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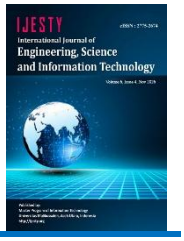

Assessing Digital Resilience in Primary Health Care: A Structural Framework

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Abstract

Digital transformation has significantly changed healthcare delivery, particularly in primary care settings such as Puskesmas (Community Health Centers) in Indonesia. Although digital technologies offer opportunities to improve accessibility, efficiency, and service quality, the capacity of healthcare institutions to adapt to digital disruptions remains insufficiently understood. This study aims to examine digital resilience in primary healthcare through a systematic literature review, focusing on research trends, key influencing factors, thematic developments, and knowledge gaps relevant to Puskesmas. The review analyzes scholarly articles, conference papers, and other academic publications retrieved from Scopus, PubMed, and Google Scholar. The analysis considers publication trends, influential authors, geographical distribution, and major research themes concerning digital resilience in healthcare. The findings indicate growing research interest in digital resilience, particularly regarding the challenges faced by healthcare systems operating under resource constraints. Four major factors emerge as relevant to digital adaptation: technological infrastructure, digital literacy, policy support, and community engagement. However, existing research predominantly emphasizes the technical dimensions of digital technologies, while organizational capacity and sociocultural factors receive comparatively limited attention. Research addressing digital resilience in Southeast Asia, particularly in Indonesian primary healthcare settings, also remains underrepresented. These gaps limit the contextual understanding of how digital resilience develops within community-based healthcare institutions. The review concludes that strengthening digital resilience in Puskesmas requires an integrated approach that combines technological readiness, organizational preparedness, workforce development, and community participation. Future research should investigate the organizational and sociocultural dimensions of digital adaptation and develop context-specific strategies for improving digital literacy among healthcare workers and communities. Policymakers should also prioritize sustainable digital infrastructure and continuous training to support resilient, accessible, and effective primary healthcare services in Indonesia.

Keywords: *Digital Literacy, Digital Resilience, Healthcare, Indonesia, Primary Care.*

1. Introduction

Digital transformation has become an increasingly important feature of contemporary primary health care (PHC), reshaping how health services are organized, delivered, and coordinated. Health information systems, electronic health records, telehealth platforms, and other data-driven technologies are increasingly integrated into clinical and administrative processes. These technologies can expand access to care, improve operational efficiency, strengthen coordination among providers, and support continuity of services [1], [2], [3]. However, greater reliance on digital infrastructures also introduces vulnerabilities that may affect the reliability and continuity of health service delivery. Consequently, digital transformation requires not only the adoption of technological solutions but also the ability of health care organizations to sustain essential functions when digital systems are disrupted.

Primary health care organizations may face technological disruptions, infrastructure failures, cybersecurity threats, and interoperability issues that affect the availability and reliability of digital services [4], [5]. Such disruptions can affect information availability, interrupt care coordination, and compromise the continuity of clinical and administrative processes. Evidence from health system resilience research further demonstrates the importance of maintaining essential services under conditions of substantial operational pressure [6], [7]. These challenges highlight the need to understand how primary health care organizations anticipate disruptions, mobilize available resources, adapt operational processes, and restore essential functions. In this context, digital resilience offers a useful perspective on how organizations sustain and improve their performance when confronted with disruptions to their digital environments.

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Digital resilience can be understood as the capacity of individuals, organizations, and communities to respond to external shocks by designing, deploying, and using information systems. Existing conceptualizations emphasize several interconnected processes, including anticipating disruptions, absorbing their effects, adapting resources and routines, recovering essential functions, and learning from disruptive experiences [8], [9]. This perspective extends beyond the technical reliability of digital infrastructure because resilience also depends on organizational arrangements, information technology resources, established routines, and the ability to mobilize new resources when circumstances change [10], [11]. Conceptually, the distinctions among ability, capability, and capacity are also important. Ability refers to specific skills or competencies; capability concerns the combination and deployment of resources and abilities. In contrast, capacity emphasizes the extent to which a system can respond to disruptions under particular contextual conditions. Distinguishing these perspectives helps clarify the different elements that may contribute to digital resilience and their potential roles in a structured assessment framework.

Digital resilience also intersects with related information systems concepts, including digital agility, digital transformation, dynamic capabilities, and absorptive capacity. Although these concepts share an emphasis on organizational adaptation and the use of digital resources, their primary orientations differ. Digital agility emphasizes responding rapidly to opportunities and threats; digital transformation concerns changes in organizational value propositions and practices; dynamic capabilities involve integrating and reconfiguring competencies in changing environments; and absorptive capacity concerns recognizing and applying external knowledge [12], [13], [9]. Digital resilience, by contrast, places particular emphasis on maintaining or restoring essential functions and adapting to disruptive events. These concepts may complement one another, but treating them as interchangeable risks obscures the specific dimensions that should be included in resilience assessment. A clear conceptual distinction is therefore necessary to identify the resources, organizational processes, and outcomes that are most relevant to assessing digital resilience in primary health care.

Research on digital and organizational resilience has examined different contexts, methodological approaches, technological environments, and levels of analysis. Previous studies have highlighted the roles of information systems resources, organizational routines, governance arrangements, and the mobilization of capabilities during periods of disruption [10], [11]. Research on primary health care has also examined system-level resilience, service continuity, and strategies for maintaining essential services during public health emergencies [6], [7], [14], [15]. Nevertheless, these research streams address related but not identical problems: studies of health system resilience may not explicitly examine the digital resources and information systems involved, whereas studies of digital resilience may draw on organizational contexts that differ from primary health care. This creates a need for a systematic synthesis that clarifies the conceptual foundations of digital resilience, identifies relevant dimensions and indicators, and examines how insights from the broader information systems literature can inform assessment in primary health care. In particular, the relationships among foundational abilities, organizational capabilities, and system-level capacity require further conceptual integration.

A structural framework can provide a systematic way to organize the dimensions and indicators associated with digital resilience in primary health care. Rather than treating resilience as a single technological attribute, such a framework can distinguish the technological, organizational, human, and governance-related elements identified in the literature. It can also organize these elements by their conceptual roles in supporting preparedness for disruption, service continuity, recovery, adaptation, and organizational learning. Research on primary health care resilience and health system performance provides a relevant foundation for considering how resilience-related dimensions can be incorporated into structured assessments [16], [6], [17]. However, the specific dimensions and relationships included in a digital resilience framework should be established through systematic evidence synthesis rather than assumed in advance. Developing such a framework can help clarify what should be assessed and provide a conceptual basis for identifying areas where digital resilience may need strengthening.

To address this need, the present study employs a systematic literature review to synthesize research on digital resilience and its application in primary health care. The review examines the definitions used in previous studies, the proposed dimensions and indicators, the adopted methodological approaches, the discussed technologies, and the conceptual relationships among relevant components. Through a structured search, screening, quality assessment, and narrative synthesis, the study identifies recurring themes and areas of conceptual convergence and divergence. The synthesis is intended to distinguish established findings from dimensions that require further contextual interpretation when applied to primary health care. The review process and study selection procedures are described in the Methods section, and the findings inform the proposed structural framework.

The primary objective of this study is to synthesize existing literature to develop a structural framework for assessing digital resilience in primary health care. Specifically, the study aims to clarify the conceptual foundations of digital resilience, identify relevant dimensions and indicators reported in previous research, and organize these components into a coherent assessment framework. The study contributes theoretically by integrating perspectives from digital resilience, information systems, and health system resilience into a structured conceptual approach. Practically, the proposed framework is intended to provide a foundation for examining the dimensions of digital resilience that primary health care organizations may need to assess and strengthen. Because the framework is derived from a literature synthesis, its applicability to specific health care settings and the empirical validity of its proposed dimensions will require further evaluation.

2. Literature Review

Digital resilience has gained attention in information systems and organizational resilience research as organizations increasingly depend on digital technologies to sustain their operations under disruptive conditions. In this context, digital resilience can be understood as the organizational capacity to maintain or restore essential functions when digital systems, technological infrastructure, or information flows are disrupted [18], [19]. Its principal characteristics include anticipating potential disturbances, absorbing their immediate effects, adapting operational processes and resources, restoring critical functions, and learning from disruptions to improve future responses [20]. Digital technologies may support these processes by facilitating information exchange, alternative service channels, and coordinated decision-making. However, dependence on digital systems can also create vulnerabilities when infrastructure, connectivity, or information security is compromised. Digital resilience should therefore be viewed as a dynamic organizational phenomenon that develops through experience, adaptation, and changes in the operating environment rather than as a fixed technological attribute [12], [21].

The concepts of ability, capability, and capacity provide complementary perspectives for examining how digital resilience may be developed and sustained. Ability generally refers to a specific skill or competence held by an individual or organizational unit, whereas capability concerns the coordinated use of resources, knowledge, skills, and organizational processes to perform particular functions.

Capacity, in contrast, refers to the broader potential of an organizational system to respond to demands and sustain or restore its operations under particular conditions. These concepts are related but should not be treated as interchangeable or as necessarily forming a universal sequence. In the context of digital resilience, individual abilities may contribute to organizational capabilities. At the same time, available resources, institutional arrangements, and the operating environment influence the extent to which those capabilities can be mobilized during disruption. This distinction provides a conceptual basis for examining digital resilience at different but interconnected levels of analysis [22].

Digital resilience is also related to digital agility, digital transformation, dynamic capabilities, and absorptive capacity, although each construct emphasizes a different organizational process. Digital agility concerns the ability to sense and respond rapidly to changing conditions, particularly when organizations must adjust their digital strategies and operations [23], [24]. Digital transformation refers to broader organizational changes enabled by digital technologies, while dynamic capabilities emphasize the processes through which organizations integrate, develop, and reconfigure resources in response to changing environments [25], [21]. Absorptive capacity focuses on recognizing, acquiring, assimilating, and applying external knowledge to organizational purposes [26]. These constructs may support digital resilience through adaptation, resource reconfiguration, and organizational learning, but they should not be regarded as equivalent to resilience itself. Distinguishing their respective roles helps clarify whether a factor represents a resilience-related resource, an enabling capability, or an outcome of organizational adaptation.

In primary health care, digital resilience must be considered in relation to the continuity, coordination, and recovery of services that increasingly rely on digital information and communication systems. Relevant contextual factors may include the reliability of digital infrastructure, information technology governance, workforce competencies, organizational routines, and the ability to adapt service delivery in response to disruptions. Research on digital health interventions highlights the role of technology in supporting access to and the quality of primary health care. In contrast, studies of health service coordination and resilience emphasize the importance of maintaining care processes under changing conditions [1], [2], [7]. Research on cybersecurity and digital transformation in health systems further indicates that technological and organizational considerations need to be examined together [27]. Evidence on the operational resilience of primary care services also provides a relevant health care context for examining continuity and recovery. However, operational resilience is not necessarily synonymous with digital resilience [28]. These considerations provide a conceptual starting point for organizing candidate dimensions and indicators, which must subsequently be assessed against the evidence identified through the systematic literature review.

3. Methods

The Systematic Literature Review (SLR) was conducted in three phases: planning, implementation, and reporting [29]. The planning phase began with identifying the need for a systematic literature review, followed by the development and evaluation of a review protocol to structure the process and minimize potential researcher bias. During the implementation phase, the research questions were formulated, search strategies were developed, inclusion and exclusion criteria were established, study quality was assessed, and data were collected and analyzed. The review protocol, which included the research questions, search strategy, inclusion and exclusion criteria, quality assessment, data collection, and data analysis, was refined iteratively throughout the implementation and reporting phases. In the reporting phase, the findings were synthesized and presented through tables and narrative analysis.

The research questions (RQs) were formulated to maintain the review's focus. The Population, Intervention, Comparison, Outcomes, and Context (PICOC) framework was used to structure the research questions [30]. Table 1 presents the PICOC framework applied in this study.

Table 1. PICOC Framework for the Research Questions

Component	Description
Population	The healthcare sector, covering different areas of healthcare management
Intervention	Existing healthcare management approaches related to digital resilience.
Comparison	No direct comparison; comparative analysis of existing models
Outcomes	Identification and categorization of existing models and dimensions of digital resilience
Context	Digital health and digital health transformation

The research questions were designed to identify the dimensions and existing models of digital resilience in primary healthcare. Table 2 presents the research questions and their intended analytical focus.

Table 2. Research Questions and Analytical Focus

Research question	Analytical focus
RQ1. What dimensions are used to assess digital resilience in primary healthcare?	Identification and categorization of the dimensions used to assess digital resilience
RQ2. What models are available for assessing digital resilience in primary healthcare?	Identification and comparison of existing models and their assessment approaches

The search strategy was developed to identify relevant studies to address the research questions. The literature search was conducted using Scopus and Semantic Scholar. Boolean search strings were formulated using combinations of keywords related to digital resilience, healthcare, and resilience models. The search strings included: (digital resilience) AND (digital healthcare resilience model); (digital resilient* OR resilient model*) AND (digital health resilience model); and (digital resilience) AND (healthcare management). The search process focused on studies addressing digital resilience in primary healthcare and digital health transformation.

The inclusion and exclusion criteria were established to determine the eligibility of the retrieved studies. Studies were included when they met the predefined requirements concerning publication period, source, publication type, accessibility, language, and relevance to the research objectives. Studies that did not address digital resilience in healthcare or were published as textbooks, theses, or dissertations were excluded. Table 3 summarizes the selection criteria.

Table 3. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Publication period	Studies published within the specified review period, 1996–2024	Studies published outside the specified period
Source	Studies retrieved from Scopus or Semantic Scholar	Studies obtained from sources outside the specified search strategy
Publication type	Journal articles and conference proceedings	Textbooks, theses, and dissertations
Accessibility	Open-access publications with available full text	Publications without an accessible full text
Language	English or Indonesian	Publications in other languages
Research relevance	Studies addressing dimensions or models of digital resilience in primary healthcare	Studies addressing digital resilience outside the healthcare sector or unrelated topics

Study quality was evaluated using five quality-assessment questions:
1. Is the article published in an open-access journal or conference proceeding, with full text available? (QA1)
2. Was the article retrieved through Scopus or Semantic Scholar? (QA2)
3. Was the article published within the specified quality-assessment period of 2014–2024? (QA3)
4. Does the article describe methods for measuring or assessing digital resilience? (QA4)
5. Does the article address the assessment of digital resilience in primary healthcare? (QA5)

Data collection was conducted in several stages. First, potentially relevant journal articles were identified through Google Scholar and Semantic Scholar. Second, the availability of full text and compliance with the language criteria were checked. Third, eligible articles were organized using Mendeley to facilitate reference management and screening.
The collected studies were subsequently analyzed to answer the research questions. The analysis focused on two aspects: (1) indicators used to assess digital resilience in primary healthcare (RQ1) and (2) methods used to assess digital resilience in primary healthcare (RQ2). The findings were synthesized into summary tables and a narrative review to describe the state of the literature, identify recurring assessment dimensions and models, and map the development of knowledge over time.

4. Result and Discussion

The results of the literature search were organized by publication year, digital resilience dimensions and indicators, assessment methods, and technologies to identify trends in the existing research. The largest number of articles was published in 2023, 2022, 2021, 2019, and 2015, with two articles identified in each year. The smallest numbers were recorded in 2017 and 2020, with one article identified for each year.
The search strategy employed Boolean search strings combining terms related to digital resilience, digital healthcare resilience models, and healthcare management. The retrieved articles were screened based on their titles, abstracts, and compliance with the inclusion and exclusion criteria. Following the initial screening and quality assessment, 303 articles were identified as eligible for further evaluation. A subsequent assessment of content relevance resulted in 12 articles being retained for the final review. Each selected article was evaluated against five quality-assessment criteria (QA1–QA5). Articles that failed to meet the required criteria were excluded. The number of articles at each screening stage is presented in the PRISMA flow diagram (Figure 1).

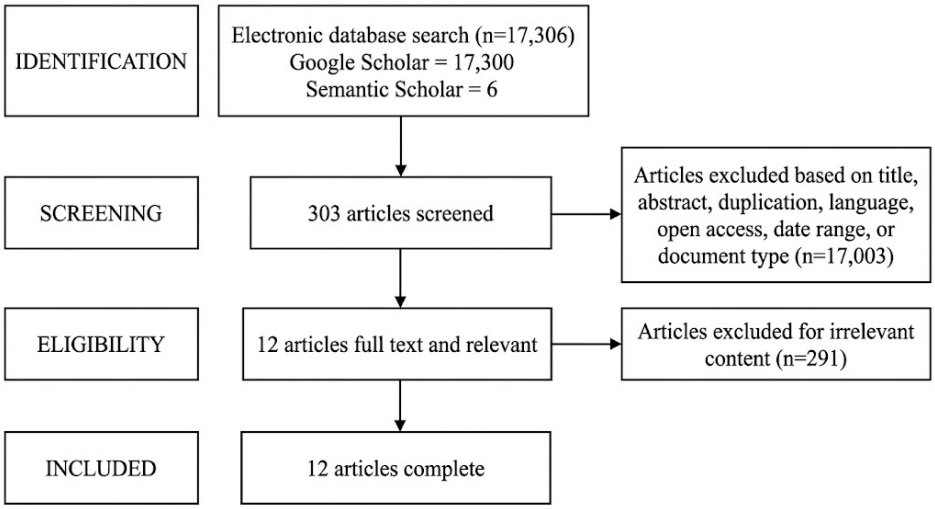

Fig 1. PRISMA Flow Diagram of the Literature Selection Process

The final selection was analyzed narratively to identify how digital resilience has been conceptualized and examined in previous studies. Table 4 presents selected definitions of digital resilience from four studies published in 2023. These studies describe digital resilience as the capacity to absorb shocks, resist disruptions, recover from adverse events, adapt operational processes, and transform organizational capabilities [31], [32], [33], [34].

Table 4. Narrative Analysis of Digital Resilience Definitions

No.	Study	Definition or conceptual emphasis
1	[31]	Digital resilience refers to capabilities developed through digital technologies to absorb major shocks, adapt to disruptions, and transform toward a new stable state.
2	[32]	The study examines physicians' digital resilience through resistance to disruptions and recovery following the COVID-19 outbreak, particularly in the context of online healthcare communities and telemedicine.
3	[34]	Digital resilience is examined through the role of centralized IT governance in helping higher education institutions adapt to crisis conditions while maintaining service satisfaction.
4	[33]	Digital resilience is conceptualized as a dynamic capability developed through data sharing, data integration, governance, analytics, and the reconfiguration of operational capabilities.

The definitions and conceptualizations indicate that digital resilience is not limited to maintaining the availability of digital systems. It also involves the capacity to respond to disruptions, recover essential services, and reconfigure resources and capabilities in response to changing conditions [31], [32], [33], [34]. In healthcare, this perspective is particularly relevant because digital platforms can support the continuity of consultations and healthcare delivery during major disruptions [32]. At the organizational level, centralized IT governance and effective data use can facilitate coordination, adaptation, and service continuity during crises [33], [34].

The subsequent analysis addresses the research questions by examining the dimensions and indicators used to assess digital resilience (RQ1) and the methods employed to assess it (RQ2). The frequency and percentage of each dimension should be calculated from the 12 selected articles and presented in Table 5. These results can then be used to identify the dimensions most frequently examined in the reviewed literature.

Table 5. Distinguishing Ability, Capability, and Capacity Perspectives on Resilience

Aspect	Ability	Capability	Capacity
Definition	A specific skill possessed by an individual, team, or organization.	Competencies developed by combining and coordinating system resources [35], [38].	The upper limits of what a system can achieve or endure under particular conditions.
Perspective on resilience	Focuses on the foundational skills and enabling factors that support resilience, without necessarily explaining how these abilities are coordinated to produce resilient outcomes [36].	Focuses on integrating and orchestrating resources and capabilities to enable a system to respond to and recover from disruptions [35].	Focuses on the contextual limits of resilience, considering the nature of shocks, system conditions, recovery requirements, and the deployment of available capabilities [39].
Examples from information systems research	Individual skills that enable resilience. The specific example concerning information accuracy in social media requires verification against an appropriate source.	The integration of information systems resources and organizational competencies to support responses to disruptions [36].	The extent to which a system can withstand and recover from disruptions depends on the context and the deployment of its information systems.

Source: Adapted from the conceptual distinctions in the cited literature.

In parallel with exploring different digital resilience phenomena, it is essential to advance conceptual clarity to organize heterogeneous findings from studies conducted in diverse contexts. Existing empirical research has shown how various assets and abilities, including the availability of information systems (IS) resources [40], established routines [33], and IT governance structures [34], shape an organization's capacity to recover from crises by leveraging IS. Nevertheless, digital resilience depends not only on harnessing existing assets and abilities but also on mobilizing new ones during crises, such as the period of forced digitalization during a pandemic [41]. Future research could theorize the building blocks of digital resilience and clarify their interplay. Key questions include how organizations can effectively draw on and adapt existing assets and capabilities to support recovery from exogenous shocks, which new assets and capabilities become critical during particular crises, and how these can be identified, developed, and mobilized. Addressing these questions could extend the conceptualization of digital resilience by clarifying the dynamics and mechanisms that shape this capacity.

Digital resilience at the individual, organizational, and community levels is not a static attribute but an evolving capacity. New IS practices introduced during a crisis may generate innovations that become institutionalized over time, creating assets that can be leveraged during future crises [42]. Similarly, the strategies and mechanisms used to design, deploy, and apply IS may vary across the stages of a crisis. For example, IS may initially be used to reduce the likelihood of disruption and later to mitigate immediate impacts and accelerate recovery [32]. Resilience also entails emerging from a crisis with an enhanced capacity to prevent and contain future errors [43]. Future research could therefore investigate how digital resilience evolves and identify the factors and mechanisms that strengthen or constrain it throughout different crisis stages.

The intersections and dependencies among recovery objectives also warrant further investigation. For example, the capacity for adaptation may depend on robust coping mechanisms that sustain continuity [35]. Examining how IS activities are designed and implemented to achieve multiple recovery objectives across the course of a crisis could provide a more nuanced understanding of digital resilience. Such research could explain why some individuals and organizations manage exogenous shocks more effectively than others and identify the strategies they use at different stages. Because individual digital resilience may also influence resilience at organizational and community levels, future studies should examine how digital resilience develops and interacts across these levels and what implications these interactions have for crisis management.

Resilience has been associated with rigidity [35] and may be perceived as a temporary coping mechanism that leaves individuals, organizations, and communities stagnant until a crisis subsides [42]. Investments in resilience may consequently be viewed as involving trade-offs among efficiency, value creation, and innovation [44]. However, an alternative perspective is that, in a digitally integrated society frequently exposed to shocks, digital resilience is essential not merely for survival but also for continued development. This perspective is consistent with the United Nations Sustainable Development Goals and the emphasis on resilience as a strategic priority for organizations [45]. Accordingly, future research should consider digital resilience not as a constraint but as a strategic endeavor. Rather than focusing

predominantly on how individuals and organizations can "bounce back" from adversity, research should investigate how digital resilience can enable them to "build forward better" after shocks and crises.

5. Conclusion

This study advances the conceptual understanding of digital resilience by integrating assets, abilities, and activities into a unified framework that explains how individuals, organizations, and communities respond to exogenous shocks. The framework's main contribution lies in connecting these components to three interrelated recovery outcomes: maintaining operational continuity during disruption, adapting to its consequences, and enabling further advancement after a crisis. This perspective extends the understanding of digital resilience beyond the ability to withstand disruptions or return to previous conditions, emphasizing its potential to support learning, transformation, and improved preparedness for the future.

The proposed framework provides a conceptual foundation for future information systems research and practical initiatives aimed at developing digital resilience. Its value lies in directing attention to the relationships among available resources, the abilities required to mobilize them, and the activities through which recovery and advancement are achieved. Future empirical research should examine these relationships across different organizational and societal contexts and crisis stages to assess the framework's applicability and identify the conditions under which digital resilience contributes to sustained adaptation and progress.

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