figure 2. Systematic search process.

The purpose of the **extraction phase** was to extract data and appraise its quality [49]. Since our research objectives were explorative, quality appraisal is optional [48]. Moreover, it is generally acknowledged that COVID-19 research papers may have lower methodological quality because of the rapid publishing cycles required to build knowledge during the pandemic [64]. As one initiative of quality appraisal, however, we only included peer-reviewed

research from academic journals and conference proceedings. All the data (full-text articles and metadata) were imported into the qualitative data analysis software Nvivo 12 for further extraction and analysis.

The purpose of the **execution phase** was to synthesize the selected research, also known as data analysis, and to write the review [49]. Our aim was not to summarize the existing literature but to synthesize and integrate the diverse literature to understand the process of digital innovation during the COVID-19 pandemic. Thus, we conducted a *quantitative synthesis* [49] with a *concept-centric focus* [67]. In doing so, we analyzed the data both deductively (i.e., analyzing data based on the conceptual research model in Figure 1) and inductively (unboxing the concepts in Figure 1 and their relations). We applied thematic analysis [12] for the coding process comprising the following six phases: 1) becoming familiar with the data, 2) generating initial codes, 3) searching for themes, 4) reviewing themes, 5) defining and naming themes, and 6) producing the report. We observed that the phases overlapped, and we needed to reiterate the process several times.

We acknowledge that our methodological approach had some limitations: 1) Since the COVID-19 pandemic is still ongoing, relevant research was published after the closure of this review, and 2) the quality appraisal was limited due to the rapid publishing cycles during the COVID-19 pandemic. Still, we consider the inclusion of all peer-reviewed articles a strength of this study in exploring this current and ongoing phenomenon.

4. Findings

We included 130 research articles through the systematic search process from 2020 (55), 2021 (53), and 2022 (22). Most of the included articles were published in health-related journals, including medicine (48), health informatics (26), health policy (15), and nursing journals (10). Medical journals included both general medicine and specialized medicine (e.g., psychiatry, and mental health, surgery, anesthesiology, cardiology, pediatrics, emergency medicine, rheumatology, and oncology). The vast number of articles from different medical journals illustrated the diffusion of digital innovations throughout the healthcare sector. Only a few articles were published in IS journals.

In the following subchapters, we present the findings of our analyses based on the conceptual research model in Figure 1. Due to page limitations, we only included reference examples to illustrate our findings.

4.1. Digital service innovation outcomes

Although different digital innovation outcomes exist, the analysis revealed that all the included research articles focused on digital *service* innovation. We categorized these outcomes into in-patient and out-patient service innovations. For the former, different technologies were mainly used to provide access to services for the surge of COVID-19 patients, while recovering safe access to services for other patients. Such services included digital bedside ward rounds, remote consultations and diagnosing, monitoring, and bedside support from outside support systems. Out-patient innovations primarily focused on providing safe services remotely to support social distancing. Such innovations included remote consultations, diagnosing, monitoring, predictions, self-management of diseases, and remote patient treatment. See Table 1 for more details and examples of both in- and out-patient service innovations during the COVID-19 pandemic.

Table 1. Service innovation outcomes

In-patient	**Examples**
Clinical visits	Virtual bedside ward rounds, e.g., Microsoft HoloLens 2 for remote participation in clinical visits [38]
Consultation	Remote bedside care consultation, e.g., tablets for in-patient palliative care consultations [56]
Diagnosing	Remote bedside diagnosing, e.g., medical screening examinations in the emergency department [65]
Monitoring	Remote bedside monitoring, e.g., remote surveillance in critical care units [32]
Support	Remote bedside support, e.g., connecting hospitalized patients to outside support system (e.g., family) [24]
Out-patient	**Examples**
Consultation	Remote consultations from home, e.g., medication consultations with doctors [58]
Diagnosing	Remote diagnosing of patients, e.g., AI-powered tools for screening and diagnosing COVID-19 [27]
Monitoring and prediction	Remote monitoring of symptoms, e.g., wearables for physiological monitoring and risk prediction [17]
Preventive services	Digital prevention services, e.g., chatbots with preventive advises [27]
Self-management	Patient self-management of symptoms and diseases, e.g., tools for self-triaging and self-scheduling [27]
Treatment	Remote patient treatment, e.g., remote mental care for patients with severe anxiety disorders [14]

In the following subsections, we present the findings related to the environment, innovation process, and innovation management areas in which these service innovations have emerged.

4.2. Digital innovation environment

The analysis revealed several different environmental factors affecting innovation processes during COVID-19. Here, we distinguish between internal environment factors under an organization's control and external factors that are not. The environmental factors are presented in Table 2.

Table 2. Environmental factors

External	Explanation and examples
Global	The COVID-19 pandemic itself introduces environmental volatility, uncertainty, complexity, and ambiguity [39], creating an urgency for digital innovations [32].
Politics and economics	Governance barriers, funding, reimbursements, legal requirements, and regulatory oversights have quickly been adapted to clinical needs [8].
Society	Societal factors, such as digital literacy [63], societal disparities [2], and socioeconomic differences [62] has become more prominent during the pandemic.
Technology	Technological factors of digital innovation includes availability of technological resources [51], interorganizational interoperability [55], data privacy [21], interorganizational infrastructure [1], and patient connectivity [63].
Internal	**Explanation and examples**
Innovation culture and readiness	This includes the organization's digital orientation [34], innovation culture and digital readiness [37], institutional logics [47], and employee resistance [22].
Resources	Resources include human resources, such as workforce availability [5] and their digital literacy [21]; organizational resources, such as existing innovation centers [10]; and collaborative resources, such as health system and vendor partnerships [45].
Technology	Technological resources includes the existing infrastructures (installed base) of healthcare organizations [1].

The most prominent factor of the external environment was the volatility, uncertainty, and ambiguity introduced by the COVID-19 pandemic [39]. This created a dynamic environment, where the political and economic conditions were rapidly adjusted to changing clinical needs [8]. Moreover, innovation was constrained by both societal factors (e.g., patient digital literacy, social disparities, and socioeconomic differences), and technological factors (e.g., technology availability, interorganizational infrastructure, and patient connectivity).

Internal environment factors affecting digital innovation during COVID-19 included existing innovation culture and digital readiness, existing resources (e.g., human, organizational, and collaborative resources), and the organization's installed technological base. In addition, the internal environment was highly dynamic during the COVID-19 pandemic. For example, rapid innovation diffusion was possible because of the clinical staff's goodwill in responding to the pandemic [60].

4.3. Digital innovation process

The COVID-19 pandemic created an urgency for digital innovation, and our findings suggest that the innovation processes accelerated during the pandemic. Examples of this included the discovery, development, and diffusion of digital innovations within only 2 weeks [e.g., 15; 43]. Moreover, the digital innovation processes during the COVID-19 pandemic were characterized as highly iterative, where innovations rapidly diffused and constantly improved based on user feedback [e.g., 15]. Our findings suggest that this accelerated process blurred the distinctions between the discovery, development, and diffusion phases.

The impact of the digital innovations during COVID-19 was primarily on providing healthcare services to the COVID-19 patient surge, while maintaining safe access to services for non-COVID-related disease patients. This rapid shift to digital service provision increased service-access inequity both during [e.g., 19] and beyond [e.g., 11] the pandemic. Our findings on the impacts of digital innovation during and beyond the pandemic are listed in Table 3.

Table 3. Digital innovation impact

During crisis	Explanation and examples
Economic	Enables cost reductions related to reduced hospitalizations [21] and reduced use of protective equipment [41]. Such technology use also leads to reduced reimbursement [53].
Interdisciplinary collaboration	Better teamwork and increased interdisciplinary collaboration [41].
Patient and provider safety	Enables infection control, increasing patient and provider safety [26].
Patient involvement	Includes increased connections between patients, providers, and family [18], patient independency [31], and increased convenience and comfort [20].
Resource utilization	Includes increased flexibility for professionals [31], and reduced pressure on the health system [1]. Changing roles can also challenge professional skills [25] and increase workload [50].
Service access	Involves sustaining and recovering services [63] through increased service access [26]. Digital innovation also increases inequality of service access during the pandemic [19].
Service efficiency	Increased service efficiency in terms of time, resources and costs to patients and providers [59].
Service quality	Increased service quality in terms of improved health outcomes [45] and clinical decision making [41].

Beyond crisis	Explanation and examples
Economic	Increased use of digital innovations can contribute to economic sustainability [3].
Environment	Remote technology involves less transportation, contributing to environmental sustainability [54].
Organizational capability	Increased innovation capabilities may result in increased innovation uptake [54].
Healthcare transformation	Increased innovation uptake may accelerate digital transformation of healthcare [61].
Inequity	Digital innovation increases inequality of service access [11].

Some of the reviewed articles addressed tensions between the short-term impacts during the ongoing COVID-19 pandemic and the long-term impact beyond the crisis: The most notable tensions concerned 1) inequitable service access beyond COVID-19 because of increased technology uptake during the pandemic [66], 2) tension between the rapidly adjusted governance structures during COVID-19 (e.g., funding, legal requirements, and regulatory oversight) and readjustments beyond the pandemic [8], and 3) tension between using the COVID-19 pandemic to spur digital revolution and disruption or for evolution and adaptation. Unresolved challenges, such as privacy, patient safety, rights, empathy, and trust can promote evolution and adaptations by learning from the pandemic [50].

4.4. Digital innovation management

The analysis revealed six themes of innovation management practices supporting successful digital innovations during the COVID-19 pandemic (see Table 4). Most prominently, the review literature argued for repurposing readily available technology using agile principles for the rapid diffusion of innovations [e.g., 56]. Early clinical personnel and patient involvement and external partner mobilization (within the wider health system and with technology vendors) were also considered crucial management practices in prompt pandemic responses [e.g., 44].

Table 4. Innovation management practices

Practice	Explanation and examples
Approach to change	Includes adoption of agile principles [31] by starting early, diffuse rapidly, and evaluating and improving during diffusion [56].
Communication	Involves widely, timely and accurate organizational communication [13].
Governance	Includes decision transparency and management support [13].
Service design	Avoiding duplication of efforts [22], evaluating clinical suitability and accounting for organizational differences [31].
Stakeholder involvement	Early involvement of multidisciplinary personnel, patients, and external partners [44] and staff empowerment in decision making [15].
Technology	Innovation using equitable technology [15] that is readily available for creative repurposing [56].

5. Discussion

Digital innovation during a crisis, such as the COVID-19 pandemic, has several distinct characteristics from innovation during "normal times." For example, existing literature distinguishes between product, process, service, and business model **innovation outcomes** [23; 36]. In the reviewed articles, the focus during the pandemic was on rapid service innovations. This is not surprising, since the primary responses to a crisis are readjustments and recovery of healthcare services [68] through the repurposing of technologies [47]. Here, we found a multitude of service innovations in different medical fields for both in- and out-patient care.

Figure 3 presents an enhanced understanding of our conceptual model (Figure 1) and summarizes our findings on the interplay between the elements of digital service innovation in crisis contexts.

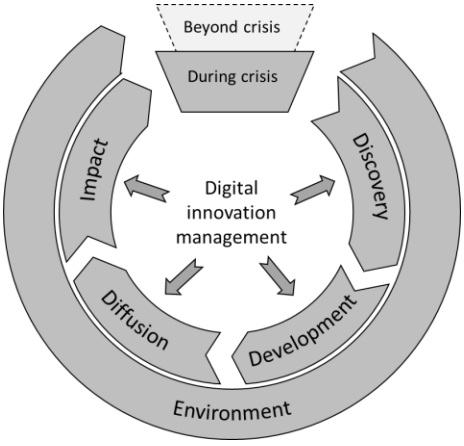

Figure 3. Digital innovation in a crisis context.

According to existing literature, the **environment**, in which digital innovation is embedded shapes the digital innovation process and outcomes and consists of both internal and external factors [36]. Our findings suggest that environmental factors are the most prominent characteristics of digital innovation during crises. The analysis revealed that some environmental factors were highly dynamic and adaptive to the crisis (illustrated in Figure 3 by a continuous arrow that overarches the innovation stages). For example, external environmental factors,

often perceived as barriers to digital innovation (e.g., regulations, funding, and reimbursements) in normal situations were quickly adapted to meet clinical needs during the crisis [e.g., 8]. We also observed dynamic factors in internal environmental factors, such as the innovation readiness of clinical employees. For example, in normal situations, reluctance to change is common, whereas the goodwill of clinical staff enabled rapid innovation diffusion during the pandemic [60]. In addition to dynamic environmental factors, we identified environmental factors that were less dynamic and adaptive to the pandemic. Such external factors were either societal (e.g., patient digital literacy, social disparities, and socioeconomic differences) or technological (e.g., interorganizational infrastructure and patient connectivity). Internal factors include organizational and technological resources (e.g., installed bases).

Results showed that **innovation process** stages overlapped and were highly iterative (illustrated as a cyclic process in Figure 3), which has been recognized in the existing literature [23; 46]. The main difference, however, is related to the dynamic environmental factors: the pandemic itself leads to an urgency of rapid innovation diffusion, whereas environmental volatility requires continuous improvement based on real user feedback to tackle constant environmental changes. Here, the targeted impact of such rapid diffusion and iterative improvement is to restore services [23; 47]. Additionally, we identified multiple impacts during the pandemic in areas related to economy, collaboration, safety, involvement, resource utilization, and service access, efficiency, and quality.

Existing literature have focused on the impacts after digital innovation is diffused [23]. Although most of our findings relate to short-term impacts during the pandemic (illustrated in Figure 3 by 'impact' is linked to 'during crisis'), we also identified a smaller portion of the literature discussing the long-term impact of the digital innovations that emerged during the pandemic (illustrated in Figure 3 by 'impact' is linked to 'beyond crisis'). Examples of such long-term impact included economic impact (increased use of digital innovations contributes to sustainable and economical health services [e.g., 3]); environmental impact (remote technology involves less transportation, contributing to environmental sustainability [e.g., 54]), and health system impact (increased innovation uptake in organizations accelerates the digital transformation of healthcare [e.g., 61]). These impacts beyond the pandemic were mostly considered positive. However, only a few research articles included here focused on potential tensions between the impacts of digital innovation during and beyond the pandemic. The most prominent tension identified was between the short-term need to provide continuity of services to patients and the future risk of increased inequity in healthcare access [e.g., 9].

In addressing tensions between short- and long-term impacts, including equitable access to healthcare services [e.g., 60], Kohli and Melville [36] indicated the need to evaluate innovation to meet organizational and societal needs [23].

Most of the identified **digital innovation management** practices, however, focused on rapid innovation to stabilize and recover disrupted services. These practices targeted all the innovation process stages (as illustrated in Figure 3), including approaches to change, communication, governance, service design, stakeholder involvement, and technology management. This short-term focus on innovation management is unsurprising due to the urgency of the pandemic.

Now that we are moving toward a new normal, it is imperative to evaluate the future impact of digital innovation and build resilience to future pandemics. Some of the literature suggests building resilience through innovation-friendly legal regulations and funding schemes, and digital-friendly reimbursement arrangement [e.g., 57], development of strategic public–private partnerships [e.g., 70], developing both digital and innovation literacy [e.g., 13], and investing in innovation-friendly technology infrastructures [e.g., 29]. Additionally, we argue that the process of building resilience should consider both external and internal environmental factors. Specifically, we suggest focusing on environmental factors that are less responsive to rapid adaptation, such as societal disparity, organizational capabilities, and technological infrastructures.

6. Conclusion

The COVID-19 pandemic has created a surge of digital innovations within the healthcare sector. We argued that digital innovation in this unique context can provide new insights into the extant literature. By reviewing research literature across research disciplines, the aim of this research was to 1) explore digital innovation in healthcare services in times of crisis and 2) understand the impacts of digital innovation in healthcare services in times of crisis.

Addressing the first research question, we found that the stages of the innovation process overlapped and were highly iterative. The main focus of the process was the rapid diffusion of innovations to address the urgent need to stabilize and recover disrupted services. Continuous improvement of the innovation was based on real-life user feedback. We also found that the environment was constantly

changing, thus affecting the innovation process. We also demonstrated that some environmental factors were dynamic and adaptive to the pandemic, while others were less adaptive. For the second research question, we found that the reviewed literature focused mostly on short-term impacts. Our findings suggest the need for evaluating innovations beyond the COVID-19 pandemic to ensure quality and equitable healthcare services beyond the pandemic.

Our findings add to the knowledge base of the digital innovation literature by revealing how digital innovation unfolds in extraordinary situations. For practice, our research can help organizations consider the long-term impacts of digital innovations beyond the COVID-19 pandemic. Moreover, the research can help organizations in building resilience against future pandemics by addressing environmental factors that are less dynamic and adaptive once potential pandemics break out.

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