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Address
İstanbul Medipol Üniversitesi
Kavacık Kuzey Yerleşkesi
Kavacık Mah. Ekinciler Cad.
No: 19 34810 Beykoz / İSTANBUL
Tel: 0216 681 51 00
jhesp@medipol.edu.tr

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In Memory of Prof. Osman Hayran

The Editorial Board of the Journal of Health Systems and Policies (JHESP) is profoundly saddened to announce the passing of Prof. Osman Hayran, Public Health Section Editor of JHESP and Member of the Advisory Board of the Health Systems and Policies Research and Application Centre (SASPAM) at İstanbul Medipol University.

Throughout his distinguished academic career, Prof. Hayran made significant contributions to scientific research and education, as well as to the development of future generations of scholars. As a Section Editor of JHESP, he provided invaluable dedication, expertise, and guidance that greatly contributed to the growth and standards of our journal. Beyond his exceptional professional achievements, Prof. Hayran will be remembered by authors, colleagues, and students for his kindness, mentorship, and unwavering integrity.

We extend our deepest condolences to his family, colleagues, students, and all those whose lives he touched. Prof. Hayran will be greatly missed and remembered with the utmost respect. His legacy will continue to inspire our community and future generations.

Editorial Board
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Identifying Barriers to Implementation of Mental Health Policies in Northwest Syria

Bakor ALBAKOR[1]
Erman GEDİKLİ[2*]

ABSTRACT

This study aims to examine the barriers to the effective implementation of mental health policies in Northwest Syria (NWS). The Delphi technique was employed, and a total of 33 professionals consented to take part in the study. These participants were physicians, policymakers, and administrators involved in healthcare, and shared their insights into the barriers to the implementation of mental health policies. Three rounds of the Delphi technique were conducted to reach consensus among the participants. Within the data collected in the second and third rounds, scores for each barrier were analyzed, and the results indicated that there was a consensus on 16 different barriers with an interquartile width of less than 1.2. These barriers are listed as insufficient societal, cultural, and religious beliefs, policy and coordination, insufficient human resources, funding and financial limitations and other related factors. These results provide a specific understanding of the limitations of mental health services and particular recommendations for reinforcing mental health impacts in NWS.

Keywords: Delphi Technique, Mental Health Policies, Northwest Syria

INTRODUCTION

Mental health policy implementation is a complex process influenced by governance capacity, institutional coordination, and sociocultural context. In conflict settings, health systems are frequently characterized by being in line

1 İstanbul Medipol University, School of Health Sciences, Istanbul, Türkiye
2 İstanbul Medipol University, Institute of Health Sciences, Istanbul, Türkiye
* Corresponding author: Erman GEDİKLİ, egedikli@medipol.edu.tr

with service structures, dependency, and limited regulatory authority. The healthcare system in Northwest Syria (NWS) has evolved under prolonged conflict since 2011, resulting in a weak and externally dependent health system. This region can be described as a patchwork of disparate healthcare systems that were influenced by different humanitarian and political factors. Numerous regional health systems with distinct capacities and structures have emerged because of the ongoing conflict. However, instead of working together, these systems function independently, which has serious repercussions for the local population's health and well-being. It takes time and effort to rebuild medical facilities, which are essential for delivering basic healthcare services. Recovery efforts are still being delayed by ongoing financial constraints and instability. Previously used as community health centres, hospital buildings are now in ruins and lack staff and necessary equipment. The influx of internally displaced people seeking safety in overcrowded camps and villages has made matters worse. The already precarious health system is further taxed by this dramatic population growth, which deteriorates the situation for patients and healthcare professionals (Enab Baladi, 2024).

Nearly all the funding for the regional health system comes from outside sources. However, the region's urgent needs cannot be met due to the instability and ongoing insufficiency of fund flows. The United Nations has been instrumental in organizing international humanitarian aid and enabling the delivery of aid from neighbouring nations like Türkiye, particularly since 2014. These systems are essential for meeting medical needs in regions that the Syrian government has no authority over. However, it is still unclear how effective these international humanitarian efforts will be overall. The situation is further complicated by accessibility constraints and the politicization of aid since humanitarian operations must take place across several regions under various jurisdictions. Throughout 2024, the health system in NWS is predicted to continue to deteriorate and remain unstable. Prolonged conflict, natural disasters like the 2023 earthquakes, and continuous military escalations have severely disrupted essential services and leaving millions in dire need of aid. While mental health care is frequently deprioritized, basic healthcare services are threatened by inadequate funding. Managing chronic illnesses and injuries sustained during conflicts is still crucial, in addition to providing basic maternity and child healthcare. However, it is predicted that by 2024, about one million people will need mental health and psychosocial support because of the combined effects of natural disasters and conflict (World Health Organization [WHO], 2024).

Both local and foreign actors operate in a disorganized manner because of the region's disjointed and ineffective healthcare governance. Poor policy creation, lax regulation, and insufficient oversight are the results of this lack of unified leadership, which exacerbates unequal access to high-quality care and restricts health outcomes. These challenges are exacerbated by the lack of coordinated management practices, which pose obstacles to hiring and retaining skilled workers.

Although existing studies and reports provide information on general functioning of the healthcare system in NWS, the main gap is the lack of empirical research examining policy implementation, specifically the absence of research explicitly addressing implementation barriers at policy and system levels. Policy-level obstacles to mental health governance, coordination, and sustainability are not sufficiently addressed by current research, which mostly concentrates on emergency response, infrastructure, and general service delivery. Therefore, the purpose of this study is to investigate the obstacles to Northwest Syria (NWS)'s successful implementation of mental health policies.

METHODOLOGY

Study Design

With the objective of comprehensively investigating the barriers to the successful implementation of mental health policy in NWS, this study employed the Delphi technique to incorporate both qualitative and quantitative methods with mixed-methods approach to provide a comprehensive understanding of the subject (Dragostinov et al., 2022). To give a thorough explanation of the current difficulties, this descriptive study collected and analyzed data using a methodical approach. The rigorous and repeated Delphi process was used to gather expert opinions from politicians and medical professionals. This approach is particularly suitable when the questions cover a variety of difficult subjects and viewpoints.

A panel of experts receives questionnaires in several rounds as part of the Delphi technique. Initially, open-ended questions are used, specifically to help collect different perspectives on the obstacles influencing the implementation of mental health policies. The answers provided were then reviewed and condensed as needed, resulting in much needed and organized statements for subsequent rounds. In order to measure consensus, participants evaluated propositions using a Likert scale. Until a consensus is reached or the responses eventually stabilise, the process is repeated. This method can be particularly useful in nations or regions like NWS, where continuous conflict and instability affect data collection and make it difficult.

Additionally, the study aims to validate the results and strengthen the conclusions' robustness by combining statistical methods with quantitative data analysis. Specifically, the quantitative data were analyzed using a statistical consensus methodology, which repeats surveys/data collection phases until consensus is reached. In Delphi research, IQR cut-off values typically range between 1.0 and 1.5, depending on the number of scale points and complexity of the topic (Diamond et al., 2014; Rayens & Hahn, 2000). In this study, for establishing the consensus mentioned, items with an interquartile range of less than 1.2 are utilized as a threshold (Zeliff & Heldenbrand, 1993).

The study's validity is strengthened by the combination of qualitative and quantitative data, which also offers a comprehensive picture of the obstacles to the successful implementation of mental health policies in NWS.

Research Question

According to the study's objectives, the following research question was formulated: What are the main obstacles to the successful implementation of mental health policies?

Participants

The Delphi technique employs non-probability sampling techniques. Purposive sampling is used to identify knowledgeable individuals who possess expertise on a particular subject (Gill et al., 2013). Accordingly, in this study, participants were selected using a purposive sampling method. Purposive sampling is frequently used in policy and health system studies, and it enables the inclusion of basic information (Patton, 2015). Participants' direct knowledge or experience with the implementation of mental health policies in NWS was the main selection criterion. Policymakers and in-service health and mental health professionals made up the participant group.

It is possible to work with a large or small group of experts using the Delphi technique. According to Şahin (2001), there should be a participant group of at least 7 experts. However, according to the phenomenon, the number of participants can be 100 or more. Therefore, the 33 healthcare professionals who agreed to participate in this study were deemed sufficient.

Data collection processes were completed in three iterative rounds. The rounds took place in March 2024 (Round 1), June 2024 (Round 2), and July 2024 (Round 3). The same group of 33 participants took roles in all rounds. All the rounds were conducted with 33 participants.

Data Collection

In the first round, a total of 33 participants were sent the first Delphi survey and were asked to answer the following question: "What are the obstacles encountered in the provision of mental health services in the Northwest Syria Region?" Participants submitted their thoughts anonymously in writing to this question, thus completing the first Delphi round.

Opinions from the first round were listed by grouping them into 35 different categories and enumerated. The second Delphi survey, a structured questionnaire, was created and distributed to participants based on this data. On a 7-point Likert scale, participants were asked to rate how much they agreed with each item. "To what extent do you agree with the barriers listed below?" was one of the questions. Additionally, participants provided written explanations for their agreement or disagreement with each item and whether they thought it was necessary or not. After being given a code, each participant had to send back their coded answers to the researcher by the deadline. The second Delphi round came to an end at this point.

A third round was initiated since there was no agreement in the second round. This is so that a consensus can be reached by repeating the surveys. Items that have an interquartile range of less than 1.2 are deemed to have reached consensus (Zeliff & Heldenbrand, 1993). A third Delphi survey was conducted, showing the average answers from all respondents as well as each participant's personal assessment of each item. This step employs a controlled feedback mechanism, providing the median and interquartile range of the group's previous responses. By asking participants to reevaluate, the goal of this round was to reach a consensus. At the end of the process, 16 different items were agreed upon.

Ethical Aspects of Study

Ethical approval for this study was obtained from the İstanbul Medipol University Non-Invasive Clinical Research Ethics Committee (Issue No: E-10840098-202.3.02-1406, Decision No: 184, 20 February 2024).

RESULTS

This study aims to identify and analyze the barriers to the effective implementation of mental health policies. The study included a total of 33 participants with diverse demographic and professional characteristics. The characteristics of participants are detailed in Table 1.

Table 1: Characteristics and demographics of participants

Characteristics	Sub-Groups	N	Percentage
Gender	Female	5	15%
	Male	28	85%
Age	20–30	2	6.1%
	31–40	21	64%
	41–50	4	12%
	51 and Above	6	18%
Area of Residence	Camp/Rural	2	6.0%
	Urban	31	94%
Education Level	Bachelors	12	36%
	Certificated	3	9.1%
	Master	16	48%
	PhD (Doctor of Philosophy)	2	6.1%
Experience in Total	1–5 Years	3	9.1%
	6–10 years	8	24%
	More Than 10 Years	22	67%
Experience in Management	0–5 Years	9	27%
	6–10 years	15	45%
	More Than 10 Years	9	27%
Position/Department	Health Manager/Director	6	18%
	Health Programs Coordinator	11	33%
	Mental Health Supervisor	8	24%
	Psychiatric	6	18%
	mhGAP Doctor*	2	6.1%

**A doctor assigned under the Mental Health Gap Action Programme (mhGAP).*

The majority of participants were male (85%), while females were 15%. Most participants were aged 31–40 years (64%), with smaller percentages in other age groups. Regarding total work experience, 67% had more than 10 years, and 24% had 6–10 years. Management experience was also variable, with 45% having 6–10 years, 27% having more than 10 years, and 24% having 1–5 years. In terms of education, nearly half of the participants held a Master's

degree (48%), whereas 36% had a Bachelor's degree. Socially, the majority were married (88%) with the remaining participants being either single (6.1%) or divorced (6.1%).

Professionally, the largest group consisted of health programs coordinators (33%), followed by mental health supervisors (24%), health project managers/ directors (18%), and those in psychiatric roles (18%), with mhGAP doctors representing the smallest group (6.1%).

At the completion of the first round, a total of 217 different responses were received from participants. These were categorized under 35 different headings using the MaxQDA 2024 program. Table 2 presents the 35 items identified in the analysis, together with the number of participants who mentioned each item. These findings highlight the key systemic and societal obstacles to effective mental health services as reported by participants. The lack of mental health professionals (n=28, 82%) is the most frequently mentioned obstacle that makes it more difficult to provide and accept mental health care, followed by the lack of funding (n=20, 59%), the social stigma associated with mental health (n=19, 56%), shortcomings in leadership and authority (n=15, 44%). The lack of an integrated healthcare system and an efficient coordination mechanism, as well as the lack of unified policies, disjointed service delivery, and inefficient data systems (n=14, 41% each), are other noteworthy obstacles. A lack of mental health support and training (n=11, 32%), low societal awareness, limited knowledge about mental health symptoms and the absence of a work protocol specifically for mental health (n=8, 24% for each), were all mentioned.

Important but less frequently mentioned obstacles include poor economic conditions, insufficient infrastructure, accessibility concerns, and cultural and religious beliefs. Numerous other particular obstacles are also reflected in the data, including the dearth of comprehensive data, policy research, and advocacy, pointing to a complex issue that requires a carefully considered response.

Table 2 also illustrates the results of a Delphi study that was conducted to identify and prioritize the barriers in the mental health system. It exhibits the mean importance scores and the interquartile ranges (IQR) for every barrier throughout the second and third rounds of expert consultation. The findings show trends concerning the consensus and the shifts in priorities during the two rounds. There is consensus on 16 different barriers illustrated in Table 3 highlighted in italics and bold.

Table 2: Delphi technique first, second and third round together (identified barriers)

#	Barrier	Frequency*	%**	2nd Round		3rd Round	
				Mean	IQR Mean IQR	Mean	IQR Mean IQR
1	***Shortage of qualified professionals, inadequate training, brain drain, and low compensation***	28	82	***6.03***	***1.00***	***6.06***	***1.00***
2	***Lack of specialized facilities, essential medication, and mental health services in rural areas***	20	59	***5.56***	***1.75***	***5.53***	***1.00***
3	***Insufficient resources allocated to mental health, dependence on external funding, and deprioritization compared to other healthcare sectors***	19	56	***5.94***	***2.00***	***6.03***	***1.00***
4	***Societal stigma, including among healthcare professionals, and cultural barriers to seeking help***	15	44	***5.38***	***1.00***	***5.34***	***1.00***
5	***Lack of leadership and authority***	14	41	***5.41***	***2.00***	***5.44***	***1.00***
6	***Absence of unified policies, fragmented service delivery, and ineffective data systems***	14	41	***6.09***	***1.75***	***6.09***	***1.00***
7	***Difficulty accessing services due to various factors such as distance, cost, and security concerns***	11	32	***5.06***	***2.00***	***5.22***	***1.00***
8	***A fragmented healthcare system with poor coordination and an unstable government, hindering effective implementation***	8	24	***5.50***	***1.75***	***5.50***	***1.00***
9	***Inadequate training opportunities and a lack of standardized job descriptions for mental health professionals***	8	24	***5.22***	***1.75***	***5.16***	***1.00***
10	***Insufficient data collection and research are hampering evidence-based decision-making***	7	21	***5.22***	***1.00***	***5.16***	***1.00***
11	***Limited public awareness and knowledge about mental health***	7	21	***5.31***	***2.75***	***5.53***	***1.00***
12	High stress and distress caused by conflict and disasters, security concerns and challenging living conditions for staff, and difficulty reaching displaced populations	7	21	4.63	3.00	4.59	3.00
13	***Absence of a work protocol specifically for mental health***	6	18	***4.66***	***2.00***	***4.56***	***1.00***
14	***Societal, cultural and religious beliefs and attributing mental disorders***	6	18	***6.16***	***1.00***	***6.16***	***1.00***
15	Poor economic and social conditions	6	18	5.22	2.00	5.28	2.00

16	Continuity of hostilities and insecurity in the region	4	12	4.66	2.00	4.63	2.00
17	Lack of cooperation between health professionals and social leaders	4	12	4.88	2.75	4.84	2.00
18	***Project support inconsistency and uncertain timeline***	4	12	***5.22***	***2.75***	***5.25***	***1.00***
19	The lack of comprehensive data and evidence of a health information management system	4	12	4.59	2.75	4.63	2.75
20	Lack of culturally adapted mental health interventions	2	6	4.13	3.75	4.13	2.75
21	Increased mental health needs are straining existing resources and hindering policies	2	6	5.13	2.00	5.19	2.00
22	Failure to ensure the continuity of treatment	2	6	4.03	3.75	4.06	3.75
23	***Considering mental health services and psychosocial support as a standalone sector***	2	6	***5.34***	***2.75***	***5.56***	***1.00***
24	Lack of key medicines and drug trafficking	2	6	5.06	2.00	5.06	2.00
25	Lack of universal healthcare coverage	2	6	4.69	3.75	4.66	3.75
26	***Absence of regional or international conferences and the possibility of publishing articles***	1	3	***4.78***	***2.00***	***5.09***	***1.00***
27	Poor adherence of some patients	1	3	5.56	2.00	5.56	2.00
28	Humanitarian aid dependency	1	3	4.78	2.00	4.81	2.00
29	The detrimental effect of nepotism-based employment policies	1	3	4.47	3.00	4.59	2.75
30	Corruption within NGO*** and INGO**** organizations	1	3	4.31	3.00	4.38	3.00
31	Lack of accountability for violations that occur in the workplace	1	3	5.47	2.00	5.47	2.00
32	Lack of experience in this field prior to the war	1	3	4.88	2.00	4.88	2.00
33	High level of ignorance among the community	1	3	4.31	3.00	4.31	2.75
34	High costs organizations have to overcome	1	3	4.53	3.00	4.53	3.00
35	Lack of better opportunities for both training and employment for individuals have undergone programs	1	3	5.38	2.75	5.41	2.75

Below 1.2 IQR value represents consensus.

** Number of participants mentioned the barrier.*
*** The proportion of participants was mentioned.*
**** Non-Governmental Organization.*

***** International Non-Governmental Organization.*

Several barriers emerged as critical issues where there was a high level of consensus. The barrier related to societal, cultural, and religious beliefs, "societal, cultural and religious beliefs and attributing mental disorders", ranked first, with a stable mean score of 6.16 and an IQR of 1.00 throughout both rounds, thus showing strong agreement on its importance. In the same manner, the barrier related to policy and coordination, "absence of unified policies, fragmented service delivery, and ineffective data systems", kept a mean score of 6.09 in both rounds. Its IQR decreased from 1.75 in the second round to 1.00 in the third round, suggesting enhanced consensus. Another significant barrier related to human resources, "shortage of qualified professionals, inadequate training, brain drain, and low compensation", ranked third, with a high mean score of 6.06 in the third round and a narrow IQR of 1.00, suggesting strong agreement among participants.

Several barriers exhibited considerable development in the agreement of the specialists between rounds. The barrier related to funding and financing "insufficient resources allocated to mental health, dependence on external funding, and deprioritization compared to other healthcare sectors" showed an increase in mean score from 5.94 to 6.03 and at the same time the IQR was reduced from 2.00 to 1.00 which indicates that the experts of the field have recognized this issue increasingly.

The barrier placed mental health as separated healthcare services "considering mental health services and psychosocial support as a standalone sector" was increasing about mean score from 5.34 to 5.56 and the IQR was reduced from 2.75 to 1.00, indicating growing recognition of the issue. Also, the barrier related to specialized care setup, "lack of specialized facilities, essential medication, and mental health services in rural areas", which had a stable mean of around 5.53, noted a decrease in the IQR from 1.75 during the second round to 1.00 in the third, thus demonstrating greater alignment among experts. At the same time, limited public awareness and knowledge, which "limited public awareness and knowledge about mental health" also showed a rise in the average score (5.31 to 5.53) as well as the IQR's narrowing (2.75 to 1.00), which pointed to its growing perceived importance.

Other barriers showed lower mean scores, thus reflecting low priority or different opinions. Based on their mean values, the following can be listed as follows: The fragmented structure of the healthcare system, poor coordination, and inconsistent management hinder effective implementation. Additional barriers include a lack of leadership and authority, social stigma, prejudice among healthcare professionals, cultural barriers that make it difficult to seek help, unclear timelines, and variable project support. These barriers are listed in Table 3 according to ranking value (mean).

Table 3: The barriers participant has reached a consensus

Rank	Barrier	Mean	Sd.
1	Societal, cultural and religious beliefs and attributing mental disorders	6.16	0.846
2	Absence of unified policies, fragmented service delivery, and ineffective data systems	6.09	0.892
3	Shortage of qualified professionals, inadequate training, brain drain, and low compensation	6.06	1.162
4	Insufficient resources allocated to mental health, dependence on external funding, and deprioritization compared to other healthcare sectors	6.03	0.782
5	Considering mental health services and psychosocial support as a standalone sector	5.56	0.981
6	Lack of specialized facilities, essential medication, and mental health services in rural areas.	5.53	1.163
7	Limited public awareness and knowledge about mental health	5.53	1.343
8	A fragmented healthcare system with poor coordination and an unstable government, hindering effective implementation	5.50	1.391
9	Lack of leadership and authority	5.44	1.366
10	Societal stigma, including among healthcare professionals, and cultural barriers to seeking help.	5.34	1.207
11	Project support inconsistency and uncertain timeline	5.25	1.646
12	Difficulty accessing services due to various factors such as distance, cost, and security concerns.	5.22	1.337
13	Inadequate training opportunities and a lack of standardized job descriptions for mental health professionals.	5.16	1.221
14	Insufficient data collection and research are hampering evidence-based decision-making.	5.16	1.346
15	Absence of regional or international conferences and the possibility of publishing articles	5.09	1.510
16	Absence of a work protocol specifically for mental health	4.56	1.216

The results point to a variety of barriers to mental health care, including resource and cultural limitations as well as institutional and legal issues. When taken as a whole, these limitations make it more difficult to provide and receive mental health care.

DISCUSSION AND CONCLUSION

The research results indicate that multiple barriers exist which prevent mental health initiatives from reaching their goals in the NWS. The results reveal that societal, cultural, and religious beliefs (including stigma) are more significant barriers than financial and infrastructural ones. Systematic deficiencies also emerged as crucial challenges compared to operational issues like working protocols. Therefore, effective intervention requires prioritizing broad cultural and policy actions over the lack of service level improvements. Similar findings have been reported in the literature. For instance, Patel et al. (2018) reported that the main problems with mental health services in violent areas emerge from three key sources: systemic failures, social obstacles and insufficient resource availability. Additionally, the analysis of multiple barriers which block mental health improvement work requires examination of four main elements, including poor governance, staff shortages, cultural stigmas and limited resources (WHO, 2022).

This top barrier shows that cultural standards and social views about mental health create the most significant obstacles to accessing care. Deeply embedded beliefs of this nature serve as the main source of stigma, which keeps numerous individuals from seeking their required mental health care services. In conflict-affected areas, this problem is prevalent across multiple regions because their cultural beliefs and social views about health care access become more influential than in typical circumstances. Existing beliefs along with cultural elements have been assessed in previous research to determine their role in preventing people from seeking assistance and reducing the effectiveness of current policies. In similar cultural contexts, this issue is further complicated by social discrimination against individuals seeking mental health care (Alibrahim et al., 2023). The research from Afghanistan and Nigeria indicates that local cultural and religious traditions create obstacles for people to access and accept mental health services in these countries (United States Institute of Peace, 2024). Therefore, finding solutions that target and tackle these hurdles, which could be through public awareness campaigns and community engagement, is critical for improving mental health outcomes and lowering stigma, especially in NWS (Thornicroft et al., 2016).

Second, systemic obstacles emerged from policy and coordination-related barriers, which represent key challenges for the system. Ambiguous mental health policies, along with scattered service delivery systems, create major obstacles to the implementation of mental health services. The government's insufficient funding for mental health services creates additional challenges,

which worsen these problems. It is well-documented that mental health services receive less funding than physical health services, not only in NWS but in many low- and middle-income countries (Wainberg et al., 2017; Zhou et al., 2018). A shortage of financial resources, combined with an inefficient referral system and political indifference, has created major obstacles for Ethiopia to include mental health treatment within its health extension services. The project's success depends on the combination of better primary healthcare services and active community participation in the area (Yitbarek et al., 2021). The methods show potential for success in NWS since better community engagement and expanded healthcare access may lead to fewer institutional obstacles and higher treatment quality (van Ginneken et al., 2013).

The evaluation process assigned the third-highest importance to staff shortage, indicating it is a critical barrier. The situation consists of two main elements, which involve both the lack of licensed mental health professionals and the low standards of their educational programs. Studies show that task-shifting methods, which train non-specialists to deliver basic mental health care, produce good results in these scenarios. The current mental health professionals working in Syria could alleviate the workload of existing mental health professionals if these recommendations were adapted to the Syrian context (Hamid et al., 2024). The war further depleted the already limited mental health professional population. Multiple studies report that many healthcare professionals left the country, making mental health services inaccessible to large segments of the population (Hamza & Hicks, 2021; Shoib et al., 2022).

The execution of mental health policies depends on the availability of resources, which poses various constraints. The use of digital technologies in mental healthcare shows promise but faces multiple challenges when applied in practice. The current system faces three main barriers, which include complex regulations, insufficient resources, and unwelcoming attitudes. These problems exist throughout the entire world, and they are not unique to Syria. The providers, together with their consumers, express doubts about the authenticity and safety standards and functional aspects of Digital Mental Health Interventions (DMHIs). The adoption of DMHIs faces major obstacles because many people lack digital literacy and cannot access the required equipment in rural and underdeveloped regions (Huang et al., 2024). The adoption of DMHIs needs community engagement, educational programs, and supportive policy reforms, which enable technology access for mental health services (Berardi et al., 2024).

Peer support initiatives have evolved into crucial resources which mental health services depend on to function properly when they operate in resource-constrained environments. The implementation of these initiatives would result in improved clinical results and better social integration and rehabilitation success rates. The success of these programs depends on proper training plus supervision and their integration with existing healthcare delivery systems (Liu et al., 2024). The creation of peer support systems would serve as a valuable resource for NWS patients who face restricted access to formal mental health care services (van Ham, 2018).

A comprehensive strategy needs to be developed to eliminate these obstacles. Systemic problems which affect healthcare delivery can be addressed when organizations shift tasks and develop better primary care systems (Patel et al., 2018). The elimination of social barriers arising from stigma and cultural misunderstandings requires targeted awareness initiatives and active community participation. Resource limitations (Bracke et al., 2019; Mezzina et al., 2022) need legislative and educational funding and resource allocation to address them. To create a more robust and effective mental health system in NWS, research into other war-affected regions and the adaptation of effective tactics to local conditions will be required. The combination of these strategies with efforts to improve policy coordination and reduce stigma will help solve the main problems revealed by the statistics.

Because mental health care is funded primarily by external sources, financial limitations also constitute a significant structural issue in the area. Multiple elements, including social stigma, religious beliefs and cultural perspectives, as well as other factors, lead to insufficient understanding and poor recognition of mental health laws. Healthcare providers and local stakeholders who fail to work together create a major barrier that produces fragmented services and poor resource distribution. The research results highlight the need to understand how these barriers unite to create a complex system which prevents mental health policy development and implementation.

In summary, successful implementation necessitates confronting the larger systemic and cultural dynamics head-on in addition to addressing personal obstacles. The region needs to understand how different mental health problems connect to improve its mental health results. The advancement of mental health requires active participation from service providers, clients, and both national and international institutions. Implementing the recommendations outlined below is essential for addressing these barriers:

- Exchange of best practices and research findings should be promoted because international collaboration must be strengthened.
- The government or authorities at all levels need to increase funding for mental health facilities, professional training programs and service delivery systems.
- The training programs need to expand their reach because this will help society fight stigma while making people more aware of the issue.
- To ensure effective policy implementation, better coordination between government entities, private organizations, and civil society groups should be established.
- The participation of communities ensures that public policies will address the specific requirements of their area.
- Mental health policies require regular evaluation of their effects, which produces data that organizations can use to develop better strategies.

Limitations

This study was conducted in NWS, where a healthcare system, whose resources have been destroyed by a protracted conflict and which relies on external financial and service assistance, is struggling to establish a local authority independent of the central government. Therefore, the findings may not be generalizable beyond this context. Furthermore, although the interviewed participants provide services in the region, they provide services from offices in Türkiye rather than residing permanently in NWS. This may have introduced potential bias into the findings.

Ethical Approval: The researcher used encryption techniques and safe data storage techniques to safeguard the information gathered. The records are only accessible to authorized staff members, preventing unauthorized disclosure and promoting wellbeing, engagement, and trust. Also to conduct the research, a decision was received from the İstanbul Medipol University Non-Invasive Research Ethics Committee regarding its scientific and ethical suitability (20.02.2024; Issue No: E-10840098-202.3.02-1406).

Authors' Contributions: BA: conceptualization, methodology, data analysis, writing – original draft; EG: methodology, validation, supervision, writing – review & editing.

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Evaluation of Electronic Health Records Quality in Outpatient and Inpatient Healthcare Services Using PDQI-9

İlknur ARSLAN[1*]
Mehmet Deniz ERHAN[2]
Serdar KULA[3]

ABSTRACT

Despite technological developments in healthcare services, increasing investments, and ongoing research, there are still no standardized definitions for software tools, functions, or datasets related to electronic health records (EHRs). Data entry into EHRs is shaped by the documentation practices, roles, knowledge, and skills of the individuals entering the data. High-quality EHR data are essential for increasing the efficiency of digital healthcare services, facilitating data analysis, and supporting clinical decision-making processes. This study aimed to evaluate admission notes recorded in the EHR system during outpatient and inpatient healthcare services using PDQI-9. The study included EHRs of patients admitted to the general pediatrics outpatient clinic and the pediatric intensive care unit of Adana City Training and Research Hospital between 1 September 2025 and 31 October 2025. Admission notes of patients receiving inpatient and outpatient healthcare services demonstrated moderate to high levels of documentation quality, and no statistically significant difference was found between the total PDQI-9 scores of the two groups. However, differences were identified between inpatient and outpatient admission notes in terms of specific data quality indicators, particularly accuracy, thoroughness, succinctness, and synthesis. No differences were observed in the indicators of being up-to-date, useful, organized, comprehensible, and internally

1 Adana City Training and Research Hospital, Adana, Türkiye
2 Adana City Training and Research Hospital, Adana, Türkiye
3 Gazi University, Faculty of Medicine, Ankara, Türkiye
* Corresponding author: İlknur ARSLAN, ilknurtolunay@gmail.com

consistent, or in the overall impression scores of PDQI-9. EHR data quality is a fundamental component of quality and efficiency in healthcare. Therefore, data quality should be regularly monitored using reliable and objective tools. PDQI-9 is an appropriate, practical, and easy-to-use method for evaluating admission notes of both patients presenting to outpatient clinics and critically ill patients admitted to intensive care units.
Keywords: Electronic Health Records, Health Informatics, Patient Notes, PDQI-9, Quality

INTRODUCTION

EHR is defined as "all kinds of information related to a person's past, present, and future physical and mental health or illnesses, which are recorded, stored, transmitted, accessed, and processed using electronic systems" (Akal, 2021; Evans, 2016). EHR enables patients and physicians to access accurate and up-to-date information, thereby ensuring continuity in treatment and reducing misdiagnosis. Access to patient records independent of time and location allows the provision of fast and effective healthcare services. Rapid access to accurate data helps to provide safe care by reducing medical errors. EHR improves the quality of medical care, and paper use is significantly reduced. The efficiency of healthcare services is increased through less paperwork and fewer repeated tests (Atasoy et al., 2019; O'Donnell et al., 2020; Subaşıoğlu, 2023).

No standards describing EHR software tools, functions, or datasets exist, despite healthcare IT improving, investments growing, and research continuing. The entry of data into EHR, which arises from the outcomes of communication between the patient and healthcare personnel, is shaped according to the application style, role, knowledge, and skills of the person entering the data (Işık et al., 2013). However, the positive effects of EHR are related to the quality of the data it contains. High-quality EHR data are required to increase the efficiency of digital healthcare services, facilitate data analysis, and support clinical decision-making processes (Yang et al., 2024). Poor quality and inappropriate data not only fail to provide benefits but may also lead to incorrect decisions. In critical units providing healthcare services, the cost of data quality problems is high and negatively affects patient safety, resource management, and the reliability of clinical studies. Inaccuracies in data frequently lead to medical mistakes (Wiebe et al., 2019).

The American Health Information Management Association (AHIMA) has established certain standards for data quality. According to the AHIMA data quality model, EHR should be accurate, reliable, complete, up-to-date, accessible, comprehensible, thorough, consistent, and detailed (American Health Information

Management Association, 2019). Reliable data quality assessment tools should be used to determine the strategies and tools that ensure the appropriateness of the data contained in EHR, and to guide and evaluate improvement efforts (Lewis et al., 2023; Ozonze et al., 2023). For the evaluation of EHR data, the physician documentation quality instrument, Physician Documentation Quality Instrument (PDQI-9), is an accepted measurement method. PDQI-9 was developed by Stetson et al. (2008) to evaluate the quality of patient records and was updated in 2012 with 9 indicators. PDQI-9 focuses on the evaluation of three main types of notes: admission, progress, and discharge. Patient records are evaluated using 9 indicators, namely "up-to-date, accurate, thorough, useful, organized, comprehensible, succinct, synthesized, and internally consistent", along with a separate "general impression score". For each indicator, a 5-point Likert scale is used, with the highest value defining the most ideal characteristic (Stetson et al., 2008; Stetson et al., 2012).

In this study, it was aimed to evaluate patient admission notes recorded in the EHR system during outpatient and inpatient healthcare services using PDQI-9.

METHODOLOGY

Evaluation of EHRs in Inpatient Healthcare Services

The inpatient healthcare service evaluation was conducted using the EHRs of patients admitted to the pediatric intensive care unit of Adana City Training and Research Hospital between 1 September 2025 and 31 October 2025. From the patient list generated by the Hospital Information Management System within the specified date range, 50 patient files were selected at regular intervals, with every fifth patient file included in the sample.

Evaluation of EHRs in Outpatient Healthcare Services

The outpatient healthcare service evaluation was conducted using the EHRs of patients who presented to the general pediatrics outpatient clinic of Adana City Training and Research Hospital between 1 September 2025 and 31 October 2025. From the patient list generated by the Hospital Information Management System within the specified date range, 50 patient files were selected at regular intervals, with every fifth patient file included in the sample.

In the Hospital Information Management System, once the relevant date range was selected on the outpatient clinic or intensive care unit screen and the search was performed, the patient list was automatically displayed. The order of the list was not modified. Completely blank files were excluded from the study; however, no further changes were made to the files included in the study.

The files of patients admitted to the intensive care unit were selected and evaluated by a pediatric specialist, while the files of patients presenting to the outpatient clinic were selected and evaluated by a pediatric intensive care specialist. Before the study began, the physician researchers from the outpatient clinic and intensive care unit reviewed the PDQI-9 criteria and scoring system in detail. Each criterion was examined individually, trial evaluations were conducted on patient files not included in the study, and consensus was reached regarding the evaluation process. Thus, evaluator training was completed before data collection.

Approval for the study was obtained from the Scientific Research Ethics Committee of Adana City Training and Research Hospital (Date: 18.12.2025, Meeting No: 20, Decision No: 935). After obtaining ethical committee approval for the study, the files were reviewed retrospectively. In addition to the ethics committee approval, institutional permission for access to and research use of the patient records was obtained from the chief physician's office of Adana City Training and Research Hospital.

Statistical Method

The analysis of the data obtained in the study was conducted using IBM SPSS Statistics v.27 software. Scores related to PDQI-9 indicators were presented with descriptive statistics (frequency, percentage, median, and interquartile range). The Mann–Whitney U test was used to compare the total PDQI-9 scores of admission notes in patients receiving inpatient and outpatient healthcare services, and the Chi-square test of independence (χ^2) was used to compare the PDQI-9 scores related to the indicators. In all analyses, the level of statistical significance was accepted as $p<0.05$.

RESULTS

Admission notes of patients receiving inpatient and outpatient healthcare services showed moderate to high levels of documentation quality, and no statistically significant difference was found between the total PDQI-9 scores ($U=1028.50$, $Z=-1.53$, $p=0.126$). The median total PDQI-9 score was 36 (IQR=12.25) for inpatient healthcare services and 33 (IQR=8) for outpatient healthcare services. When the rank averages were evaluated, it was seen that inpatient healthcare services (mean rank=54.93) tend to score higher than outpatient healthcare services (mean rank=46.07), although this difference did not reach a statistically significant level. This finding indicates that the documentation quality of the two groups is at a similar level in terms of total scores (Table 1).

Table 1: Total PDQI-9 scores of admission notes in inpatient and outpatient healthcare services

Group	n	Median (IQR)	Mean Rank	U	p
Inpatient	50	36(12.25)	54.93	1028.50	0.126
Outpatient	50	33(8)	46.07		
Total	100		—		

In the admission notes of patients receiving inpatient and outpatient healthcare services, differences were detected in terms of the data quality indicators accurate (p=0.036), thorough (p=0.032), succinct (p=0.014), and synthesized (p=0.032). No difference was observed in the indicators up-to-date (p=0.232), useful (p=0.060), organized (p=0.091), comprehensible (p=0.404), and internally consistent (p=0.347), and in the PDQI-9 general impression scores (p=0.162) (Table 2).

Table 2: PDQI-9 results of admission notes of patients

Attribute	Situation	1 Point Number (%)	2 Points Number (%)	3 Points Number (%)	4 Points Number (%)	5 Points Number (%)	p
Up-to-date	Inpatient Outpatient	4 (8%) 0	9 (18%) 11 (22%)	9 (18%) 12 (24%)	14 (28%) 17 (34%)	14 (28%) 10 (20%)	0.232
Accurate	Inpatient Outpatient	0 0	0 0	3 (6%) 3 (6%)	24 (48%) 36 (72%)	23 (46%) 11 (22%)	**0.036**
Thorough	Inpatient Outpatient	0 0	7 (14%) 6 (12%)	14 (28%) 19 (38%)	19 (38%) 24 (48%)	10 (20%) 1 (2%)	**0.032**
Useful	Inpatient Outpatient	0 0	1 (2%) 1 (2%)	12 (24%) 23 (46%)	22 (44%) 20 (40%)	15 (30%) 6 (12%)	0.060
Organized	Inpatient Outpatient	0 0	6 (12%) 2 (4%)	14 (28%) 23 (46%)	19 (38%) 20 (40%)	11 (22%) 5 (10%)	0.091
Comprehensible	Inpatient Outpatient	0 0	1 (2%) 1 (2%)	9 (18%) 8 (16%)	21 (42%) 29 (58%)	19 (38%) 12 (24%)	0.404
Succinct	Inpatient Outpatient	0 0	6 (12%) 6 (12%)	14 (28%) 17 (34%)	12 (24%) 22 (44%)	18 (36%) 5 (10%)	**0.014**
Synthesized	Inpatient Outpatient	0 0	0 0	17 (34%) 20 (40%)	19 (38%) 26 (52%)	14 (28%) 4 (8%)	**0.032**
Internally Consistent	Inpatient Outpatient	0 0	1 (2%) 1 (2%)	1 (2%) 4 (8%)	24 (48%) 28 (52%)	24 (48%) 17 (34%)	0.347
General Assessment	Inpatient Outpatient	0 0	1 (2%) 2 (4%)	16 (32%) 23 (46%)	17 (34%) 18 (36%)	16 (32%) 7 (14%)	0.162

DISCUSSION AND CONCLUSION

Healthcare is a field in which accurate and reliable information is critically important. To ensure effectiveness and efficiency, one must implement a strategically designed information system, a methodical approach to gathering data, and the use of superior-quality information. Administrative data and EHR constitute the backbone of the health system, and clinical notes are the cornerstone of communication. However, no data is perfect, and data quality should be evaluated regularly (O'Donnell et al., 2020; Subaşıoğlu, 2023). PDQI-9 used in our study is an accepted measurement tool developed by Stetson et al. (2008, 2012) to evaluate the quality of patient records. In the emergency department, there are scribes who participate in consultations alongside physicians. No difference was found in terms of PDQI-9 scores between consultation notes written with scribes and non-scribes. It has been reported that it is insufficient in distinguishing between good and poor notes in the emergency department. However, in this study, physician intervention in consultation notes was not investigated. Emergency department conditions were not taken into account; for example, in a patient seen only for suturing, past medical history information may not have been recorded (Walker et al., 2017). Lack of communication between physicians in patients transferred from the intensive care unit to the ward leads to adverse outcomes in patients. On the other hand, it has been shown that evaluating intensive care handover notes with measurement tools and improvement efforts leads to a reduction in medical errors and adverse events. PDQI-9 is a useful tool for the objective evaluation of handover notes which also provides the opportunity to evaluate user performance in the areas of communication skills, practice-based learning and improvement, and system-based practice. It sheds light on the creation of shorter, more understandable, and more efficient notes instead of inflated notes (Lyons et al., 2024). It is suitable for evaluating admission, progress, and discharge notes of hospitalized patients and has the potential to improve documentation (Colussi et al., 2020). As a result of the evaluation of audio scenarios generated from real physician notes with PDQI-9, it has been reported that large language models are a potential way to facilitate patient care by reducing the physician documentation burden (Palm et al., 2025; Patel et al., 2025). As a result of the study, no difference was found between the total PDQI-9 scores of admission notes of patients receiving outpatient and inpatient healthcare services. According to the total PDQI-9 scores and general impression scores, patient admission notes were found to be of moderate and high quality. PDQI-9 is an appropriate, practical, and easy method to evaluate the quality of

admission notes of both children applying to outpatient clinics and critically ill patients admitted to intensive care units. The main limitations of PDQI-9 are the need for evaluator training and the time required for note assessment. However, it was thought that this problem would be resolved in the future with the integration of artificial intelligence-supported systems into EHR.

Although completeness, accuracy, consistency, plausibility, and currency have been reported as the main indicators of EHR data quality, completeness is the most emphasized indicator (Lewis et al., 2023). However, user preferences and workflow, the hospital information management system and management perspective, and differences in the software used affect data quality indicators (Declerck et al., 2024; Penev et al., 2024). In our study, the indicators "accurate, thorough, succinct and synthesized" were found to be of higher quality in the admission notes of patients admitted to the intensive care unit. While the proportion of score 5 was markedly higher in hospitalized patients (46% vs. 22% for accurate; 20% vs. 2% for thorough; 36% vs. 10% for succinct; 28% vs. 8% for synthesized), outpatients were predominantly concentrated at the level of score 4. In outpatient healthcare services, the time allocated to the patient is fixed and limited, and physicians may have to write notes simultaneously while taking the medical history. In this case, the notes may be up-to-date, useful, organized, and comprehensible, but may not be succinct, thorough, and synthesized at the same time. Conversely, in patients admitted to the intensive care unit, more time is allocated for admission notes, and since the patients are critically ill, it may be possible to write notes that are more accurate, thorough, and at the same time succinct, focusing on the disease.

The limitations of the study are that it was conducted in a single center with a limited number of patients and that only admission notes were evaluated. It is possible to improve data quality in EHR and healthcare delivery through multicenter studies with large patient series using different software systems. In this respect, our study has pioneering characteristics.

In conclusion, EHR data quality is a fundamental component of quality and efficiency in healthcare. Data quality should be regularly monitored using reliable and objective tools. PDQI-9 is an appropriate, practical, and easy-to-use method for evaluating admission notes of both patients presenting to outpatient clinics and critically ill patients admitted to intensive care units.

Ethical Approval: Ethical approval for the study was obtained from the Scientific Research Ethics Committee of Adana City Training and Research Hospital (Date: 18.12.2025, Meeting No: 20, Decision No: 935). In addition to the ethics committee approval, institutional permission for access to and research use of the patient records was obtained from the chief physician's office of Adana City Training and Research Hospital.

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Recent Trends in Medical Waste Management in Hospitals: A Thematic Review Integrating Operations Research, Sustainability, and Digitalization

Gülce KARAÇAY[1*]
Yasin GÖÇGÜN[1]

ABSTRACT

Medical waste management has become a strategic priority for healthcare institutions due to volumetric increases experienced during crises, such as infectious diseases, climate change, and the COVID-19 pandemic, and has undergone significant transformations in recent years, focusing on sustainability, circular economy, and digitalization. This thematic review addresses the existing academic literature on medical waste management in hospitals, focusing on operational and managerial challenges. Findings indicate that a significant portion of the literature focuses on operational research approaches; multi-criteria decision-making methods are used for technology and location selection, while mathematical modeling and heuristic algorithms are used for cost and risk minimization in logistics network design and vehicle routing. The sustainability paradigm requires the integration of Environmental, Social, and Governance and Sustainable Development Goals frameworks into medical waste management processes. Circular economy, resource segregation, and waste-to-energy conversion technologies are emphasized. Digitalization enables optimization, whereas stakeholder engagement and training form the basis of success.

The literature review was conducted using keywords identified in the Web of Science, Scopus, PubMed, and Google Scholar databases, and relevant studies were analyzed using a thematic synthesis approach by reviewing their titles,

1 İstanbul Medipol University, Graduate School of Engineering and Natural Sciences, Istanbul, Türkiye
* Corresponding author: Gülce KARAÇAY, gulce.karacay@std.medipol.edu.tr

abstracts, and full texts. The review revealed that subjectivity in multi-criteria decision-making models, the lack of real-world validation in optimization studies, and the limited treatment of ethical and data governance dimensions of digital technologies are key research gaps. It is considered important for future studies to incorporate data-driven decision support systems, hybrid decision models, advanced optimization approaches, and validation studies with real hospital applications.

Keywords: ESG, Medical Waste Management, Operations Research, Optimization, SDGs

INTRODUCTION

In recent years, medical waste management (MWM) has undergone a significant transformation driven by approaches focusing on sustainability, circular economy, and digitalization, shaping current research trends in the field. MWM is considered a critical necessity not only for ensuring environmental sustainability but also for protecting public health. Global threats, such as increasing infectious disease risks, the pressure of climate change on healthcare systems, and antimicrobial resistance have transformed this area from an operational cost item into a strategic priority for healthcare institutions. Public health crises, particularly the COVID-19 pandemic, have tested the resilience of existing systems with sudden and uncertain increases in waste volumes, demonstrating the need for process redesign.

Academic literature provides a detailed analysis of the obstacles to an effective MWM system. Chief among these obstacles is the lack of standardized protocols and guidelines, inadequate waste separation practices, low awareness and knowledge among personnel, and a lack of financial and human resources. Given that a significant portion of medical waste is recyclable, inadequate separation practices that lead to the mixing of hazardous waste with general waste pose serious health threats to both sanitation personnel and the public. To address these complex challenges, the disciplines of operations research and decision science have found widespread application in literature. Multi-criteria decision making (MCDM) methods, such as the analytical hierarchy process (AHP), VIKOR, PROMETHEE, and analytic network process (ANP), are widely used in strategic decisions, such as facility location selection, disposal technology selection, and disposal company evaluation. MWM processes encompass complex decision-making problems involving numerous potentially conflicting criteria, such as cost, environmental impact, infection risk, regulatory compliance, and social acceptance. Therefore, MCDM methods are widely preferred in literature because they allow for the systematic and transparent

evaluation of alternatives. Particularly in sustainability and governance-focused decision-making environments, the inadequacy of purely cost-based optimization approaches has led to MCDM methods becoming fundamental decision support tools in medical waste management research. At the operational level, medical waste logistics and network design play a central role. Reverse logistics network models, which aim to minimize costs, environmental impacts, and infection risks, are supported by approaches such as stochastic programming or robust optimization to manage uncertainties in waste volumes. Vehicle route planning (VRP), with the goal of cost and risk minimization, is solved using heuristic methods, such as genetic algorithms and NSGA-II.

In recent years, the perspective on MWM has evolved from technical optimization to holistic sustainability frameworks. Environmental, Social, and Governance (ESG) principles have become a fundamental component of healthcare organizations' long-term strategic planning. Similarly, waste management strategies aligned with the Sustainable Development Goals (SDGs) play a key role in improving institutions' environmental performance and corporate accountability. In this context, strategies such as circular economy principles, meticulous waste separation at source, and energy recovery through recycling and waste-to-energy (WtE) facilities are gaining prominence.

Digitalization is the most important catalyst supporting this transformation. Technologies such as artificial intelligence (AI), the Internet of Things (IoT) and blockchain are opening new horizons in process optimization. AI-based deep learning models increase the accuracy of waste classification, smart bins with IoT sensors provide real-time monitoring, and blockchain technology offers transparency and traceability. However, the success of technology is directly related to human and managerial factors. Stakeholder engagement, ongoing staff training, and practices such as Green Human Resource Management (Green HRM) are critical to achieving sustainability goals. This study aims to identify current trends, methodologies, and future research needs by systematically compiling the multidisciplinary literature in the field of waste management on a thematic basis.

Contributions

The main rationale for this study is the limited number of comprehensive synthesis studies in the medical waste management literature that address operational research approaches, sustainability frameworks, and digital transformation applications from a holistic perspective. While existing studies generally focus on specific methods or application areas, there is a noticeable lack of studies that

comprehensively evaluate methodological trends, sustainability dimensions, and emerging research gaps. This study aims to contribute to the literature by bringing together approaches developed in different disciplines under a thematic structure, systematically presenting current trends in literature, identifying key research gaps, and providing a holistic roadmap for future research. In this respect, the study distinguishes itself from previous reviews in existing literature by offering a thematic classification that integrates operational research approaches with the dimensions of sustainability, ESG, circular economy, and digitalization.

Scope

The scope of this study is to comprehensively compile the academic literature in the field of MWM under specific thematic headings. The study focuses on operations research approaches used in solving MWM problems, examining MCDM methods used for strategic decisions, such as facility location, technology selection, and disposal company selection, as well as mathematical programming and optimization models developed for operational challenges, such as logistics network design and vehicle routing (VRP). The study then examines the integration of MWM processes with ESG principles and the SDG frameworks. The scope also includes circular economy principles, energy recovery disposal technologies, and WtE approaches. The role of digitalization is discussed in the context of the impact of technologies such as artificial intelligence, IoT, and blockchain on data-driven logistics and corporate governance. Finally, a holistic perspective is presented by analyzing the importance of stakeholder participation and public awareness and the role of performance measurement and decision support systems (DSS) in MWM effectiveness.

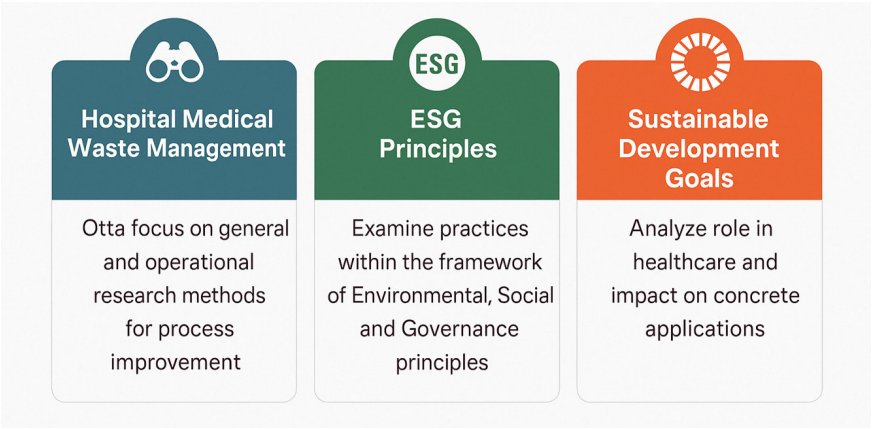

Figure 1. The scope graph of research

METHODOLOGY

This study was conducted through a comprehensive, thematic literature review to analyze current trends, methodologies, challenges, and future research directions in the field of medical waste management. Major academic databases, such as Web of Science, Scopus, PubMed, and Google Scholar, were used in the research process. The search was conducted using keywords, such as “medical waste management”, “operations research”, “ESG”, “SDGs”, “optimization”, “MCDM”, and “sustainability”.

The resulting academic articles were first screened for titles and abstracts. Then, studies directly related to the operational, strategic, sustainability, and technological dimensions of medical waste management processes were included in the full-text review. During the synthesis phase, the compiled information was grouped under seven main thematic headings. In the thematic synthesis process, studies using MCDM methods were given consideration because these approaches constitute one of the dominant methodological trends in the literature for strategic decision problems in medical waste management, such as site selection, disposal technology determination, and service provider evaluation. The inclusion of these studies in the analysis allowed for a comparative evaluation of how sustainability criteria and multidimensional performance indicators are integrated into decision models. This methodology aims to present the main research trends, the most used methods, and existing knowledge gaps in the medical waste management literature from a holistic perspective.

Figure 2 presents the flowchart of the search and screening strategy implemented in the systematic literature review and provides an overview of the reasons for exclusion.

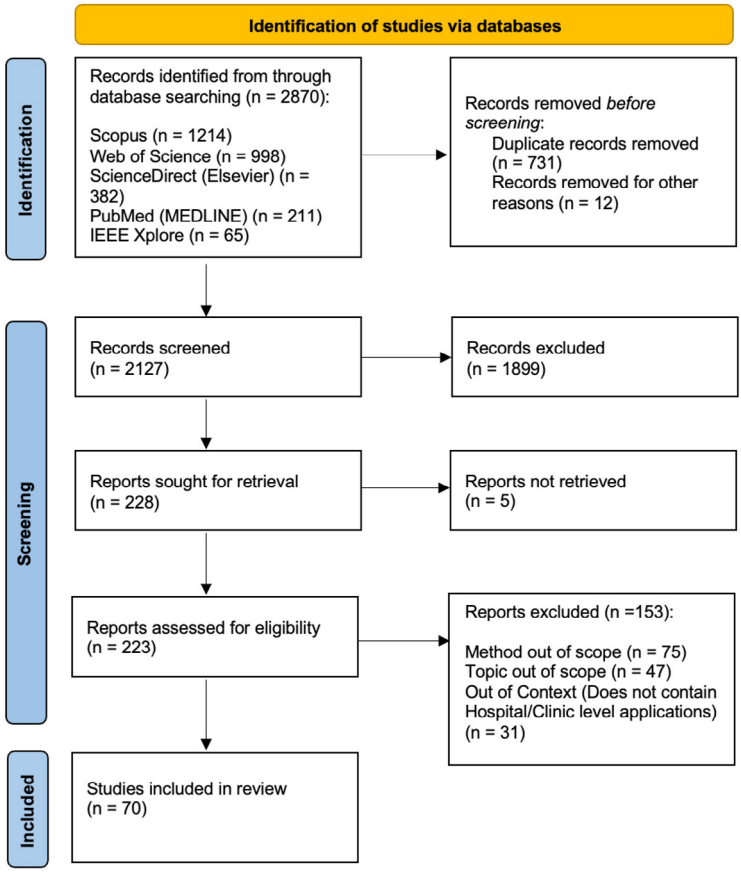

Figure 2. PRISMA flow chart for study selection

A total of 2,870 records were initially identified from the following databases: Scopus (n=1,214), Web of Science (n=998), ScienceDirect (n=382), PubMed (n=211), and IEEE Xplore (n=65). After removing 743 records (n=731 duplicates and n=12 others) before the search, a total of 2,127 studies were evaluated for title and abstract screening. After eliminating 1,899 studies through title and abstract screening, 228 studies were selected for full-text review. Because 5 of these 228 reports were not retrieved, 223 full-text articles were reviewed for eligibility assessment. Following comprehensive full-text review, an additional 153 reports (Reason 1: Method out of scope, n=75; Reason 2: Topic out of scope, n=47; Reason 3: Out of Context (Hospital/Clinic level applications), n=31) were eliminated, resulting in a final total of 70 eligible studies for inclusion in this study.

This study incorporates systematic search and selection steps, while adopting a thematic review approach in interpreting the findings. The literature review process was conducted in accordance with the principles of the PRISMA flowchart, and the study is positioned as a thematic review aiming to reveal conceptual trends and research orientations in the literature, rather than a quantitative review for meta-analysis purposes. Inclusion criteria were defined as studies focusing on medical waste management at the hospital or clinic level, being related to operational research methods, sustainability approaches, or digital technologies, and having full-text access. Exclusion criteria were defined as methodological incompatibility, subject inconsistency, and studies outside the context of hospital practice.

In the thematic synthesis process, selected studies were evaluated using a content analysis approach, and seven main thematic categories were inductively created by considering recurring research focuses, methods used, and application areas in the literature. This thematic structure was developed to encompass operational research practices, sustainability and ESG integration, circular economic approaches, digitalization and smart technologies, logistics and network optimization, decision support systems, and governance and stakeholder engagement dimensions. This approach allows for a more transparent and holistic analysis of methodological trends and research gaps in literature.

Literature Review

In this study, a bibliometric mapping analysis was conducted to visualize the intellectual structure of academic research in the fields of 'medical waste' and 'optimization' in terms of general topics. Figure 3, generated using VOSviewer software, shows the co-occurrence network of keywords in articles obtained from the Web of Science database. Each circle (node) on the map represents a keyword, and the size of the circle indicates the frequency of that word's use in the literature. The lines between the nodes indicate the frequency of these keywords' co-occurrence in articles; clusters, indicated by different colors, represent groups of keywords that are highly correlated and constitute specific research themes in the field. Figure 4 is a zoomed-in version of Figure 3. This map presents a holistic view of the dominant research topics in the medical waste optimization literature, the relationships between these topics, and potential research gaps.

Figure 3 shows that research in literature focuses particularly on concepts such as management, transfer stations, emission control, and data-driven

decision-making. The keywords "management" and "station", centrally located on the map, reveal that logistics network design, transfer station planning, and operational process management are key research focuses on medical waste management studies. Furthermore, the strong connections between concepts such as "emission", "environmental impact", and "SDGs" within the network indicate that environmental sustainability and performance evaluation approaches have gained increasing importance in the literature in recent years. Examining the time-based color distribution shows that studies related to sustainability and data analytics represent more current research trends.

The zoomed-in network structure presented in Figure 4 more clearly reveals the relationships between optimization methods and sustainability-based approaches. The connection between optimization techniques, such as "mixed integer programming", "routing", "solution", and "NSGA-II", and the concepts of "SDGs", "health facility", and "reduction" demonstrates that operational research methods are beginning to integrate with sustainable healthcare system goals. In contrast, the fact that some logistics and cost-based concepts are situated around the periphery of the network with more limited connections indicates that there is still potential for development in integrated and interdisciplinary studies in these areas. These findings reveal that the medical waste management literature is evolving from traditional optimization approaches towards sustainability, digitalization, and data-driven decision support systems.

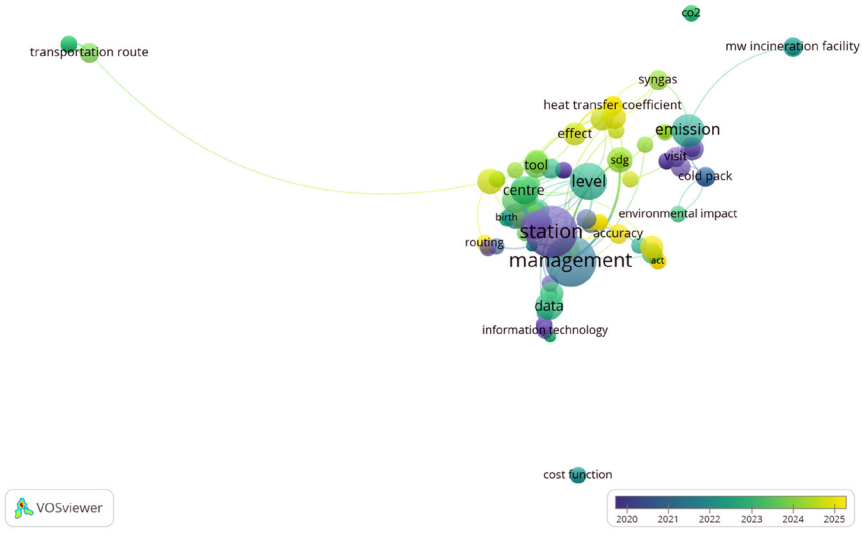

Figure 3. Medical waste and optimization literature keyword co-occurrence network (VOSviewer)

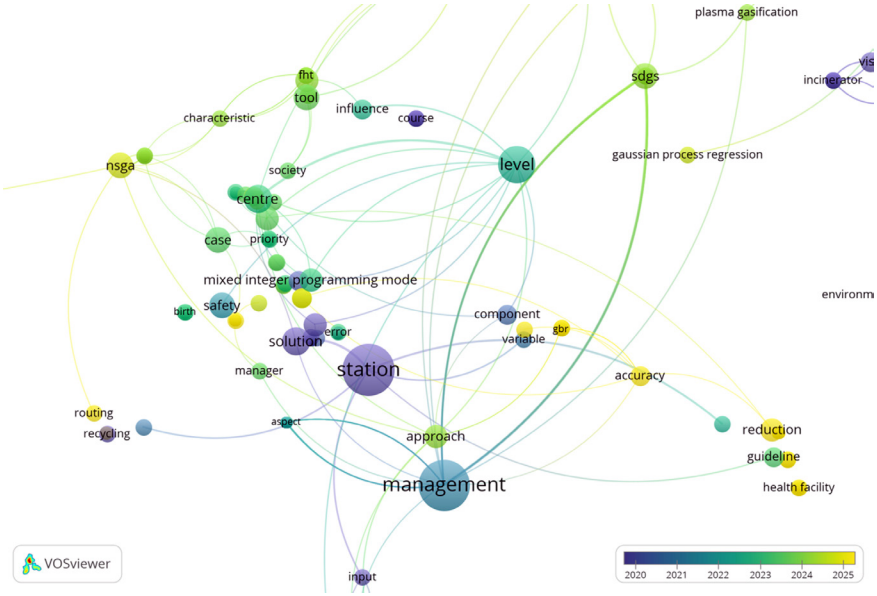

Figure 4. Detailed view of the cluster in Figure 3

Medical Waste Management in Hospitals and Operations Research Approaches

MWM has become a strategic priority for healthcare institutions due to factors such as increasing infectious disease risks, climate change, and drug resistance (Lee & Lee, 2022). It is considered a critical necessity not only for ensuring environmental sustainability but also for protecting public health (Quttainah & Singh, 2024). A significant portion of academic studies has focused on analyzing the barriers and success factors for medical waste management processes. A study based on hospital personnel data and using the AHP method found that the most significant factor affecting medical waste management was the "medical waste management" category itself, with a weight of 26.6%. This was followed by "operational management issues", "training", "awareness", and "environmental assessment" factors (Lee & Lee, 2022). In general, the main barriers to medical waste management in the literature are identified as the lack of standard guidelines, inadequate waste separation, low staff awareness, and financing problems (Quttainah & Singh, 2024). Inadequate separation practices are a serious problem, especially considering that approximately 85% of medical waste is recyclable (Lee & Lee, 2022). A case study in Pakistan showed that mixing of hazardous waste with general waste poses serious health threats to sanitation personnel and waste collectors (Ali et al., 2016).

MCDM methods have been widely used to support decision-making processes, particularly in strategic areas, such as facility location and disposal technology selection. In a study on the siting of a central incineration plant in Kenya, eight potential sites identified through geospatial analysis were evaluated using AHP, VIKOR, and PROMETHEE II methods, and the most suitable alternative was determined (Hariz et al., 2017). In selecting the disposal firm, the ANP method, which considers the interdependencies between criteria and alternatives, was used. To reduce the risk of dependence on a single source, multiple supply models were developed through which waste was distributed to firms (e.g., 500, 500, and 1000 kg/day, respectively) (Chauhan & Singh, 2021). In a study on disposal technology selection, a hybrid fuzzy method called F-DBM was applied. In this analysis, the "social dimension" was the criterion with the highest weight with 32.17%, followed by the "economic" (30.08%) and "technological" (24.59%) dimensions; "disinfection effectiveness" stood out as a critical sub-criterion in terms of inactivation of microorganisms (Demir & Moslem, 2024b).

Medical waste logistics and network designs have been extensively studied to manage increasing and uncertain waste volumes, especially during times of crisis such as the COVID-19 pandemic (Govindan et al., 2024; Yu et al., 2020). Studies in this area have generally focused on modeling reverse logistics networks aiming to minimize costs, environmental impacts, and/or risks. Scenario-based stochastic mixed integer linear programming (MILP) models (Govindan et al., 2024) or robust optimization approaches (Homayouni & Pishvaee, 2020) have been used to address uncertainties in waste quantities and facility capacities. Strategies such as establishing new collection centers, utilizing overtime, and third-party logistics (3PL) collaboration have been integrated into these models to increase resilience (Govindan et al., 2024). A multi-loop and multi-objective emergency logistics network model developed using the Wuhan outbreak example was solved with the MOPSO-NSGA2 hybrid algorithm. This study showed that the multi-cycle model more effectively reduced both the economic cost (110.139 million CNY in the optimal solution) and the infection risk (5137.88 in the optimal solution) compared to the single-cycle model (Liu et al., 2021).

VRP, an operational sub-branch of network design, has been frequently addressed in the MWM literature with the objective of minimizing cost and risk. Multi-center, two-objective route optimization models have been developed that aim to simultaneously minimize transportation cost and maximum infection risk (Wang et al., 2023). Infection risk has been defined in different ways, such as the VanUlden and S-I models, factors such as leakage amount,

surrounding population density, transportation time, and wind speed (Hu et al., 2024), or storage risks at transit points in addition to transportation risk (Zhang et al., 2025). In a model focusing on COVID-19 waste, the total cost is combined as the sum of transportation costs, low-temperature sterilization costs, and various risk costs weighted by AHP (Xue et al., 2023b). Various optimization techniques have been proposed to solve these complex VRPs, such as the epsilon-constraint method (Wang et al., 2023), specialized genetic algorithms (GA) (Xue et al., 2023a), improved NSGA-II (Zhang et al., 2025), and the adaptive hybrid artificial fish swarm algorithm (AH-NSAFSA) (Hu et al., 2024).

In recent years, models for the use of electric vehicles (EVs) in medical waste collection processes have been developed in line with "green governance" (Zhao et al., 2023) and sustainability goals. Models have been designed for heterogeneous EV fleets (Erdem, 2022) or combining facility location, charging station visits, and routes (Lin et al., 2024). These models aim to minimize energy costs, charging costs, and infection risk (associated with severity and probability depending on the type of waste). Advanced algorithms, such as E-ALNS/D (Lin et al., 2024) and hybrid ALNS (Erdem, 2022), have been used for this solution. These studies have shown that fast chargers increase overall performance and that a significant portion (66%) of total energy costs arise from initial charging costs.

Technology integration is also considered as a critical element in improving the effectiveness of management processes. Advanced online monitoring technologies and real-time tracking systems (e.g., the COVID-19 BMW application in India) ensure an accurate data collection throughout the waste's lifecycle, supporting effective policy development and management planning (Bagwan, 2023).

Medical Waste Management within the Environmental, Social and Governance (ESG) Framework

Today, companies' responsibilities extend beyond profit maximization to encompass social and environmental aspects; ESG practices are seen as a fundamental tool for long-term sustainability and financial performance (Singhania & Saini, 2022). This approach is critical for the healthcare sector due to the threats posed by climate change. ESG principles have become a core component in the long-term strategic planning of large operational units, such as hospitals (van Schie, 2024) and pharmaceutical companies (Jia et al., 2022). Adopting ESG principles in healthcare organizations allows them to manage environmental and social risks, promote health equity, contribute to

community well-being, and strengthen their reputation (Jia et al., 2022).

This framework is also being integrated into specific operational challenges such as medical waste management. In a study evaluating alternatives for the recovery of medical waste within the scope of ESG, MCDM methods, such as DFS-WINGS and DFS-CODAS were integrated (Chu et al., 2025). DFS-WINGS findings revealed that criteria, such as supply chain traceability, risk monitoring index, acidifying emissions, transparency and accountability, and renewable energy use were decisive in the assessment process. DFS-CODAS analysis, on the other hand, showed that the most suitable alternative within the ESG framework is the rotary kiln combustion method with heat recovery and flue gas treatment.

The success of such sustainability practices depends on factors such as management knowledge, commitment of healthcare professionals, use of technology (van Schie, 2024), and stakeholder engagement (Yu et al., 2024). Green HRM practices, which integrate environmental management with human resources, play a significant role in enhancing organizational sustainable performance (Khan & Muktar, 2024). Research shows that Green HRM practices, such as green recruitment, training, and performance evaluation, have a positive impact on sustainable performance, and this relationship is strengthened by "green employee empowerment". Employee participation in environmental decision-making processes, such as waste management and energy efficiency, directly strengthens sustainable performance in hospitals.

The integration of technology and AI is another critical element in achieving ESG goals. AI applications reduce waste by optimizing resource use in the environmental dimension; analyze occupational safety and diversity in the social dimension; and strengthen transparency and risk management in the governance dimension (Rane et al., 2024). In healthcare logistics and pharmaceutical supply chains, AI-based predictive analytics provide demand forecasting and inventory optimization, reducing the risks of waste and overstocking (Alemde, 2025). Given the high R&D costs of "green" or "double-carbon" products, advanced technologies, such as AI, digital twins, and blockchain, are becoming essential to increase operational efficiency, transparency, and profitability across the supply chain (Alemde, 2025; Yang, 2023).

Measuring and reporting ESG performance is critical for all stakeholders. To this end, integrated MCDM frameworks (Yu et al., 2024) or advanced data analytics models using deep learning techniques and prescriptive methodologies are recommended. For example, a model tested on Fortune 500 companies that used quartile scores instead of traditional weighted

averages achieved nearly 99% accuracy in classifying ESG performance groups (Sariyer et al., 2024). Green employment, a tangible outcome of successful ESG strategies, demonstrates companies' environmental and social commitments and directly correlates with Sustainable Development Goals, such as SDGs 7, 8, 12, and 13 (Figuerola-Ferretti et al., 2025).

However, some limitations and challenges are also noted in literature. One limitation is that the medical waste management model is based only on qualitative data from experts in Hong Kong and has not yet been validated in the real world (Chu et al., 2025). Similarly, MCDM methods may rely on subjective differences in qualitative assessments and single expert opinion (Yu et al., 2024). Data privacy, algorithmic bias, and ethical issues are challenges that need to be considered when using AI (Rane et al., 2024). Future studies are recommended to integrate dynamic decision support tools and data-driven optimization models (Chu et al., 2025), support group decisions and quantitative data (Yu et al., 2024) and detail the long-term impacts and lifecycle sustainability of ESG criteria. Furthermore, policy makers need to support inter-hospital information sharing infrastructures and financial investments for environmental sustainability (van Schie, 2024).

Medical Waste Management Within the Framework of Sustainable Development Goals (SDGs)

Global health threats, such as infectious diseases, climate change, and antimicrobial resistance, have made MWM a strategic priority for healthcare institutions (Lee & Lee, 2022). Public health crises such as COVID-19 have further complicated these challenges, leading to sudden increases and uncertainties in the amount of medical waste (Barouki et al., 2021; Govindan et al., 2024) and placing significant pressure on healthcare systems. Correct classification of medical waste and implementation of environmentally friendly disposal methods are critical for establishing a healthcare environment aligned with the SDGs (Lee & Lee, 2022).

Literature identifies the obstacles to an effective MWM system as the lack of standardized protocols, inadequate waste separation practices, low awareness and knowledge among staff, and a lack of financial and human resources (Quttainah & Singh, 2024). Inadequacies in MWM practices can lead to waste rates exceeding World Health Organization (WHO) recommendations. In fact, a study conducted in training hospitals in Kermanshah reported that the total daily waste amount was 6279 kg and the medical waste rate was equal to the general waste rate (Alighardashi et al., 2024). For successful sustainability practices, management knowledge, involvement of managers in the process,

commitment of healthcare professionals and use of technology stand out as key factors (van Schie, 2024).

Various management strategies and operational models have been developed to overcome these challenges and achieve the SDGs targets. At the operational level, optimizing single-use products through inventory management and expiration tracking (Lee & Lee, 2022) or adopting management strategies such as circular economy (CE) and plan-do-check-act (PDCA) have been found to be effective in reducing waste (Alighardashi et al., 2024). The design of logistics networks also plays a central role in optimizing MWM. Multi-loop and multi-purpose emergency medical waste disposal logistics network models have been developed that aim to simultaneously optimize economic cost and infection risk by considering uncertainties in waste generation and population density (Liu et al., 2021). These multi-loop analyses have been found to yield more advantageous results in terms of cost and risk compared to single-loop analyses. Reverse logistics network designs that include measures, such as overtime, the use of 3PL, and the establishment of new collection centers are also recommended to increase network resilience during crises (Govindan et al., 2024).

In the context of reducing environmental impact, strategies such as separating and recycling waste at source are gaining prominence as an alternative to traditional incineration methods. Life cycle assessment (LCA) studies show that switching from hazardous waste incineration to general waste management and plastic recycling strategies reduces global warming impact by 79.7% (Cho et al., 2024).

In addition to operational improvements, managerial and human factors also directly impact sustainability performance. Integrated management systems (IMS), which integrate standards such as ISO 9001 (Quality) and ISO 14001 (Environment) simultaneously improve clinical quality and environmental sustainability, providing measurable improvements in waste management, resource efficiency, patient satisfaction, and staff engagement (Simion Luduşanu et al., 2025). In terms of human resources, the adoption of Green HRM practices (recruitment, training, performance evaluation) and the empowerment of employees in environmental initiatives (Green Employee Empowerment) directly and positively impact the environmental performance of organizations (Khan & Muktar, 2024).

Finally, MWM performance is seen as an integral part of the overall sustainability performance of institutions. Measuring environmental performance is a fundamental requirement for hospital managers to develop strategies, monitor targets, and ensure institutional accountability (Dolcini et

al., 2025). To this end, advanced data analytics-based models that evaluate Environmental, Social, and Governance (ESG) components across quartiles (Sariyer et al., 2024) and holistic assessment frameworks that enable benchmarking across healthcare institutions have been proposed (Yu et al., 2024). Tracking indicators such as green employment is considered as concrete evidence of institutions' commitment to goals, particularly SDG 8 (Decent Work and Economic Growth) and SDG 13 (Climate Action) (Figuerola-Ferretti et al., 2025).

Future studies should consider the integration of Industry 4.0 technologies, such as the IoT (Tirkolaee et al., 2024), RFID-tagged waste bags, EVs (Govindan et al., 2024), and AI (Simion Luduşanu et al., 2025), for the optimization of MWM processes. The use of meta-heuristic algorithms for large-scale problems and the development of domain-specific multidisciplinary approaches (Barouki et al., 2021; Quttainah & Singh, 2024) are suggested.

Circular Economy, Energy, and Technology-Based Disposal Strategies

The inadequacy of current hospital waste management practices necessitates the development of new disposal strategies based on energy and technology, in line with CE principles (Ali et al., 2016; Alighardashi et al., 2024). A study conducted in hospitals in Kermanshah found that the total daily waste amount was 6279 kg, and the proportion of medical waste exceeded the WHO recommendations (Alighardashi et al., 2024). This suggests that national waste management guidelines should be revised to include environmental and economic aspects. Effective strategies require careful separation of waste at source. A study based on Portuguese legislation revealed that by meticulously separating only those wastes that must be incinerated, the amount of waste to be incinerated could be reduced by 80% (Alvim-Ferraz & Afonso, 2005). This separation can achieve dramatic reductions in emissions, such as 98% for particulate matter (PM), 99.5% for dioxins, and 93% for SO_2 and NOx. LCC studies also confirm that switching from hazardous waste incineration to separation and plastic recycling strategies results in significant reductions in environmental impacts. For example, landfilling general waste reduces global warming impacts by 79.7%, while plastic recycling contributes an additional 11.8% (Cho et al., 2024).

Energy recovery is at the core of technology-based approaches. WtE facilities not only provide disposal but also serve as a climate-friendly alternative to fossil fuels for energy and metal recovery (Lausselet et al., 2016). Thermal disposal systems with heat recovery installed within hospitals can be both

energy efficient and economically attractive, with average overall efficiencies of up to 73% and a capital payback period of 3.1 years (Bujak, 2015). The success of these systems depends on the need for facilities capable of consuming the recovered energy (typically 95.8% of which is hot water). Integrated systems such as chemical disinfection or thermal friction sterilization, developed as alternatives to incineration systems, can reduce the load on incineration by 33% to 70%, resulting in economic savings of 43% to 61%, particularly from transportation costs (Jia et al., 2022).

AI and optimization play a critical role in achieving circular economy goals. AI technologies such as machine learning and computer vision have the potential to reduce environmental burdens by optimizing waste classification, recycling, and collection processes (Snoun et al., 2025). This is particularly important for overcoming classification barriers and implementing underutilized strategies, such as "redesign" and "reduce" in the management of plastics in the healthcare sector (Cano et al., 2025). In the logistics and supply chain dimension, multi-objective optimization models developed for reverse logistics and closed-loop supply chains are gaining importance (Elliazidi & Dkhissi, 2024; Torkayesh et al., 2021). These models support network design, inventory management, and transportation decisions by optimizing economic (cost), environmental (CO_2 emissions), and social criteria together.

Tools such as life cycle osting (LCC) are used for holistic evaluation of these strategies. LCC models allow for the calculation of environmental LCC and societal LCC by transparently analyzing budget, transfer, and externality costs (Martinez-Sanchez et al., 2015). Analyses show that practices that require additional costs, such as organic waste decomposition, provide significant environmental gains in categories such as toxicity and eutrophication. However, some studies lack environmental cost-benefit analyses (Jia et al., 2022) or are limited to greenhouse gas emissions (Ali et al., 2016), suggesting the need to expand the scope of research in this area.

Digitalization, Data-Driven Logistics, and Corporate Governance – Resilience

Digitalization and data-driven logistics approaches play a critical role in optimizing community temporary storage areas and disposal routes (Zhao et al., 2023). Especially in the management of infectious medical waste, managing risks in transportation and storage processes is vital for system resilience (Zhang et al., 2025). These approaches also increase institutional resilience by providing a proactive roadmap to reduce resource waste in medical supply

chains during disasters (Bastani et al., 2021). From a corporate governance perspective, operational decisions in these processes should be based on criteria of feasibility, controllability, and efficiency.

AI applications play a central role in optimizing resource use by supporting circular economy models in waste management (Snoun et al., 2025). When integrated with ESG criteria, AI supports environmental sustainability by optimizing resource use, reducing waste, and minimizing carbon footprint (Rane et al., 2024). Technologies such as machine learning and computer vision are improving waste classification and collection processes (Snoun et al., 2025). For example, deep learning-based methods such as 'Deep MWM' can visually classify medical waste with high accuracy, reducing waste volume, costs, and environmental risks (Zhou et al., 2022). Similarly, predictive analytics and IoT-based systems allow municipalities to predict waste generation patterns and reduce operational costs by up to 30% (Bello & Odiete, 2022).

The integration of specific technologies provides tangible improvements in logistics processes. Smart bins equipped with IoT sensors provide real-time monitoring of biomedical waste management with response times ranging from 3 to 16 minutes to overflow alarms (Ishaq et al., 2025). Blockchain-based management frameworks, when combined with IoT sensors and smart contracts, can offer significant gains compared to traditional methods, such as 100% traceability accuracy, a 30% reduction in disposal time, and a 90% increase in regulatory compliance (Lakshmanan et al., 2025).

Route optimization problems in medical waste reverse logistics are addressed with multi-objective models that integrate cost and risk factors. During epidemic periods such as the COVID-19 pandemic, models that consider transportation, sterilization, and multiple risk costs have been developed (Xue et al., 2023b; Yu et al., 2020). In these models, risk weights are estimated using the AHP, while customized genetic algorithms, improved NSGA-II (Zhang et al., 2025), or interactive fuzzy methods are used for the solution. Case studies show that these methods significantly reduce total cost and transportation time (Xue et al., 2023a; Xue et al., 2023b). A two-stage solution method reduced solution time by an average of 26.6%, providing effective plans for situations requiring rapid decision-making (Zhang et al., 2025).

In decision support processes, methods such as MCDM help determine optimal solutions based on cost and other criteria among different disposal technologies, such as autoclaves and incinerators (Ciplak, 2015).

However, the full integration of AI and data-driven systems also presents challenges such as data accessibility, algorithmic bias, and ethical issues. Successful implementation, especially in developing countries, requires developing strategies

tailored to local socioeconomic and infrastructural conditions (Bello & Odiete, 2022) and establishing strong AI governance frameworks (Alemde, 2025). Future work is recommended to integrate dynamic patterns of waste generation and real-time data into route optimization models (Xue et al., 2023b), model more complex scenarios (Zhang et al., 2025) and utilize advanced methods such as stochastic programming to manage uncertainty (Yu et al., 2020).

Stakeholder Participation and Social Awareness

Stakeholder participation and public awareness play a critical role in ensuring sustainable and safe waste disposal processes in healthcare institutions. Waste management effectiveness is directly related to the participation of key stakeholders, such as administrators, healthcare personnel, and environmental health authorities, in decision-making processes (Azami-Aghdash et al., 2023). This participation increases interaction among different actors (Alighardashi et al., 2024), increasing information sharing and general awareness (Chauhan & Singh, 2021), thereby strengthening the effectiveness of practices, such as waste reduction and source separation.

Stakeholder theory emphasizes the importance of integrating both top-down perspectives from managers and bottom-up input from healthcare professionals in policy development processes (van Schie, 2024). Indeed, as seen in the example of the medical waste management program implemented in primary health care centers in Saudi Arabia, top-down approaches based solely on top-management decisions limit the participation of practitioners in the process, reduce their sense of responsibility, and lead to inconsistency in policy objectives (Almubarak et al., 2024). Therefore, ensuring effective collaboration and coordination among stakeholders in policy design and implementation is essential for sustainability.

Stakeholder engagement is fundamental to training programs that increase staff knowledge, attitudes, and skills. Continuing education, consulting, and awareness-raising strategies are decisive in achieving goals such as zero-waste by encouraging staff's active participation in processes (Alanazi et al., 2024). Supporting training programs with guidance materials, workshops, hands-on monitoring activities (Azami-Aghdash et al., 2023) and visual aids, such as color-coded bags and labeling systems, increase awareness and process safety. Furthermore, establishing information-sharing infrastructures among hospitals and making financial investments in environmental sustainability strengthen the awareness of both staff and the public (van Schie, 2024).

Participatory approaches provide tangible benefits at different operational stages of waste management. The success of strategies such as adopting green procurement practices (Nsowah et al., 2024) and reducing inventory waste depends directly on the active participation of managers and staff. Analytical tools such as the ABC-VEN matrix prevent waste by providing decision-making support to stakeholders in the management of high-cost and critical inventory (Alanazi et al., 2024). When selecting disposal companies, stakeholders can create cost advantages and operational efficiencies by conducting risk and performance assessments (Chauhan & Singh, 2021) or by using game theory-based collaboration models (e.g., Shapley value) (Eryganov et al., 2020). Technological integrations also support participation; in emergency hospitals, technologies such as BIM, artificial intelligence, and IoT facilitate interdisciplinary coordination and shared decision-making (Chen et al., 2022). Furthermore, tools such as the hospital-stakeholder collaboration (HSC) and the hospital performance factor (HPF) systematically collect the opinions of external stakeholders, such as patients, physicians, and insurance companies, and integrate them into service improvement processes (Purwaningsih et al., 2023).

Despite all these requirements, significant shortcomings are observed in current practices. Studies conducted in some training hospitals show that the amount of medical waste produced is equal to the general waste rate and above the WHO recommendations, indicating that current management practices and stakeholder participation are inadequate (Alighardashi et al., 2024).

Performance Measurement and Decision Support Systems

The effectiveness of medical waste management in healthcare institutions is directly related to the integrated use of performance measurement and DSS (Chu et al., 2025). DDS is considered as a fundamental tool in processes such as selecting waste disposal companies, planning logistics processes and optimizing strategic decisions. Public health crises such as COVID-19 have increased the importance of robust and effective DSS frameworks in the face of increasing waste volumes (Govindan et al., 2024). The literature demonstrates that different methodologies are utilized in the development of these systems. Methods such as the ANP increase the accuracy of decision processes by considering interactions between criteria such as the disposal company's experience or technology (Chauhan & Singh, 2021), while MCDM allows for the evaluation of different disposal and process options on a regional basis (Ciplak, 2015). To increase operational efficiency, multiple performance objectives, such as cost, risk, emissions, and employment, are simultaneously optimized using stochastic

MILP models that consider uncertainties (Govindan et al., 2024), multi-objective mathematical models (Tirkolaee et al., 2024; Torkayesh et al., 2021), and robust optimization approaches (Homayouni & Pishvaee, 2020). These models provide managers with pareto-based solution alternatives, allowing them to jointly improve operational and environmental performance.

In recent years, performance measurement has become strongly integrated with ESG indicators. Corporate sustainability depends not only on financial returns but also on fulfilling environmental and social responsibilities. In this context, ESG criteria, such as supply chain traceability, transparency, accountability, and renewable energy use (Chu et al., 2025) have become critical performance metrics for DSS (Yu et al., 2024). The integration of ESG principles in supply chains in the pharmaceutical sector (Yang, 2023) or in the overall assessment of corporate performance (Sariyer et al., 2024) increases the effectiveness of systems. Similarly, the implementation of IMS provides a comprehensive decision support framework that improves compliance with ESG goals, resource efficiency and waste management in healthcare institutions (Simion Luduşanu et al., 2025).

In specific application areas, DSS is used in medical waste logistics for optimizing electric vehicles (Lin et al., 2024) or reverse logistics networks (Qi et al., 2023). A hybrid DSS model used in the selection of disposal methods revealed that the social dimension (32.17%) is of the highest importance, followed by the economic (30.08%), technological (24.59%), and environmental (13.16%) dimensions (Demir & Moslem, 2024b). Regional analyses indicate that solutions combined with autoclave technology may be more optimal than complete incineration due to high costs (Ciplak, 2015).

The main limitations of existing studies are the subjectivity of expert opinions and the lack of data (Yu et al., 2024). Future studies recommend the integration of AI (Alemde, 2025; Chu et al., 2025), IoT applications (Tirkolaee et al., 2024), big data analytics (Sariyer et al., 2024), and metaheuristic algorithms (Homayouni & Pishvaee, 2020; Torkayesh et al., 2021) to measure performance and improve the effectiveness of DSS. AI-assisted predictive optimization and the use of real-time data such as electronic health records (EHR) have the potential to increase the accuracy and sustainability of decision processes.

Holistic Thematic Synthesis and Comparative Literature Review

When the literature examined in this study is evaluated holistically, it is seen that research on medical waste management in hospitals is clustered around three main research axes: operational research and optimization approaches, sustainability and governance frameworks (ESG-SDGs), and digitalization and data-driven decision support systems. Operational research-based studies mainly

focus on minimizing cost and infection risk in facility location selection, logistics network design, and vehicle routing problems, while sustainability-focused studies expand these technical goals to include environmental performance, social responsibility, and corporate governance dimensions. The digitalization literature emerges as a complementary transformation area that enables the real-time monitoring and management of these multi-dimensional performance goals through artificial intelligence, IoT, and blockchain technologies.

Comparative analysis between studies shows that MCDM methods are dominant in strategic decision problems, while network design and VRP-based optimization models stand out at the operational level. This situation demonstrates that MCDM approaches are positioned as fundamental decision support tools in the literature, given that medical waste management decisions involve multiple and often conflicting criteria, such as cost, environmental impact, infection risk, and social acceptance. However, the definition of the risk concept, the integration of sustainability indicators into the model, and performance measurement approaches show significant differences between studies, limiting the direct comparability of the results. It has been observed that, although many optimization models utilize advanced meta-heuristic algorithms, issues such as validation with real hospital data, scalability, and applicability in dynamic decision-making environments are limited.

While studies within the ESG and SDGs frameworks expand sustainability performance, environmental indicators are seen to be more dominant compared to social and governance dimensions; stakeholder engagement, human factors, and corporate governance mechanisms are often considered separately from technical modeling studies. Similarly, although digital technologies offer high operational potential, socio-technical challenges, such as data accessibility, system integration, ethical risks, and AI governance, have not yet been addressed in an integrated manner in the literature.

The cross-theme assessment points to a fundamental transformative trend in the literature: Medical waste management research is evolving from technical optimization to sustainability-based governance and data-driven intelligent systems. However, a significant portion of current studies focus on specific methods or individual application contexts, and studies that simultaneously integrate operational research models, sustainability performance, digital infrastructures, and stakeholder engagement remain limited. Therefore, developing interdisciplinary approaches that integrate data-driven dynamic decision support systems, real-time monitoring technologies, and sustainability indicators is critical for future research.

This holistic thematic synthesis goes beyond summarizing individual studies, revealing methodological clusters, inter-thematic relationships, and conceptual gaps in the literature; thus, it offers a comparative and multidimensional academic framework for the field of medical waste management in hospitals.

Classification of the Literature

Table 1 provides the classification of papers on the basis of methodology used. As perceived from the table, various methodologies have been used within the context of medical waste management.

Table 1: Paper classification by methodology used

Paper	Methodology Used
Ali et al., 2016; Demir & Moslem, 2024a; Demir & Moslem, 2024b; Erdem, 2022; Govindan et al., 2024; Hariz et al., 2017; Homayouni & Pishvaee, 2020; Hu et al., 2024; Lee & Lee, 2022; Lin et al., 2024; Liu et al., 2021; Quttainah & Singh, 2024; Wang et al., 2023; Xue et al., 2023a; Xue et al., 2023b; Yu et al., 2020; Zhang et al., 2025; Zhao et al., 2023	Operations Research
Alemde, 2025; Chu et al., 2025; Figuerola-Ferretti et al., 2025; Jia et al., 2022; Khan & Muktar, 2024; Rane et al., 2024; Sariyer et al., 2024; Singhania & Saini, 2022; van Schie, 2024; Yang, 2023; Yu et al., 2024	The ESG Framework
Alighardashi et al., 2024; Barouki et al., 2021; Cho et al., 2024; Dolcini et al., 2025; Figuerola-Ferretti et al., 2025; Govindan et al., 2024; Khan & Muktar, 2024; Lee & Lee, 2022; Liu et al., 2021; Quttainah & Singh, 2024; Simion Luduşanu et al., 2025; van Schie, 2024	The SDGs Framework
Ali et al., 2016; Alighardashi et al., 2024; Alvim-Ferraz & Afonso, 2005; Bujak, 2015; Cano et al., 2025; Cho et al., 2024; Elliazidi & Dkhissi, 2024; Jia et al., 2022; Lausselet et al., 2016; Martinez-Sanchez et al., 2015; Snoun et al., 2025; Torkayesh et al., 2021	Technology-Based Disposal Strategies
Alemde, 2025; Bastani et al., 2021; Bello & Odiete, 2022; Ciplak, 2015; Ishaq et al., 2025; Lakshmanan et al., 2025; Rane et al., 2024; Snoun et al., 2025; Xue et al., 2023a; Xue et al., 2023b; Yu et al., 2020; Zhang et al., 2025; Zhao et al., 2023; Zhou et al., 2022	Digitalization, Data-Driven Logistics, and Corporate Governance
Alanazi et al., 2024; Alighardashi et al., 2024; Almubarak et al., 2024; Azami-Aghdash et al., 2023; Chauhan & Singh, 2021; Chen et al., 2022; Eryganov et al., 2020; Nsowah et al., 2024; Purwaningsih et al., 2023; van Schie, 2024	Stakeholder Participation and Social Awareness
Alemde, 2025; Chauhan & Singh, 2021; Chu et al., 2025; Ciplak, 2015; Demir & Moslem, 2024a; Demir & Moslem, 2024b; Govindan et al., 2024; Homayouni & Pishvaee, 2020; Lin et al., 2024; Qi et al., 2023; Sariyer et al., 2024; Simion Luduşanu et al., 2025; Tirkolaee et al., 2024; Torkayesh et al., 2021; Yang, 2023; Yu et al., 2024	Performance Measurement and Decision Support Systems

Research Gap

The literature review indicates that, while significant progress has been made in the field of medical waste management, significant research gaps persist in certain areas.

First, decision support systems and MCDM models face significant issues of subjectivity and data limitations. Many studies rely on the qualitative opinions of a single expert or a small group of experts for criteria weighting and alternative evaluation. This limits the generalizability and objectivity of the results and highlights the need for hybrid models based on quantitative data or that more effectively integrate group decisions.

It is observed that mathematical models developed in operations research and optimization (e.g., VRP or network design models) are largely theoretical and lack validation with real-world data. The number of case studies testing the applicability of models to large-scale, dynamic, and uncertain real-world hospital operations is insufficient.

While the integration of digitalization and Industry 4.0 technologies (AI, IoT, Blockchain) is rapidly increasing, the ethical dimensions of these technologies, including data privacy, algorithmic bias, and cybersecurity risks, have not been adequately addressed in the context of AI. The lack of strong AI governance frameworks and ethical guidelines is a significant gap.

Cost-benefit analyses and LCA studies are often limited in scope. Many analyses focus solely on greenhouse gas emissions or direct economic costs, while holistic LCAs that include other environmental externalities, such as toxicity and eutrophication, or social impacts, are lacking.

Finally, while studies on stakeholder engagement and management models exist, there is a gap in integrated governance and collaboration models that balance the conflicting objectives of different stakeholders (management, staff, patients, regulators) and encourage bottom-up participation.

When these research gaps are considered together with the thematic structure identified in the study, it shows that the deficiencies in the literature stem not only from methodological limitations but also from a lack of inter-thematic integration. While operational research models mostly focus on technical optimization performance, ESG and SDGs-based studies address sustainability indicators independently of operational decision-making mechanisms. Similarly, although digitalization and Industry 4.0 technologies offer significant opportunities, studies examining the integrated use of these technologies with optimization models, governance structures, and circular economy strategies remain limited. This situation reveals a conceptual disconnect between thematic areas in medical waste management research and highlights the need for integrated analytical frameworks.

Future Limitations

These limitations, when evaluated within the thematic framework presented in this study, demonstrate that the existing literature largely relies on one-dimensional research approaches. In particular, the fact that operational research, sustainability (ESG-SDGs), circular economy, and digitalization are often treated as separate research streams limits the development of integrated decision support systems.

While this review aims to provide a comprehensive overview of the medical waste management literature, it has several limitations. As a review, it is limited by the databases and keywords selected; there is a possibility that certain studies were overlooked (publication bias) because a systematic review or meta-analysis protocol was not followed. Furthermore, because the analysis relied on a synthesis of existing literature, the practical applicability or effectiveness of the proposed models was not directly tested.

Considering these limitations and the identified research gaps, the following recommendations for future research have been developed:

- **Advanced Modeling and Optimization:** Future studies should utilize advanced methods, such as stochastic programming, fuzzy logic, and robust optimization, to more effectively manage uncertainty (waste production volume, transportation times, etc.). The use and comparative analysis of metaheuristic algorithms (e.g., ALNS, Enhanced NSGA-II) should be encouraged, especially for large-scale and complex VRP or network design problems.
- **Data-Driven and Dynamic Systems:** As an alternative to static models, dynamic decision support systems should be developed. Integrating AI-supported predictive analytics (for waste production estimation), real-time data from IoT sensors (smart boxes), and electronic health records (EHR) into route optimization models will increase system efficiency and resilience.
- **Holistic Sustainability Analysis:** When evaluating disposal technologies and logistics strategies, comprehensive LCA models that go beyond mere cost or CO_2 emissions should be applied. These models should consider environmental, economic, and social dimensions (e.g., employment, public health risk) together.
- **Quantitative and Hybrid Decision Models:** To reduce subjectivity in MCDM studies, hybrid models that combine qualitative methods based on expert opinions (such as AHP and ANP) with quantitative tools such as big data analytics or simulation are needed.

- **Real-World Validation:** Validation and piloting of proposed theoretical models and algorithms through real-world hospital case studies in regions with different socioeconomic and infrastructural conditions (especially in developing countries) is critical.
- **Governance and Policy:** Ethical guidelines, data governance frameworks, and regulatory standards should be developed for the use of AI and other digital technologies in MWM processes. Furthermore, policymakers should support inter-hospital information-sharing infrastructures and financial investments in green technologies.

CONCLUSION

This literature review clearly demonstrates that medical waste management has evolved from a simple operational obligation into a multidisciplinary and strategic area that directly impacts the resilience, sustainability, and public health security of healthcare systems. The reviewed studies demonstrate that research in medical waste management primarily focuses on operational efficiency, sustainability integration, technological adaptation, and managerial frameworks.

Operations research approaches represent a mature strand of the medical waste management literature. Multi-objective optimization models and metaheuristic algorithms (GA, NSGA-II, ALNS, etc.) have been widely used, particularly in logistics network design, VRP, and facility layout, aiming to simultaneously minimize cost and infection risk. Similarly, the use of MCDM methods, such as AHP, ANP, and VIKOR, has become standard practice in strategic decisions such as disposal technology or supplier selection.

With the paradigm shift experienced in recent years, MWM processes are now being addressed in an integrated manner within the ESG and SDGs frameworks. Research highlights the critical roles that measuring environmental performance, implementing Green HRM, and institutional transparency play in helping hospitals achieve their long-term sustainability goals. This trend has also fueled the adoption of circular economy principles. Strategies such as rigorous source separation, plastic recycling, and WtE facilities reduce environmental impact while also achieving economic and energy efficiency.

Technology integration represents the most dynamic research direction in this field. Industry 4.0 technologies, such as AI, the IoT, and blockchain, have the potential to revolutionize MWM processes. AI-powered visual classification systems, real-time route optimization with IoT-based smart waste bins, and blockchain-based traceability systems are increasing both efficiency and

regulatory compliance. However, the success of these technological advances depends on human factors, such as stakeholder engagement and public awareness. Lack of training and low staff participation in decision-making can lead to the failure of even the most advanced systems.

The reviewed literature, while significant progress has been made in this area, also highlights significant limitations and future research needs. Many MCDM studies rely on subjectivity in qualitative assessments and the opinion of a single or small number of experts, limiting the generalizability of the results. Data privacy, algorithmic bias, and ethical issues remain significant challenges in the implementation of AI and data-driven systems. Furthermore, the fact that many proposed models have not yet been validated with real-world data or tested on large-scale problems is a significant limitation.

Future work should focus on filling these gaps. Dynamic decision support tools and data-driven optimization models (fed by real-time data, such as AI, IoT, and electronic health records) need to be developed. Integrating stochastic programming and robust optimization approaches, particularly for situations with high uncertainty (such as a pandemic), will increase system resilience. Hybrid MCDM models that support group decision-making and make greater use of quantitative data are needed to reduce subjectivity. Finally, policymakers' support for inter-hospital information-sharing infrastructures and financial investments for environmental sustainability are essential for translating theoretical models into practice.

The key contribution of this study is its analysis of the medical waste management literature not solely through individual methods or application areas, but under an integrated thematic perspective that reveals the interaction between operational research approaches, ESG and SDGs frameworks, circular economy strategies, and digitalization-based smart systems. The findings demonstrate that the evolution of the field is progressing from technically optimized models to a sustainability-based governance approach and data-driven adaptive systems. This thematic synthesis highlights the need for a critical research direction for future research, not only in developing new methods but also in developing interdisciplinary decision models that simultaneously integrate operational, environmental, social, and digital dimensions.

Accordingly, the thematic framework developed within the scope of this study reveals that medical waste management research should be considered not only as a methodologically focused field, but also as an integrated research area shaped by the interaction of operational optimization, sustainability governance, and digital transformation. This approach guides future research

trends that integrate OR-based analytical methods into data-driven and adaptable decision support systems aligned with ESG and SDGs goals, rather than the tendency to develop fragmented models.

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Review Article
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Strengthening the Mental Health System in Zimbabwe: A Scoping Review of Policy and Health System Barriers to Achieving SDG 3

Dominic NYONI[1*]
Nigel JAMES[2]
Princess NYONI-KACHAMBWA[3]

ABSTRACT

Mental health is crucial for achieving Sustainable Development Goal 3 (SDG 3), yet it remains overlooked in many low- and middle-income countries. In Zimbabwe, the burden of mental disorders is increasing despite the existence of a national health strategy, raising concerns about the readiness of the health system to deliver equitable and effective mental health care. This scoping review synthesises evidence on the policy and health-system barriers influencing progress toward SDG 3 mental health targets in Zimbabwe. Guided by the Health Policy and Systems Analysis (HPSA) framework and reported in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines, 12 peer-reviewed studies published between 2014 and 2025 were reviewed. Data were charted and analysed across key HPSA themes, including governance, financing, workforce, service delivery, and health information systems. The review identified several persistent system-level challenges. Although mental health policy frameworks exist, their implementation is limited by weak accountability mechanisms, insufficient decentralisation, and fragmented leadership. Chronic underfunding, combined with reliance on donor support, undermines the sustainability of services. Shortages and uneven distribution

1 University of Zimbabwe, Faculty of Social and Behavioural Sciences, Harare, Zimbabwe
2 University of Richmond, School of Arts and Sciences, Department of Health, Virginia, United States
3 University of KwaZulu-Natal, School of Medicine, Durban, South Africa
* Corresponding author: Dominic NYONI, dominicnyoni60@gmail.com

of skilled mental health professionals restrict access to care, particularly in rural areas. Task-sharing initiatives have improved access but remain inadequately supported and are not fully integrated into the health system. In addition, weak mental health information systems limit the use of data for planning and monitoring. Broader challenges, including stigma, urban–rural inequalities, and poor intersectoral coordination, further constrain progress. Progress toward SDG 3 mental health targets in Zimbabwe requires stronger governance and accountability, increased domestic financing, investment in community-based mental health workforces, and better integration of mental health indicators into routine health information systems. Zimbabwe's experience offers useful lessons for other resource-constrained settings.
Keywords: Mental Health System, Sustainable Development Goal 3, Zimbabwe

INTRODUCTION

Although Sustainable Development Goal 3 (SDG 3) aims to ensure healthy lives and promote well-being for all, the continued neglect of mental health remains a major obstacle to achieving this ambition (United Nations, 2025). Despite global commitments, mental disorders continue to rise. Between 1990 and 2021, the age-standardised incidence of mental disorders increased by 15.23%, while disability-adjusted life years rose by 17.28% (Fan et al., 2025). Beyond their impact on morbidity and mortality, poor mental health also imposes a substantial economic burden; productivity losses associated with depression and anxiety alone are estimated at nearly US$1 trillion annually (World Health Organization, 2025). Despite this burden, more than half of individuals in low and middle-income countries (LMICs) receive no mental health treatment, with treatment gaps reaching up to 90% in the poorest settings (Freeman, 2022).

Zimbabwe is not spared from the global mental health crisis. Though, the country is facing a growing burden of numerous cases of mental disorders, which are already high, mental health remains one of the least prioritised areas within its public health agenda. According to the World Health Organization (WHO) Special Initiative for Mental Health Situation Analysis conducted in 2020, Zimbabwe faces a substantial burden of mental disorders, coupled with limited access to treatment across all conditions and population groups (World Health Organization [WHO] & University of Washington, 2020). Estimated prevalence rates include schizophrenia (0.1%), bipolar disorder (0.5%), major depressive disorder (approximately 1.4% overall, rising to 5.5% among older

adults), epilepsy (0.3%), and alcohol use disorder (1.3%) (WHO & University of Washington, 2020). These figures highlight a significant mental health load further compounded by economic instability, prolonged humanitarian crises, and weak public health systems.

The Government of Zimbabwe has acknowledged these challenges in its National Health Strategy 2021–2025, which outlines key policy priorities aimed at strengthening service delivery and improving access to care (Zimbabwe Ministry of Health and Child Care, 2021). However, it remains unclear whether these policy frameworks have translated into meaningful improvements in service availability, financing, or accountability. This implementation gap is common across many LMICs, where mental health policies often exist but are constrained by limited resources, weak infrastructure, and workforce shortages. These persistent gaps between policy intent and system performance raise concerns about Zimbabwe's ability to meet its mental health targets. Understanding how structural and contextual factors interact is therefore critical to informing reforms that can support a more equitable, responsive, and sustainable mental health system.

Several studies have examined aspects of mental health in Zimbabwe, focusing on areas such as community-based programmes, workforce training, and service accessibility. However, there is limited synthesis of this evidence to provide a system-level understanding of the mental health landscape. In particular, existing research has not sufficiently explored how policy frameworks and health system structures interact to influence mental health outcomes.

This study aims to conduct a scoping review to synthesise and map existing evidence on the policy and health system barriers hindering Zimbabwe's progress towards achieving its mental health goals. Scoping reviews are well suited to under-researched areas as they enable a systematic mapping of available evidence, identification of knowledge gaps, and clarification of key conceptual relationships. The analysis was guided by the Health Policy and Systems Analysis (HPSA) framework (Gilson, 2012), which highlights the interrelated roles of governance, financing, health workforce, service delivery, and health information systems. This framework provides a structured approach to examining how systemic constraints shape progress toward equitable, effective, and sustainable mental health care.

METHODOLOGY

Study Design

This scoping review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines (Tricco et al., 2018). The review aimed to systematically map and synthesise evidence on health system and policy barriers hindering Zimbabwe's progress toward achieving its mental health goals. The analysis was guided by the HPSA framework, which provided a structured approach to examining key health system domains.

Objectives of the Review

The review aims to identify and map the available evidence on health-system and policy barriers affecting the achievement of SDG 3 mental-health targets in Zimbabwe. It further seeks to categorise these barriers across the five domains of the Health Policy and Systems Analysis framework, namely governance, financing, health workforce, service delivery, and health information systems. In addition, the review aims to identify evidence gaps and highlight opportunities for system strengthening and policy reform.

Conceptual Framework

The HPSA framework informed the conceptual approach of this review (Gilson, 2012). The framework emphasises the interconnected roles of governance, policy, financing, health workforce, service delivery, and health information systems in shaping health system performance. It was selected for its ability to capture the complex and interrelated factors influencing mental health outcomes in resource-constrained settings such as Zimbabwe. In addition, the HPSA framework incorporates critical dimensions such as policy processes, power dynamics, and institutional contexts. The five domains of the HPSA framework were used to guide data analysis and to directly correspond to the analytical objectives of the review (Table 1).

Table 1: The conceptual framework

HPSA Domain	Analytical Focus	Link to SDG 3 Mental Health Targets
Governance and Leadership	Examines policies, legislation, coordination, and accountability mechanisms	Identifies institutional barriers to effective mental health governance
Health Workforce	Reviews training, staffing, and integration of mental health professionals	Identifies human resource constraints limiting service coverage
Health Information Systems (HIS)	Assesses data availability and utilization for mental health planning	Highlights evidence gaps and weak monitoring systems
Service Delivery	Evaluates accessibility, quality, and continuity of care	Maps operational and structural service barriers
Financing	Analyses funding levels, mechanisms, and sustainability	Identifies fiscal inequities constraining mental health services

Studies and documents were deemed eligible for inclusion if they met the following criteria:

- Focused on Zimbabwe's mental health system or the broader health system with explicit reference to mental health.,
- Addressed at least one of the five HPSA framework (governance, workforce, financing, service delivery, or health information systems),
- Included peer-reviewed articles, as well as government and NGO reports, policy briefs, and strategic documents,
- Published in English language or had an available English language translation,
- No restriction was placed on publication year.

Studies and documents were excluded if they met any of the following criteria:

- Studies focusing solely on clinical interventions or prevalence without system-level analysis,
- Commentaries or opinion pieces lacking empirical or policy relevance,
- Non-English language publications without an available translation.

Search Strategy

Two independent reviewers conducted a literature search using PubMed and Google Scholar between January and March 2025. These sources were selected to capture both peer-reviewed studies and relevant grey literature on mental health systems in Zimbabwe. PubMed was included as a core biomedical database to ensure coverage of peer-reviewed health and clinical research. Google Scholar was used to complement this by providing broader

interdisciplinary coverage and facilitating the identification of additional studies, including those from regional journals and grey literature that may not be indexed in traditional subscription-based databases.

The search combined controlled vocabulary Medical Subject Headings (MeSH terms) and free-text words. Terms were organized around three main concepts: (1) mental health and mental disorders (e.g., "mental health", "depression", "psychological distress"); (2) health systems and policy (e.g., "governance", "health workforce", "financing", "service delivery", "health information systems"); and (3) geographic context ("Zimbabwe").

Boolean operators (AND, OR) have been used to combine and refine the search terms. The full search strategy for each database is provided in Table 2.

Table 2: Comprehensive search strategy for all the databases

Database	Search Terms / Strategy
PubMed	("mental health"[MeSH] OR "mental disorders"[MeSH] OR "depression" OR "psychological distress") AND ("health systems" OR "health policy" OR "governance" OR "financing" OR "service delivery" OR "health workforce" OR "information systems") AND ("Zimbabwe")
Google Scholar	"mental health" AND ("health system" OR "policy" OR "governance" OR "financing" OR "workforce" OR "service delivery") AND "Zimbabwe"

Grey Literature

Grey literature was identified through Google Scholar and targeted searches of institutional websites. These included the Zimbabwe Ministry of Health and Child Care, WHO, the United Nations Development Programme, the World Bank, and non-governmental organizations (NGOs) such as the Friendship Bench. Documents were included if they were published by recognised institutions and provided relevant information or evaluations of Zimbabwe's mental health system.

Selection Process

All identified records were imported into EndNote and Microsoft Excel for management and screening. Duplicate records were removed prior to screening. Study selection was conducted in two stages. First, titles and abstracts were screened to exclude clearly irrelevant sources. Second, full-text articles were assessed against the inclusion criteria. Screening was conducted independently by two reviewers, with disagreements resolved through discussion and consensus. The selection process was summarised in Figure 1.

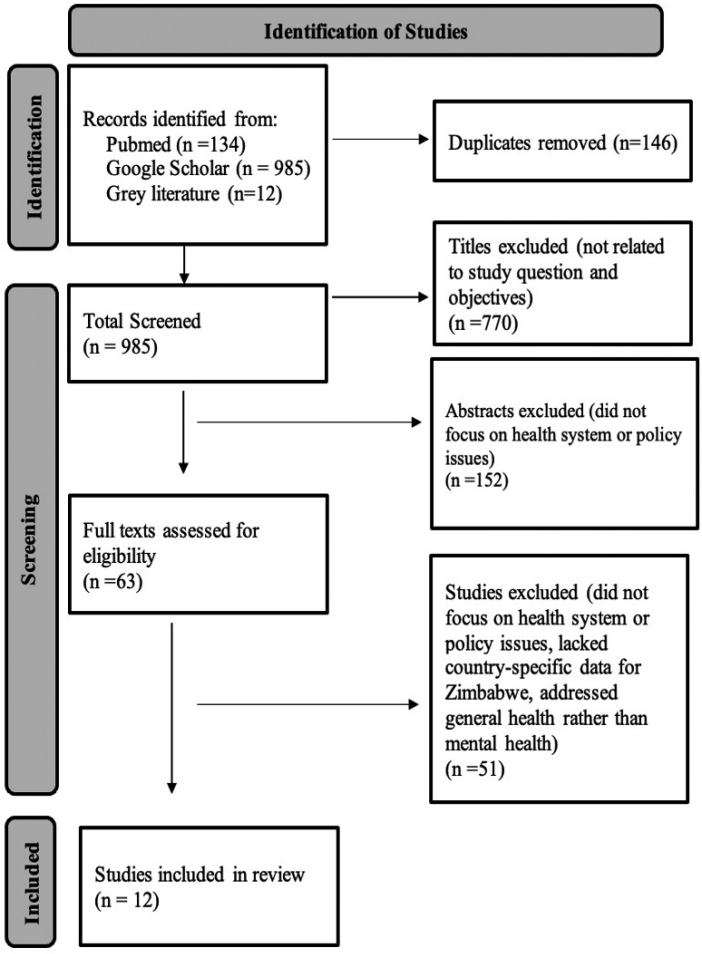

Figure 1. PRISMA flowchart diagram

Quality Assessment

Consistent with established methodological guidance for scoping reviews, a formal critical appraisal of included studies was not undertaken. As outlined by the Joanna Briggs Institute, the primary objective of scoping reviews was to systematically map the breadth, range, and nature of existing evidence, rather than to evaluate the methodological quality of individual studies (Khalil et al., 2025; Peters et al., 2015). In line with this approach, the present review prioritised a comprehensive identification and synthesis of evidence on health system and policy barriers, enabling a broad and inclusive understanding of the field. This approach is particularly appropriate given the heterogeneity of study designs and evidence types included in the review.

Data Charting

Data from the included sources were charted using a standardised Excel form developed by the authors. Extracted information included author, year of publication, source type, study focus, methodology, reported barriers or enabling factors, and the corresponding HPSA domain. The charting form was piloted on five studies to ensure consistency and allow for refinement. Two reviewers independently extracted the data and cross-checked the entries to ensure accuracy.

Synthesis

Data were synthesised using a thematic approach, guided by the HPSA framework. A deductive analytical approach was applied, whereby findings were organized into five pre-defined HPSA domains: governance, health workforce, health information systems, service delivery, and financing. Within each domain, data were coded and summarised to identify recurring patterns, cross-cutting challenges, and interactions between system components. For example, the analysis examined how financing constraints influenced workforce capacity and the functioning of health information systems. The synthesis drew on examples from individual studies to illustrate key themes. Overall, the analysis focused on understanding system interconnections and underlying structural factors, rather than providing a purely descriptive summary.

RESULTS

A total of 12 publications were included in the final synthesis. The studies were published between 2014 and 2025, with most (11 of 12; 91.7%) appearing after 2015, reflecting growing, though still limited research attention to mental health systems in Zimbabwe over the past decade. Most studies were conducted in urban or peri-urban settings such as Harare, Masvingo, Mutare, and Gweru, while a few included national-level analyses or multi-country comparisons involving Zimbabwe.

Across the studies, sample sizes and participant characteristics varied widely, ranging from small qualitative studies with 6–30 participants to larger quantitative or mixed-methods studies with several hundred respondents. The predominant study designs were qualitative (n=7), followed by mixed methods (n=2), quantitative (n=2), and documentary reviews (n=1).

Collectively, the included studies drew on perspectives from health professionals, policymakers, educators, and service users, providing a multi-level view of governance, workforce, financing, service delivery, and health information systems shaping mental health in Zimbabwe.

Governance and Leadership

The reviewed studies highlight governance challenges that extend beyond policy gaps to reflect deeper structural constraints within the health system. Although Zimbabwe has policy frameworks aligned with global mental health priorities, their implementation remains limited due to restricted decentralised decision-making and insufficient implementation capacity (Chihambakwe & Mlambo, 2024; Kidia et al., 2017). Even where policies and strategic documents exist, follow-through is often weak, with limited monitoring and accountability mechanisms (Abas et al., 2014; Kidia et al., 2017). This gap between policy and practice suggests that while strategic direction is present, it is undermined by operational challenges and weak coordination across sectors.

Centralisation further shapes these governance challenges by concentrating decision-making authority at higher levels of the system. As a result, frontline providers have limited autonomy, which can constrain responsiveness to local needs and reduce opportunities for adaptive learning. These governance dynamics are therefore not only administrative but also reflect broader system relationships including limited trust, slow responsiveness, and weak participatory planning. Together, these factors constrain progress toward SDG 3 by limiting system responsiveness, slowing innovation, and reinforcing inequalities in access and quality of care.

Financing

Across the reviewed studies, underinvestment in mental health reflects broader political and institutional prioritisation rather than simply a budgetary shortfall. Mental health consistently received a disproportionately small share of national health funding, highlighting its low priority relative to other health areas (Abas et al., 2014; Chibanda et al., 2016b; Mayavo, 2024). This chronic underfunding created structural constraints, including recurrent medication stockouts, deteriorating infrastructure, and limited capacity to recruit, train, and retain skilled personnel. These challenges, in turn, affected both the quality and the continuity of care.

Limited domestic investment was not fully offset by donor-supported programmes. While NGOs and community-based initiatives expanded access to psychosocial support in some settings, these efforts were often fragmented and time-limited. This highlights the risks of relying on externally funded programmes, which may not be sustained beyond the duration of specific projects. As a result, service delivery may fluctuate, with periods of expansion followed by gaps when funding ends.

These financing patterns therefore extend beyond resource constraints. They also signal the marginal position of mental health within a broader health system. Low investment contributes to weak system performance, which can in turn reinforce continued deprioritization. Without more predictable and sustained domestic financing, Zimbabwe remains vulnerable to funding instability, limiting the system's ability to deliver consistent and equitable mental health care and to progress toward SDG 3 targets.

Health Information Systems

Gaps in mental health information systems extended beyond technical data limitations to reflect broader weaknesses in institutional learning and accountability. Across the reviewed studies, inconsistencies in recording mental health consultations and poor integration into national reporting systems resulted in fragmented and unreliable data (Abas et al., 2014; Chihambakwe & Mlambo, 2024; Khombo et al., 2023; Zirima, 2022). These challenges were further compounded by limited disaggregation of data by age, geography or diagnosis which hampers the ability of planners to identify priority groups, tailor interventions, and monitor equity.

Data-related challenges also reflected the limited prioritisation of mental health within national health information systems. Inadequate training in mental health data management, together with the absence of standardised indicators, limited the ability of health workers to effectively record, interpret, and use data. This in return, contributed to a cycle in which limited data availability reduced visibility and weakened attention to mental health in planning and resource allocation.

As a result, mental health remained underrepresented in routine health planning and performance monitoring processes, constraining evidence-based decision-making and policy implementation. Without reliable data on service needs, utilisation, and outcomes, decision-makers lacked the information required to guide resource allocation and system improvements. These information system gaps therefore both reflect and reinforce broader system weaknesses, limiting targeted investment and slowing progress toward SDG 3 Mental Health Targets.

Health Workforce

Persistent workforce shortages and uneven distribution of skills emerged as key structural barriers across the reviewed studies. Mental health specialists, including psychiatrists and psychologists, were largely concentrated in urban

tertiary facilities, creating significant service gaps at primary and district levels, where care is often delivered by general nurses with limited mental health training (Abas et al., 2014; Chihambakwe & Mlambo, 2024; Mayavo, 2024). This imbalance reflects longstanding challenges in training capacity, weak incentives for rural deployment, and limited integration of mental health into pre-service and in-service training.

Task-sharing initiatives, including the use of lay counsellors and non-specialist health workers, have shown potential to expand access to basic psychosocial care (Chibanda et al., 2016b; Kemp et al., 2022). However, their sustainability has been constrained by limited supervision, irregular refresher training, and the lack of formal pathways for accreditation and career progression. As a result, many of these programmes remain small-scale or donor-supported, limiting their continuity and scalability.

Overall, these workforce challenges point to a system that struggles to develop, deploy, and retain mental health personnel in line with the service needs. This contributes to persistent inequities in access, particularly for rural and underserved populations, and limits the system's capacity to respond to increasing demand. In return, these constraints slow down the progress toward the mental health targets of SDG 3.

Service Delivery

Service delivery gaps were consistently characterised by limited geographic coverage, fragmented care pathways, and variable quality across facilities. Evidence showed that mental health services remain concentrated in urban tertiary centres, resulting in reduced access for rural and peri-urban populations who face barriers to counselling, diagnostic services, and essential psychotropic medicines (Chibanda et al., 2016a; Chihambakwe & Mlambo, 2024; Mayavo, 2024). This reflects the historical centralisation of specialist services and the limited integration of mental health into primary care.

Community-based and task-shared interventions demonstrated strong acceptability and the potential to extend psychosocial support into underserved settings. However, their sustainability was constrained by reliance on donor funding, limited integration into national systems, and weak supervisory structures. As a result, many promising initiatives struggled to move beyond pilot phases into routine scalable service models.

Service gaps were particularly pronounced for young people, with shortages of youth-friendly services and limited access to appropriate mental health information among adolescents (Doyle et al., 2023; Khombo et al., 2023).

Overall, the uneven distribution of services and disruptions in continuity of care contribute to inequitable access and limit the delivery of comprehensive, integrated mental health services. These challenges reduce the health system's ability to respond to increasing demand and slow progress toward the mental health targets of SDG 3.

Table 3: Summary of the eligible studies

Author & Year	Study Type	Study Setting	Study Participants	Key Findings
(Abas et al., 2014)	Qualitative (In-depth Interviews)	Broader Zimbabwe	6 Doctors	**Health Workforce** • Lack of learning resources • Small number of mental health trainers • Lack of specialist training opportunities • No training in ethics or professionalism • No training in management and public health advocacy • Poor integration with other medical specialties • Stigma of psychiatry among health professionals • Low salaries • Lack of training in research for psychiatry students **Health Financing** • Lack of resources for patient care **Health Information System** • Lack of exposure to up-to-date evidence/ research
(Chibanda et al., 2016a)	Qualitative Participatory Study (Focus Group Discussions)	Harare, Zimbabwe	149 Multiple Stakeholders That Included Policy Makers From the Ministry of Health, University Lecturers, Research Officers, Psychiatrists, Psychologists	**Service Delivery** • Nurses lack the time to provide structured counselling at City Health clinics
(Chibanda et al., 2016b)	Mixed-Methods Study (Focus Group Discussions, Workshops, Skills Assessment, In-Depth Interviews)	Broader Zimbabwe	48 Nurses, 12 District Health Promoters, 300 Lay Health Workers, 6 Key Stakeholders	**Health Workforce** • Lack of training **Service Delivery** • Shortage of psychiatric drugs • Nurses lack the time for counselling • Poor and unreliable referral system for people suffering from depression

(Chihambakwe & Mlambo, 2024)	Mixed-Methods Study (Qualitative Descriptive Durvey, In-Loco Observation, Interviews, FGDs, Document Analysis)	Broader Zimbabwe	5 Mental Health Nurses, 2 Social Workers, 4 General Hands, 1 Psychiatrist	**Governance and Leadership** • Institutional practices guided by medical models with limited recognition of counselling as a core component • The Mental Health Act (1996) does not clearly provide for the inclusion of professional counsellors within the health team **Health Workforce** • Shortage of qualified counselling professionals within mental-health teams • Multidisciplinary collaboration limited to nurses, social workers, and psychiatrists, absence of professional counsellors • Some staff members unaware of the importance of counselling for patient recovery and relapse prevention **Service Delivery** • Lack of psychosocial follow-up
(Doyle et al., 2023)	Quantitative Study (Population-Based Cross Sectional Study)	Five Urban and Peri-Urban Communities in Harare and Mashonaland East	634 Young People Aged 13–24 Living in Households in the Study Areas	**Service Delivery** • Lack of youth friendly mental health services
(Kemp et al., 2022)	Qualitative (Case Study)	Bangladesh, Jordan, Paraguay, the Phillipines, Ukraine and Zimbabwe	Multiple Stakeholders	**Service Delivery** • No psychiatric care for inmates • Lack of specialized facilities for child/ adolescence **Health Workforce** • Severe shortage of mental health professionals [18 psychiatrists, 917 psychiatric nurses (6.5 per 100,000) and 6 psychologists (0.04 per 100,000)] • Maldistribution of mental-health professionals in (17 of psychiatrists in Harare)
(Khombo et al., 2023)	Qualitative Study (Semi-structured interview)	3 Different Secondary Schools, Gweru	15 Students	**Health Information System** • Adolescents lack correct mental health information
(Kidia et al., 2017)	Qualitative Needs Assessment (Interviews)	Broader Zimbabwe	30 Participants Including Policy Makers, Administrators, Providers, and Researchers	**Governance and Leadership** • Lack of implementation of mental health policy • Little consultation with key stakeholders in policy formulation • Outdated mental health policy and law

(Masara & Zirima, 2024)	Quantitative Study (Survey)	Great Zimbabwe University, Masvingo	400 Undergraduate Students	**Health Information System** • Only 50.51% of participants were mental health literate
(Mayavo, 2024)	Documentary (Review)	Broader Zimbabwe	Discussed Documents and Reports Relating to Sustainable Development Goal 3 Implementation	**Health Workforce** • Severe shortage of trained mental health personnel, including trainers and specialist • Few opportunities for professional development, ethics or management training, and almost no exposure to research • Poor integration of psychiatry with other health disciplines, low remuneration, and stigma toward mental health professionals further weaken the workforce • The lack of training in research and limited specialist pathways exacerbate skill gaps and retention challenges within the mental health system **Health Information System** • Limited access to current research and up-to-date learning materials undermines evidence-based practice **Health Financing** • Inadequate resources for patient care indicate chronic underfunding in the mental health sector **Service Delivery** • Nurses at City Health clinics lack sufficient time to offer structured counselling, reflecting systemic understaffing and heavy workloads
(Sibanda et al., 2022)	Qualitative Study (Semi-Structured Interviews)	Odzi High School, Mutare	12 Teachers	**Health Information System** • Participants lack training and development on dealing with mental health among students
(Zirima, 2022)	Qualitative Study (In-depth Interviews)	Broader Zimbabwe	11 Practitioners, 5 Psychologists, 4 Counsellors, 2 Clinical Social Workers	**Health Workforce** • Inadequate mental health specialists • Lack of professionalism among mental health staff **Service Delivery** • Lack of psychiatric drugs in hospital • Little coordination between professionals in the mental health sector **Health Financing** • Lack of government funding for non-pharmacological mental health practitioners

Cross-Cutting Themes

Several cross-cutting system weaknesses have been identified across all domains, highlighting structural challenges that undermine sustained mental health system strengthening. The stigma has emerged not only as a social attitude but also as a barrier within the health system, shapes managerial priorities, influences provider's behaviour, and reduces demand for services. Its presence in both communities and the health sector has limited the service uptake and reduced the political prioritisation of mental health.

Rural inequities were also evident, with persistent disparities in financing, workforce distribution, and service availability disproportionately affecting non-urban populations. These inequities reflect longstanding centralisation of resources and point to the need for more equity-focused planning approaches to reach underserved communities.

Financing patterns further contributes to the system fragility. Reliance on fragmented, donor-driven funding leads to inconsistence for programme continuity and limited domestic ownership, constraining the scale-up of effective interventions and weakening long-term sustainability.

Together, these intersecting barriers show how stigma, geographic inequities, and financial dependency reinforce one another. Rather than acting in isolation, they shape broader system conditions that limit the effectiveness of reforms, slow integration, and constrain progress toward achieving the mental health targets of SDG 3.

DISCUSSION

This review highlights how interrelated weaknesses across governance, financing, health information systems, workforce, and service delivery continue to constrain the mental health system in Zimbabwe. These challenges operate as a connected system, where limitations in one domain reinforce weaknesses in others. For example, underinvestment restricts the workforce capacity and service availability, while weak governance and information systems limit effective implementation and planning. Together, these constraints contribute to persistent inequities in access to care, particularly for rural populations and young people, and slow down the progress toward achieving the mental health targets of SDG 3.

Governance and Leadership

Consistent with the findings of this review, weak governance structures particularly limit the decentralised decision-making, poor implementation of policy frameworks, and inadequate monitoring and accountability emerged as

key barriers to strengthening mental health care in Zimbabwe. Similar patterns have been reported in other LMICs. A multi-country study across Africa and Asia has found that weak governance, characterised by poor coordination, limited district-level management capacity, and insufficient accountability and transparency, have significantly constrained the delivery and scale-up of mental health services (Petersen et al., 2017). These similarities suggest that strengthening decentralised governance and improving accountability mechanisms may be critical for translating mental health policies into effective practice in Zimbabwe.

Financing

Underfunding emerged as a major constraint to the process of strengthening mental health system in Zimbabwe. Limited financial allocation restricts the implementation of policies, the expansion of services, and the availability of essential resources, ultimately affecting the quality and continuity of care. This pattern reflects broader trends that have been observed across Africa, according to the WHO reports, that governments in the region allocate on average less than US$0.50 per capita to mental health which is well below the recommended US$2 per capita for low-income countries (World Health Organization [WHO], 2022). Other studies similarly highlight the persistent low prioritisation and underfunding of mental health services across African settings (Kauye et al., 2014; Mostert et al., 2024). Together, these findings indicate that insufficient and inconsistent financing not only limits service delivery but also undermines the effective implementation of mental health policies, reinforcing gaps in access and quality of care.

Health Information Systems

Challenges in mental health information systems including inconsistencies in data recording and insufficient integration into national reporting platforms were identified as key barriers to effective policy implementation in Zimbabwe. Weak data systems limit the ability to monitor service coverage, track outcomes, and support evidence-based planning. Similar challenges have been reported in other LMICs. A multi-country study across Africa and Asia found that limited infrastructure, a shortage of health management information system specialists, and inadequate technical support constrained the collection and use of mental health data (Upadhaya et al., 2016). In addition, a commentary in the Lancet Psychiatry notes that mental health information systems in many LMICs remain either unavailable or too underdeveloped to effectively monitor

key indicators such as service coverage (Ryan et al., 2015). Collectively, these findings suggest that weak information systems not only hinder the monitoring of mental health policies but also limit informed decision-making and resource allocation. Strengthening data systems, including improving data quality, integration, and use will therefore be essential for supporting effective mental health system planning and accountability.

Health Workforce

Workforce shortages identified in this review reflect a broader challenge observed across many LMICs. For example, South Africa has also been reported experiencing significant shortages of mental health care providers, limiting service availability and access (Wolvaardt et al., 2024). Similarly, a study using WHO Assessment Instrument for Mental Health Systems data in 58 LMICs found that all the LMICs and 59% of these had far fewer mental health professionals than required to deliver a core set of interventions (Bruckner et al., 2011). In addition, consistent with the findings of this review, the limited number of available specialists in these settings are often concentrated in urban areas, further widening disparities in access between urban and rural populations (Wolvaardt et al., 2024). Overall, these findings suggest that addressing workforce shortages and improving the distribution of mental health personnel particularly through training, task-sharing, and incentives for rural deployment will be critical to improving access and advancing progress toward mental health targets.

Service Delivery

Service delivery gaps identified in this review were characterised by unequal access, with services largely concentrated in urban areas and limited availability in rural and informal settlements. These disparities disproportionately affect vulnerable groups, particularly young people, and constrain the effective implementation of mental health policies. Similar challenges have been reported in other settings. For example, in South Africa, psychiatric services are primarily available at regional and tertiary levels, with fewer resources at primary and community levels and limited attention to specialised areas such as child and adolescent mental health (Sorsdahl et al., 2023). More broadly, a review of LMICs found that mental health resources are unevenly distributed, with most specialists based in urban centres, making access difficult for rural populations due to distance and transport barriers (Rathod et al., 2017). These findings suggest that improving mental health service delivery will require

greater integration of services into primary care, expansion of community-based models, and targeted efforts to address geographic and population-level inequities in access.

Global and Regional Context

The challenges identified in Zimbabwe reflect broader patterns observed across LMICs, where persistent gaps in governance, financing, workforce capacity, poor service delivery, and information systems continue to limit the scale-up of mental health services (Semrau et al., 2019; World Health Organization, 2019). These findings suggest that Zimbabwe's experience is part of a wider pattern of underinvestment and limited prioritisation of mental health within health systems.

Across sub-Saharan Africa, similar constraints are evident. For example, in Ghana, the implementation of mental health policy has been slowed by funding and workforce limitations, although the establishment of a Mental Health Authority demonstrates the potential of stronger governance structures (Walker & Osei, 2017). In Kenya and Malawi, efforts to integrate mental health into community-based and primary care platforms including task-sharing approaches have shown potential to improve access despite resource constraints (Kauye et al., 2014; Kiima & Jenkins, 2010). Taken together, these experiences highlight that while system-level constraints are widespread, targeted reforms particularly in decentralised governance, sustainable financing, and community-based service delivery can strengthen mental health systems. Applying these lessons within the Zimbabwean context will be critical to improving access and advancing progress toward the mental health targets of Sustainable Development Goal 3.

Study Limitations

This review is not without limitations. First, the number of included studies was relatively small (n=12), and most were qualitative in nature and conducted in urban areas. This reflects the limited availability of research specifically focused on mental health systems and policy in Zimbabwe, where much of the existing literature has concentrated on clinical outcomes or prevalence rather than system-level analysis. Second, the review has included a limited number of databases. However, the use of Google Scholar alongside PubMed has allowed for broader coverage, as Google Scholar indexes a wide range of academic sources including studies from multiple databases as well as grey literature. This approach increased the likelihood of capturing relevant studies,

although it is still possible that some publications may not be identified. Finally, as this is a scoping review, no formal quality appraisal of included studies has been conducted. While this approach is consistent with scoping review methodology, it limits the ability to assess the methodological rigour of the included evidence.

Implications of the Study

Despite the study limitations, this review provides important insights into the structure and functioning of Zimbabwe's mental health system. It highlights key system-level challenges across governance, financing, workforce, service delivery, and information systems, offering a foundation for future research and policy development. Given the limited evidence base, there is a clear need for more comprehensive and methodologically diverse studies on mental health systems and policy in Zimbabwe. Future research should move beyond descriptive and prevalence-focused studies to include evaluations of system performance, implementation processes, and the effectiveness of policy interventions. These findings also underscore the importance of adopting a systems approach to mental health reform. Strengthening coordination across health system domains, investing in sustainable financing, and expanding community-based models of care will be critical to improving access and advancing progress toward mental health targets.

CONCLUSION

The challenges that Zimbabwe's mental health system faces are both locally specific and consistent with patterns observed across many LMICs. While shaped by economic constraints, they are rooted in structural weaknesses including underfunding, workforce shortages, and gaps in governance and implementation. Addressing these challenges will require coordinated, system-level reforms supported by sustained political commitment to prioritising mental health within national health agendas. Strengthening governance, increasing domestic financing, expanding the mental health workforce, and improving data systems will be critical to improving access and quality of care. Integrating mental health into primary care and broader universal health coverage frameworks will be essential to achieving more equitable and sustainable service delivery. These efforts will be key to advancing progress toward the mental health targets of SDG 3 in Zimbabwe.

Based on the key findings of this review, the following recommendations are proposed to strengthen Zimbabwe's mental health system:

Strengthen Mental Health Governance and Accountability: Weak implementation, limited decentralisation, and poor coordination that have been identified in this review highlight the need for stronger governance structures. Establishing a dedicated mental health directorate within the Ministry of Health and Child Care could improve coordination, accountability, and oversight of policy implementation. Strengthening the decentralised decision-making may also enhance responsiveness to local needs.

Increase and Stabilise Domestic Financing: Chronic underfunding and reliance on donor-supported programmes have been the key constraints identified in this review. Increasing domestic investment in mental health, including earmarked funding within primary health care budgets will be critical to improving sustainability and reducing fragmentation. More predictable financing mechanisms can support continuity of services and long-term system strengthening.

Expand and Support the Mental Health Workforce: Workforce shortages and uneven distribution of skilled personnel, particularly in rural areas were major obstacles to accessing services. Expanding task-sharing approaches and strengthening training for non-specialist health workers may improve coverage. These efforts should be supported by regular supervision, clear career pathways, and incentives for rural deployment.

Strengthen Mental Health Information Systems: Weak data systems and poor integration into national reporting platforms have limited the evidence-based planning and accountability. Integrating mental health indicators into routine health information systems, such as District Health Information Software and improving data quality and use will be essential for monitoring progress and guiding resource allocation.

Improve Equitable and Integrated Service Delivery: Service delivery gaps, particularly in rural areas and among young people highlight the need to expand community-based and primary care mental health services. Strengthening the integration into primary health care and scaling up community-based interventions can improve access and continuity of care.

Ethical Approval: Not applicable. This study is a review of published literature and does not involve human participants or primary data collection.

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Digital Health as an Organizational Change Catalyst: A Conceptual Review From a Healthcare Management Perspective

Ufuk Burak KARCIOĞLU[1*]

ABSTRACT

Digital health technologies encompassing telemedicine, artificial intelligence (AI), electronic health records (EHRs), wearable sensors, and blockchain-enabled platforms are no longer peripheral tools but increasingly central catalysts for profound organizational transformation within healthcare systems. This conceptual review synthesizes evidence from high-impact sources (published between 2018–2026) to examine how digital health reshapes structures, processes, cultures, and governance in healthcare organizations. Drawing on Socio-technical Systems (STS) theory and diffusion of innovations (DOI) frameworks, digital health can be conceptualized as a disruptive force that simultaneously challenges legacy hierarchies and enables new forms of value creation, patient-centeredness, and system resilience. Key insights from the reviewed literature indicate that mature digital health implementations are associated with reported efficiency gains ranging from 15% to 30% and reductions in avoidable hospitalizations between 10% and 25%, depending on implementation context, health system capacity, and level of integration. However, uneven adoption exacerbates digital divides: Low- and middle-income countries face infrastructural and workforce barriers that limit benefits to 20–40% of potential. This study identifies critical enablers leadership commitment, interprofessional training, ethical governance and barriers, including resistance to change, interoperability deficits, and privacy risks. This review calls for healthcare managers and policymakers to adopt a

1 İstinye University, Faculty of Health Sciences, Istanbul, Türkiye
* Corresponding author: Ufuk Burak KARCIOĞLU, burakkarci23@gmail.com

deliberate change-management lens, treating digital health not as a technology project but as a strategic organizational redesign imperative. Future trajectories point towards AI-human symbiosis, federated learning ecosystems, and value-based digital financing models that could redefine health system performance by 2035. By bridging theory and practice, this synthesis offers a roadmap for equitable, sustainable digital transformation in global healthcare.
Keywords: Digital Health, Healthcare Management, Organizational Change

INTRODUCTION

The convergence of digital technologies and healthcare delivery has reached an inflection point where incremental adoption has given way to systemic disruption. Digital health is broadly defined as the use of information and communication technologies to support health and health-related fields (World Health Organization [WHO], 2021), now permeates every layer of healthcare organizations, from frontline clinical decision-making to strategic governance and population health management. What began as isolated electronic health records (EHRs) implementations in the early 2000s has evolved into an interconnected ecosystem encompassing telemedicine platforms, artificial intelligence (AI) driven diagnostics, real-time wearable monitoring, blockchain-secured data exchange, and predictive population analytics (Topol, 2019; Wachter, 2017).

This transformation is not merely technological; it constitutes a profound organizational change process. Healthcare organizations, characterized by complex professional hierarchies, regulatory constraints, high-stakes decision environments, and pluralistic stakeholder interests, are among the most resistant to change in modern economies (Bate et al., 2007). Yet, digital health compels structural reconfiguration (e.g., virtual care pathways replacing physical visits), cultural reorientation (e.g., shifting from physician-centric to data-informed collaborative models), and governance innovation (e.g., new accountability mechanisms through real-time performance dashboards) (Greenhalgh et al., 2020).

The urgency of this shift is underscored by converging pressures. Global healthcare expenditure continues to outpace GDP growth, reaching 10.3% of GDP in OECD countries in 2023, and is projected to rise further driven by ageing demographics and chronic disease burdens (Organisation for Economic Co-operation and Development [OECD], 2025). The COVID-19 pandemic acted as an exogenous shock that dramatically accelerated telemedicine utilization, with some health systems reporting up to a 38-fold rise in usage, although the magnitude varied significantly across countries and organizational contexts

(Frankish & Ramsey, 2014; WHO, 2024). Concurrently, the proliferation of consumer-facing health technologies, including wearables, that generate 2.5 quintillion bytes of health data daily, has democratized information flows while creating new challenges in data governance, interoperability, and digital literacy (World Economic Forum [WEF], 2023).

From a healthcare management perspective, digital health must be understood not simply as a set of tools, but as a socio-technical catalyst capable of either reinforcing silos or enabling radically patient-centered, integrated, and resilient systems. Socio-technical systems (STS) theory posits that the success of technological adaptation depends on the alignment of technical capabilities with social structures, organizational processes, and human values (Bostrom & Yudkowsky, 2014). When misaligned, digital interventions produce unintended consequences: Clinician burnout from poorly designed EHRs (with 30–50% of physicians reporting high burnout linked to digital burden; Shanafelt et al., 2022), widened inequities among digitally excluded populations (up to 25% in rural and low-income groups; OECD, 2025), or data breaches that erode public trust (IBM, 2024).

Conversely, aligned implementations yield transformative outcomes; Denmark's fully digitized MedCom infrastructure, for instance, has reduced duplicate testing by 40% and enabled seamless cross-sector data sharing (Organisation for Economic Co-operation and Development [OECD], 2023). Singapore's National Electronic Health Record (NEHR) supports predictive analytics that decreased hospital readmissions by 19% in high-risk cohorts (Ministry of Health Singapore, 2025). In low-resource settings, Rwanda's drone-delivered blood supply system, integrated with digital logistics platforms, has cut emergency response times by 80% (World Health Organization [WHO], 2023). These examples illustrate that digital health's organizational impact is context-dependent and mediated by leadership vision, change management capability, and institutional readiness.

This conceptual review addresses a critical gap in literature. While numerous studies examine specific digital health applications (e.g., AI in radiology, tele-ICU), fewer adopt holistic healthcare management lens to synthesize how these technologies collectively catalyze organizational change across structure, culture, strategy, and performance. This study draws on a purposive synthesis of peer-reviewed literature (PubMed, Scopus, and Web of Science; 2018–2026), seminal theoretical works, and authoritative grey literature from the WHO (World Health Organization), OECD (Organisation for Economic Co-operation and Development), and WEF (World Economic Forum) to construct a coherent framework.

The review is structured as follows: First, conceptual foundations and theoretical underpinnings; second, typology of digital health technologies and their organizational applications; third, dynamics of induced change; fourth, global evidence synthesis; fifth, barriers and enablers; sixth, implementation strategies; and finally, future directions and implications for healthcare leadership.

In an era when health systems face simultaneous demands for cost containment, quality improvement, equity, and resilience, digital health offers not just efficiency gains, but a once-in-a-generation opportunity to reimagine organizational purpose, transitioning from reactive illness management to proactive, personalized, and population-oriented health creation. Realizing this potential requires moving beyond technology determinism toward deliberate, value-driven organizational redesign, a challenge that defines the next decade of healthcare management scholarship and practice. This study aims to provide a structured narrative synthesis of digital health as an organizational transformation catalyst, with explicit implications for healthcare management practice.

METHODOLOGY

This study was designed as a narrative literature review, guided by structured methodological principles to enhance transparency, rigour, and reproducibility. In line with best practices for narrative syntheses, the review process was informed by the SANRA (Scale for the Assessment of Narrative Review Articles) framework and supported by elements of the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) approach to ensure the systematic identification and selection of relevant literature.

A comprehensive literature search was conducted across three major electronic databases: PubMed, Scopus, and Web of Science. The search covered publications published between January 2018 and January 2026, reflecting the most recent developments in digital health and organizational transformation. The search strategy combined keywords and Boolean operators, including “digital health”, “telemedicine”, “artificial intelligence”, “electronic health records”, “organizational change”, “healthcare management”, “digital transformation”, and “health systems”.

Inclusion criteria were defined as follows: (i) peer-reviewed journal articles and high-impact reports from international organizations (e.g., WHO, OECD, and WEF); (ii) studies addressing digital health technologies in relation to organizational, managerial, or system-level outcomes; (iii) publications in English, and (iv) studies providing empirical findings; conceptual frameworks, or policy-relevant insights.

Exclusion criteria included: (i) studies focusing solely on technical algorithm development without organizational implications; (ii) conference abstracts without full text; (iii) non-English publications; and (iv) studies published prior to 2018 unless considered seminal.

The study selection process followed a structured screening approach, where initially, titles and abstracts were reviewed to assess relevance. Subsequently, the full texts of potentially eligible studies were evaluated against the inclusion criteria. Priority was given to high-quality and widely cited sources to ensure the systematic identification and selection of relevant literature. Although this study is not a full systematic review, PRISMA principles were followed to enhance transparency and reproducibility.

Rather than performing a quantitative meta-analysis, this review employed a thematic synthesis approach. Identified studies were analyzed and categorized into key domains, including technological typologies, organizational change dynamics, performance outcomes, and implementation strategies. Quantitative findings reported in the literature were interpreted as indicative ranges across studies and contextualized accordingly, rather than being treated as pooled effect sizes.

The initial database search yielded approximately 512 records. After the removal of duplicates (n=124), 388 records remained for screening. Following title and abstract screening, 276 studies were excluded. Full-text assessment was conducted for 112 articles, of which 38 met the inclusion criteria and were included in the final synthesis. This approach enables a comprehensive and integrative understanding of digital health as a socio-technical catalyst for organizational change, while acknowledging the heterogeneity of study designs, settings, and measurement frameworks across literature. The study selection process is illustrated in a PRISMA flow diagram (Figure 1).

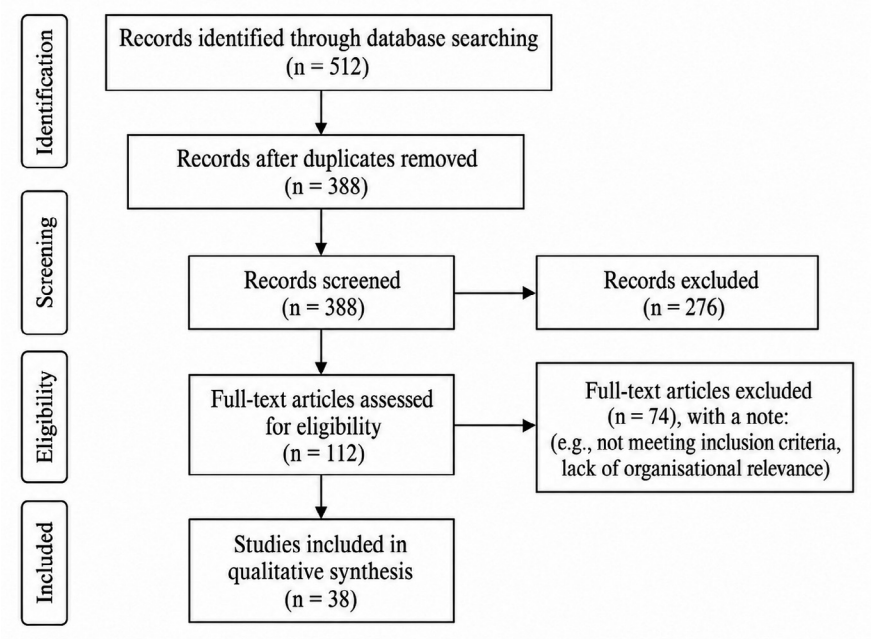

Figure 1. PRISMA flow diagram of study selection process

Conceptual Foundations of Digital Health in Healthcare Management

Digital health's conceptual underpinnings in healthcare management rest on the recognition that technology is never neutral: It is embedded in, and reshapes, the social fabric of organizations. Rather than viewing digital tools as mere adjuncts to existing workflows, contemporary scholarship positions them as active agents of socio-technical reconfiguration (Greenhalgh et al., 2017; Sittig & Singh, 2010). This section elucidates the evolution of digital health as a field and the primary theoretical lenses socio-technical systems theory and diffusion of innovations (DOI) theory that illuminate its role as an organizational change catalyst.

The evolution of digital health mirrors broader societal shifts from analogue to digital infrastructures. Early applications (1980s–2000s) focused on administrative digitization: electronic health records (EHRs) for billing and storage. These yielded marginal efficiency gains but often increasing clinician burden through poor usability. The 2010s marked a pivot toward clinical integration: Meaningful use incentives in the U.S. drove EHR adoption from 12% in 2008 to 96% in hospitals by 2021, yet interoperability remained fragmented (Office of the National Coordinator for Health Information

Technology, 2021). The COVID-19 pandemic accelerated a qualitative leap telemedicine consultation surged 38-fold in some systems, while AI-supported triage and qualitative leap: Telemedicine consultations surged 38-fold in some systems, while AI-supported triage and remote monitoring (RPM) became mainstream (Frankish & Ramsey, 2014; World Health Organization [WHO], 2024). By 2025, OECD countries reported average online digital health service availability at 82%, with AI applications in diagnostics and predictive analytics proliferating (OECD, 2025). This trajectory reflects not linear progress but punctuated equilibrium: Exogenous shocks (pandemic, policy mandates) catalyze rapid change, while entrenched socio-technical misalignments constrain sustainability.

Socio-technical systems theory provides the foundational lens for understanding these dynamics. Originating from Trist and Bamforth's (1951) coal-mining studies, STS posits that organizational performance emerges from the interdependent optimization of technical and social subsystems rather than subordinating one to the other (Poole & van de Ven, 2021). In healthcare, this manifests as the interplay between digital artefacts (EHR interfaces, AI algorithms, wearable sensors) and human elements (clinician workflows, patient trust, interprofessional collaboration).

Recent scholarship extends STS to digital health transformation. Greenhalgh et al.'s (2017) NASSS framework (Non-adoption, Abandonment, Scale-up, Spread, Sustainability) synthesizes STS principles into seven interacting domains: the condition/illness, technology, value proposition, adopters (staff, patients, carers), organization(s), wider system, and temporal adaptation. Applied to digital health, NASSS reveals why many initiatives falter: Complexity in one domain (e.g., high illness comorbidity) interacts with others (e.g., organizational readiness deficits) to produce non-linear outcomes. A 2025 synthesis of 50+ implementations confirmed that "complicated" (multi-domain) cases succeed only when adaptive governance enables ongoing mutual adjustment between technology and social structures. This resonates with the eight-dimension socio-technical model for health IT safety proposed by Sittig & Singh (2010), which emphasizes people, hardware/software, clinical content, workflow and communication, internal organizational policies, external rules and regulations, and system measurement and monitoring domains that are frequently overlooked in technology-centric deployments.

Complementing STS, diffusion of innovations theory (Rogers et al., 2009) explains adoption trajectories. DOI identifies five perceived attributes influencing uptake: relative advantage, compatibility, complexity, trialability, and

observability. In digital health, relative advantage (e.g., AI-enabled reductions in diagnostic time of 30–40%; Topol, 2019) drives early adoption among innovators, while compatibility with existing routines determines mainstream diffusion. A 2025 meta-analysis of telemedicine adoption applied DOI across 45 studies, finding that observability (visible outcome improvements) and low complexity predict 60–70% variance in clinician uptake, whereas high perceived complexity correlates with abandonment rates of 40% (Villanueva-Miranda et al., 2025). Critically, DOI's staged model (knowledge, persuasion, decision, implementation, confirmation) intersects with STS: Macro-level policy (e.g., reimbursement changes) accelerates persuasion, while micro-level socio-technical friction (e.g., workflow disruption) impedes confirmation and sustainability.

These theories converge on a key insight: Digital health succeeds as an organizational change catalyst when it is deliberately designed to co-evolve with social structures. World Health Organization's Global Strategy on Digital Health 2020–2025 frames this as ecosystem-level alignment, technical infrastructure must support governance, workforce capacity, and equity (World Health Organization [WHO], 2021). OECD's 2025 Health at a Glance underscores the stakes: Countries with mature digital governance (e.g., Estonia's X-Road interoperability) achieve 25% higher efficiency in chronic care management, while laggards face widening digital divides (OECD, 2025). WEF's 2023 report on post-pandemic digital transformation warns that without socio-technical alignment, investments risk "pilotitis", defined as isolated successes that fail to scale (WEF, 2023).

Looking ahead, these foundations point toward hybrid human-AI systems where digital tools augment rather than automate clinical judgement. Federated learning ecosystems, enabling collaborative AI training without data centralization, offer a pathway to privacy-preserving, equitable innovation (Rieke et al., 2020). Blockchain-integrated platforms could ensure trust and traceability in multi-stakeholder networks. Yet realization demands a paradigm shift in healthcare management: From technology procurement to socio-technical orchestration, where leaders cultivate adaptive cultures, invest in digital literacy, and institutionalize continuous evaluation.

In sum, socio-technical systems and diffusion theories provide complementary lenses (STS for depth of interaction, DOI for breadth of spread) that together explain digital health's catalytic potential. As health systems confront escalating complexity driven by multimorbidity, workforce shortages, climate-related disruptions, mastering this socio-technical interplay will determine whether digital health becomes a force for fragmentation or genuine transformation.

Digital Health Technologies: Typology and Applications

Digital health encompasses a heterogeneous array of technologies (WHO, 2021). Its organizational impact varies by maturity, integration level, and context of deployment. This section presents a typology grounded in functional purpose and organizational leverage, drawing on recent syntheses (OECD, 2025; Topol, 2019; WHO, 2024). This study classifies technologies into three primary categories: connectivity and remote care platforms, intelligence and analytics engines, and trust and data infrastructure layers. Each category is examined for its capacity to catalyze structural, cultural, and performance changes in healthcare organizations.

Telemedicine and Remote Monitoring

Connectivity platforms, such as telemedicine, virtual wards, remote patient monitoring (RPM), and asynchronous messaging, represent the most mature and widely diffused digital health domain. Telemedicine enables synchronous video or asynchronous consultations, while RPM integrates wearable sensors (e.g., continuous glucose monitors, smartwatches) with cloud-based dashboards for real-time physiological data.

Organizationally, these technologies disrupt traditional location-bound care delivery. Virtual care pathways shift workflows from episodic in-person visits to continuous, data-informed management, enabling interdisciplinary teams (nurses, pharmacists, specialists) to operate asynchronously (Greenhalgh et al., 2020). Empirical studies report reductions in outpatient visits ranging from 20% to 35% and decreases in emergency admissions of between 15% and 25%, although these outcomes are highly dependent on care model design, patient population, and integration with existing clinical workflows (Hollander & Carr, 2020; Kruse et al., 2017; OECD, 2025). Denmark's telehealth-integrated chronic care model, for instance, reduced hospital days by 22% while maintaining or improving patient satisfaction (OECD, 2023).

In low- and middle-income countries (LMICs), mobile-enabled telemedicine addresses workforce maldistribution: India's eSanjeevani platform served over 200 million consultations by 2025, reducing the travel burden for rural patients by 80% (WHO, 2024). However, organizational change is uneven: RPM success depends on nurse-led triage protocols and clinician buy-in; without them, alert overload and "digital fatigue" emerge (Shanafelt et al., 2022). Looking ahead, hybrid models combining RPM with AI triage could evolve into proactive "virtual hospitals at home", redefining acute care boundaries and alleviating bed pressure in ageing societies.

AI, Big Data Analytics, and Predictive Tools

Intelligence engines, including artificial intelligence (AI), machine learning (ML), natural language processing (NLP), and big data analytics, constitute the most transformative yet contentious category. From a management perspective, AI induces profound cultural and structural shifts. It challenges physician autonomy by introducing algorithmic "second opinions", necessitating new governance models: human-in-the-loop protocols, explainability mandates, and continuous model validation (Topol, 2019). Successful organizations redesign by roles creating "clinical data scientists" and hybrid AI-clinician teams, while investing in digital literacy (an estimated 40–60% of the workforce requires upskilling by 2030 (OECD, 2025).

Real-world evidence is accumulating Singapore's AI-powered national stroke registry improved thrombolysis rates by 25% through predictive alerting (Ministry of Health Singapore, 2025). In LMICs, low-cost NLP tools extract insights from unstructured notes in resource-constrained EHRs, enabling population health analytics where none existed (WHO, 2024). Yet risks abound: Algorithmic bias amplifies inequities (e.g., skin cancer AI underperforming on darker skin tones (Adamson & Smith, 2018), and "automation complacency" can degrade clinician skills over time. Future trajectories point to federated learning (training models across institutions without data sharing) to preserve privacy while scaling intelligence (Rieke et al., 2020).

Blockchain and Cybersecurity in Health Data Management

Trust infrastructure, including secure multi-party computation, zero-knowledge proofs, and advanced cybersecurity address the foundational challenge of data sovereignty in fragmented health systems. Blockchain enables immutable, auditable ledgers for consent management, supply-chain traceability (e.g., vaccine distribution), and secure data exchange across organizational boundaries (Agbo et al., 2019).

Organizationally, these technologies catalyze ecosystem-level change. Interoperability platforms like Estonia's X-Road or MedRec reduce duplication and enable seamless transitions across providers, cutting administrative costs by 15–25% (OECD, 2025). In pharmaceutical supply chains, blockchain-verified provenance reduces counterfeit drugs by up to 90% in pilot regions (Kuo et al., 2017; WHO, 2023). Cybersecurity layers, zero-trust architectures, and homomorphic encryption have become essential as ransomware attacks on health systems rose 300% between 2020 and 2024 (IBM, 2024).

The organizational transformation is governance-intensive: New roles emerge (chief data officers, privacy engineers), and decision rights shift toward shared stewardship models involving patients, providers, and payers. In LMICs, blockchain pilots (e.g., MediLedger for drug traceability) demonstrate feasibility despite low digital maturity, offering leapfrog opportunities (WEF, 2023). However, energy intensity and scalability constraints persist, prompting exploration of proof-of-stake variants.

Collectively, these technologies form a layered ecosystem: Connectivity provides access, intelligence adds insight, and trust ensures legitimacy. Their organizational impact is multiplicative: Isolated adoption yields limited gains, while integrated deployment can yield 20–40% system-wide efficiency improvements and enhanced resilience (OECD, 2025). Yet integration demands deliberate design: socio-technical alignment, ethical oversight, and adaptive governance. As health systems confront rising complexity, driven by factors such as multimorbidity, climate-induced disruptions, and workforce shortages, these technologies offer not incremental tools but architectural building blocks for next-generation organizations: distributed, intelligent, equitable, and antifragile. However, blockchain technologies are not without criticism. Concerns have been raised regarding scalability limitations, high energy consumption in certain consensus mechanisms, regulatory uncertainty, and the complexity of integrating blockchain infrastructures into legacy health information systems. Additionally, questions remain about cost-effectiveness and the practical necessity of blockchain in contexts where conventional secure databases may provide comparable functionality.

Organizational Change Dynamics Induced by Digital Health

Digital health does not merely augment existing processes; it triggers cascading organizational change across structural, cultural, and performance domains. This section dissects these dynamics through a socio-technical lens, drawing on empirical syntheses and theoretical models to illustrate how technologies reshape hierarchies, routines, norms, and outcomes. Change is rarely linear or uniformly positive: It produces both enabling reconfiguration and disruptive friction, with outcomes contingent on leadership, context, and adaptive capacity (Greenhalgh et al., 2017; Sittig & Singh, 2010).

Structural Shifts: Workflow Redesign and Interdisciplinary Teams

Digital health compels a fundamental redesign of organizational structures and workflows. Telemedicine and remote monitoring platforms dissolve physical location constraints, enabling virtual wards and asynchronous care coordination (Frankish & Ramsey, 2014). In mature systems, this manifests as flattened hierarchies: Nurses and allied health professionals assume expanded triage and monitoring roles, while specialists focus on high-complexity cases. Denmark's MedCom-integrated chronic care model restructured primary-secondary interfaces, reducing referral delays by 45% and enabling shared care plans across municipal and hospital boundaries (OECD, 2023).

AI-driven tools further accelerate structural evolution. Predictive analytics shift decision-making from reactive to proactive: Sepsis alerts prompt rapid-response teams, while bed-management algorithms optimize resource allocation, decreasing average length of stay by 10–18% in pilot hospitals (Villanueva-Miranda et al., 2025; WEF, 2023). Organizationally, this demands new entities (e.g., digital command centers and clinical informatics units) and role redefinition: "hybrid clinicians", who integrate algorithmic insights with human judgement, become essential (Topol, 2019). World Health Organization integrates algorithmic insights with human judgement become essential (Topol, 2019).

Yet structural change is double-edged. Poorly designed EHRs fragment workflows, increasing cognitive load and contributing to 30–50% clinician burnout rates linked to digital burden (Shanafelt et al., 2022). In LMICs, structural gains are constrained by infrastructure: Rwanda's drone-RPM integration succeeded because it was embedded in existing community health worker networks, yielding 80% faster emergency response without overhauling hierarchies (WHO, 2023). Looking ahead, future structures may converge toward "platform organizations": modular, API-driven ecosystems where care is orchestrated across distributed nodes, redefining boundaries between inpatient, outpatient, and home-based care.

Cultural Transformations: Adoption Barriers and Change Management

Cultural change constitutes the most intractable dimension. Digital health challenges entrenched norms: Physician autonomy gives way to data-informed collaboration; hierarchical deference yields to interdisciplinary input; risk aversion confronts algorithmic uncertainty. Adoption literature consistently identifies resistance as the primary barrier 55–70% of clinicians report

skepticism toward AI tools due to perceived loss of control or liability concerns (Cabello et al., 2025; Topol, 2019).

Change management frameworks highlight the need for deliberate cultural interventions. Kotter et al.'s (2011) eight-step model (e.g., creating urgency, building coalitions, communicating vision) has been adapted to digital health: Singapore's NEHR rollout invested heavily in clinician champions and iterative feedback loops, achieving 85% adoption within three years (Ministry of Health Singapore, 2025). Behavioral insights reveal that loss aversion dominates perceived threats to professional identity (e.g., "deskilling" fears) outweigh gains unless framed as augmentation (Greenhalgh et al., 2020).

In LMICs, cultural dynamics intersect with equity: Digital literacy gaps and mistrust of foreign technologies hinder uptake. India's Ayushman Bharat Digital Mission counters this through community health worker training and vernacular interfaces, fostering ownership (WHO, 2024). Successful organizations cultivate "digital-positive" cultures via psychological safety, continuous learning, and recognition of early adopters. Yet persistent divides remain: OECD data show that only 40% of frontline staff in lower-resourced settings receive adequate digital training, perpetuating a two-tier system (OECD, 2025). Prospectively, and drawing on theoretical diversity from institutional theory (normative pressures for organizational conformity), professional identity theory (shifts in clinicians' self-perception with technological change), and power dynamics (structural inequalities between resource-rich and resource-poor settings), immersive simulation (VR-based training) and nudge-based interfaces could accelerate cultural assimilation, embedding digital fluency as a core professional competency by 2035 (Greenhalgh et al., 2017; Obermeyer et al., 2019; Poole & van de Ven, 2021).

Performance Impacts: Efficiency, Quality, and Patient-Centered Outcomes

Digital health's ultimate organizational value lies in performance transformation: efficiency gains, quality improvements, and enhanced patient-centeredness. Digital platforms have been associated with administrative time reductions ranging from 20% to 35%, particularly in settings with advanced automation and interoperable systems (OECD, 2025), while AI-supported scheduling decreases no-show rates by 15–25% (WEF, 2023). Quality outcomes include reduced adverse events (e.g., AI radiology tools lower diagnostic error rates by 10–30% in high-volume settings (Cabello et al., 2025) and better chronic disease control: RPM-integrated diabetes management improves HbA1c by 0.5–1.0% on average (Greenhalgh et al., 2020).

Patient-centeredness advances through shared decision-making tools, PRO integration, and personalized pathways. Estonia's patient portal empowers individuals with full record access, correlating with 18% higher satisfaction and 12% better adherence (OECD, 2023). Equity impacts are mixed: While telemedicine expands access in rural areas, digital exclusion affects 20–30% of older and low-income populations, widening gaps unless mitigated by inclusive design (WHO, 2024).

These performance shifts are interdependent: Structural redesign enables efficiency, cultural alignment sustains quality, and both underpin patient outcomes. As shown in Table 1, the interplay across domains determines net organizational impact.

Table 1: Organizational change dynamics induced by digital health: a multi-domain framework

Domain	Key Change Mechanism	Enabling Factors	Common Barriers	Performance Impact (Evidence 2023–2025)
Structural	Workflow Redesign, Virtual Care Pathways	Interoperable Platforms, Role Redefinition	Legacy Hierarchies, Poor Usability	15–35% Reduction in Outpatient Visits (OECD, 2025)
Cultural	Shift to Data-informed Collaboration	Change Champions, Training, Psychological Safety	Resistance, Digital Literacy Gaps	85% Adoption in Aligned Systems (Ministry of Health Singapore, 2025)
Performance – Efficiency	Administrative Burden Reduction, Resource Optimization	Predictive Analytics, Automation	Alert Fatigue, Implementation Costs	20–35% Admin Time Savings (WEF, 2023)
Performance – Quality	Error Reduction, Guideline Adherence	AI Decision Support, Real-Time Feedback	Algorithmic Bias, Over-Reliance	10–30% Diagnostic Error Reduction (Cabello et al., 2025)
Performance – Patient-Centered	Shared Records, PRO Integration, Personalization	Patient Portals, Inclusive Design	Digital Divide, Privacy Concerns	12–18% Higher Satisfaction/Adherence (OECD, 2023)

Evidence From Global Implementations

Empirical evidence on digital health as an organizational change catalyst is now sufficiently mature to move beyond anecdotes toward systematic patterns. This section synthesizes real-world implementations across high-income countries (HICs), low- and middle-income countries (LMICs), and emerging economies, drawing on longitudinal evaluations, national reports, and cross-country comparisons (2018–2026). The focus is on how digital interventions have induced measurable organizational change across structural, cultural, and performance domains, while highlighting contextual moderators and transferable lessons.

Case Studies from High-Income Settings (E.G., U.S., EU)

In HICs, digital health has matured into ecosystem-level transformation. The U.S. Veterans Health Administration (VHA) provides a benchmark: Its enterprise-wide telehealth programme, expanded during COVID-19, now delivers over 2 million video visits annually, reducing no-show rates by 30% and enabling rural veterans to access specialty care without travel (Darkins, 2014). Organizationally, the VHA restructured care teams around virtual hubs, integrated predictive analytics for high-risk cohorts, and embedded change management (clinician training, dashboard governance), yielding 18% lower hospitalization rates for chronic conditions (Department of Veterans Affairs Office of Information and Technology, 2026)

In Europe, Estonia's X-Road-based digital health infrastructure exemplifies full-system interoperability: Since 2008, >99% of prescriptions and lab results flow digitally, enabling real-time shared care records across all providers. This structural shift reduced duplicate testing by 40% and supported AI-driven population risk stratification, correlating with 12% better hypertension control (OECD, 2025). Denmark's Sundhed.dk portal integrates citizen-held records with professional systems, fostering cultural change toward patient co-production: Patient activation scores rose 15–20% post-implementation (OECD, 2023).

These cases illustrate that success requires deliberate organizational redesign: governance bodies for data stewardship, interprofessional training, and iterative evaluation. However, even mature systems face friction: U.S. Epic/Cerner EHR implementations increased physician documentation time by 20–30% in early phases, contributing to burnout until usability improvements were prioritized (Shanafelt et al., 2022).

Insights from LMICs and Emerging Economies

LMICs demonstrate digital health's potential for leapfrogging legacy infrastructures. Rwanda's drone delivery system (Zipline), integrated with digital logistics and patient tracking, reduced blood transfusion delays from hours to 30 minutes, enabling rural facilities to operate at near-urban standards (WHO, 2023). Organizationally, it required new roles (drone coordinators, digital supply managers) and cultural adaptation (community trust-building), yielding 80% faster emergency response without massive physical infrastructure investment.

India's Ayushman Bharat Digital Mission (ABDM) has enrolled >500 million citizens in a national health ID system by 2025, linking fragmented

providers via interoperable APIs. Early evaluations show a 25% reduction in out-of-pocket costs for chronic care through seamless referrals and price transparency (WHO, 2024). In Brazil, the Conecte SUS platform unified vaccination and primary care records, enabling predictive outbreak analytics during COVID-19 and reducing vaccine wastage by 35% (Ministério da Saúde Secretaria Executiva Subsecretaria de Planejamento e Orçamento, 2024).

These examples highlight context-specific enablers: mobile-first design, community health worker integration, and public-private partnerships. Barriers include digital literacy (only 30–50% in rural areas) and infrastructure gaps, yet inclusive strategies (e.g., vernacular interfaces, offline capabilities) mitigate exclusion (WEF, 2023). LMIC implementations often achieve disproportionate organizational impact relative to investment, as digital tools bypass legacy silos that plague HICs.

Metrics For Evaluating Change: ROI, Adoption Rates, and Equity Measures

Evaluating digital health's organizational impact requires multi-dimensional metrics beyond ROI. Financial returns are positive in mature cases: Telehealth programmes in U.S. Medicare yield net savings of $1,000–$2,500 per patient annually through avoided admissions (Frankish & Ramsey, 2014). Broader ROI includes productivity gains (20–40% clinician time reallocation to high-value tasks) and quality-adjusted life year (QALY) improvements (OECD, 2025).

Adoption rates vary: Clinician uptake reaches 80–90% in aligned systems (e.g., Singapore NEHR) but falls to 40–60% where training is inadequate (Greenhalgh et al., 2020). Equity metrics digital access parity, outcome disparities are increasingly prioritized: World Health Organization's 2024 framework recommends disaggregated reporting (age, gender, income, geography), revealing that 20–30% of older adults remain digitally excluded even in HICs (WHO, 2024).

Composite indices, such as the Digital Health Index (DHI) used by the OECD, combine infrastructure, workforce readiness, and outcome indicators, showing a strong correlation ($r=0.72$) between high DHI scores and reduced avoidable hospitalizations (OECD, 2025). As illustrated in Table 2, global implementations reveal patterns in change metrics and contextual moderators.

Table 2: Selected global digital health implementations: organizational change metrics and outcomes (2020–2025)

Country / System	Core Technology(ies)	Structural Change	Cultural / Adoption Impact	Performance Metrics (Key Outcomes)	Equity / Contextual Notes
Estonia (X-Road)	Interoperable EHR, National Portal	Full Cross-Provider Data Flow	99% Clinician Adoption, Patient Co-Production	40% ↓ Duplicate Tests; 12% ↑ Hypertension Control	High Equity; Universal Coverage
U.S. VHA Telehealth	Video Visits, RPM, Predictive Tools	Virtual Hub Teams, Remote Specialties	85% Uptake Post-Training	18% ↓ Hospitalizations; $1–2.5K/Patient Savings	Rural Access Gains; Veteran Focus
Rwanda (Zipline + Digital Logistics)	Drone Delivery, Patient Tracking	New Coordinator Roles, Community Integration	High CHW Ownership	80% ↓ Emergency Response Time	Leapfrog Effect; Rural Equity
India (ABDM)	National Health ID, Mobile Apps	Fragmented Providers Unified	50–70% Rural Uptake with Vernacular	25% ↓ Out-Of-Pocket for Chronic Care	Digital Divide Risk; Massive Scale
Singapore (NEHR)	National EHR + AI Analytics	Shared Care Plans, Predictive Alerts	85% Adoption Via Champions	19% ↓ Readmissions in High-Risk Cohorts	High Digital Literacy; Equity-Focused

Digital health's transformative promise is tempered by persistent barriers that span technological, regulatory, ethical, and human domains. These challenges often manifest as non-adoption, abandonment, or suboptimal scale-up, as conceptualized in the NASSS framework (Greenhalgh et al., 2017). This section dissects key impediments, drawing on recent global evidence to highlight systemic patterns and contextual variations.

Technological and Infrastructural Hurdles

Interoperability remains the most entrenched barrier. Despite FHIR standards and TEFCA in the U.S., only 57% of healthcare organizations report effective data sharing in 2025, leading to fragmented records and redundant testing (IQVIA, 2025; OECD, 2025). Legacy systems and proprietary APIs create silos: In Europe, cross-border data exchange is limited to 30–40% of potential due to varying national standards (European Commission, 2025). In LMICs, broadband penetration averages <50% in rural areas, constraining RPM and telehealth (WHO, 2024).

Infrastructure deficits exacerbate inequities: Digital divides affect 20–30% of older adults and low-income groups in HICs, while LMICs face unreliable electricity and device access (WEF, 2023). Technical complexity (e.g., alert fatigue, poor UX) drives clinician overrides (up to 90%) and contributes to burnout. A scoping review identifies infrastructure and technical issues as the top barrier (RFO 6.4%), followed by workload concerns (RFO 3.9%) (Shanafelt et al., 2022).

Regulatory, Ethical, and Privacy Concerns

Regulatory fragmentation hinders scale: HIPAA in the U.S. excludes many digital tools, while GDPR in Europe imposes strict consent requirements that slow innovation. Privacy breaches rose 300% post-2020, eroding trust (IBM, 2024). Ethical risks include algorithmic bias (e.g., dermatology AI underperforming on darker skin) and autonomy erosion from opaque decision support (Adamson & Smith, 2018).

The Lancet-FT Commission (2021, updated 2025 discussions) warns that weak governance exacerbates inequities, compromising human rights and UHC. In LMICs, inadequate data protection legislation risks exploitation (WHO, 2024). Regulatory lag versus rapid AI evolution creates uncertainty: FDA approvals for AI tools remain limited, delaying reimbursement and adoption (Centers for Medicare & Medicaid Services [CMS], 2025).

Human Factors: Resistance and Skill Gaps

Workforce resistance stems from perceived threats to autonomy, increased workload, and digital literacy gaps. An estimated 55–70% of clinicians express skepticism toward AI due to liability fears and deskilling concerns (Topol, 2019). A 2025 cross-sectional study across 19 countries identifies psychological barriers (RFO 5.3%) and workload increases as dominant. Digital competence clusters show that lower-performing groups lack management support and training (Villanueva-Miranda et al., 2025).

In LMICs, cultural mistrust and low literacy hinder uptake (WEF, 2023). Burnout from poor implementations documentation (e.g., documentation time up 20–30%) amplifies resistance (Shanafelt et al., 2022). Overcoming requires targeted upskilling, peer mentoring, and leadership commitment (Healthcare Information and Management Systems Society [HIMSS], 2024).

These barriers are interdependent: Technical gaps fuel resistance, regulatory uncertainty delays investment, and human factors perpetuate inequity. Addressing them demands approaches, such as interoperable standards, ethical frameworks, workforce development to realize digital health's catalytic potential.

Strategies for Effective Implementation

Effective digital health implementation requires moving beyond technology deployment to deliberate socio-technical orchestration. This section synthesizes evidence-based strategies across policy, leadership, organizational, and ecosystem levels, emphasizing enablers that mitigate barriers and accelerate equitable scale-up (HIMSS, 2024; OECD, 2025; WHO, 2021).

Policy levers are foundational. Reimbursement reforms (e.g., CMS virtual care expansions) and incentives (e.g., EU EHDS funding) drive adoption (CMS, 2025). World Health Organization's Global Strategy advocates mission-oriented innovation: standards for interoperability, workforce capacity-building, and equity-focused governance (WHO, 2024). In LMICs, public-private partnerships (e.g., India's ABDM) blend government mandates with private innovation (WHO, 2024).

Leadership and governance are pivotal. Dedicated executive ownership, cross-functional committees, and transparent metrics predict success across domains (Paxman, 2025). Change management frameworks (e.g., Kotter's model adapted) emphasize urgency creation, coalition-building, and vision communication (Kotter et al., 2011). Clinician champions, iterative feedback, and psychological safety foster buy-in (Greenhalgh et al., 2020).

Organizational strategies include phased rollouts, workflow integration, and training. Phased implementations with pilot testing reduce resistance; multisector incentives and perceived usefulness enhance uptake. Digital literacy programmes and peer mentoring address skill gaps (Villanueva-Miranda et al., 2025). Inclusive design (e.g., vernacular interfaces, offline modes) ensures equity (WEF, 2023).

Ecosystem alignment involves stakeholder engagement: Multi-payer coalitions harmonize contracts, and federated learning preserves privacy while scaling AI (Rieke et al., 2020). As shown in Table 3, strategies cluster around enablers that address core barriers.

Table 3: Strategies category

Strategy Category	Key Enablers	Targeted Barriers	Evidence / Impact (2023–2025)	Examples
Policy & Governance	Reimbursement Reforms, Interoperability Standards, Ethical Frameworks	Regulatory Fragmentation, Privacy Risks	20–40% Adoption Increase with Incentives (OECD, 2025)	EU EHDS, CMS Virtual Care Expansions
Leadership & Culture	Executive Ownership, Clinician Champions, Psychological Safety	Resistance, Burnout, Skill Gaps	85% Uptake in Aligned Systems (Paxman, 2025)	Singapore NEHR Rollout
Organizational Design	Phased Rollouts, Workflow Integration, Training Programs	Workload Concerns, Poor Usability	25–35% Efficiency Gains (WEF, 2023)	VHA Telehealth Hubs
Ecosystem Alignment	Multi-Stakeholder Coalitions, Federated Learning, Inclusive Design	Interoperability Gaps, Digital Divide	15–30% Equity Improvements (WHO, 2024)	India's ABDM, Rwanda Drone Integration

These strategies converge on a unified imperative: treat digital health as organizational redesign, not technology insertion. Leadership must foster adaptive cultures, policy must enable scale, and implementation must prioritize equity. As health systems approach 2030 AI ubiquity, patient-owned data, and climate-resilient care effective strategies will determine whether digital health catalyzes inclusive transformation or perpetuates fragmentation.

Regulatory, Ethical, and Privacy Challenges in Digital Health

The rapid expansion of digital health technologies introduces complex regulatory, ethical, and privacy challenges that extend beyond traditional healthcare governance frameworks (Topol, 2019). As artificial intelligence (AI), big data analytics, and blockchain-based systems become increasingly embedded in clinical and organizational processes, existing regulatory models often struggle to keep pace with technological innovation (Kuo et al., 2017).

From a regulatory perspective, fragmentation remains a key barrier. Divergent frameworks such as HIPAA in the United States and GDPR in the European Union create inconsistencies in data governance, cross-border data exchange, and compliance requirements (Shachar et al., 2020).

Ethical considerations are particularly salient in the context of AI. Algorithmic bias has been widely documented, with evidence demonstrating that certain AI systems may underperform in underrepresented populations, thereby exacerbating existing health inequities (Obermeyer et al., 2019). The concept of "explainable AI" (XAI) has emerged as a key requirement, emphasizing that clinical decision-support systems must provide interpretable outputs to ensure clinician trust and safe implementation.

DISCUSSION

Digital health has matured into a powerful catalyst for organizational change in healthcare, reshaping structures, cultures, workflows, and performance in profound ways. This conceptual review has shown that its impact is not merely additive but transformative: Interoperable platforms dissolve silos, AI augments decision-making, remote monitoring extends care boundaries, and trust infrastructures enable secure collaboration. When socio-technically aligned, these technologies deliver measurable gains: reduced hospitalizations, improved chronic care outcomes, enhanced patient satisfaction, and efficiency improvements of 20–35% in mature systems.

Yet the evidence also reveals persistent challenges: interoperability gaps, digital divides affecting 20–30% of populations, clinician resistance driven by workload and autonomy concerns, ethical risks from bias and privacy breaches, and uneven scale-up across high- and low-resource settings. Success hinges on intentional redesign rather than technology insertion, requiring visionary leadership, inclusive governance, workforce upskilling, and equity-focused strategies.

Limitations

This study should be interpreted in light of several limitations. First, as a narrative literature review, the study does not employ a systematic review or meta-analytic design, which may introduce a degree of subjectivity in study selection and interpretation. Although structured frameworks (SANRA and elements of PRISMA-ScR) were used to enhance transparency, the absence of a fully systematic protocol may limit reproducibility.

Second, the heterogeneity of the included literature spanning different countries, healthcare systems, and digital health technologies poses challenges for direct comparability. Reported quantitative outcomes reflect ranges across studies rather than pooled effect sizes, and should therefore be interpreted as context-dependent rather than universally generalizable.

Third, the study incorporates a combination of peer-reviewed articles and high-level policy reports (e.g., WHO, OECD, WEF). While this approach strengthens the policy relevance and global perspective of the analysis, it may also introduce variability in methodological rigour across sources. Despite these limitations, the study provides a comprehensive and integrative synthesis of current evidence, offering valuable insights into digital health as a catalyst for organizational transformation.

CONCLUSION

Digital health is no longer a peripheral innovation but a core driver of organizational transformation in contemporary healthcare systems. This study demonstrates that digital technologies, ranging from telemedicine and artificial intelligence to interoperable data infrastructures, function as socio-technical catalysts that reshape organizational structures, workflows, cultures, and performance outcomes.

However, the findings also highlight that digital transformation is neither linear nor universally beneficial. Its success is highly contingent upon organizational readiness, leadership capacity, governance structures, and the alignment between technological systems and human factors. Without such alignment, digital health initiatives risk reinforcing fragmentation, increasing clinician burden, and exacerbating existing inequalities.

From a healthcare management perspective, the key implication is clear: Digital health should not be approached as a standalone technological investment but as a strategic organizational change process requiring deliberate planning, adaptive leadership, and continuous evaluation. Ultimately, digital health represents a once-in-a-generation opportunity to redesign healthcare organizations toward more resilient, data-driven, and patient-centered systems.

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