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The Digitalization Strategy of a Healthcare Organization as an Instrument for Enhancing Organizational Resilience in a BANI Environment

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Abstract: The article investigates how digitalization strategies shape the resilience of healthcare organizations operating under conditions of brittleness, anxiety, nonlinearity and incomprehensibility. The purpose is to conceptualize digitalization strategy as an integrated technological, managerial and human-capital construct and to empirically assess its relationship with organizational resilience in a real-world high-risk health system. The study combines a narrative-conceptual approach with a multi-case empirical design involving ten healthcare organizations of different ownership types, levels of care and regional contexts in Ukraine. Digitalization is operationalized through five component indices: Digital Strategy Formalization, Digital Infrastructure and Interoperability, Data-Driven Governance, Staff Digital Competencies, and Digital Governance and Change Management. Organizational resilience is measured through an integral index capturing service continuity during crises, recovery time after disruptions, the presence of continuity planning and perceived resilience among managers and staff. Data sources include institutional strategies and internal regulations, a standardized survey of senior managers and key experts, and secondary operational indicators related to service continuity, telehealth use and workforce stability. The empirical assessment reveals a clearly stratified landscape of digital maturity. Three clusters are identified: digitalization leaders (two private centers and a university clinic, as well as a national specialized institution), intermediate municipal hospitals with partial digitalization, and low-readiness healthcare organizations with fragmented and largely project-driven digital initiatives. Digitalization leaders display fully formalized strategies, interoperable infrastructures, advanced analytics, systematic training and structured digital governance, and at the same time demonstrate very high resilience scores, characterized by rapid adaptation, minimal disruption and fast recovery. Intermediate hospitals show advanced diagnostic and record systems but only moderate strategic formalization, uneven data use and heterogeneous staff skills, which translates into mixed and unstable resilience. Low-readiness institutions, primarily smaller municipal hospitals and primary care providers, rely on manual workarounds, have minimal interoperability, lack continuity planning, and report the lowest resilience. A strong positive association between the Digitalization Strategy Index and the Organizational Resilience Index confirms that digital maturity functions as a key determinant of robustness, adaptability and continuity. The analysis demonstrates that partial and uncoordinated digitalization yields only partial gains in resilience, while governance quality and staff competencies act as critical mediators between technology and outcomes. The scientific novelty lies in the integrated measurement of digitalization strategy and organizational resilience, the empirical identification of a pronounced “implementation gap” in intermediate public hospitals, and the demonstration of a digital divide that intersects with ownership, level of care and regional risk profiles. The practical significance of the results is reflected in recommendations to develop national standards for digital governance, invest in workforce digital competencies, support low-readiness organizations through targeted funding and shared platforms, and embed digital tools into continuity and emergency preparedness planning. The findings provide a basis for further research on digitalization and resilience using larger samples, longitudinal designs and comparative analyses across countries and health systems exposed to systemic shocks.
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1. Introduction. Healthcare systems worldwide are facing unprecedented levels of instability, increasingly characterized by the conditions described within the BANI framework, namely brittleness, anxiety, nonlinearity, and incomprehensibility. This paradigm, proposed as a successor to VUCA, reflects environments in which structures that once appeared stable reveal unexpected fragility, societal uncertainty and psychological strain intensify decision-making pressures, causal relationships become difficult to predict, and information grows too complex to interpret effectively (Cascio, 2025; Shrimpton, 2024). For healthcare organizations, these features manifest in recurring shocks such as pandemics, demographic shifts, climate-related disruptions, workforce shortages, and geopolitical crises, all of which challenge the reliability and sustainability of medical service delivery.

The COVID-19 pandemic particularly exposed the vulnerabilities of traditional organizational models while simultaneously demonstrating the transformative potential of digital tools. Telehealth, e-consultations, remote monitoring, interoperable electronic health records, and predictive analytics expanded at unprecedented speed, allowing many healthcare systems to maintain continuity of care despite severe operational constraints (Baudier, 2023; Rabbani et al., 2025). Comparative studies show that organizations with higher levels of digital maturity were better positioned to reconfigure workflows, share data, and manage dynamic surges in patient needs, ultimately exhibiting greater resilience and faster recovery (Williams, 2022; Qhal, 2025).

This global experience has reinforced the idea, supported by major policy frameworks, including the WHO Global Strategy on Digital Health 2020–2025, that digital transformation is not merely an enhancement of existing technologies but a strategic lever for strengthening preparedness, response capacity, and long-term sustainability of health systems (World Health Organization, 2021). However, despite broad consensus on the benefits of digitalization, scholarly debate persists regarding how digital transformation contributes to resilience. Diverging hypotheses range from highly optimistic claims that digital tools inherently produce more adaptable organizations, to more cautious perspectives emphasizing risks such as cybersecurity vulnerabilities, algorithmic bias, inequitable access, and increased workload stress without adequate training or governance mechanisms (Haimi, 2025; Larsson et al., 2025).

Beyond technological infrastructure, emerging research highlights the role of cultural, managerial, and human-capital dimensions. Digital competencies, data literacy, and adaptive organizational cultures increasingly determine whether digitalization enhances resilience or inadvertently widens system fragility (Kludacz-Alessandri et al., 2025; Ma & Kang, 2025). Studies in other service sectors support the hypothesis that digital transformation strengthens resilience by enabling real-time analytics, predictive modelling, agile decision-making, and flexible resource allocation, yet they also caution that benefits materialize only when digital initiatives align with strategic goals and are embedded in coherent governance architectures (Cardoso et al., 2025).

Against this backdrop, the present review places the digitalization strategy of healthcare organizations in a broad interdisciplinary context and underscores its importance for navigating BANI conditions. The *purpose* of this work is to synthesize existing evidence and conceptualize digitalization strategy as a structured approach that integrates technological, managerial, and human-capital components to enhance organizational resilience.

2. Literature Review.

Research on digitalization in health care has evolved substantially over the past decade, driven by rapid technological innovations, the pressures of global crises, and increasing recognition of the role of digital tools in strengthening organizational resilience. Early digital health studies primarily focused on introducing electronic medical records, using telemedicine to expand access, and applying information technologies to improve operational efficiency. These foundational works established the conceptual basis for understanding digital health as both a technological and organizational transformation (Marinescu, 2025; Williams, 2022). Over time, the field expanded to include broader systemic implications, such as digital governance, interoperability, cybersecurity, and the integration of analytics into clinical decision-making.

A significant stream of research positions digital transformation as a catalyst for developing adaptive and resilient healthcare systems. Empirical findings show that digital maturity, the extent to which an organization adopts and effectively integrates digital tools, correlates with its ability to anticipate risks, coordinate resources, and maintain service continuity during crises (Kirmizi, 2022). Baudier (2023) and Rabbani et al. (2025) demonstrate that telemedicine and remote monitoring systems not only expand access to care but also function as stabilizing mechanisms during periods of heightened uncertainty, such as infectious disease outbreaks. These studies collectively establish the foundation for viewing digital tools as resilience enablers rather than simple technological upgrades.

Another important body of literature examines the relationship between digital transformation, organizational culture, and human capital. Scholars such as Kludacz-Alessandri et al. (2025) highlight that digital intensity and transformation management practices significantly influence job satisfaction through the mediating effect of organizational resilience. Their work suggests that digitalization must be accompanied by cultural readiness, staff engagement, and adequate training to produce positive outcomes. Similarly, Larsson et al. (2025) and Henshall et al. (2022) emphasize the dual role of digital tools. They can enhance

psychological resilience and reduce workload stress when properly implemented, but may also generate fatigue and burnout when poorly designed or insufficiently supported. These studies underscore that digital transformation is a socio-technical process, requiring alignment between human competencies, technological infrastructure, and organizational goals.

Beyond the healthcare sector, broader management and innovation research offers valuable insights into how digital technologies influence resilience. Cardoso et al. (2025) and Soomro et al. (2024) find that digital business models and innovation capabilities significantly enhance organizational performance in turbulent environments, offering a conceptual bridge between digital transformation and resilience theory. Reza et al. (2025) and Ma & Kang (2025) further contribute by demonstrating how data-driven culture, predictive analytics, and supply chain flexibility mediate the relationship between digital technologies and adaptive capacity. These contributions help situate healthcare digitalization within a wider strategic management context, reinforcing the argument that resilience emerges through integrated digital ecosystems rather than isolated technologies.

Nevertheless, several unresolved issues persist in the literature. First, although the resilience-enhancing potential of digital technologies is widely acknowledged, studies diverge on the specific mechanisms through which digital transformation contributes to organizational resilience. Some scholars attribute resilience primarily to technological upgrades and enhanced data availability, while others highlight governance, workforce competencies, and agile management structures as more decisive factors. Second, despite increasing research on digital maturity, there remains limited consensus on standardized metrics for evaluating how digitalization influences resilience outcomes, making comparisons across organizations and health systems difficult. Third, risks associated with digital transformation, including cybersecurity threats, unequal access to digital services, algorithmic bias, and ethical concerns, remain insufficiently integrated into theoretical models of digital resilience (Haimi, 2025).

Finally, existing literature tends to examine individual components of digital transformation such as telehealth, interoperability, or digital skills, rather than integrating them into a comprehensive strategic framework. This fragmentation limits understanding of how digital infrastructures, managerial practices, and human capital converge to produce resilience in healthcare organizations operating within a BANI environment. The gap identified in these studies forms the basis for the present review, which seeks to synthesize the multifaceted contributions of digitalization into a coherent conceptual model that explains its strategic role in strengthening organizational resilience.

3. Methodology and research methods.

This study integrates elements of a narrative review with an empirical multi-case analysis of digitalization strategies implemented across ten healthcare organizations. Its methodological design seeks to connect conceptual insights on digital transformation and organizational resilience with measurable institutional-level indicators.

The research approach is grounded in systems theory and socio-technical perspectives, which consider healthcare organizations as complex adaptive systems shaped by continuous interactions among technological, human, and organizational components. Principles from resilience theory and the dynamic capabilities framework support the interpretation of how digital resources and competencies enhance an organization’s capacity to anticipate, absorb, and adapt to shocks within a BANI environment.

The empirical design includes ten healthcare organizations (H1–H10) that differ in levels of care, ownership structures and regional settings, thus ensuring analytical diversity and comparability. The sample includes Municipal Non-Commercial Enterprises (MNCEs), highly specialized state institutions, university clinics and private medical centres: the MNCE “City Hospital No. 3 of Mykolaiv City Council”; the MNCE “Odesa Regional Clinical Oncology Center” of the Odesa Regional Council; Medical House Odrex (a private multidisciplinary centre in Odesa); the MNCE “Chuhuiv Central Hospital named after M. I. Kononenko” of the Chuhuiv City Council in Kharkiv Region; the MNCE “Teplodar Primary Health Care Centre” of Teplodar City Council; the Centre for Reconstructive and Restorative Medicine (University Clinic of Odesa National Medical University); MediClub (a private medical centre in Dnipro); the State Scientific Institution “Ukrainian Mother and Child Care Center of the Ministry of Health of Ukraine” (UMCCR Mother and Child); the MNCE “Central City Hospital of Oleksandria” of Oleksandria City Council; and the MNCE “City Clinical Hospital No. 10” of Odesa City Council.

The inclusion of healthcare providers operating at primary, secondary and tertiary levels allows the study to capture the multi-layered nature of digital transformation in the Ukrainian health system. Primary care representation enables the analysis of digital tools that support family medicine, continuity of care and population-based registries, domains where digitalization has a direct effect on preventive services and patient navigation. Secondary-level multidisciplinary hospitals provide insights into the integration of electronic health records, diagnostic information systems and digital bed-management solutions that are essential for operational resilience, clinical coordination and emergency response. Highly specialized tertiary care institutions offer a perspective on advanced infrastructures, digital competencies and complex clinical pathways. These organizations operate high-technology diagnostics, participate in academic and research

networks and demonstrate early adoption of clinical decision support systems, telemedicine and digital quality-monitoring tools.

The private sector segment contributes important contrasting dynamics, particularly higher investment capacity, faster organizational adaptation and accelerated uptake of innovative digital solutions, which frequently set the benchmark for market-driven digital transformation in Ukraine.

Geographical representation across southern, eastern and central regions further strengthens the empirical base. This regional dispersion is significant because it captures heterogeneous demographic structures, varied morbidity profiles, uneven exposure to military threats and war-related systemic pressures, as well as pronounced disparities in workforce stability, financing, donor support and access to digital innovations.

Taken together, the selected organizations form an analytically robust and contextually relevant sample that reflects the structural diversity of Ukraine's healthcare system. This breadth enables the identification of systemic, organizational and regional determinants shaping digital transformation and its role in strengthening healthcare resilience within the broader dynamics of a BANI environment.

Data collection combines three complementary methods. First, document analysis encompasses institutional strategies, internal regulations on digital systems and telemedicine, policies on data protection and clinical decision support, and reports. Second, a standardized survey was conducted among key managers and experts, including chief executives, medical directors, heads of IT units, with two to four respondents per organization. The structured questionnaire assessed the degree of digitalization, the presence of strategic digital priorities, digital governance practices, staff competency development, and perceived resilience, with all indicators evaluated using a Likert scale. Third, secondary operational and statistical data were analyzed, including service continuity metrics, patterns of telehealth use, stability of bed occupancy, recovery time following disruptions, and basic HR indicators such as turnover and absenteeism where available. All participating organizations were informed of the study's purpose, and all data were aggregated and anonymized.

The main indices were Digital Strategy Formalization Index (DSFI), Digital Infrastructure and Integration Index (DIII), Digital Data Governance Index (DDGI), Staff Digital Competence Index (SDCI), and Digital Governance and Change Management Index (DGCMI).

4. Results.

The comparative assessment of ten healthcare organizations across five dimensions of digitalization, specifically Digital Strategy Formalization (DSFI), Digital Infrastructure and Interoperability (DIII), Data-Driven Governance (DDGI), Staff Digital Competencies (SDCI) and Digital Governance and Change Management (DGCMI), reveals a clearly stratified landscape of digital maturity within the Ukrainian healthcare system (see table 1). The analysis identifies three distinct clusters of institutions: digitalization leaders, mid-level municipal hospitals with partial implementation, and low-readiness organizations constrained by structural and contextual limitations.

Table 1. Component Index Scores (1–5) and Classification by Type of Healthcare Provider

Healthcare Organization	DSFI	DIII	DDGI	SDCI	DGCMI	Overall Profile
Medical House Odrex	5	5	5	5	5	Digitalization leader (private sector)
MediClub (Dnipro)	5	5	5	5	5	Digitalization leader (private sector)
University Clinic ONMedU	5	5	5	5	5	Advanced tertiary/academic centre
UMCCR Mother and Child	5	4	4	4	5	Highly specialized clinical leader
Odesa Regional Clinical Oncology Center	4	5	4	3	3	High infrastructure, moderate governance
City Hospital No. 3 Mykolaiv	3	4	3	3	3	Mid-level municipal hospital
City Clinical Hospital No. 10 Odesa	3	4	3	3	3	Mid-level municipal hospital
Oleksandria Central City Hospital	2	3	2	2	2	Low–moderate municipal organization
Teplodar Primary Health Care Centre	2	2	2	2	2	Resource-limited PHC provider
Chuhuiv Central Hospital	2	2	2	2	2	Lowest digitalization readiness

Source: consolidated by the author.

The first cluster comprises digitalization leaders such as Medical House Odrex, MediClub and the University Clinic of ONMedU, which demonstrate uniformly maximal scores across all five indexes. These organizations exhibit fully formalized digital strategies embedded in institutional development plans, complete

with defined priorities, milestones and monitoring mechanisms. Their infrastructures are comprehensive and interoperable, allowing seamless integration of clinical and managerial workflows in real time. Moreover, they have established advanced analytics ecosystems that include predictive modelling tools and crisis-response dashboards, supporting agile and evidence-based decision-making. Workforce development is systematic and continuous, with clearly defined digital roles and high levels of staff engagement and satisfaction. Governance structures in these institutions are mature and cross-functional, incorporating risk management and structured communication strategies that reinforce organizational adaptability. Digital transformation in such environments is not peripheral but embedded as a core component of institutional functioning, strengthening resilience, innovation capacity and service quality, attributes particularly essential in the BANI environment. The UMCCR Mother and Child, although scoring slightly lower in infrastructure and analytics, demonstrates a similarly advanced strategic and governance orientation, placing it among the highly specialized leaders of digital transformation.

The second cluster includes institutions with partial digital maturity, such as the Odesa Regional Clinical Oncology Center, Mykolaiv City Hospital No. 3 and Odesa City Clinical Hospital No. 10. These hospitals show a pattern of high infrastructure development but only moderate formalization of digital strategies. This suggests that technological investments were made ahead of comprehensive strategic planning. Their use of digital data is uneven. While clinical performance indicators are used actively, integration into broader managerial, financial or operational decision-making remains limited. Staff competencies vary significantly across departments, with younger clinicians and IT personnel showing higher proficiency, while others encounter challenges in adopting complex digital systems. Governance models in these institutions remain IT-department-centred, leading to limited clinical involvement in strategic decisions and slower organizational adaptation. This cluster reflects a common trajectory of public-sector digitalization, where technical implementation advances but organizational processes and governance structures lag behind. Although these institutions have built a foundation for digital transformation, they lack the systemic mechanisms needed to fully harness digital tools for resilience and performance optimization.

The third cluster is represented by low-readiness organizations, including Oleksandria Central City Hospital, the Teplodar Primary Health Care Centre and Chuhuiv Central Hospital. These organizations consistently score lowest across all indexes, revealing deep structural and systemic constraints. Digitalization in these settings is not guided by formal strategies; instead, it is approached through isolated and often donor-driven projects lacking institutional integration. Their infrastructures are minimal or fragmented, with continued reliance on mixed paper–digital workflows that hinder efficiency and continuity of care. Data is used primarily for retrospective reporting rather than real-time operational management, limiting the ability to adapt to crisis conditions or unexpected fluctuations in service demand. Staff training in digital competencies is either irregular or absent, contributing to low digital literacy and limited uptake of available systems. Governance approaches are reactive, driven largely by external mandates rather than internal strategic vision. These organizations reflect the systemic vulnerabilities faced by smaller municipal providers operating under resource scarcity, workforce shortages, outdated equipment and connectivity limitations, conditions further aggravated by the ongoing war and associated financial pressures. Without targeted support, the digital divide between these institutions and the national leaders is likely to widen.

Across all clusters, several cross-cutting insights emerge. First, ownership and institutional autonomy strongly correlate with digital maturity. Private providers and university-affiliated clinics consistently outperform municipal institutions due to greater investment capacity, management flexibility and incentives for innovation. Second, effective digital transformation requires the parallel development of strategy, infrastructure and governance; when these elements evolve in isolation, bottlenecks appear, particularly in data utilization and workforce capacity. Third, regional and contextual pressures, including security risks, staff migration and constrained budgets, significantly shape digital readiness, with smaller municipalities disproportionately affected. Fourth, workforce digital competencies emerge as a critical differentiator: even robust infrastructures cannot produce meaningful impact without systematic training and defined competency frameworks. Finally, digital governance is a foundational determinant of resilience. Healthcare organizations with structured governance mechanisms demonstrate stronger continuity planning, better crisis responsiveness and a higher degree of adaptive capacity, underscoring the central role of governance as a mediator between technological adoption and organizational performance.

Table 2. Digitalization Strategy Index (DSI) and Organizational Resilience Index (ORI) Scores Across Healthcare Organizations

Healthcare Organization	DSI Score (1–5)	ORI Score (1–5)	Interpretation
Medical House Odrex	5.0	4.9	Very high resilience: rapid crisis adaptation, strong continuity planning
MediClub (Dnipro)	5.0	4.8	Very high resilience supported by fully integrated digital strategy
University Clinic ONMedU	5.0	4.7	High resilience due to advanced digital governance and analytics

UMCCR Mother and Child	4.6	4.5	Strong resilience; slightly lower due to partial gaps in infrastructure integration
Odesa Regional Clinical Oncology Center	3.8	3.7	Moderate resilience: strong clinical data use but slower recovery in crises
City Hospital No. 3 Mykolaiv	3.4	3.2	Mid-level resilience; bottlenecks in workflows and data integration
City Clinical Hospital No. 10 Odesa	3.4	3.1	Mid-level resilience with longer recovery periods after disruptions
Oleksandria Central City Hospital	2.2	2.0	Low resilience; limited continuity planning and high vulnerability
Teplodar Primary Health Care Centre	2.0	1.9	Very low resilience: dependence on manual processes and limited infrastructure
Chuhuiv Central Hospital	2.0	1.8	Lowest resilience due to minimal digital capacity and high crisis sensitivity

Source: consolidated by the author.

The results presented in Table 2 demonstrate a strong and systematic association between the maturity of digitalization strategies (DSI) and the level of organizational resilience (ORI) across ten Ukrainian healthcare organizations. The observed distribution of scores reveals a clear gradient, in which institutions with more advanced, strategically aligned and comprehensively implemented digitalization efforts consistently exhibit higher resilience capacities. Conversely, organizations with fragmented or minimal digitalization display significantly lower resilience scores, marked by operational vulnerabilities and limited ability to adapt to crises. This pattern supports the study's hypothesis that digital maturity is a key determinant of organizational resilience in the BANI environment.

High-DSI Organizations: Digital Leaders with Strong Resilience Capacities

Organizations such as Medical House Odrex, MediClub (Dnipro) and the University Clinic of ONMedU demonstrate the highest values on both indexes (DSI = 5.0; ORI range 4.7–4.9). These institutions have developed fully integrated digital strategies, combining advanced electronic infrastructures with strong governance frameworks, comprehensive staff training and data-driven management practices. As a result, they reported rapid crisis adaptation, minimal service disruptions, and efficient restoration of clinical operations following emergencies such as epidemic waves or IT failures.

Their near-optimal ORI scores (4.7-4.9) reflect:

- rapid transition capabilities (e.g., teleconsultations, remote triage),
- high interoperability of internal and external systems,
- mature continuity planning with digital redundancy,
- strong managerial confidence supported by real-time dashboards.

The UMCCR Mother and Child, though marginally lower (DSI = 4.6; ORI = 4.5), follows a similar trajectory, demonstrating that specialized institutions with well-developed digital governance structures also achieve strong resilience outcomes, even if some infrastructural gaps remain.

These findings align with international literature indicating that fully developed digital ecosystems enable adaptive learning, quicker recovery cycles and reduced operational brittleness during crises.

Medium-DSI Organizations: Partial Digitalization and Moderately Developed Resilience

The second cluster, represented by the Odesa Regional Clinical Oncology Center and two municipal hospitals in Mykolaiv and Odesa, presents intermediate DSI scores (3.4-3.8) and moderately high but uneven ORI performance (3.1-3.7). These institutions have established some elements of digital infrastructure, particularly in diagnostics and clinical documentation, but lack the strategic coherence and governance maturity needed for digitalization to function as a fully integrated resilience mechanism.

This group shares several characteristics:

- digitalization exists but is not systematically embedded in managerial processes;
- reliance on hybrid paper–digital workflows slows down crisis responsiveness;
- clinical analytics is developed, but operational analytics remains underutilized;
- staff competencies are uneven across departments, reducing consistency in system use.

Their ORI profiles confirm these gaps: while they can maintain core services during disruptions, recovery times are longer, and organizational adaptation is hindered by workflow fragmentation. They serve as transitional cases, highlighting that partial digitalization produces only partial resilience unless supported by broader organizational changes.

Low-DSI Organizations: Structural Vulnerability and Minimal Digital Resilience

Organizations with the lowest digitalization scores (Oleksandria Central City Hospital, Teplodar Primary Health Care Centre and Chuhuiv Central Hospital) exhibit the weakest resilience performance (ORI = 1.8-2.0). These organizations rely heavily on manual processes, have minimal interoperability, and lack institutionalized digital governance structures. Continuity plans are either absent or insufficiently implemented, contributing to increased vulnerability, especially under conditions of war-related disruptions, supply shortages and workforce instability.

Key weaknesses in this cluster include:

- absence of strategic digital planning,
- fragmented or outdated IT infrastructure,
- inability to maintain services during IT failures,
- low staff digital competencies, creating resistance or fear of digital tools,
- strong exposure to contextual risks (e.g., energy instability, communication breakdowns).

Their ORI scores reflect the operational fragility of institutions at early or pre-digital stages of development. These results underscore the need for systemic capacity-building, targeted investments and structured policy support to prevent further widening of digital inequality across healthcare regions.

Across all organizations, several generalizable insights emerge. First, digital maturity is a powerful predictor of resilience. With a strong positive correlation ($r \approx 0.93$), suggesting that digitalization is not simply a technological asset but a foundational determinant of organizational robustness, adaptability and continuity. Second, strategic alignment matters as much as technology. Continuity planning, governance structures and staff training amplify the impact of infrastructure, while their absence limits the benefits of digital tools. Third, resilience deficits cluster in resource-limited settings, highlighting structural inequities that could widen without targeted interventions, especially under wartime conditions. Fourth, managerial perception of resilience correlates with digitalisation, indicating that digital readiness influences not only objective performance but also decision-makers' confidence and preparedness. Fifth, partial digitalization delivers partial resilience, confirming that piecemeal implementation without governance reform does not yield substantial resilience gains.

5. Discussion.

The comparative assessment of digitalization maturity across ten Ukrainian healthcare organizations reveals a stratified pattern that aligns with broader international research on digital transformation and organizational resilience. Three distinct clusters emerge, namely digitalization leaders, intermediate municipal hospitals, and low-readiness organizations, each characterized by specific technological, managerial and contextual attributes. These findings illuminate how structural capacity, governance orientation and contextual constraints jointly shape the trajectory and impact of digital transformation in healthcare settings.

First cluster – digital leaders.

Organizations in the first cluster (Medical House Odrex, MediClub and the University Clinic ONMedU) demonstrate a convergence of strategic clarity, advanced digital infrastructure, skilled workforce and structured governance mechanisms. Their uniformly high scores across all five component indexes reflect the comprehensive nature of their digital strategies. Digital transformation in these institutions operates not as a series of disconnected technological upgrades, but as an integrated organizational paradigm supported by clear priorities, cross-functional committees, and iterative performance monitoring.

This aligns with empirical evidence showing that digital maturity enhances adaptive capacity, accelerates recovery in crises, and strengthens continuity of care (Williams, 2022; Latifi, 2025). Highly digitized organizations tend to embed analytics into decision-making, maintain redundancy systems, and transition rapidly between operational modes (e.g., from in-person to virtual care). The high Organizational Resilience Index (ORI) scores of these institutions indicate not only structural readiness but also cultural and managerial receptiveness to digital innovation. These findings affirm theoretical models that consider digital transformation a key enabler of dynamic capabilities and organizational learning in turbulent environments.

Second cluster – intermediate digitalization.

The second cluster, represented by the Odesa Regional Clinical Oncology Center and municipal hospitals in Mykolaiv and Odesa, exhibits a hybrid pattern where infrastructure investments precede or outpace strategic and governance development. High DIII scores suggest substantial adoption of diagnostic systems, electronic records and telemedicine tools, yet moderate DSFI, DDGI and DGCMI scores point to incomplete integration of these technologies into managerial processes.

This "implementation gap" reflects a challenge widely recognized in public-sector digitalization literature: technological modernization alone does not generate organizational resilience unless accompanied by coherent strategies, participatory governance and robust competency frameworks. In these institutions, workflows remain fragmented due to partial interoperability, inconsistent data use, and uneven digital literacy. Consequently, ORI scores are moderate but unstable, indicating that digital tools improve some crisis responses but fail to deliver systematic resilience.

These findings resonate with global observations that the public hospital sector often experiences a lag between technology acquisition and organizational transformation, leading to partial digitalization outcomes with limited strategic value (Ma et al., 2025; Kludacz-Alessandri, 2025). Strengthening digital governance and expanding staff digital training represent high-impact opportunities for this group.

Third cluster – low-readiness institutions.

The third cluster (Oleksandria Central City Hospital, Teplodar PHC Centre, and Chuhuiv Central Hospital) exhibits consistently low scores across all indexes, highlighting multidimensional barriers to digital transformation. These organizations operate under resource scarcity, outdated infrastructure, workforce shortages and regional instability, factors exacerbated by wartime pressures. Digitalization efforts in these

institutions are fragmented, donor-driven or compliance-oriented, lacking strategic coherence and managerial ownership.

The extremely low ORI scores reflect high operational fragility. The inability to maintain continuity of services during IT failures, poor recovery after disruptions, and limited adaptability to sudden shifts in patient flows. Staff digital competencies are insufficient to support advanced systems, and governance structures are largely reactive. These patterns mirror findings in resilience research indicating that under-resourced organizations face disproportionate risks of system failure, especially when digital transformation is attempted without investment in foundational capacity (Larsson et al., 2025).

The digital divide observed here represents a systemic challenge for the Ukrainian healthcare system, as unequal digital readiness reinforces pre-existing disparities in service quality, patient safety and crisis responsiveness. Without targeted policy interventions—especially for PHC providers and small municipalities. This gap risks widening further.

Across all clusters, several consistent themes emerge:

1. Digital maturity strongly correlates with resilience. The near-linear relationship between DSI and ORI ($r \approx 0.93$) supports the hypothesis that digital transformation is not simply technological modernization but a strategic determinant of adaptability, continuity and crisis responsiveness.
2. Governance is the critical mediator. Even when technology is available, the absence of structured governance limits its impact. Conversely, institutions with active steering committees, risk assessment procedures and change management systems demonstrate superior resilience regardless of size or ownership.
3. Human capital defines digital outcomes. Digital competencies, continuous training, and staff engagement with new systems are decisive. High technologies cannot compensate for low digital literacy; conversely, empowered staff can extract significant value from modest systems.
4. Strategy matters more than individual tools. Partial digitalization produces partial resilience. Fragmented systems, paper–digital hybrids, and inconsistent data use dilute the effects of technological investments. Only comprehensive strategies, aligned with mission, operations and risk context, translate into measurable resilience.
5. Contextual pressures shape digital readiness. Organizations in high-risk regions, under financial strain or affected by staff migration experience slower digitalization, demonstrating that resilience is not solely an internal characteristic but shaped by external constraints.

The findings of this study highlight several strategic priorities for Ukrainian healthcare policymakers and institutional leaders:

1. Develop national standards for digital governance to ensure that all healthcare organizations, not only advanced or private ones, can implement structured digital strategies aligned with resilience objectives.
2. Invest in workforce digital competencies, including competency frameworks, standardized training and digital leadership programs.
3. Support smaller municipal hospitals and PHC organizations with targeted funding, shared digital platforms, and technical assistance to prevent widening inequalities.
4. Promote interoperable, scalable infrastructures to organizations data continuity across the care continuum.
5. Encourage integration of digital tools into continuity and emergency preparedness planning, making resilience a core dimension of digital transformation strategies.

6. Conclusions.

The study provides empirical evidence that digital transformation in Ukrainian healthcare is highly heterogeneous and structurally stratified. The comparative assessment of ten healthcare organizations across five dimensions of digitalization (strategy formalization (DSFI), infrastructure and interoperability (DIII), data-driven governance (DDGI), staff digital competencies (SDCI) and digital governance and change management (DGCMI)) revealed three distinct clusters of institutions, namely digitalization leaders, intermediate municipal hospitals and low-readiness organizations. This typology reflects not only differences in technological capacity, but also deep divergences in governance models, human capital development and exposure to contextual constraints.

First, the results confirm that digitally mature organizations (private providers and university-affiliated centres with fully formalized digital strategies, integrated infrastructures and advanced governance mechanisms) demonstrate the highest levels of organizational resilience. Healthcare organizations such as Medical House Odrex, MediClub and the University Clinic ONMedU show that when digitalization is embedded as a core strategic paradigm, supported by analytics, continuity planning and systematic staff training, organizations are able to adapt rapidly to crises, maintain essential services and recover quickly from disruptions. These findings are consistent with international studies that link digital maturity with dynamic capabilities, learning capacity and enhanced continuity of care.

Second, the study reveals a previously underexplored phenomenon in the Ukrainian context. The “implementation gap” in intermediate public hospitals, where investments in infrastructure and diagnostic

systems are not fully matched by strategy, governance and human capital development. Institutions in this cluster exhibit partial integration of digital tools, reliance on hybrid paper–digital workflows and fragmented data use. As a result, their resilience is moderate but unstable. This pattern parallels global evidence from public-sector digitalization, but the present analysis specifies its mechanisms in a health system under war-related pressures and resource constraints.

Third, the identification of a low-readiness cluster consisting of smaller municipal hospitals and a primary health care provider highlights a critical structural vulnerability. These organizations operate with minimal digital infrastructure, lack strategic digital planning and depend heavily on manual processes and externally driven projects. Their very low Organizational Resilience Index scores indicate high operational fragility and limited capacity to cope with shocks. Compared with international analogues, where under-resourced providers also lag in digitalization, the Ukrainian case is additionally shaped by security risks, energy instability and staff migration, which further amplify the digital divide.

A key empirical contribution of the study is the demonstrated strong positive association ($r \approx 0.93$) between the Digitalization Strategy Index (DSI) and the Organizational Resilience Index (ORI). This relationship empirically supports the central hypothesis that digital maturity is not merely a technological attribute, but a foundational determinant of organizational robustness, adaptability and continuity in a BANI environment. The analysis shows that partial digitalization yields only partial resilience, and that governance quality and staff competencies are critical mediators between technology and outcomes. This extends existing theoretical models by quantifying the DSI–ORI relationship in a real-world, high-risk health system context.

On this basis, several practical recommendations can be formulated. At the policy level, there is a need to develop national standards and guidelines for digital governance in healthcare, ensuring that digital strategies explicitly incorporate resilience objectives, continuity planning and risk management. Targeted support (financial, infrastructural and methodological) should be directed to low-readiness municipal and PHC organizations to prevent further widening of digital inequalities. At the organizational level, investments should prioritize not only hardware and software, but also workforce digital competencies and leadership capacity, including competency frameworks, continuous training and support for “digital champions”. Finally, interoperable, scalable platforms and shared data ecosystems should be promoted to enable continuity of information across levels of care.

The findings also outline several promising directions for further research. Future studies could expand the sample to include a larger number of organizations and regions, allowing for more robust statistical modelling of the determinants of digital maturity and resilience. Longitudinal research would make it possible to track the dynamics of DSI and ORI over time and to evaluate the impact of specific reforms, donor programs or regulatory changes. Comparative analyses with other countries in Eastern Europe or post-conflict settings could further clarify the role of contextual factors, such as war, economic crises or demographic shifts, in shaping digital transformation trajectories. Additionally, micro-level studies focusing on patient outcomes, staff well-being and care quality in high- versus low-DSI institutions would deepen understanding of how digital resilience translates into clinical and social results.

Overall, the study demonstrates that digital transformation, when strategically aligned and institutionally embedded, constitutes a powerful lever for strengthening the resilience of healthcare organizations. Conversely, fragmented, project-based and under-governed digitalization not only fails to generate systemic benefits, but may reinforce existing structural vulnerabilities. Addressing these disparities is therefore not only a technological or managerial task, but a strategic priority for the future development and post-war recovery of the Ukrainian health system.

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Стратегія цифровізації закладу охорони здоров'я як інструмент підвищення організаційної стійкості в умовах BANI-середовища

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Стаття присвячена аналізу впливу стратегія цифровізації на стійкість закладів охорони здоров'я, що функціонують в умовах крихкості, тривожності, нелінійності та незбагненності сучасного середовища (BANI-середовище). Метою дослідження є концептуалізація цифровізації як інтегрованого технологічного, управлінського компонента, а також емпірична оцінка її взаємозв'язку з організаційною стійкістю в умовах високоризикової системи охорони здоров'я. Авторський підхід поєднує концептуальний аналіз десяти закладів охорони здоров'я різних форм власності і рівнів медичної допомоги з урахуванням регіонального контексту України. Цифровізацію досліджено завдяки аналізу п'яти індексів, що охоплюють формалізацію цифрової стратегії, рівень інфраструктури та інтероперабельності, орієнтацію управління на дані, цифрові компетентності персоналу та якість цифровізації та управління змінами. Організаційну стійкість виміряно за інтегральним індексом, який включає безперервність надання послуг у періоди криз, тривалість відновлення після збоїв, наявність планування безперервності та суб'єктивно оцінену стійкість керівників і персоналу. Інформаційну базу дослідження становлять стратегічні та нормативні документи закладів, стандартизоване опитування менеджерів та експертів, а також вторинні операційні показники щодо безперервності послуг, використання телемедицини та стабільності кадрового складу. Емпіричні результати демонструють наявність чітко стратифікованого цифрового ландшафту. Виокремлено три кластери: лідери цифровізації, заклади з проміжним рівнем цифрової готовності та організації з низьким рівнем цифровізації, у яких цифровізація має фрагментарний характер. Лідери характеризуються повністю формалізованими стратегіями, високим рівнем інтероперабельності, розвиненою аналітикою, системною підготовкою персоналу та структурованим цифровим врядуванням. Ці характеристики узгоджуються з високими показниками стійкості, швидкою адаптацією та мінімальними порушеннями у кризових ситуаціях. Заклади середнього рівня демонструють достатній рівень цифрових рішень у діагностиці та документації, однак мають обмежену стратегічну формалізацію, нерівномірне використання даних і неоднорідні компетентності персоналу, що зумовлює нестабільний рівень стійкості. Найнижчі показники притаманні закладам з мінімальною інтероперабельністю, відсутністю стратегічного планування та значною залежністю від «ручних» процесів. Встановлено прямий зв'язок між інтегральним показником цифровізації та індексом організаційної стійкості, що підтверджує визначальну роль цифрової зрілості у формуванні здатності закладів протистояти зовнішнім загрозам, підтримувати безперервність роботи та швидко відновлюватися після збоїв. Аналіз засвідчив, що часткова, несистемна цифровізація забезпечує лише часткові ефекти, тоді як якість управління та компетентності персоналу виступають ключовими медіаторами взаємодії технологій і результатів діяльності. Наукова новизна полягає в інтегрованому вимірюванні стратегії цифровізації та стійкості організацій, емпіричному виявленні «розриву впровадження» в закладах охорони здоров'я середнього рівня готовності до цифровізації та у висвітленні цифрової нерівності, що перетинається з формою власності, рівнем медичної допомоги та регіональними ризиками. Практична значущість визначається обґрунтованими рекомендаціями щодо запровадження національних стандартів цифрового врядування, інвестування в розвиток цифрових компетентностей персоналу, підтримки закладів з низьким рівнем готовності до цифровізації через цільове фінансування та спільні цифрові платформи, а також інтеграції цифрових інструментів у стратегічне планування. Отримані результати формують підґрунтя для подальших досліджень на ширших вибірках, у динаміці та в міжнародних порівняннях закладів охорони здоров'я, що перебувають під впливом системних шоків.

Ключові слова: цифровізація; охорона здоров'я; сталий розвиток; менеджмент; стратегія.