

The landscape of Artificial Intelligence Driven Digital Platforms in Healthcare and Life Sciences: A Scoping Review Towards Universal Integration

Rahela Penovski, Stanko Srčić, Reinhold Scherer

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The landscape of Artificial Intelligence Driven Digital Platforms in Healthcare and Life Sciences: A Scoping Review Towards Universal Integration

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Abstract

Background: Digital platforms are transforming healthcare and life sciences by enhancing operational efficiency, improving patient outcomes, and accelerating product development and market access. These platforms facilitate telemedicine, remote patient monitoring, and data-driven care delivery, while in life sciences, they streamline research, optimize manufacturing, and support regulatory compliance. However, current Artificial Intelligence (AI) based solutions remain fragmented and domain-specific, lacking the integration necessary to address complex challenges within and across these industries. While AI excels in specialized areas—such as radiology image analysis, sepsis-detection predictive analytics, and AI-driven drug discovery—these solutions often operate in isolation.

Objective: This scoping review aims to critically analyze the current landscape of digital platforms in healthcare and life sciences, identify existing gaps and opportunities, and explore the feasibility of developing a comprehensive, universal AI-based platform.

Methods: A scoping review was conducted following PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) guidelines. A comprehensive search of peer-reviewed literature, industry reports, and regulatory documents was performed across databases including PubMed, Embase, CINAHL, PsycINFO, Scopus, IEEE Xplore, and Web of Science. Inclusion criteria focused on studies, reports, and documents published from 2014 to 2024, addressing digital platforms, AI integration, healthcare and life science applications, regulations, and professional ethics. Data were charted and synthesized to identify themes related to platform capabilities, gaps, and integration potential.

Results: The review identified seven common digital platform types utilized across healthcare and life sciences, alongside a growing trend in the implementation of AI, including generative AI. Significant gaps were found in interoperability, cross-sector collaboration, and platform utilization. AI technologies showed promise in accelerating drug discovery and improving diagnostic accuracy while reducing healthcare costs. Despite these advances, differences in data standards, regulatory constraints, and proprietary formats hinder seamless integration with existing electronic health record systems and healthcare workflows. Moreover, AI applications often neglect comprehensive, personalized treatment plans that integrate genomics, lifestyle factors, comorbidities, and social determinants of health. Organizations like World Health Organization, Massachusetts Institute of Technology, and Microsoft are exploring integrated solutions, but challenges in data standardization, privacy, regulatory, and ethical considerations remain.

Conclusions: A universal AI-based digital platform could revolutionize healthcare and life sciences by improving efficiency, patient outcomes, and research innovation. By addressing current fragmentation and fostering integration across sectors, such a platform could enable continuous improvement and innovation in healthcare delivery and treatment development. However, overcoming challenges related to interoperability, regulatory compliance, and ethical standards is critical. Collaborative efforts

across sectors are essential to develop connected, responsive, and effective national and global healthcare systems. Future research should focus on defining the universal platform's structure and scope, developing comprehensive design strategies, and aligning AI applications with healthcare ethics to ensure equitable and effective integration.

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Original Manuscript

Review Paper

The landscape of Artificial Intelligence Driven Digital Platforms in Healthcare and Life Sciences: A Scoping Review Towards Universal Integration

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Keywords: AI in healthcare, digital platforms, life sciences, interoperability, ethical AI, healthcare innovation, scoping review

Introduction

Background

The rapid evolution of digital platforms is reshaping healthcare and life sciences by streamlining operations, enhancing patient care, and accelerating the development and deployment of new medical technologies [1-4]. In healthcare, digital platforms support telemedicine, remote patient monitoring, and data-driven approaches to care delivery [5-8]. In life sciences, they optimize research methodologies, manufacturing processes, and regulatory compliance, thereby reducing the time-to-market for new therapies [9,12]. Despite these advances, Artificial Intelligence (AI) based solutions remain fragmented and specialized, lacking the integration needed to address multifaceted challenges across sectors [4, 13-15].

The lack of interoperability between digital platforms and healthcare systems poses significant barriers [16-19]. Disparities in data standards, regulatory frameworks, and proprietary formats obstruct efficient information sharing across institutions and industries [20-23]. This fragmentation limits the ability of digital platforms to provide comprehensive, coordinated care and integrated solutions in life sciences [1, 12, 17, 24].

Objective

This paper critically:

- (i) **Identifies and examines** digital platforms currently used in healthcare and life sciences, analyzing their core functions, applications, and contributions to healthcare delivery, research, and patient outcomes.
- (ii) **Synthesizes technological, regulatory and ethical frameworks** governing digital healthcare and life sciences platforms, evaluating their role in shaping platform design, implementation, and compliance with technological advancements.

- (iii) **Recognizes gaps and opportunities** in the current digital healthcare and life sciences ecosystem, identifying areas for improvement and prioritizing future developments that could enhance the effectiveness and integration of digital platforms with AI and emerging technologies.
- (iv) **Explores the feasibility** of developing and implementing a comprehensive, universal AI-based platform, assessing key requirements, technical and regulatory barriers, potential benefits and risks, and how existing platforms could be leveraged or transformed to achieve this vision.

By exploring the **technological, regulatory, and ethical dimensions** of current digital platforms, this review lays the groundwork for understanding the potential and challenges of an integrated, AI-driven future in healthcare and life sciences industries.

Methods

This scoping review was conducted in accordance with PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) guidelines [25] to ensure reporting of the key aspects of the review, and all critical elements are covered, as well as a systematic and transparent approach to literature identification and analysis. The methodology encompassed several key steps: formulation of research questions, identification of relevant literature, application of inclusion and exclusion criteria, data extraction, and thematic synthesis. PRISMA 2020 (Preferred Reporting Item for Systematic Reviews and Meta-Analyses) flow diagram [26] was used to document literature selection and transparent reporting of search strategy. Excel bar chart, power point shape tool and a partially AI-assisted image creation method were utilized to visualize the findings.

Research questions

Our research questions were as follows:

1. Current Landscape of Digital Platforms

- What digital platforms are currently being used in healthcare and life sciences?
- What are the core functions and applications of these digital platforms?
- How do these platforms and AI technology contribute to healthcare delivery, research, and patient outcomes?

2. Gaps, Opportunities and Prioritization

- What are the major gaps in current digital platforms used in healthcare and life sciences?
- What are the key opportunities for improving or expanding current digital platforms?
- How can AI and emerging technologies enhance existing healthcare and life sciences platforms?
- Which areas should be prioritized for future development and investment?

3. Regulatory and Ethical Frameworks

- What are the existing regulatory frameworks governing digital healthcare and life sciences platforms?
- How do ethical considerations shape the design, implementation, and use of these platforms?
- What challenges exist in aligning technological advancements with regulatory and ethical requirements?

4. Feasibility of a Universal AI-Based Platform

- What are the key requirements for developing a comprehensive, universal AI-based platform?
- What are the technical, regulatory, and ethical barriers to implementation?
- How feasible is the integration of a universal platform into existing healthcare and life sciences ecosystems?
- What are the potential benefits and risks of adopting a universal AI-based platform?
- How can existing platforms be leveraged or transformed to achieve this vision?

Search Strategy

A comprehensive literature search of academic literature was performed across multiple electronic databases, including PubMed, Embase, CINAHL, PsycINFO, Scopus, IEEE Xplore, and Web of Science, chosen for their extensive coverage of peer-reviewed publications in healthcare, life sciences, and technology. Targeted website searches via Google and Google Scholar of professional organizations, government agencies, international organizations, research institutions and reputable private organizations have been employed for non-peer reviewed materials.

In addition to academic literature, industry reports, regulatory and ethics documents, and guidelines were included to offer a holistic perspective. Grey literature, such as policy papers, white papers, product descriptions, trainings, and instructions, from reputable organizations, was also considered to capture emerging trends not yet reflected in peer-reviewed sources.

Inclusion and Exclusion Criteria

The review focused on documents published between 2014 and 2024, reflecting the significant advancements in digital platforms over the past 10 years. The documents had to be in English, German, Italian, or a bilingual format with English as one of the languages. Studies, reports, and documents discussing digital platforms, AI integration, applications in healthcare and life sciences, regulatory frameworks, and professional ethics were included. Publications were selected if they provided insights into digital platform capabilities, identified gaps, discussed integration opportunities, or addressed regulatory and ethical considerations pertinent to developing a universal AI-based platform. Excluded were articles unrelated or irrelevant to digital platforms in healthcare or life sciences, or those lacking methodological rigor. In case where multiple similar articles addressed the same topic, additional criteria were applied. The additional criteria were the following: to prioritize articles that were more comprehensive in scope and more recent in publication, while excluding those that were less detailed and older.

Data Extraction and Charting

Data were systematically extracted from selected sources and charted to identify key themes and patterns. Information was categorized based on platform types, technological capabilities, integration challenges, regulatory considerations, and ethical implications. The extracted data were synthesized to highlight commonalities and differences across the literature, providing a comprehensive overview of the current landscape.

Thematic Synthesis

The charted data were analyzed to identify recurring themes related to digital platform functionalities, gaps in current implementations, opportunities for integrated solutions, and barriers to adopting universal platforms. Special attention was given to the role of AI technologies, digital system interoperability, and the ethical and regulatory frameworks governing their use in healthcare and life sciences.

Ethical Considerations

Since this research utilized published data from existing studies and reports, no additional ethical approval was required. All original studies from which insights were drawn had obtained the necessary ethical clearances at the time of their data collection.

Quality Assurance

To ensure reliability and validity, the selection process encompassing 10% was conducted independently by the authors, with discrepancies resolved through discussion and consensus. The PRISMA-ScR checklist guided the reporting to ensure comprehensive coverage of all relevant aspects of the scoping review process (Multimedia Appendix 1).

Results

Identification of relevant literature

PRISMA ScR checklist was created to document and ensure reporting of the key aspects of the review, as well as all critical elements are covered (Multimedia Appendix 1). The literature selection and transparent reporting of search strategy was documented in PRISMA flow diagram (Figure 1).

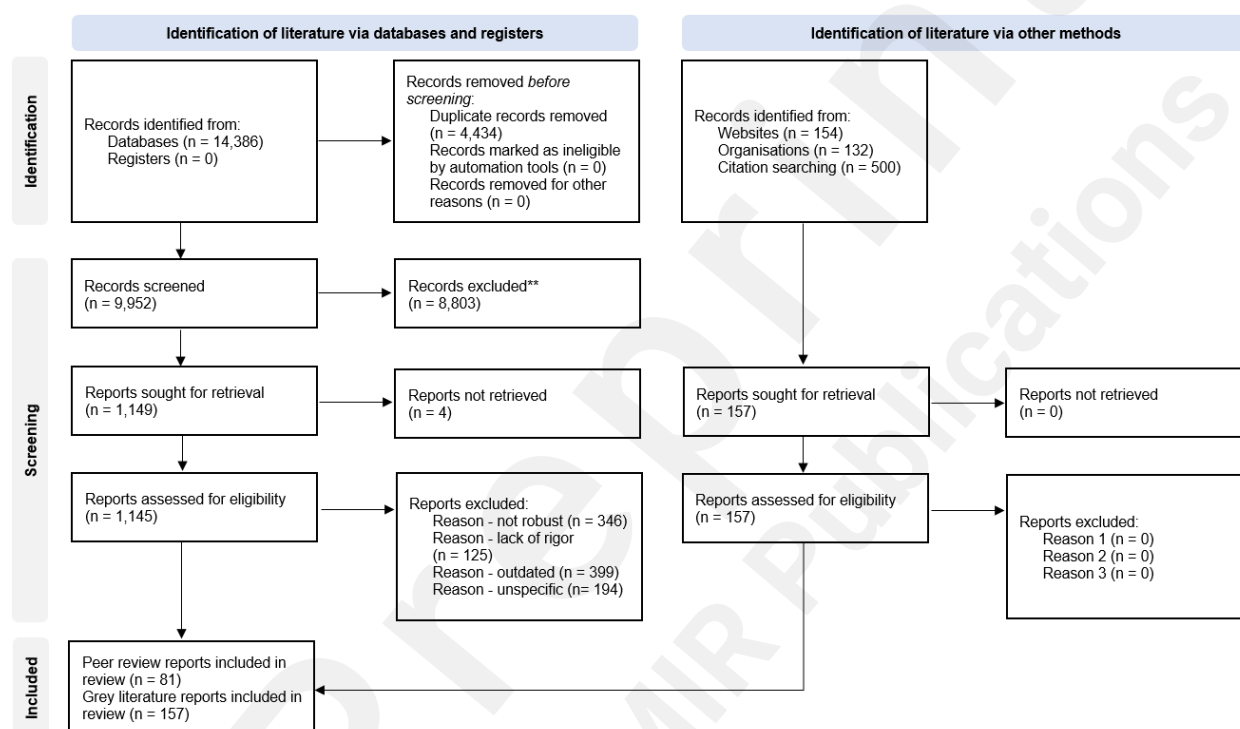


Figure 1. PRISMA 2020 flowchart presenting search strategy and literature selection.

A comprehensive search across multiple databases and grey literature sources yielded 14,540 records. After duplicate removal, 10,106 (70%) unique records remained.

Screening

The titles and abstracts of these 10,106 records were screened against our inclusion criteria. The 8,003 records were excluded at the screening stage, leaving 1,303 (9%) articles for selection.

Eligibility and Inclusion

Full texts of 1,299 articles were retrieved and assessed in detail. Four articles could not be retrieved due to limited resources. After applying our eligibility criteria, 238 (2%) publications were deemed to meet the criteria and were included in the review [1-24, 27-240]. Two references supporting PRISMA-ScR checklist and PRISMA 2020 flowchart [25, 26] have not been counted towards 238 publications as they support theory of research methodology rather than directly research outcomes and have been highlighted in grey in Multimedia Appendix 2 Table A [1-240].

The finally selected publications were clustered in three categories as follows: digital solutions (142 publications [1-13, 15-23, 27-31, 34-54, 56-76, 78-105, 109-111, 113-118, 122, 123, 151, 160, 167, 202, 203, 210, 212-223, 225-234, 236-240]), regulatory framework (45 publications [24, 33, 55, 77, 106, 112, 119-121, 124-126, 128-145, 147-150, 152, 153, 156, 158, 159, 161, 163, 206, 207, 208, 209]) and ethics (51 publications [14, 32, 107, 108, 146, 154, 155, 157, 162, 164-166, 168-201, 204, 205, 211, 224, 235]) (Figure 2, Multimedia Appendix 2 Table A).

The publications included 81 peer review papers [2-8, 10, 11, 14-23, 27-32, 34, 55, 80-83, 85, 87-105, 109, 113, 114, 157, 162, 164-167, 202, 205, 211, 212, 216, 217, 219-223, 225-228, 230, 231, 234, 236, 237, 239, 240], 40 national and international standards and legislations [24, 33, 77, 106, 112, 120, 121, 124-126, 128-150, 152, 153, 156, 158, 159, 204, 224], 34 professional code of conduct regulations [168-201], and 83 reports and manufacturer guidelines [1, 9, 12, 13, 35-54, 56-76, 78, 79, 84, 86, 99, 107, 108, 100, 111, 115-119, 122, 123, 127, 151, 154, 155, 160, 161, 163, 203, 206-210, 213-215, 218, 229, 232, 233, 235, 238] (Figure 2, Multimedia Appendix 2 Table A).

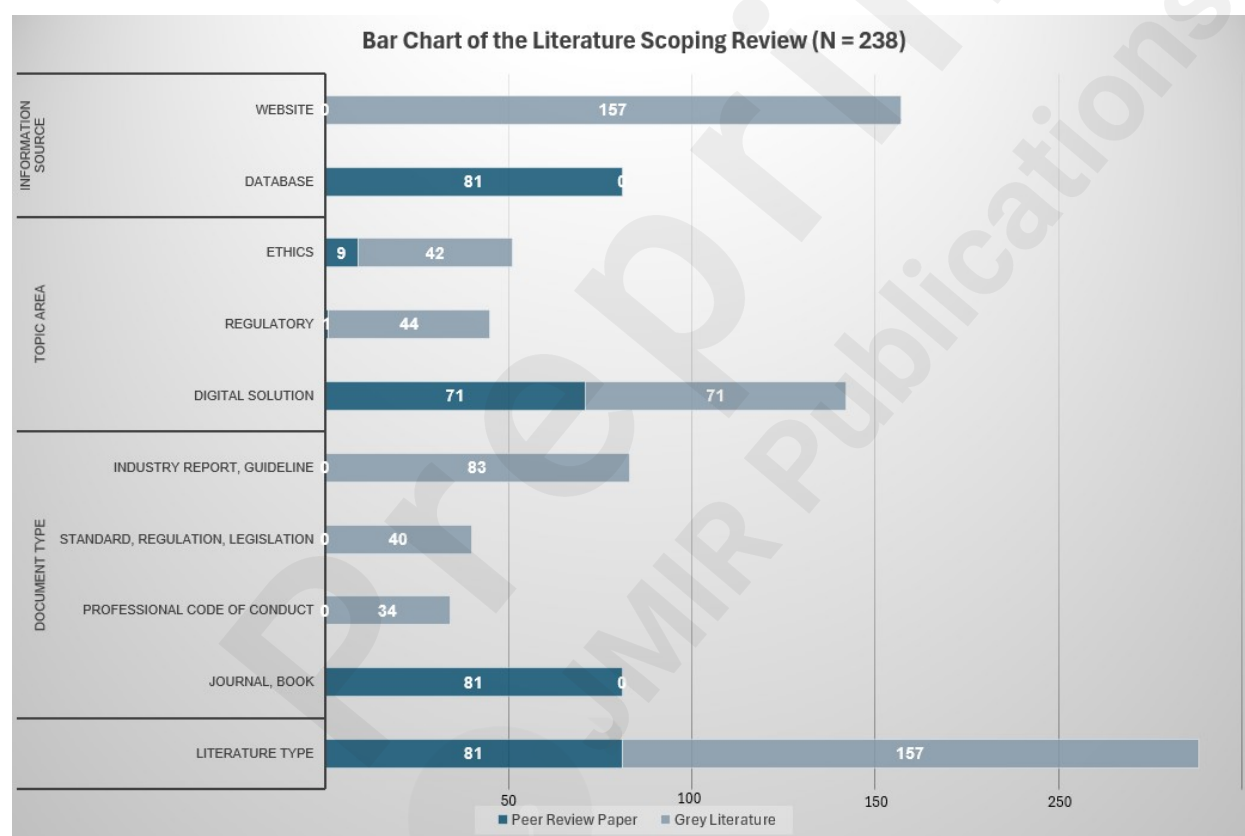


Figure 2. Visual presentation of the literature scoping review.

All publications, including professional codes of conduct, were in English, except for those for nurses, pharmacists, and dentists in Germany, which were in German, and for pharmacists in Japan, which were in a bilingual format (Japanese and English).

Current Landscape, Gaps, Opportunities, and the Case for a Comprehensive, Universal AI-Based Digital Platform Landscape

Digital platforms in healthcare, pharmaceutical, medical devices, and biotechnology industries currently offer fragmented solutions with limited synchronization, lacking holistic, end-to-end integration [1-3, 5, 9, 12, 13, 17, 27]. Emerging technologies, including social media platforms (e.g., Facebook, Instagram, LinkedIn, Twitter,

TikTok, and YouTube) and online communities (e.g., Patients Like Me, HealthBoards Message Boards, MedHelp, WebMD, HealthUnlocked, and Fitbit Community), hold significant potential for enhancing patient engagement, facilitating rapid and widespread dissemination of health information, and fostering knowledge sharing. However, their effective utilization is hindered by evidence-based gaps that necessitate foundational changes in evaluation and support. Social media platforms primarily serve as networks for peer support, health-related information sharing, and connections among diverse groups, including patients, caregivers, and healthcare professionals. In contrast, online communities cater to more specialized needs by linking individuals facing similar health challenges, offering more tailored resources, and enabling the exchange of more sensitive experiences [1, 28-34].

Seven common types of digital platforms are utilized across healthcare and life sciences [1, 17] including cloud-based health monitoring, data analytics, AI (including generative AI), electronic health record (EHR) systems, telehealth, patient engagement tools, clinical trial platforms, and supply chain management (Multimedia Appendix 3 Table S1 [35-86]). Data analytics and AI enhance personalized care in healthcare and facilitate drug or technology discovery in life sciences [10, 11, 41, 43, 45-60, 78]. EHR systems support clinical trials and patient monitoring [16, 37, 38, 79, 80], while patient engagement tools contribute to real-world evidence collection and improved patient experiences [3, 28, 81, 75-77]. Clinical trial platforms optimise clinical trial recruitment and workflow efficiency [39,40, 78, 82] while supply chain management platforms ensure compliance and transparency in drug distribution [73, 74, 83-86]

Despite their utility, none of these platforms offer a universal solution with a holistic approach to addressing the challenges in healthcare and life sciences [1, 17], as detailed in Multimedia Appendix 3 Table S2 [3-5, 8, 10, 11, 15, 16, 20, 79 -105]. These challenges are categorized into routine operations, healthcare crisis management, disease prevention, and preventive management [99, 106]. Significant gaps and missed opportunities persist (Table 1), largely due to insufficient collaboration among healthcare providers, industry, regulators, and governments.

Table 1. Identified main gaps and opportunities of the current digital platforms.

Gap		Opportunity	
Category	Description	Category	Description
Data interoperability and cybersecurity	Many systems lack integration, complicating the seamless flow of data between stakeholders and cybersecurity risks [16, 18, 23, 80]	AI including generative AI	Expanding AI in drug discovery and patient care presents significant potential [10, 11, 78]
Digital maturity	Especially in pharmaceuticals, many organizations struggle with scaling digital strategies [12, 13, 82]	Cloud adoption	Shifting to cloud-based platforms for scalability and cost-efficiency driven by several factors including company size (mostly bigger companies), operational needs, and regulatory requirements [9, 45, 55]
Regulatory challenges	Varying compliance requirements hinder	Integrated patient journeys	Enhancing digital touchpoints to deliver cohesive patient

Category	Gap Description	Category	Opportunity Description
	national and global digital platform deployment [3, 107, 108]		experiences across healthcare and life sciences industries [13, 47, 51, 106]

Digital platforms have transformative potential to improve efficiency, accessibility, safety, and personalization of treatments and services [1, 2]. They can enhance healthcare crisis management and disease prevention through real-time data, predictive analytics, remote care capabilities, and public health education [99, 5, 106]. The definition of "real-time" in healthcare varies, from milliseconds for patient monitoring to days or weeks for population-level predictive analytics (Multimedia Appendix 3 Table S3 [4, 5, 7, 8, 10-13, 27, 45, 78, 79, 81, 87, 88, 92, 94, 99, 106, 109-112]).

AI technologies significantly reduce the time required for critical healthcare processes—sometimes by up to 10,000 times faster than traditional methods [78, 11]. Emergency and intensive care unit (ICU) scenarios benefit the most, with AI-assisted emergency responses like automated defibrillators (AEDs), ICU monitoring, and radiology operating up to 6,000 times faster, reducing critical delays that can mean the difference between life and death [4, 87]. Wearable health monitoring powered by AI can detect symptoms up to 86,400 times faster than human recognition (Multimedia Appendix 3 Table S3).

AI-driven diagnostics, hospital resource allocation, and pandemic responses operate 24 to 288 times faster, enhancing healthcare system efficiency [6, 101]. These technologies enable healthcare systems to respond quickly, allocate resources effectively, and prevent disease spread before it becomes widespread [99, 107]. AI-driven drug discovery can shorten development times from five years to months, making the process 12-60 times faster compared to traditional approach and accelerating innovation (Multimedia Appendix 3 Table S3).

AI is transforming healthcare [87] and life sciences by enhancing diagnostic accuracy and reducing costs across various applications (Multimedia Appendix 3 Table S4 [4, 6, 11, 78, 94, 113-116]). AI models, such as those analyzing lung ultrasound videos, have achieved diagnostic accuracy rates as high as 96.57% [113]. Predictive analytics and remote patient monitoring powered by AI have demonstrated significant cost savings. For example, an expected net savings of \$7.3 million per year were identified in a study modelled 199 high-cost claimants (HiCC)-risk individuals (defined by annual costs above \$250,000) in targeted care management programs [114]. The model was based on care management program enrolling 500 people with the highest HiCC risk which expected to treat 199 true HiCCs [114]. Automating administrative tasks with AI reduces errors and operational costs, contributing to overall healthcare cost reductions and staff workload [115, 116]. By integrating AI into various aspects of healthcare, organizations can enhance diagnostic accuracy, improve patient outcomes, and achieve substantial cost savings [117]. It has been estimated that generative AI could accelerate results per business function in the life sciences worldwide from \$3 billion in medical affairs to \$30 billion in commercial [78].

The concept of a universal digital platform capable of integrating AI, databases, healthcare services, research, education, healthcare crisis management, and disease prevention is ambitious but increasingly feasible [1, 17, 106]. While no single platform has achieved this full scope, several efforts are moving toward similar goals (Multimedia Appendix 3 Table S5 [9, 12, 13, 45-67, 70, 99, 106, 112, 118-122]). Organizations like World

Health Organization (WHO), Massachusetts Institute of Technology (MIT), Microsoft, Google, Amazon, and Array Insights are actively exploring components of such platforms [24, 45, 48, 64, 66, 67, 70, 123].

Microsoft Cloud for Healthcare, Microsoft Healthcare Data Solutions in Microsoft Fabric, and Microsoft Azure for Healthcare serve complementary purposes in healthcare data management and analytics (Multimedia Appendix 3 Table S6) [45-60]. Comparative analyses highlight similarities, differences as well as unique and shared gaps and opportunities in integration, usability, and data security (Multimedia Appendix 3 Tables S6, S7 and S8) [45-60]. A synthesis of these analyses is illustrating overlapping functionalities and integration challenges across platforms (Multimedia Appendix 3 Table S8) [45-60]. While these platforms offer robust capabilities, a fully cohesive experience across them remains an area for improvement [52, 55].

Based on the current state of technology advancements, standardisation and governance frameworks, the summary analysis of the main gaps, opportunities, strengths and weaknesses associated with the universal platform itself as well as its creation, implementation and maintenance, is presented in Table 2.

Table 2. Main pros and cons arguments identified for the universal AI-based platform and its development, implementation and maintenance.

Focus	Opportunities	Gaps	Strengths	Weaknesses
Platform	Integration of real-time data for disease prevention and crisis management [99, 106, 111]	Ensuring ethical data collection and usage [107]	Centralized data facilitates research [45]	High initial cost of development [13]
	Unified platform for education and training of healthcare professionals and patients [55]	Addressing regulatory and compliance issues across national and global healthcare systems [59]	Enhances interoperability [56]	Risk of cybersecurity vulnerabilities [59]
	Enhanced patient empowerment through AI-powered health monitoring [94]	Mitigating bias in AI algorithms to ensure equity [78]	Streamlined patient care and management [53]	Ethical challenges in AI decision-making [107]
Platform development, implementation and			Enables national and global crisis response [106]	Potential for technological dependence [78]
	Creating unified global standards like Fast Healthcare Interoperability Resources (FHIR) [57]	Data standardisation and interoperability challenge [55]	Improved patient outcomes through AI-driven insights [45]	High cost of development, implementation and maintenance [13]
	Development of advanced encryption and federated learning [67]	Privacy and security concerns [59]	Acceleration of research and drug discovery [11]	Risk of data breaches and misuse [59]
	Investment in affordable infrastructure and training [51]	Limited options in low-resource settings [106]	Integration of diverse healthcare services [55]	Complexity in managing diverse stakeholder needs [55]
	Education and incentives for stakeholders [52]	Resistance to adoption [13]	Enhanced accessibility and personalized care [52]	Potential over-reliance on technology [78]

Focus	Opportunities	Gaps	Strengths	Weaknesses
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Regulatory and Ethical Considerations

The feasibility of a universal platform depends significantly on legal and regulatory frameworks and ethical considerations [107, 124-150, 154]. Regulatory agencies like the Food and Drug Administration (FDA), Medicines and Healthcare products Regulatory Agency (MHRA), and European Medicines Agency (EMA) emphasize the safety and effectiveness of digital technologies, while ethical frameworks focus on aligning healthcare ethics with AI ethics [151-154]. A comparative analysis of existing and draft legislations and regulations reveals consistent gaps and opportunities across international frameworks (Multimedia Appendix 3 Table S9 [124-150]). These include limited interoperability standards, ethical concerns around data usage, and unclear liability definitions for AI-driven healthcare decisions (Table 3).

Table 3. Common gaps and opportunities identified across national, international, government and regulatory agency frameworks.

Gaps	Opportunities
Limited interoperability standards between regions and systems [18, 21, 23, 80, 132, 156]	Establish global interoperability guidelines and promote national and cross-border data sharing protocols [159, 160]
Ethical concerns around data usage, privacy, and bias [107, 108, 125, 154, 157]	Develop nationally and globally recognized ethical frameworks for AI in healthcare [107, 125, 154, 161]
Lack of clarity around liability for AI-driven healthcare decisions [126, 145, 155]	Create legal frameworks that define liability and encourage responsible innovation [126, 145, 162]
Variability in the content scrutiny, implementation and enforcement of AI regulations across countries [124, 127, 147, 158]	Promote harmonization of regulations through multilateral collaborations, such as WHO or Organization for Economic Co-operation and Development (OECD) guidance [106, 125, 158]

Global and national regulatory bodies and regulatory agencies are responsible for protecting public health by ensuring the safety and effectiveness of digital technologies used in healthcare [107, 151-153, 163]. While the design of digital platforms, including universal platforms, may not always subject them to direct regulatory scrutiny [126, 145], any digital technologies, including AI, employed for healthcare purposes are consistently under regulatory oversight (Multimedia Appendix 3 Table S10 [151-153]).

Various technologies pose differing levels of risk to health and well-being, prompting regulatory agencies to adopt a risk-based approach in evaluating medical applications. This method balances the need to foster innovation and promote the broad adoption of digital health solutions while ensuring that high-risk technologies undergo appropriate regulatory scrutiny [124, 127, 133]. Agencies often encourage developers to engage early in the process to clarify the risk classification of their applications and determine if premarket approval is necessary [151-153].

Ethical frameworks vary significantly across countries, regions and professions, creating challenges for the implementation of a universal platform [107, 125, 154]. While healthcare ethics traditionally guide clinical decision-making, AI ethics emphasize responsible technology design and deployment [155, 164, 165]. Addressing these variabilities offers opportunities to create nationally and globally coherent ethical

frameworks (Table 4). Furthermore, the alignment of ethical principles for healthcare professionals varies by country, highlighting gaps and opportunities for interdisciplinary integration (Multimedia Appendix 3 Tables S11 [168-176] and S12 [168-201]).

Table 4. Gaps and opportunities identified in integration of ethics.

Gap	Opportunity
Variability in ethical frameworks across countries, regions and professions [107, 125, 154, 204]	Developing national unified ethical standards for healthcare and AI with possibility to progress to global unified standards. [125, 161, 166, 204]
Limited inclusion of AI ethics in traditional healthcare ethics training [161, 164, 167, 204]	Introducing AI ethics modules (specific training) for healthcare professionals' curricula across disciplines [166, 167, 204]
Lack of accountability mechanisms for AI developers in clinical settings [155, 158, 162, 202-205]	Establishing co-regulatory models involving healthcare professionals and AI developers [107, 158, 162, 202-205]

Feasibility of Universal Platform Implementation

The feasibility of implementing a universal platform varies based on healthcare system types [106, 163]. Fragmented systems, such as those in the United States, face more significant barriers due to diverse regulations and competition between private and public sectors [13, 147, 151]. Conversely, publicly funded systems, like the United Kingdom National Health Service (UK NHS), offer more straightforward integration pathways but risk slower innovation due to bureaucratic constraints (Multimedia Appendix 3 Tables S13 [13, 106, 107, 124, 127, 147, 151, 156, 163, 206-209] and S14 [163, 206-209]). Table 5 summarizes how different ethnic groups attributes might impact AI implementation in a universal platform, emphasizing the need for diverse data representation and culturally sensitive AI design.

Table 5. Analysis summary of how different ethnic group attributes might impact AI of the universal platform.

Aspect	Strengths	Weaknesses	Gaps	Opportunities
Data Diversity	AI trained on diverse datasets can identify trends across populations [210]	Data collection often underrepresents minority ethnic groups [211]	Lack of representative datasets for some ethnic groups leads to biased AI outcomes [157]	Developing national and global data-sharing frameworks to ensure diverse, inclusive datasets [158]
Health Disparity Insights	AI can help identify disparities in healthcare delivery and outcomes [106]	Algorithms may reinforce existing disparities if they reflect biased historical data [211]	Insufficient research on how algorithms interact with social determinants of health [33]	Leveraging AI to design tailored interventions for underrepresented groups [107]
Cultural Sensitivity	AI can personalize healthcare solutions based on cultural and ethnic contexts [158]	Algorithms may misinterpret or overlook culturally specific symptoms and behaviours [210, 211]	Few models incorporate sociocultural factors into healthcare predictions [154]	Engaging diverse stakeholders in AI design to embed cultural competence into models [107]

Aspect	Strengths	Weaknesses	Gaps	Opportunities
Ethical Compliance	Emerging regulations encourage fairness and equity in AI systems [125]	Lack of enforcement mechanisms for noncompliance [158]	Varying standards for fairness across regions hinder global adoption [154]	Harmonising AI ethics frameworks to address equity and inclusion globally [161]
Community Engagement	Community involvement can improve trust and adoption of AI systems [166]	Historical mistrust in healthcare systems may limit acceptance by minority groups [157]	Limited community participation in AI system development processes [162]	Building participatory models where communities co-design AI solutions with developers [107]
Regulatory Oversight	Regulatory bodies like GDPR and HIPAA encourage accountability [106]	Current regulations may not explicitly address ethnic diversity in AI healthcare systems [158]	Need for regulations specifically addressing bias detection and correction in AI [125]	Advocating for inclusive AI policies to protect underrepresented groups from harm [161]

Synthesis of results

A comprehensive framework and interdependencies established by the review, are reflected in Figure 3. This framework brings together key elements—including digital platforms, the challenges they face, the transformative impact of AI, the regulatory and ethical landscape, and practical feasibility aspects - to provide a holistic view of the path toward the universal AI-based digital platform.

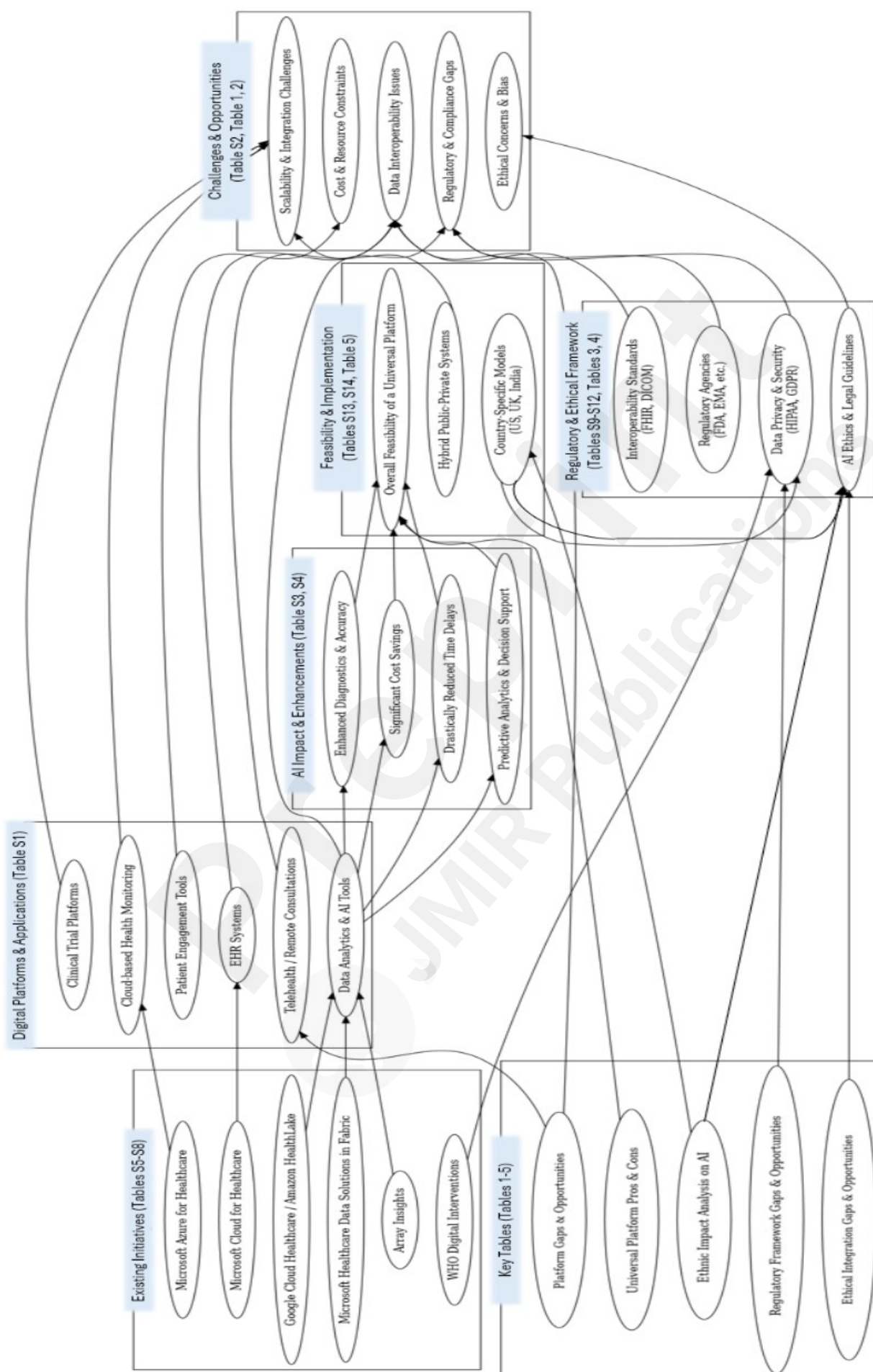


Figure 3. Integrated conceptual framework. A visualisation of findings from the main text Tables 1-5 and the Multimedia Appendix 3 Tables S1–S14 (partially AI-assisted image).

Discussion

Our research confirms that current digital platforms used in healthcare and life sciences cater to specific use cases while contributing to the broader goal of integrated healthcare and life sciences delivery [212]. For example, Epic EHR system [37] facilitates comprehensive electronic health record management, enabling seamless data sharing across healthcare providers [213, 214], while Teladoc Health [35] supports telemedicine through remote consultations [215]. Mobile technology including smartwatches provide opportunity for real-time health monitoring [216, 217]. Pharmaceutical platforms like Veeva Vaults and Systems [40, 42] facilitate clinical trials, regulatory compliance, and product lifecycle management [218]. AI-driven platforms like Microsoft Azure for Healthcare [58-60] and IBM Watson Health [43] offer predictive insights to optimize healthcare delivery [219]. Patient engagement tools like MyChart, a feature of the Epic EHR system [37] and MyTherapy, a personal, digital health companion [75] enhance patient-provider communication and self-management, respectively [220, 221, 222].

While the development of a comprehensive universal AI-based platform is theoretically feasible, challenges persist in scalability, regulatory compliance, data bias, and interoperability across national and cross-border systems [223]. Notable research efforts from organizations like the WHO [106, 112, 118-121] and industry leaders such as Microsoft [45-60] and IBM [43] aim to develop interoperable systems that unify healthcare operations [224]. Integrating platforms like Microsoft's Azure for Healthcare [58-60], Cloud for Healthcare [45-52], and Healthcare Data Solutions in Fabric [53-58] could address gaps in usability, data security, and workflow efficiency, creating a comprehensive digital ecosystem [225].

Key barriers to integration include fragmented systems, regulatory constraints, and accessibility challenges [226]. Many platforms struggle with data interoperability [227], making seamless communication between disparate systems difficult. Additionally, varying regulatory requirements across regions create hurdles for wider deployment [228]. Accessibility issues, particularly in smaller organizations with limited resources, further complicate widespread adoption. However, integration offers opportunities to expand AI capabilities, establish national and global standards, and design user-centric platforms [229].

The WHO's role in promoting digital health, particularly in low-resource settings, has been instrumental. Their digital health initiatives in countries like Vietnam and Kyrgyzstan focus on integrating maternal and child health with non-communicable disease management through digital tools [118, 119, 224]. Although these initiatives have achieved success, scalability and cross-border implementation challenges remain [230, 231]. These challenges align with the broader issues addressed in this paper—specifically, the need for a **universal AI-based platform** that can overcome fragmentation by ensuring **standardized data-sharing, AI-driven predictive analytics, and ethical interoperability across healthcare systems**.

The adoption of a universal AI-based platform may be more feasible in publicly funded healthcare systems due to standardized protocols and a greater openness to collaboration [213, 214]. These systems benefit from easier standardization and integration but also face bureaucratic delays and funding constraints. Fragmented healthcare systems encourage competition and innovation but encounter significant challenges in interoperability and scalability.

AI integration into a universal platform offers significant potential for personalized care [221], operational efficiency, and improved health outcomes [232, 233]. AI-driven diagnostics have demonstrated remarkable accuracy, speed and predictive analytics [234]. However, ethnic diversity significantly influences the design, deployment, and impact of AI systems [157]. AI models trained on non-representative datasets can lead to biased outcomes, as seen with early Google's dermatology AI model and pulse oximeters. Addressing these challenges involves retraining algorithms with diverse datasets, considering cultural factors, and engaging local communities in AI tool development [235, 236].

Review Established Conceptual Frameworks

The conceptual model concluded based on review is presented in Figure 4. Figure 4. Digital Platforms Ecosystem and Transforming Process Flowchart. This diagram shows how various digital platforms, together with their data and outcomes feed into an AI integration layer, which in turn enables the development of the universal AI-based digital platform in healthcare and life sciences. Surrounding this core process is the regulatory and ethical environment that both constrains and guides the platform's design and implementation.

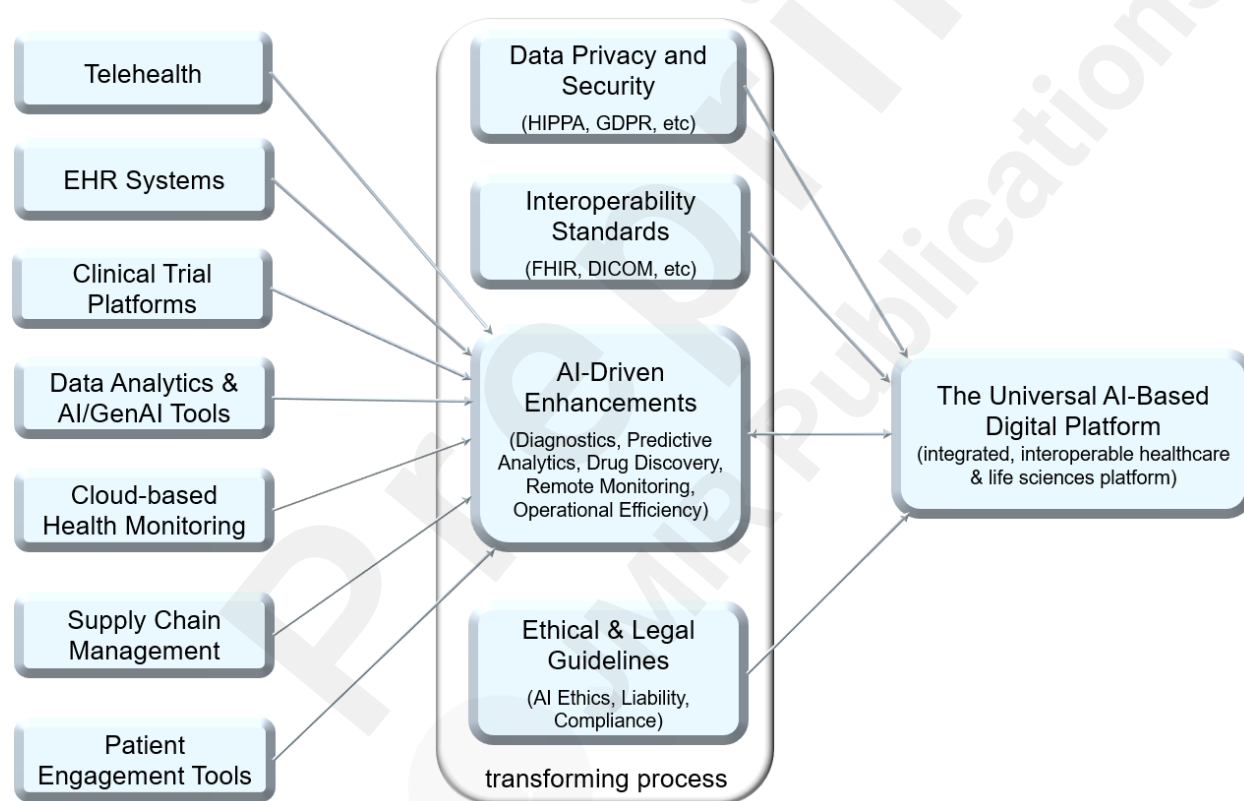


Figure 4. Digital Platforms Ecosystem and Transforming Process Flowchart.

Synthesis of Findings and Their Implications

The synthesis of key insights from our extensive review and analysis, drawn from Multimedia Appendix 3 Tables S1–S14 and Tables 1–5, provides a holistic view of the current landscape and its implications for developing the universal AI-based digital platform in healthcare and life sciences.

Digital Platforms and Operational Gaps

Our analysis begins with an overview of existing digital solutions (Table S1), which categorizes diverse platforms. These platforms are pivotal in supporting various aspects of healthcare and life sciences delivery. However, Table 1 and Table S2 reveal significant operational gaps, such as data fragmentation,

interoperability issues, and inefficiencies in service delivery. These findings emphasize that while current platforms serve specialized functions, their compartmentalized nature hinders a cohesive digital ecosystem. These shortcomings underscore the necessity for data format standardization which is essential step enabling a universal platform becoming capable of unifying disparate systems to enhance overall efficiency and patient care.

Transformative Impact of AI

Tables S3 and S4 provide quantitative evidence of AI's transformative impact. Evidence shows that AI-driven solutions can dramatically enhance diagnostic accuracy, reduce operational costs, and substantially decrease processing times. These improvements are further contextualized by Table 2, which outlines the pros and cons of developing a universal platform. The data collectively underscore the pivotal role that AI must play in bridging existing operational gaps and driving the performance enhancements required for an integrated system. Insights from existing fragmented platforms suggests that integrating AI into a universal platform that operates seamlessly across the entire healthcare ecosystem can lead to significant improvements in clinical decision support, predictive analytics, and overall system responsiveness.

Comparative Analysis of Existing Initiatives

Table S5 reviews current initiatives by major players like Microsoft, WHO, and Google toward more integrated digital solutions. Tables S6, S7, and S8 provide a comparative analysis of Microsoft's healthcare platforms, highlighting strengths and weaknesses. While these solutions offer robust features, they fall short in integration, scalability, and interoperability. The insights suggest a holistic approach that combines the best features of existing platforms while addressing their limitations.

Regulatory and Ethical Considerations

The regulatory and ethical landscape is examined in depth in Tables S9–S12 and further interpreted in Table 3 and Table 4. These tables highlight significant disparities and gaps in current regulatory and ethical frameworks—ranging from inconsistencies in data privacy standards (e.g., Health Insurance Portability and Accountability Act (HIPAA), General Data Protection Regulation (GDPR)) and interoperability protocols (e.g., FHIR, Digital Imaging and Communications in Medicine (DICOM)) to challenges in integrating AI ethics with traditional healthcare ethics. Harmonizing these frameworks is critical to ensure that a universal platform is safe, compliant, and ethically sound. Such alignment is essential not only for fostering stakeholder trust but also for enabling seamless national and cross-border integration.

Feasibility and Implementation Insights

Feasibility analyses presented in Tables S13 and S14, along with Table 5, which examines the ethnic impact on AI implementation, assess the practical challenges of implementing a universal platform in diverse healthcare settings. These analyses reveal that while the promise of a universal system is substantial, its success depends on developing adaptable, locality-specific solutions. Variations in healthcare infrastructure, economic resources, and cultural contexts must be considered. These findings underscore the need for pilot studies and hybrid public–private collaborations to tailor the platform effectively to different locality needs while ensuring scalability and sustainability.

Integrated Conceptual Framework

The comprehensive conceptual diagram (Figure 3) presented earlier synthesizes these themes by visually illustrating how:

- **Digital Platforms (Tables S1, S2, Table 1)** provide the foundational tools and simultaneously expose operational gaps.
- **AI Enhancements (Tables S3, S4, Table 2)** offer transformative benefits that can mitigate these gaps.
- **Comparative Analyses (Tables S5–S8)** highlight lessons learned from current initiatives, guiding future design.
- **Regulatory and Ethical Frameworks (Tables S9–S12, Tables 3, 4)** necessitate harmonization for safe and equitable implementation.
- **Feasibility Considerations (Tables S13, S14, Table 5)** identify practical challenges, national and regional adaptations needed for success.

This integrated framework offers a clear, visual synthesis of our extensive findings and sets the stage for targeted research and strategic action.

Implications for Future Research and Practice

In summary, our synthesis reveals that the path toward a universal AI-based digital platform requires addressing critical gaps in interoperability, regulatory harmonization, cybersecurity, and ethical alignment [212, 224, 230, 237-240]. Key research priorities include developing standardized data protocols, enhancing the transparency of AI models, and creating integrated regulatory frameworks [204, 205, 212, 238, 239, 240]. Future pilot studies should test the scalability of hybrid platforms in real-world settings, while strategic collaborations between academia, industry, and regulatory bodies will be essential to drive innovation and ensure widespread adoption [212, 238, 239, 240].

By integrating these multifaceted insights, our review provides a clear roadmap for future efforts aimed at developing a unified, efficient, and ethically sound digital platform that can transform healthcare and life sciences on a national and wider scale.

Elaboration of Review Identified Priorities

The next steps, pilot studies, and strategic collaborations are the review-identified priorities intended to guide further research and practical initiatives of the universal AI-based digital platform. They are directly derived from the critical gaps and opportunities identified in the review. They reflect the key areas—such as data interoperability, regulatory harmonization, explainable AI, and scalability—that emerged from the comprehensive analysis of digital platforms, AI integration, as well as the regulatory and ethical landscape.

Key Next Steps

Data Interoperability and Integration

- Develop standardized data formats and protocols (e.g., leveraging Health Level 7 (HL7) and Fast Healthcare Interoperability Resources (FHIR) standards) that enable seamless data exchange across diverse healthcare systems [16, 17, 21, 159].
- Investigate novel data governance models that support real-time integration while maintaining data quality and security [1, 80].

Regulatory and Ethical Harmonization

- Conduct comparative studies to map existing regulatory frameworks and identify gaps, with the goal of proposing alignment of national and unified international standards [20, 32, 107, 108, 204].

- Advance interdisciplinary research to merge AI ethics with traditional healthcare ethics, focusing on transparency, accountability, safety, and bias mitigation [32, 154].

Robustness and Explainability of AI Models

- Prioritize research on developing explainable AI techniques that ensure transparency in decision-making processes in clinical settings [87, 107, 108, 155, 101].
- Evaluate continuous learning mechanisms for AI tools to maintain performance as clinical data evolves [11, 91].

Feasibility and Scalability of Universal Platforms,

- Explore models for hybrid public–private digital platforms, with a focus on scalability and cost-effectiveness in diverse healthcare environments [6, 9, 13, 43].
- Study the long-term economic impacts and cost-savings associated with integrated AI-driven systems [78, 106].

Possible Pilot Studies

Integrated Digital Platform Pilots

- Implement a controlled pilot project within a locality and national healthcare systems that combines telehealth, HER systems integration, and AI diagnostic tools [79, 112].
- Monitor key metrics such as data flow efficiency, diagnostic turnaround times, and user satisfaction to assess scalability [8, 237].

Federated Learning and Secure Data Sharing

- Pilot a federated learning model across multiple healthcare institutions to test secure data sharing without compromising privacy [24, 67].
- Evaluate how well this model addresses interoperability challenges and supports real-time analytics [24, 60, 67].

Real-Time AI Diagnostic Trials

- Test AI-driven diagnostic systems (e.g., for imaging analysis or remote monitoring) in an emergency or critical care setting [8, 234].
- Measure improvements in diagnostic accuracy and response times compared to traditional methods [234, 236].

Ethical and Regulatory Framework Simulations

- Conduct simulation studies that mimic real-world ethical and regulatory scenarios to validate the effectiveness of proposed unified ethical guidelines and legal frameworks [126, 204].
- Include diverse patient demographics to assess how well the framework accommodates ethnical and cultural differences [198, 211].

Strategic Collaborations

Academic-Industry Partnerships

- Foster collaborations between research institutions, healthcare providers, life sciences, and technology companies (e.g., partnerships involving entities like Microsoft, Google, or Amazon) to co-develop integrated digital solutions [4, 48].
- Leverage academic expertise in data science and ethics alongside industry resources for large-scale pilot implementation [4, 78].

Government and Regulatory Engagement

- Collaborate with national and international regulatory bodies and agencies (such as the FDA, EMA, WHO, and OECD) to align pilot projects with evolving regulatory standards [151, 161].
- Participate in public–private partnership initiatives that aim to harmonize healthcare regulations nationally and internationally [151, 161].

Standards Organizations and Consortia

- Engage with bodies like HL7, International Organization for Standards (ISO), and Institute of Electrical and Electronics Engineers (IEEE) to drive the development and adoption of universal interoperability standards [60, 159].
- Form multidisciplinary consortia that include healthcare professionals, AI researchers, ethicists, life scientists, and policymakers to create an integrated roadmap for platform development [106, 204].

Patient Advocacy and Community Involvement:

- Involve patient advocacy groups early in the design and pilot phases to ensure that the universal platform is patient-centric and addresses privacy and accessibility concerns [28, 47].
- Establish feedback loops with community stakeholders to continuously refine the platform based on real-world needs and experiences [28, 121].

Limitations of this Scoping Review

This review is constrained by the availability of publicly accessible information, as proprietary AI models, data protocols, and platform designs are often protected by intellectual property rights, corporate confidentiality, and trade secrets. Additionally, critical insights from industry-led initiatives, unpublished pilot studies, and regulatory deliberations may not be fully disclosed, limiting the breadth of analysis. Variability in regional regulatory frameworks and ethical standards further complicates the synthesis of universally applicable findings, particularly in the absence of direct access to policy deliberations and proprietary legal interpretations. Lastly, given the rapid evolution of AI and digital platforms, new advancements may emerge beyond the timeline of this review, highlighting the need for continuous updates through stakeholder engagement and real-world pilot studies.

Conclusion

Digital platforms have immense potential to transform healthcare, pharmaceutical, biotechnological, and medical technology industries. Current AI-driven solutions, such as Microsoft's Azure for Healthcare, Cloud for Healthcare, and Healthcare Data Solutions in Fabric, illustrate how targeted approaches address specific challenges within these sectors. However, these remain fragmented, reinforcing the need for a fully integrated, universal AI-based platform.

A comprehensive universal AI-based platform can only be realized through robust collaboration among governments, private sectors, and international organizations. Overcoming challenges related to interoperability, regulatory frameworks, and ethical standards is crucial to realizing the full potential of a universal platform. By addressing these barriers, the platform can deliver equitable, efficient, and innovative solutions both nationally and globally. Integrating advanced AI and data analytics within a unified digital ecosystem can revolutionize healthcare delivery, streamline pharmaceutical development, and improve patient outcomes across diverse populations.

Ultimately, the growing demand for comprehensive, integrated digital health solutions underscores the urgency of developing a universal AI-based platform. **Future research must now shift toward defining the structure and scope of such a platform, proposing a comprehensive design, and formulating strategies for its development and implementation.** This includes aligning healthcare and AI ethics principles to ensure responsible, equitable, and effective technology integration. Practical steps should address cross-sector collaboration, regulatory alignment, and ethical frameworks to facilitate national and global adoption and maximize impact. By fostering cross-sector collaboration and ensuring an ethical, scalable, and user-friendly design, **the universal AI-based platform will be pivotal in shaping the future of digital healthcare and life sciences—enhancing efficiency, accessibility, and patient outcomes on a national and wider scale.**

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Conflicts of Interest

Rahela Penovski is the **Founder and Consultant at Cognedt Ltd, United Kingdom**, specializing in AI applications in medical affairs and clinical development. She is also a PhD student at the **Faculty of Pharmacy, University of Ljubljana**. Her consulting activities did not influence the content or conclusions of this manuscript. **Professor Reinhold Scherer** and **Professor Stanko Srčič** declare no conflicts of interest.

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Abbreviations

AED	Automated Defibrillator
ADA	American Dental Association
AI	Artificial Intelligence
AMA	American Medical Association
ANA	American Nurses Association
APhA	American Pharmacists Association
API	Application Programming Interface
AWS	Amazon Web Services
CCPA	California Consumer Privacy Act
CDA	Canadian Dental Association
CDPA	Virginia Consumer Data Protection Act

CMA	Canadian Medical Association
CNA	Canadian Nurses Association
CPRA	California Privacy Rights and Enforcement Act
CPA	Colorado Privacy Act
COVID-19	Corona Virus Disease 2019
CTDPA	Connecticut Data Privacy Act
DCI	Dental Council of India
DICOM	Digital Imaging and Communications in Medicine
DORA	Digital Operational Resilience Act
EHR	Electronic Health Records
EMA	European Medicines Agency
EU	European Union
FDA	Food and Drug Administration
FHIR	Fast Healthcare Interoperability Resources
GDA (BZÄK)	German Dental Association (Bundes Zahnärzte Kammer)
GDC	General Dental Council
GDPR	General Data Protection Regulation
GenAI	Generative Artificial Intelligence
GFCPh (BAK)	German Federal Chamber of Pharmacists (Bundes Apotheker Kammer)
GMA (BÄK)	German Medical Association (Bundes Ärzte Kammer)
GMC	General Medical Council
GNA (DBfK)	German Nurses Association (Deutscher Bundesverband für Pflegeberufe)
GPhC	General Pharmaceutical Council
HiCC	High-Cost Claimants
HIPAA	Health Insurance Portability and Accountability Act
HITRUST	Health Information Trust Alliance
HL7	Health Level 7
HPC	Related to Azure
HPCSA	Health Professions Council of South Africa
IAB	Interactive Advertising Bureau
IAM	Identity Access Management
IBM	International Business Machines Corporation
ICT	Information and Communication Technology
ICU	Intensive Care Unit
IEEE	Institute of Electrical and Electronics Engineers
INC	Indian Nursing Council
ISO	International Organisation for Standardization
JDA	Japanese Dental Association

JMA	Japan Medical Association
JNA	Japanese Nursing Association
JPA	Japanese Pharmaceutical Association
mHealth	Mobile Health
MA	Marketing Authorisation
MCI	Medical Council of India
MHRA	Medicines and Healthcare products Regulatory Agency
MIT	Massachusetts Institute of Technology
ML	Machine Learning
MRI	Magnetic Resonance Imaging
NAPRA	National Association of Pharmacy Regulatory Authorities
NIST	National Institute of Standards and Technology
NLP	Natural Language Processing
NMBA	Nursing and Midwifery Board of Australia
NMC	Nursing and Midwifery Council
OECD	Organization for Economic Co-operation and Development
PCI	Pharmacy Council of India
PET	Privacy Enhancing Technology
PRISMA-ScR	Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews
RMF	Risk Management Framework
SADA	South African Dental Association
SAIL	Secure AI Labs
SANC	South African Nursing Council
SAPC	South African Pharmacy Council
SDOH	Social Determinants of Health
SME	Small and Medium Enterprise
TCF	Transparency and Consent Framework
UHC	Universal Health Coverage
UK	United Kingdom
USA	United States of America
WHO	World Health Organization

Multimedia Appendix 1

PRISMA-ScR checklist

Multimedia Appendix 2

Table A

Multimedia Appendix 3

Tables S1-S14 detailing platform types, gaps, regulatory frameworks, and ethical considerations.

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Supplementary Files

Multimedia Appendixes

PRISMA ScR Fillable Checklist.

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Table A.

URL: <http://asset.jmir.pub/assets/ee1f3f37e39e9a1b86b800d1d6a8f464.docx>

Table S1-S14.

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