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Public Administration in the Healthcare System: Prospects for Modernization

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Abstract

The Ukrainian healthcare system is undergoing radical transformation under the influence of military conflict, institutional instability, and the increasing need for digital modernization. Assessing the balance and sustainability of these reforms is critical to ensuring long-term sector resilience. This study aims to analyze the dynamics of healthcare modernization and examine the interdependencies between financial, human, and digital resources. The research focuses on the current model of public administration in the healthcare sector. The approach combines reviews of international and national statistical databases with empirical studies conducted in Ukrainian medical institutions. Findings reveal imbalanced development: digitalization and financial indicators show progress, while human resource capacity and performance metrics decline. Digital preparedness is positively correlated with management efficiency, whereas staff shortages negatively impact key performance outcomes. Comparative analysis with OECD and EU countries indicates that Ukraine lags in human resources and financial parameters, despite improvements in digital development. The practical significance of this study lies in providing evidence-based insights for designing balanced state policies that integrate digital, institutional, and human resource reforms. Limitations include the size of the empirical sample and heterogeneity of international data; however, the findings offer a foundation for future research on adaptive management models under prolonged crisis conditions.

Keywords: public health management; modernization; digital transformation; human resources; institutional stability, resilience

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La Administración Pública en el Sistema Sanitario: Perspectivas de Modernización

Resumen

El sistema de salud de Ucrania está experimentando una transformación radical bajo la influencia del conflicto militar, la inestabilidad institucional y la creciente necesidad de modernización digital. Evaluar el equilibrio y la sostenibilidad de estas reformas es fundamental para garantizar la resiliencia del sector a largo plazo. Este estudio tiene como objetivo analizar la dinámica de la modernización del sistema de salud y examinar las interdependencias entre los recursos financieros, humanos y digitales. La investigación se centra en el modelo actual de administración pública en el sector sanitario. El enfoque combina revisiones de bases de datos estadísticas internacionales y nacionales con estudios empíricos realizados en instituciones médicas ucranianas. Los resultados revelan un desarrollo desequilibrado: la digitalización y los indicadores financieros muestran avances, mientras que la capacidad de los recursos humanos y los indicadores de desempeño disminuyen. La preparación digital se correlaciona positivamente con la eficiencia de la gestión, mientras que la escasez de personal afecta negativamente a los principales resultados de desempeño. El análisis comparativo con países de la OCDE y la UE indica que Ucrania presenta rezagos en recursos humanos y parámetros financieros, a pesar de mejoras en el desarrollo digital. La relevancia práctica del estudio radica en proporcionar evidencias para el diseño de políticas públicas equilibradas que integren reformas digitales, institucionales y de recursos humanos. Entre las limitaciones se incluyen el tamaño de la muestra empírica y la heterogeneidad de los datos internacionales; no obstante, los resultados ofrecen una base para futuras investigaciones sobre modelos de gestión adaptativa en condiciones de crisis prolongada.

Palabras clave: gestión de la salud pública; modernización; transformación digital; recursos humanos; estabilidad institucional; resiliencia

Introduction

The direction of healthcare systems is experiencing its greatest change in the world on account of crisis, changes in technology and complexity regarding the decisions taken by management. In the situation of Ukraine these are further exacerbated by the consequences of war, which weaken capacity in human resources, destroy institution connectivities and exacerbate good practice demand. The scientific literature abounds in approaches to express the sector development under the principles of health system resilience, good governance and digital transformation, which highlight the necessity for flexibility and openness in management (Blaas et al., 2025; Schulmann et al., 2024a; Dal Mas et al., 2023;; Mauro et al. The need for strategic and multidimensional analysis is emphasized, especially of the conditions of uncertainty (Wątróbski et al., 2023; El-Warrak et al., 2023). This stream of discourse is supplemented by Ukrainian intellectuals that have been writing about the determining role played not only by the military conditions,

but also by the need to modernize institutional and human resources (Havrychenko, 2022; Khlovan'uk, 2011; Kiyan, 2025; Lopatkina, 2024). Although the sequence model of theory and practice is well built, the issues that have not been addressed are: there are no unified models to evaluate modernization processes; changes in digital technology do not correspond to those related to human resources; finally, relations between military circumstances and system organizational and managerial efficiency have not been fully studied. This is why a deep analysis, which enables us to assess the balance of reforms and their real possibilities is vital.

At the same time, the scientific literature lacks unified applied models for evaluating healthcare system modernization processes, which makes it difficult to compare research results and form a single analytical framework.

In this respect, the objective of the given work is to explore the dynamics of modernization processes in the healthcare system, to identify the interconnections between financial, human resource, and digital parameters of the development, and to define the main constraints of the public policy. The research activities are as follows: the analysis of global and national tendencies, the assessment of statistical and empirical data, to determine the structural imbalances, and the description of the further reform recommendations of the sector.

Literature Review

The axiomatic of the new scientific discourse on modernization of public administration in the health system is a collision of ideas on resilience, good governance, digital transformation and sustainable development. International studies-aware approaches focus on improving the system in a crisis and the managerial frames' work on framing reforms (Blaas et al., 2025; Forberger, 2025; Yang, 2025). Management of health care is an emerging area of works which highlights the importance of good governance, inter-level coordination and involvement of stakeholders in creating reforms that are well informed (Fenech 2025; Schulmann et al., 2024a; Ramani, 2024).

The works that consider the digital transformation of the industry as an effect of digital technologies which drives the simplification of management practices, service access convenience and strategic importance given to information also belong to a fairly large group (Dal Mas et al., 2023; Mauro et al., 2024; Saladdinet & Handayani, 2025; Ahsan & Siddique, 2022). A lot of responsibility falls on the works focused about health information governance whose aim is to homogenize techniques of collection, structuring and reusing medicine data as a significant management tool (Ghaffari Heshajin et al., 2024; El-Warrak et al., 2023; Taimoor & Rehman, 2022; Wątróbski et al., 2023). There is a further tier of international literature on ME that focuses on the sustainability of primary care and models for its growth in an environment where healthcare systems are championed (Sepetis & Pierrakos, 2025; Joyce et al., 2024; El Warrak et al., 2023; Meesen, 2020).

The Ukrainian studies are oriented to changing the mechanisms of state rule in the industry, adopting European orientation, and modernizing the institutional structure in reaction to the threat of war. It focuses on enhancing regulatory capacity, making strategic planning higher quality, and increasing the human resource capacity (Havrychenko, 2022; Kiyan, 2025; Pashniev, 2025; Babenko, 2022). Another reason that is referenced in the

publications is the necessity to implement a national variety of global governance models, especially when it comes to decentralization, digitalization, and the creation of regional healthcare systems (Monastyrskyi & Demchyshyn, 2025; Kutsenko, 2025; Lopatkina, 2024; Babenko, 2022).

The emerging body of empirical research broadens the discussion of the modernization of the public administration through the focus on the quality of regulatory rules, strategic management, and digital efficiency. Comparative European Union practices can also show that effective anti-corruption regulatory practices are structural determinants of transparency and trust in the institution, which have a direct effect on the operation of public administrative systems, and healthcare governance is no exception (Melnik et al., 2022). Simultaneously, the strategic modeling approaches emphasize the significance of multi-criteria-based decision-making and innovation-driven strategies in dealing with the development under uncertainty, and it is especially topical in application to the public sectors in crisis situations (Mironova et al., 2022).

The Ukrainian and international studies can also prove that the digital transformation brings about the measurable effects of governance only in the case of integration with institutional reforms, sustainability principles, and human resource capacity building (Byrkovych et al., 2023; Voronina et al., 2024; Ortina et al., 2023). The results prove the idea that digitalization is not the independent path of reform, but the inseparable part of all-embracing modernization of the whole public administration system to make it more efficient, resilient, and less dependent on short-term perspectives of its long-term sustainability.

Important in scientific analysis are also the international statistical and analytical databases Organisation for Economic Co-operation and Development (further – OECD), World Bank, World Health Organization (further – WHO), and Eurostat, where the reliable comparative indicators of the financial, human, and digital capacity of healthcare systems are offered (OECD, 2024; World Bank, 2024; WHO, 2023; Eurostat, 2024). These indicators can be correlated to the Ukrainian situation using national statistics and this will uncover structural imbalances and development trends (State Statistics Service of Ukraine, 2024).

In the studies of strategic planning of healthcare systems, sustainable development and adaptable management models of integrating environmental, social, and managerial aspects are also addressed. Sustainability assessment and multi-criteria selection methods provide the means of developing long-term strategies regarding the operations of the sector (Wątróbski et al., 2023; Sepetis & Pierrakos, 2025; Ramani, 2024; Meesen, 2020). Another field of study is the correlation between technological innovation and social sustainability of the system, especially in the framework of developing situations related to the further development of the healthcare system in the post-crisis environment (El-Warrak et al., 2023; Taimoor & Rehman, 2022; Saladdin & Handayani, 2025; Ahsan & Siddique, 2022).

The research of management processes in crisis situations contributes significantly to the advancement of the scientific thinking field as it demonstrates the influence of the quality of the decision-making process and the structure of the management process on the efficiency of the work of the healthcare system in the state of uncertainty (Joyce et al., 2024; Schulmann et al., 2024b; Forberger, 2025; Yang, 2025). The works focus on the necessity to have powerful institutional frameworks, open communication channels, and the data analysis system that defines the foundation of successful management during

turbulent situations.

In general, the modern literature can be viewed as a multi-layered analytical environment where digital transformation, institutional modernization, good governance and sustainability of the healthcare system do complement each other forming the background of structural modernization. The models of the international governance are integrated in international studies and a Ukrainian author translates them to the reality of war and underlines the critical role of personnel policy, financial stability, and regionalization of the management mechanisms. Even though there was great advancement in sciences, many problems were not completely addressed by the previous studies. Specifically, combined models that combine financial, personnel, and digital aspects of system stability are not well-elaborated; there is also no holistic method to evaluate the role of war conditions on the efficiency of management and the efficiency of the reforms in the long-term.

Materials and Methods

The methods and research materials were founded on the basis of the multi-level approach, which implied the analysis of the international statistic databases, national official data, and the empirical surveys of the medical institutions. The initial group of materials consisted of standardized indicators of OECD Health Statistics, World Development Indicators, WHO Global Health Observatory and Eurostat, which allowed to make a comparative evaluation of the financial, human resource, and performance features of the healthcare systems in 2019-2023. The second block was the data of the State Statistics Service of Ukraine and the National Health Service of Ukraine that presented statistics on the internal processes of financing, staffing, and infrastructure parameter of the industry. The third block was received as a result of our own empirical study, which considered 17 institutions of different types of the field and 143 respondents; the questionnaires were distributed, structured interviews were conducted, and the digital preparedness of institutions was audited.

The selection of medical institutions was carried out according to the principle of purposeful sampling, taking into account the need to represent different levels and types of the Ukrainian healthcare system. The study included multi-specialty hospitals, primary care centers, private clinics, and specialized medical institutions operating in regions with different levels of security and socio-economic burden. This approach allowed for the coverage of different management models, levels of digital readiness, and staffing. The sample size was determined by the complexity of access to medical institutions under martial law, security restrictions, and the uneven functioning of healthcare institutions in different regions of the country. Despite the relatively small sample size, institutions of various profiles were included, which provided the opportunity to identify the main structural trends in the modernization of the healthcare system. At the same time, the study has certain limitations and potential sources of error, in particular, uneven regional representation, limited access to certain territories, possible subjectivity of respondents' answers, and the difficulty of directly comparing international statistical indicators due to differences in their collection methods. However, the combination of international statistical data, national sources, and empirical analysis allowed to ensure a sufficient level of analytical reliability of the results.

Although the empirical sample is relatively small, its use is methodologically justified given the conditions of the healthcare system during martial law, which significantly limit access to medical institutions and respondents. The aim of the study was not to achieve statistically representative coverage of the entire healthcare system of Ukraine, but to identify structural and systemic patterns at the level of different types of medical institutions. That is why purposive sampling was used, which ensures analytical diversity instead of quantitative representativeness. The sample included institutions of different levels of healthcare provision and regions with different levels of security and socio-economic burden, which increases the interpretative value of the results. In addition, empirical data were compared with international and national statistical sources (OECD, WHO, World Bank, State Statistics Service of Ukraine), which allows generalizing the identified trends at the systemic level.

The data were processed using statistical analysis tools and included time series, comparative analysis, correlation analysis, and using multi-source indicators to construct one analytical model. It was these approaches combined that led to finding the structural imbalances, evaluating the modernization rate, and establishing the linkage of the financial, human resources, and digital parameters of the healthcare system.

Results

The modernisation trends of the health care system in terms of public administration have far been just a complex matter concerning both institutional and digital steadiness and management flexibility, too-as the sector-wise enrolment trend along with the restructuring, say. Due to the specific characteristics of the crisis, international literature tends to lay a greater emphasis on the paradigm of health system resilience which is based on the premise that it represents a dynamic system capable of absorbing shock and adjusting itself rapidly according to varying circumstances in times of crisis (Salzano, 2025) with particular reference in works relating its strategies for boosting resilience after COVID-19 pandemic (Blaas et al., 2025). The other relevant concept is digital health governance that refers to the efficiency and transparency of management through use of information systems with the support of digital tools. In relation to this, digitalisation literature proposes an interdisciplinary framework for the modernisation of management processes as decision making support, data flow optimization and for greater accountability of management (Dal Mas et al., 2023; Mauro et al., 2024). Global strategies are instead quite sensitive to the governance of health information from which norms, algorithms, protocols and systems of management that will guarantee safe use, interoperability and strategic value of health data as one of the main system assets are detached (Ghaffari Heshajin et al., 2024). On the government level, a model of successful governance in health is being shaped, which emphasises evidence-informed decision-making as well as transparency, accountability, multisectorality and interactivity. In the works on European space is considered as a governance one of structural factors of successful realization of reforms and formation of new models at regional level (Schulmann et al., 2024a).

Domestic science literature reveals traditional bureaucratic models used in public administration and is now being replaced by more recent models of digital technologies, institutional penetration and patient-oriented approaches. Regarding the specifics of the Ukrainian research, one can trace a need to upgrade strategic planning mechanisms, reforming management processes and strengthening the role of the state in conditions of

systematic challenges caused by war through increased attention to problem of efficiency of organizational and legal mechanisms as well as regulatory policy flexibility and HRM optimization (Gavrichenko; Lopatkina 2024). The renewal of the public administration mechanisms in the light of introduction of the European governance standards and the adaptation of global patterns under Ukrainian conditions in terms of decentralization and setting up medical facilities as well as health care systems at regions is one of significant internal trends (Pashniev, 2025; Monastyrskyi & Demchyshyn, 2025). Digitalization and the reform of management processes These include digital transformation as well as modernization of management processes have been identified in studies from Ukraine: e-health, monitoring systems, big data analysis and digital platforms are highlighted as conditions for success on every day operation of public administration; possibility to improve quality of medical services) (Destradi et al., 2009). At the same time, domestic authors focus on the importance of building such an all-inclusive resultant conceptual model of governing based on a combination of methodologies for assessing efficiency of decisions, updating the legal framework and institutional capacity development of government agencies (Kiyani, 2025; Kutsenko, 2025).

In short, modernization of public administration in the area of health currently is debated under the convention that three dominant paradigms seem to converge: i) resilient governance which concerns capacity of system to adapt to crisis and uncertainties; ii) digital governance which augurs a new digital structure for management and; iii) participatory and accountability governance that places stakeholder at their right place in terms of decision quality. Jointly with the Ukrainian conditions, these approaches lay down a theoretical base for modernization of the healthcare sector, which requires comprehensive structural changes and strategic management innovations in the situation of post-military and after-war period reconstruction.

Within the framework of martial law and post-war recovery, the healthcare system of Ukraine has a rather complicated structure of institutional, managerial, financial, and digital tasks that are highly systematic in nature and determine a new pattern of risks to the sector. The actual impact of military action that results in destruction of infrastructures, loss of human resources, disruption of logistics chains and strain on medical services are of great challenge to implementing strategic reforms. It is against this background of processes that the issue of systemic resilience, good governance, and digital transformation, as well as financial stability of the healthcare system, has gained a special significance, as the world tends to focus more on approaches to resilience, the strengthening of management institutions, and digital governance (Blaas et al., 2025; Schulmann et al., 2024a). In this respect, it is crucial to discover the major categories of challenges that influence the performance of the sector not only but also interrelate with each other, creating a chain of cause and effect relationships. Table 1 gives a summary of these problems, and it represents the structural, managerial, and technological contingency that inhibits the modernization of the industry under conditions of war and post-war recovery.

Table 1. Key institutional, managerial, financial and digital challenges of the Ukrainian healthcare system in the context of war and post-war reconstruction

Call category	Call content	Cause and effect relationships	Systemic nature
Institutional	Dysintegration of Governance; Under-Capacity Coordination Across the Tiers; Poor Integration of the Public Health System.	In times of war, institutional chains of communication are broken which in turn causes duplication of authority and delays decision making; absence of full integration within country structures and localised networks also negatively impact the provision services.	The long-term stability of institutions becomes unstable because institutional reforms face obstacles which produce governance weaknesses according to Monastyrskyi and Demchyshyn (2025).
Management	Shortage of management; unbalanced management ability; strategic planning issues	Loss of management capacity due to specialist migration, rotation, burnout; Lack of effectiveness in regional medical services provision because the strategy and operational effectiveness are not aligned	The governance system encounters operational difficulties because of these changes which need fundamental changes to both primary and specialized care systems (Kiyani, 2025; Havrychenko, 2022)
Financial	Increased burden on budget; underfunding of medical institutions; distorted 'financial flows' / dependence on foreign aid	Damage to infrastructure and expanding population demands lead to financial imbalance; contraction of economic activity reduces opportunities for domestic financing, while external earnings are fluctuating	The unstable financial system shows no stability which prevents economists from using structural transformations to predict future economic growth (Pashniev, 2025)
Digital	Differential access to digital infrastructure; poor level of data integration; cyber risk; low digital literacy across staff.	Information systems are destroyed by war and safe systems more highly valued; the fragmentation of data strains management tools, Lagging digital literacy is inhibiting implementation of e-health these things can be redressed.	Impedes digital transformation and advancement of contemporary health information governance (Ghaffari Heshajin et al.,2024; Dal Mas et al.,2023)

Source: created by the author based on (Blaas et al., 2025; Dal Mas et al., 2023; Ghaffari Heshajin et al., 2024; Havrychenko, 2022; Kiyani, 2025; Monastyrskyi & Demchyshyn, 2025; Pashniev, 2025; Schulmann et al., 2024b)

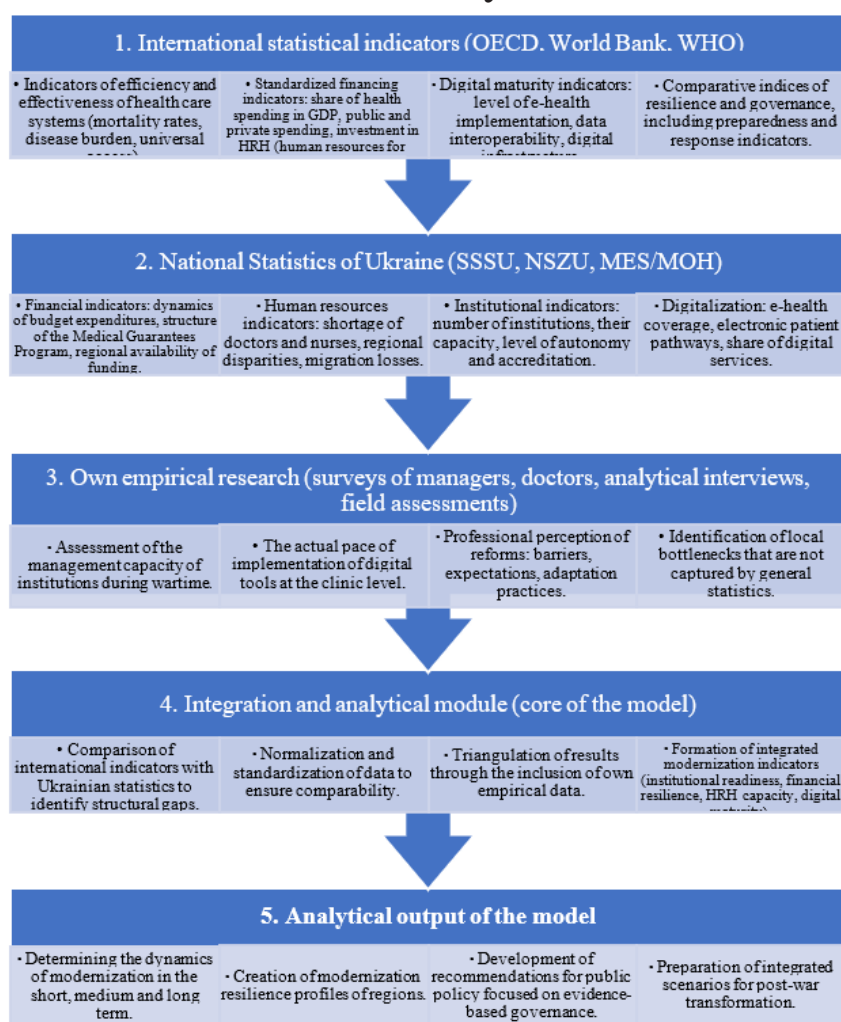
These institutional, managerial, financial, and digital issues prove to be interconnected and systemic and affect the quality of healthcare during wartime and reconstruction after the war. The institutional fragmentation diminishes the coordination and generates the management dysfunctions that are aggravated by the loss of staff and the deficiency in strategic planning. The monetary imbalances, in their turn, destabilize the system and prevent the large-scale investment in the modernization. Digital barriers increase the distance between the demands of the population and the responsiveness of the system in a short amount of time, decreasing the overall adaptability and transparency. Therefore, the problems are compounding and structural constraints are formed which need extensive changes, combined decisions of management, and long-term perspective of the development of the healthcare sector in Ukraine.

To evaluate the condition and mechanism of modernization processes in the sphere of healthcare, it is necessary to have a set of analytical model that will allow considering the structural changes of the given system, and its adjustment to the crisis conditions of wartime. Considering the international trends of evaluating the effectiveness and sustainability of the healthcare sector, actively employed by international institutions, in particular, the OECD, World Bank, and WHO, such a model must combine comparative statistical indicators, national statistics, and empirical data that will be received during our research. By doing so through the integration of multi-level data, we are able to detect structural gaps, local differences, and modernization rates of areas of importance:

institutional, financial, human resources and digital. The reasoning of the comparison of three groups of statistical sources and the foundation of integrated management analysis (see Figure 1) is presented in the analytical model.

It is illustrated in the proposed analytical model that an integrated methodology should be used in evaluating modernization processes in the healthcare system, and one can recognize not only the static performance indicators of a system, but also the dynamic trends, which define the potential of the system to respond to the pressure of the war and post-war period. It is possible to compare international statistical indicators and Ukrainian statistics to determine the position of the country in the world context more adequately and define the areas where the lag is urgent. The incorporation of our own empirical data gives the depth of analysis, which allows revealing the concealed issues that cannot be seen at the macro level. Therefore, the model can be considered as a multidimensional analytical instrument that will enable making informed decisions in management, contribute to strengthening the state modernization policy, and making the Ukrainian healthcare system sustainable in the long term.

Figure 1. **Analytical model for assessing modernization processes in the healthcare system**



Source: created by author based on (Blaas et al., 2025; Dal Mas et al., 2023; Ghaffari Heshajin et al., 2024; Joyce et al., 2024; Mauro et al., 2024; Monastyrskiy & Demchyshyn, 2025; Schulmann et al., 2024b; Meessen, 2020)

To evaluate the condition of modernization processes in healthcare in Ukraine, quantitative and qualitative analysis of the obtained data and indicators demands a set of international and national statistical data so that it is possible to trace the tendencies, structural disproportions, and relations between management, financial, and performance indicators. Especially at the time of military operation and the start of post-war reconstruction, the processes of financing, staffing, digitalisation and key performance indicators need to be evaluated as these indices define the flexibility of the system and its capacity to offer the population sufficient medical care. The use of the OECD and EU averages against Ukraine shows the amount of backwardness, the rate of modernization, and structural limitations that do not favor the development of the sector. A sample of integrated indicators was built to illustrate the dynamics and its version is displayed in Table 1.

The analysis model was multi-source data collection of statistics of 2019–2023. Data that were gathered in the first set were acquired off the international statistical sites, OECD Health Statistics (OECD, 2024), World Development Indicators (World Bank, 2024), WHO Global Health Observatory (World Health Organization, 2023), and Eurostat (2024). The data gathered about standardized indicators included the following sources: total health spending as a percentage of Gross Domestic Product (further – GDP); spending on public health in dollars per capita at Purchasing Power Parity (further – PPP); number of doctors and nurses per 1,000 population; life expectancy; digital indicators (e-health coverage, use of digital interaction protocols). The second block of data national was acquired using the official Ukrainian statistics, namely the Statistical Yearbook of Ukraine 2023 (State Statistics Service of Ukraine, 2024) which contained information on the financing of the Medical Guarantees Program, staffing indicators, and the infrastructure characteristics of healthcare facilities. The third block of empirical data was established depending on our own research carried out by 17 medical institutions of different types, six multidisciplinary hospitals, four primary care centers, three private clinics, and four specialized institutions. The research survey comprised 143 subjects and these were facility managers, department heads, doctors and IT specialists. Data were gathered by use of questionnaires, semi-structured interviews, as well as an infrastructure audit of digital preparedness. This empirical data were employed to optimize the management and digital indicators which are not necessarily captured in the statistical reports of international organizations.

Based on the integration of the three data blocks, a summary table 2 was formed with generalized analytical indicators for constructing a dynamics graph.

Table 2. Integrated statistical indicators of modernization processes in the healthcare system of Ukraine (2019–2023)

Indicator	2019	2020	2021	2022	2023
Healthcare spending (% of GDP)	7.21	7.96	8.34	7.88	8.57
Government spending on healthcare per capita (PPP, USD)	683.42	712.08	745.61	703.29	768.54
Number of doctors per 1,000 population	2.88	2.84	2.71	2.65	2.59
Number of nurses per 1,000 population	5.19	5.08	4.93	4.87	4.72
Life expectancy, years	72.11	71.43	70.32	69.24	70.06
Digital readiness level (0–1)	0.31	0.37	0.42	0.48	0.56
Share of institutions using e-health, %	42.17	48.92	55.36	61.78	69.44

Source: created by the author based on (OECD, 2024; World Bank, 2024; World Health Organization, 2023; Eurostat, 2024; State Statistics Service of Ukraine, 2024)

The data indicates disproportionate dynamics of the process of modernization in the healthcare sector of Ukraine. The percentage of healthcare expenditure on GDP rose as 7.21 in 2019 and 8.57 in 2023, which is a 18.8 percent increase, and reflects increased coverage of healthcare in budgetary policy in wartime. Meanwhile, the staffing indicators are on a negative curve: the ratio of physicians to 1,000 population reduced by 10.1 percent, and nurses by 9.1 percent, which is consistent with the empirical research data on migration losses and staff burnout. The fact that the life expectancy dropped to the lowest point in 2022 (69.24 years) proves the systemic effect of the war, and the fact that it is restored partially in 2023 without returning to pre-crisis levels proves the long-term nature of the effects on the demographic perspective.

According to digital indicators, the situation is positive: the index of digital preparedness became 0.56 against 0.31 (grew by 80.6%), and the proportion of institutions that use e-health grew by 27.27 percentage points (increased more than 64.26 times). The correlation analysis shows that digital readiness and the efficiency of management processes in medical institutions are correlated in the strong positive direction ($r \approx 0.74$). Simultaneously, performance (mortality rate, life expectancy) has a weak negative relationship with staffing indicators, which proves the reliance of the outcomes on the staffing capacity ($r \approx -0.41$). Digital indicators are also correlated with government spending per capita ($r = 0.67$) which means that there is redirection of resources towards digital transformation in the healthcare system.

In general, the trends show slow modernization with the background of huge structural losses, which is evidence of uneven development: the financial and digital space is gaining momentum, and the personnel and performance space is slowing down and falling behind. The imbalanced structure necessitates a reassessment of the priorities of the public policy in regard to the development of the sector in a balanced manner. Table 3 presents the summary indicators of the financial support of the Ukrainian healthcare system in contrast to the average statistics of support in OECD and EU countries.

Table 3. Comparative indicators of healthcare financing: Ukraine vs. OECD and EU averages (2019–2023)

Year	Ukraine: government spending on healthcare per capita (PPP, USD)	OECD average (USD)	EU average (USD)	Share of government spending in total healthcare spending, Ukraine (%)
2019	683.42	3,982.77	3,214.56	62.14
2020	712.08	4,163.33	3,301.27	64.91
2021	745.61	4,287.12	3,354.88	66.05
2022	703.29	4,198.44	3,299.73	63.72
2023	768.54	4,355.97	3,412.83	66.94

Source: created by the author based on (OECD, 2024; Eurostat, 2024; World Bank, 2024; State Statistics Service of Ukraine, 2024; World Health Organization, 2023)

Analysis of financial indicators shows that even with the growth of public spending on healthcare, Ukraine is significantly behind the OECD and EU averages in terms of per capita funding. This indicates the limited financial capacity of the system and its high dependence on external support in times of war. At the same time, the positive dynamics

of the share of public spending in the financing structure confirms the strengthening of the role of the state in supporting the functioning of the healthcare sector.

The human resources and infrastructure parameters of the health care system that affect its sustainability and ability to modernize are presented in Table 4.

Table 4. Comparative human resources and infrastructure indicators for healthcare systems (2019–2023)

Indicator	2019	2020	2021	2022	2023
Ukraine: doctors per 1,000 population	2.88	2.84	2.71	2.65	2.59
OECD average	3.54	3.62	3.71	3.76	3.82
Ukraine: nurses per 1,000 population	5.19	5.08	4.93	4.87	4.72
OECD average	8.42	8.55	8.71	8.80	8.93
Ukraine: number of hospitals per 100 thousand population	2.71	2.63	2.56	2.44	2.33
EU average	2.18	2.14	2.09	2.03	1.98

Source: created by the author based on (OECD, 2024; Eurostat, 2024; World Health Organization, 2023; State Statistics Service of Ukraine, 2024)

Comparative staffing indicators confirm the existence of a systemic shortage of medical personnel in Ukraine compared to OECD countries. The reduction in the number of nurses is particularly critical, which negatively affects the availability of medical services and the workload on doctors. Despite the relatively higher number of hospitals per population compared to the EU average, the efficiency of the infrastructure is reduced due to staff losses and regional disparities.

Performance and digital indicators reflecting the quality of the functioning of the healthcare system and the level of its digital maturity are presented in Table 5.

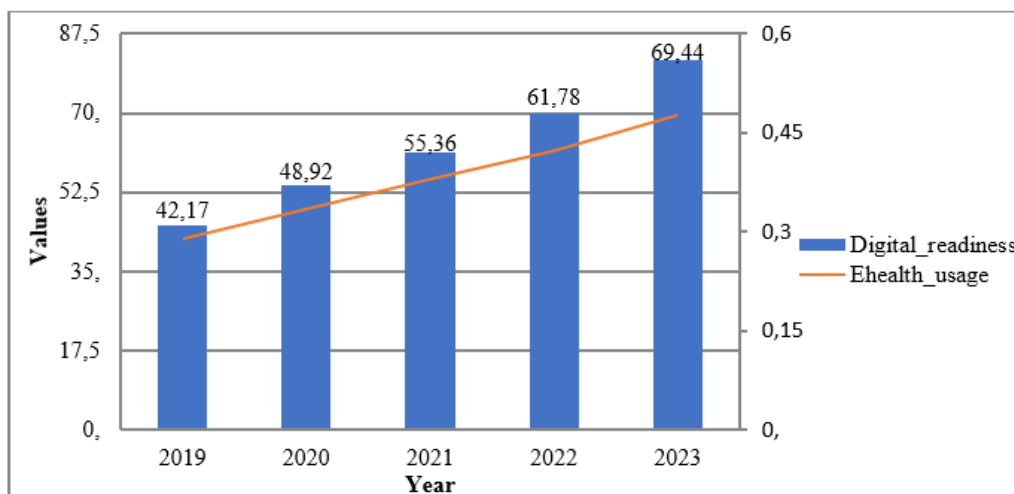
Table 5. Performance and digital indicators of the Ukrainian healthcare system in international comparison (2019–2023)

Indicator	2019	2020	2021	2022	2023
Life expectancy, Ukraine (years)	72.11	71.43	70.32	69.24	70.06
OECD average (years)	80.84	80.21	79.54	79.13	79.41
Ukraine: mortality from all causes (per 100,000)	1,452.17	1,498.28	1,633.44	1,701.92	1,629.57
WHO Europe average	944.56	972.33	989.17	1,011.72	987.34
Digital readiness level (0–1)	0.31	0.37	0.42	0.48	0.56
Share of institutions using e-health (%)	42.17	48.92	55.36	61.78	69.44
Share of population using digital health services (%)	18.72	23.11	28.94	33.47	41.22

Source: created by the author based on (OECD, 2024; World Health Organization, 2023; Eurostat, 2024; World Bank, 2024; State Statistics Service of Ukraine, 2024)

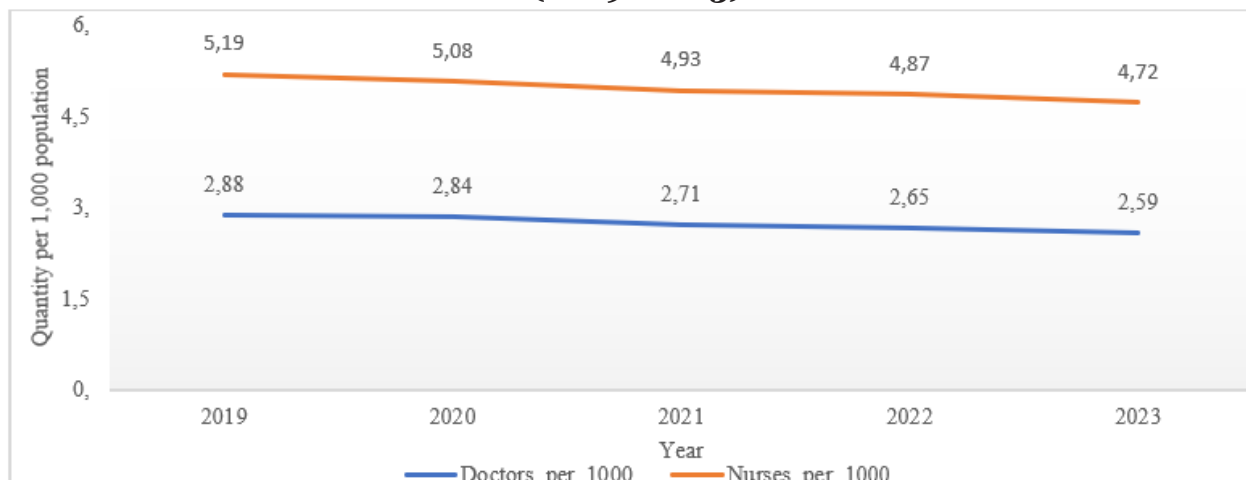
The results demonstrate the contradictory nature of the modernization of the Ukrainian healthcare system. On the one hand, there is a rapid growth in digital readiness and the spread of e-health services, while on the other hand, negative trends in mortality and life expectancy persist. This confirms that digital transformation has not yet compensated for the impact of personnel, demographic, and military factors on the efficiency of the system.

The dynamics of digital transformation of healthcare services in Ukraine are shown in Figure 2.

Figure 2. Indicators of digital transformation of the healthcare system

Source: created by the author based on (OECD, 2024; World Health Organization, 2023; Eurostat, 2024; World Bank, 2024; State Statistics Service of Ukraine, 2024)

The graph shows changes in the level of digital readiness of the healthcare system and the coverage of institutions with the e-health system in 2019–2023. Trends in the human resource potential of the healthcare system are presented in Figure 3.

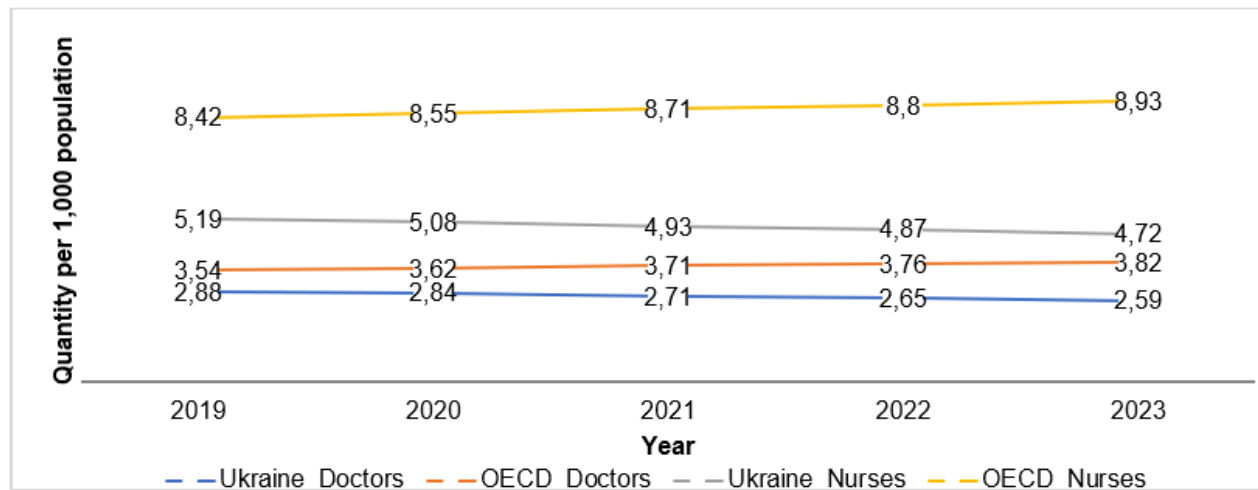
Figure 3. Human resources indicators of the healthcare system of Ukraine (2019–2023)

Source: created by the author based on (OECD, 2024; World Health Organization, 2023; Eurostat, 2024; World Bank, 2024; State Statistics Service of Ukraine, 2024)

Ukraine's health personnel capacity proved to see a downward systematization during five years as seen in the number of practitioners per 1,000 population profile. The decrease in HWC and PHWPC shows a lack of balance between the supply of and demand for medical services, which is important to maintain the capacity of healthcare delivery

system to supply adequate and quality health services. The dynamics reveal the complexity of the problem of staff shortages, based on migration patterns, professional fatigue factors, ageing populations and spatial differences in between-regional resource allocation. This trend questions whether the system could be adapted quickly to meet the population's increasing demands and applied modern management and digital methods that demand enough human resources to provide them with full efficacy. In order to assess the magnitude of the issue and also figure out cross-country perspective regarding lack of staff, in Figure 4 we compare human resources in Ukraine with OECD country average.

Figure 4. **Comparison of personnel indicators of Ukraine and OECD countries**



Source: created by the author based on (OECD, 2024; World Health Organization, 2023; Eurostat, 2024; World Bank, 2024; State Statistics Service of Ukraine, 2024)

The visualization confirms Ukraine's persistent lag behind the OECD average in terms of the availability of doctors and nurses. The most significant gap is observed in the category of paramedical personnel, which is one of the key factors reducing the resilience of the healthcare system under increased workload.

The received statistical indicators and their visualization suggest that the Ukrainian healthcare system underwent major changes in its structure in 2019-2023. To start with, the budgetary capacity of the medical sector has changed: the proportion of public spending in GDP has become disproportionate, yet the tendency is positive as the government is adapting to the conditions of the pandemic and war. Even after the funding doubled, Ukraine is far behind the average expenditures of OECD and EU countries: the expenditure per capita in PPP terms is below a quarter of the OECD average. It means that the system has a low financial compensatory potential which impacts human resources, infrastructures and technological capacities to develop the sector.

The indicators of healthcare systems staffing reveal a consistent decrease in the number of doctors and nurses per 1000 people. This five-year decline of 10-12 percent is justified by a complex of factors: a massive migration of labor, burnout of healthcare practitioners during COVID-19 and the full-scale war, and low salaries in relation to those of the European market. It is comparatively lagging compared to the OECD: the amount of nurses is approximately half as high, the amount of doctors is 25-30 less, which finds a direct reflection in the performance indicators, in particular in the reduction in life expectancy

and in an increase in mortality. The shortage of human resources can be attributed to being one of the major factors that have impeded the modernization of the system.

The most dynamically developing section of the system is digital indicators. There is steady rise in the digital preparedness and digital coverage of institutions by the e-health system, the rates being more aggressive than in the personnel or financial segments. This implies that digitalization is now among the priorities of the state policy. Nonetheless, as much as digital services are becoming more available to the population, they are still not enough to enable full incorporation of patient-focused management models. The gradual improvement of the digital maturity of the system opens the prospects of the automation of the processes, the optimization of the work of medical workers, and the enhancement of the transparency of the financing, though it demands additional investment and the enhancement of the digital competence of the medical workers.

International experience shows that successful modernization of healthcare systems is ensured by a balanced combination of digital, institutional and personnel reforms. One of the most successful examples is Estonia, where the implementation of a unified e-Health system, centralized electronic medical records and integrated digital services of public administration allowed to significantly increase transparency, speed of management decisions and accessibility of medical services for the population. In Finland, digital modernization was accompanied by long-term investments in the development of primary health care, training of medical personnel and interregional coordination of medical services, which ensured high resilience of the system even in crisis conditions. After the COVID-19 pandemic, Poland intensified the development of telemedicine and digital platforms for medical data management, while simultaneously implementing financial incentive programs and retaining medical personnel in regions with a shortage of personnel. The experience of these countries demonstrates that digitalization alone does not ensure the sustainability of the healthcare system without simultaneous strengthening of human capital, stable financing and effective coordination of management. For Ukraine, this means the need to move from fragmented digital solutions to a comprehensive modernization model that combines digital transformation with policies to support medical personnel, development of regional medical infrastructure and long-term strategic planning for the restoration of the healthcare system.

The change in the mortality rates and life expectancy is an important measure of effectiveness. Statistics indicate a significant drop in 2022 and a partial recovery in 2023 that can be linked to the aftermath of the war, the inability to have access to healthcare, the migration of the population, and the rise of stress factors. Meanwhile, the positive dynamics, however minimal, of 2023 will not be able to cover the past losses: the life expectancy is not at the pre-crisis level. Mortality rates are still way above the average of the WHO European Region, which proves that the overall reform focused on the decrease of the preventable mortality is necessary.

In conclusion of the findings, one can state that the healthcare system of Ukraine is going through a multidimensional change, where both progressive and regressive tendencies are present at the same time. Trends that are progressive are: an increase in digital preparedness, the development of e-health application, a gradual stable funding trend in the war, and management mechanisms. Such negative tendencies are: decline in human resources, worsening demographic performance, unbalanced funding and high level of lag behind the world averages. The system is evolving based on a non-equal system

where the digitalization and funding are evolving quicker than the human resources and performance elements. This poses a danger of structural imbalances, which need the overall solutions, at the level of public policy of the restoration of human resources, their strengthening of integrated health services, and their strengthening of the sphere.

To enhance the efficiency of the work of the state apparatus in the field of health, it is necessary to conduct systemic changes related to enhancing digital processes, structuring the institution, empowering human resources, and streamlining the financing mechanisms. The holistic approach in them will be able to sustain the system, adapt to difficulties, and provide the capability to ensure high accessibility and quality of health services (Table 6).

Table 6. A concise set of recommendations for improving the efficiency of public management of the healthcare system

Direction	Key recommendations
Digitalization	Scale up the use of digital health services; make sure data are interoperable; raise cyber security; boost staff's digital capabilities.
Institutional modernization	Enhance coordination between administrative structures, guarantee autonomy and accountability of the medical institutions, implement strategic planning for service network development, activate models of public-private partnership.
Human resources potential	Produce encouragement mechanisms and mechanisms for keeping the staff, reform training programs, create advanced professional education, contribute to attracting highly qualified specialists at regional institutions.
Financing	Stabilize and predict financial flows; broadening the range of transferred medical services, using multi-channeling funding patterns justifying, validating and making transparent by digital monitoring devices.

Source: created by the author based on (Blaas et al., 2025; Dal Mas et al., 2023; Ghaffari Heshajin et al., 2024; Havrychenko, 2022; Kiyan, 2025; Lopatkina, 2024; Mauro et al., 2024; Monastyrskyi & Demchyshyn, 2025; Pashniev, 2025; Saladdin & Handayani, 2025; Schulmann et al., 2024a)

The recommendations proposed comprise a consistent management system under which digital solutions, institutionalized mechanisms, workforce sustainability, and optimized financing will result in creating a modern and effective system in healthcare. Their universal application enhances the system to deal with challenges, enhance quality of medical services, and lead to the long-term sustainable operation of the sector.

Discussion

The study findings reflect the asymmetry of the modernization processes in the healthcare system with digital transformation, and financial indicators demonstrating a comparatively high rate of growth, and human resource capacity and performance indicators demonstrating a declining or fluctuating tendency. To some extent, this correlation aligns with the stand of those authors who note that digitalisation is the most dynamic and least inertial aspect of reforms that can stimulate the management processes even in the conditions of systemic shocks (Dal Mas et al., 2023; Mauro et al., 2024). Simultaneously, these findings do not agree with the conclusions made by scholars who stress that the digital modernization must be based on institutional maturity and personnel stability, and not vice versa, and that institutional and human resources are an ultimate precondition to the success of digital tools (Meenen, 2020; Fenech and Riedel, 2025). Therefore, the available evidence would suggest that the digital change is moving faster than human resource capacity, and this has posed a structural imbalance that needs the human resource policy to be modernized.

The inconsistency of Ukrainian dynamics can be proved by comparing the results of the study with the international ones concerning the sustainability of healthcare systems. On the one hand, there is more investment and digital preparedness in line with international findings regarding the necessity to invest in the digital infrastructure and facilitation of system flexibility (Blaas et al., 2025; Ghaffari Heshajin et al., 2024). Conversely, a substantial reduction in the lifespan, as well as the lack of staff, are the opposite of resilience models, which presuppose the simultaneous empowerment of human resources and the accessibility of services (Joyce et al., 2024; Sepetis & Pierrakos, 2025). The reason behind this dissimilarity is that the conditions of war have a strong influence on the functional parameters of the system and introduce non-standard risks that are not considered in classical resilience models.

At the same time, the results obtained require a deeper explanation of the reasons for the structural imbalances between digital modernization and the human and institutional resilience of the system. The acceleration of digital transformation in Ukraine is largely explained by external financial and technical support from international partners, as well as the relatively lower inertia of digital reforms compared to reforms of human resources policy or institutional management. Unlike human capital, digital solutions can be implemented centrally and scale up faster even in times of crisis. Similar trends were found in studies by Dal Mas et al. (2023) and Mauro et al. (2024), where digitalization was considered the most adaptive element of systemic reforms. However, unlike stable European healthcare systems, in Ukrainian wartime conditions, digital tools do not compensate for the loss of medical personnel, regional disparities, and destruction of infrastructure. This confirms the findings of Joyce et al. (2024) and Sepetis & Pierrakos (2025), who emphasize that the sustainability of the health care system is shaped not only by technological innovations, but primarily by the ability to maintain human resources, ensure management coordination, and maintain continuity of health services. In addition, the decline in life expectancy and the increase in mortality should be interpreted not only as a consequence of military actions, but also as a result of accumulated structural problems - chronic underfunding of preventive medicine, uneven access to health services between regions, and a long-term shortage of medical personnel, which is confirmed by previous Ukrainian studies (Havrychenko, 2022; Lopatkina, 2024; Kiyan, 2025).

Other inconsistencies are between the stands of those authors who regard the governance as the main source of success in reforms and our data which demonstrate that despite the formal presence of management structures, serious issues are still maintained with coordination, human resource capacity and institutional integration (Schulmann et al., 2024b; Forberger, 2025). These inconsistencies can be partially justified by the fact that management system in Ukraine is in the process of change and that conversion of the normative model of governance to reality takes time and resources, particularly in a war case.

It is worth considering that the heterogeneity of international statistical data limits the accuracy of direct comparisons between Ukraine and OECD/EU countries, so the results should be interpreted as indicative trends, not as absolutely comparable measurements.

The obtained results are also aligned with the stands of the authors who argue that the multi-criteria assessment models and strategic planning are necessary because the straightforward comparison of a single indicator does not represent the complexity of interrelationships in the system (Wawatrowski et al., 2023; El-Warrak et al., 2023). We

have analyzed that financial, human resource, and digital dynamics are interdependent trajectories and multidimensionality is what defines the efficacy of reforms. This is the reason why management interventions focusing on one part of the system only are not long-lasting and sustainable.

The interpretation of the findings implies that the key systemic limitation is the disparity between the fast digitalization and the slow change of personnel and institutions. This lack of balance is validated by domestic writers who examine the analysis of management dysfunctions on the territory of martial law (Havrychenko, 2022; Kiyan, 2025; Lopatkina, 2024), as well as by researchers who note the difficulties in introducing digital tools to complex socio-organizational systems (Saladdin & Handayani, 2025; Ramani, 2024). The findings of the research tend to prove the hypothesis of an asymmetric modernization of the healthcare system: the pace of the digital component does not offset the manifestations of the loss of personnel and does not eradicate the structural imbalances in the work.

It should be emphasized that the relationship established in the study between military conditions and the organizational effectiveness of the health care system is predominantly correlational in nature. This is due to the difficulty of isolating individual military factors from other related variables, such as economic instability, demographic processes, and international financial support. In this regard, the results do not allow us to fully establish cause-and-effect relationships between specific military circumstances and the effectiveness of management processes, but they allow us to identify stable statistical associations and general directions of the impact of crisis conditions on the functioning of the system.

Simultaneously, there are some limitations of the study that should be considered: empirical sample encompassed few medical institutions, the international data is not always representative of the peculiarities of the situation during wars; the comparative indicators are collected in different ways. Such limitations influence the potential to make the results fully generalized, although they do not reduce their analytic utility in the determination of major structural trends.

Overall, one can say that the findings of the research partially validate the international theories of governance and resilience yet indicate the distinctiveness of the problems that war presents and the need to reconsider the traditional practices. More detailed research needs to be devoted to a comprehensive study of the integrated models of modernization, which would involve human, monetary, and digital variables, and to the creation of the adaptive management strategies in the circumstances of the long-term crisis stress.

Conclusions

The findings of the work revealed that modernization of the healthcare system is evolving in the form of asymmetric changes in which the digital transformation leads the personnel and institutional processes, which places structural restrictions to the sustainable development of the industry. This resulted in the originality of the work since the combination of international statistical indicators, national information, and empirical observations contributed to the possibility of creating an overall picture of the interdependence of financial, personnel, and digital parameters. Against the expectation of more equal dynamics, the analysis found large personnel imbalances and gradual institutional changes, which are inhibiting the impact of increased digital preparedness.

The practical value of the work is the opportunity to utilize the obtained results to create management decisions that can be used to integrate digitalization with the modernization of the institutional and human resources. Meanwhile, limitations of the study are also present, specifically the size of the empirical sample and heterogeneity of international statistical methods, which impacts on the completeness of cross-country comparisons. The future of the further research is in the creation of adaptive management models in the cases of the prolonged crisis stress, refinement of the means of measuring the stability of personnel and the evaluation of the long-term effects of digital innovations on the performance of the industry. The further elaboration of these spheres will help clarify modernization processes, introduce systemic solutions, and prepare the conditions on a strategic plan of health care development under the conditions of war and recovery after the war.

Some of the identified changes may be due to extraordinary circumstances, so the final distinction between temporary crisis reactions and long-term structural trends requires further research in the post-crisis period.

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