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RESEARCH ARTICLE

Overcoming Challenges for Improved Patient-Centric Care: A Scoping Review of Platform Ecosystems in Healthcare

MBANEFO C. CHIBUIKE[1], SARA S. GROBBELAAR[1,2], AND ADELE BOTHA[1,3]
[1]Department of Industrial Engineering, Stellenbosch University, Stellenbosch 7600, South Africa
[2]DSI-NRF CoE in Scientometrics and Science Technology and Innovation Policy (sciSTIP), Stellenbosch University, Stellenbosch 7600, South Africa
[3]Department of Industrial Engineering, Council for Scientific and Industrial Research (CSIR), Pretoria 0001, South Africa

Corresponding author: Sara S. Grobbelaar (ssgrobbelaar@sun.ac.za)

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ABSTRACT In recent studies, platform ecosystems, an extension of business ecosystems, have emerged as highly disruptive mechanisms for generating value within various industries. The transformative influence of digital technologies on conventional business landscapes is increasingly evident, facilitating inclusive and sustainable development. However, realizing value co-creation within digital platform ecosystems faces formidable hurdles in healthcare, primarily attributed to the complex challenges surrounding privacy, security, and effective data governance. Following the Joanna Briggs Institute Guidelines for scoping reviews, the study explores the extent literature on the integration of digital platform ecosystems in healthcare. The contribution of this article is to explore the applications of platform ecosystems in healthcare delivery, specifically focusing on electronic healthcare records, smartphones, artificial intelligence, big data, the Internet of Things, and blockchain technologies. The research identifies and discusses the challenges of implementing these technologies in the healthcare industry. Furthermore, the study proposes a healthcare platform ecosystem framework, integrating communication strategies, GDPR compliance, and architectural components. This study synthesizes the extant literature to formulate a theoretical healthcare ecosystem framework for improved patient-centric care. The review and resultant framework is intended to support understanding of digital health dynamics and guides healthcare organizations, technology developers, and policymakers in ensuring data security, compliance and interoperability.

INDEX TERMS Platform ecosystems, healthcare, applications, challenges.

I. INTRODUCTION

In recent studies, platform ecosystems (PEs), an extension of business ecosystems, have emerged as highly disruptive mechanisms for generating value within various industries [1], [2], [3], [4]. PEs represent "a collaborative network of a focal firm with autonomous actors integrating resources around a platform for value creation" [5]. The realization that the conventional business structure, which directly links producers and consumers, no longer remains sufficient has led to the emergence of the platform model [1], [6], [7]. This innovative PE approach has introduced novel relationships between consumers and producers, facilitating collaborative value co-creation, exchange, and consumption [6], [7]. Consequently, the platform's market potential surpasses that of individual participants within the ecosystem by offering a conducive and symbiotic environment fostering an enhanced landscape for value generation and exchange [1]. Over the last two decades, platform ecosystems have emerged as vital components across various industry sectors, including marketplace giants like Amazon and eBay, ride-sharing services like Uber and Bolt, leading information and communication technology platforms like Android OS and iOS, and housing services like Airbnb [8], [9], [10].

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The PE's mechanism of multi-actor engagement is widely explored in literature as a structure for value co-creation, with efforts towards adapting it to the healthcare sector [11], [12], [13]. Regardless of the form and sector of application, Olsson and Bosch [14] outlined the essential properties of PEs to include platform orchestrator, multiple participants, platform technology and resource integration. Thus, PEs in healthcare would comprise interconnected service platform providers and healthcare institutions that integrate complementary resources and collaborate under a platform to create economic value [15]. This implication, alongside evidence from Faggini et al. [16], Orefice and Nyarko [17], and Kapoor and Agarwal [10], suggests how sustainability of value can be pursued for healthcare through PEs.

Despite this growing interest in PEs, their integration into healthcare is yet to be fully achieved. Existing knowledge regarding PEs in healthcare primarily explored potential applications, e.g. [18], [19], [20], [21], and [22] have focused on their utilization in electronic health records, the Internet of Things, smartphones, big data, blockchain, and AI. Others have focused on barriers towards adoption and usage, e.g. [23], [24], [25], [26], and [27] highlighted critical issues such as privacy, security and interoperability concerns. However, this present understanding of the potential healthcare applications of PEs and the challenges they may encounter related to successful implementation in other industries, such as automobile, ICT, and e-commerce, is yet to drive substantive progress in the healthcare sector. Moreover, a paradigm shift has emerged, viewing healthcare as a business entity rather than a social intervention [28]. This perspective is pivotal in fostering collaboration among service providers and decentralizing healthcare to alleviate the burden on physicians, including the available volume of patient data, increasing technological capabilities, specialized healthcare processes, and the increasing need for system integration while enhancing care delivery [29].

This study contributes to the literature on PE's multi-actor engagement approach and overcoming the barriers towards practical application in healthcare. By conducting a scoping review on platform applications in healthcare, we provide a theoretical background examining the current state of literature in this area. We draw on the research question: *How can platform ecosystems contribute to overcoming challenges in healthcare and enhancing patient-centric care?* This study synthesizes the extant literature to formulate a theoretical healthcare ecosystem framework for improved patient-centric care.

Following the laid-out theoretical background on platform and healthcare ecosystems in Section II, the structure of the rest of the paper follows the scoping review methodology and results analysis in Sections III and IV, respectively. Section V discusses the state of research in the field and the future of platform ecosystem development in healthcare. The conclusion, including the study limitations and recommendations, is presented in section VI.

II. THEORETICAL BACKGROUND

A. PLATFORM ECOSYSTEMS

The concept of ecosystem was first popularized in business literature in the 1990s, referring to actors and factors that facilitate or constrain businesses in a particular area [30]. For managers and management scholars, this notion of ecosystems was showcased to explore how IBM PC's power of modular technical systems combined with managed business ecosystems [30], [31], [32]. This collaborative approach of a network of actors integrating resources around a digital platform for value co-creation is now referred to as a platform ecosystem [5].

Platform ecosystems (PEs) emerged in various industries, which have made significant strides in tackling problems related to limited resources, resource allocation, infrastructure, and leadership. This is achieved by aggregating actors within a platform facilitating interaction and collaboration [33], [34], [35]. By bringing together diverse stakeholders possessing different resources, mutually beneficial relationships can be fostered to utilize the available resources for creating customer value [12], [36], [37]. These ecosystems form resilient structures that promote inclusive and sustainable innovations, contributing to economic growth and industrialization [38].

Moreover, the rise of digitization and globalization has increased the participation of entrepreneurs and consumers in the sharing economy [39]. Wei et al. [40], Ceccagnoli et al. [41], and Zhang et al. [42] have reported early findings on multi-sided digital platforms across various sectors such as retail, transportation, asset sharing, and professional services. Over the past decade, these platforms have experienced significant growth to meet the needs of consumers and providers [8], [43].

In theorizing PEs, three layers of abstraction have emerged for researchers: a platform as an information system, a system for actor engagement and an ecosystem [44], [45]. These conceptualizations have aimed to provide a framework for designing PEs supporting innovation, management and co-creation [45]. As information systems, platforms are viewed as structures in an environment offering value propositions to third parties [44]. As a system for actor engagement, the platform is contextualized as a system where third parties can engage in the value proposition offered by the platform owner [44]. This interaction between the participants can be transactional or innovative contributions [44]. In this contribution, the authors conceptualize the platform as an ecosystem of internal factors and environmental dynamics [44].

Despite these advancements in value co-creation frameworks for theorizing digital multisided platforms, scholars have yet to agree on an adaptable structure for advancing this approach in healthcare. Alternatively, the potential applications and challenges to successful adoption in the sector have been accounted for.

B. PLATFORM ECOSYSTEMS IN HEALTHCARE

PEs in healthcare, like other ecosystems, focus on delivering value to the customer (patient) while fostering positive reinforcement among various actors involved [46], [47]. The advent of electronic health (eHealth) and mobile health (mHealth) has leveraged information and communication technologies to enable home-based care, support continuous self-care and autonomous care, and reduce friction-related[1] costs between care providers [46], [48]. The digitization of healthcare has opened up opportunities for collaboration and interaction between healthcare providers and consumers or patients, driving technological innovations in the field [12], [46]. Given this novel approach, Singal [46] further emphasized that the capabilities defining healthcare ecosystems will include i) traditional care modalities, such as direct care, pharmaceuticals, and providers ii) the evolution of patient-centric home-based care; iii) community-based holistic social care; iv) wellness through daily activities and v) healthcare infrastructure and financial support.

Consequently, healthcare PEs are emerging as a reoccurring innovation mechanism involving digital technology, multiple actors, activities, and mutually beneficial [49]. This network-centric approach emphasizes innovation and connectivity, transforming shared assets and resources into new products and services [7], [9], [49]. Schiavone et al. [11] expanded on healthcare value co-creation beyond collaboration by emphasizing the importance of digital business model integration. Their multi-stakeholder ecosystem analysis provides foundational elements for discussing value creation and integration of platform ecosystems in healthcare [11]. Yet, this analysis only focuses on ridesharing services in healthcare, requiring a holistic consideration of complex and varied models of resource integration across the sector.

Furthermore, as patient's needs commonly serve as the defining element of the healthcare ecosystem, there is the need to constantly evaluate impacts and modify frameworks for actor relationships within the ecosystem. Therefore, identifying the structure and components of a healthcare ecosystem reduces the complexity and provides a holistic view of its actors.

Structurally, the healthcare systems consist of hospitals, healthcare service providers, government (including regulators and policymakers), independent organizations (including pharmaceutical and insurance companies), non-profit organizations and patients [50], [51]. As an integrated ecosystem, this represents a connected network of various actors sharing resources for value co-creation. While the system's resilience continues to be stretched, the recent coronavirus pandemic has underlined the immense potential of digital transformation and networks to transform healthcare's future and improve patient care quality [52].

[1] Business friction relates to impediments that prevent products or services from entering the market or being purchased by customers. This includes capital, capability, technology, distribution channels and other factors of production.

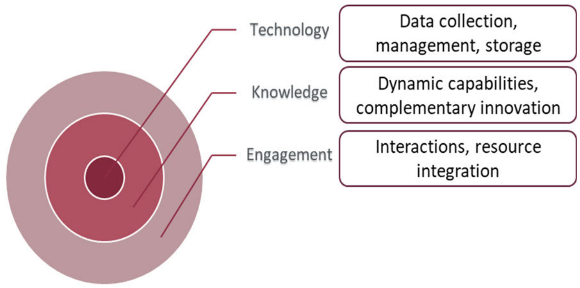

FIGURE 1. Component layers of platform ecosystems [53].

Its component layers can revolve around the user's technology, knowledge, and engagement [53]. The ecosystem's technology layer typically serves as the foundational infrastructure embedded within the platform by the owner or orchestrator to facilitate operations [12], [53], [54]. This layer encompasses data collection, management, and storage channels specific to the healthcare ecosystem [53].

The ecosystem's knowledge layer involves the various players' dynamic capabilities and the platform's complementary innovations [5], [53]. Lastly, the engagement layer outlines the strategies for interactions and resource integration among the diverse healthcare providers participating in the ecosystem [12], [53].

Several reports have suggested that the PE mechanism improves the workflow efficiency of actors and facilitates value-creating interactions between service providers and consumers [39], [51], [55]. However, it is worth noting that only a limited number of studies have focused on platform ecosystems in healthcare, and there is a substantial gap in the literature concerning platform ecosystems in integration in the sector.

C. APPLICATION AND CHALLENGES OF PLATFORM ECOSYSTEMS IN HEALTHCARE

While digital technology has revolutionized the traditional modes of health service delivery [56], improving healthcare access and patient outcomes [57], reducing costs [23], [26], and overall healthcare efficiency [58], the evolution of ecosystems is yet to be fully witnessed in healthcare.

Digital technologies in healthcare range from tools and platforms, including electronic health records (EHR), mobile medicine, healthcare applications, wearable devices, artificial intelligence (AI), Internet of Things (IoT), and data analytics [23], [26], [29], [56]. These platforms provide patients with several functions, such as online consulting, information support, routine monitoring, and access to healthcare [56]. For care providers, the platforms present an opportunity to interact, exchange information, and co-create value [23], [56], [59]. Given its immense potential, Ding et al. [56] have estimated the growth of digital products and services to a market share of 12% within the healthcare industry.

Unfortunately, this growth of digital platforms in healthcare has not come without significant challenges. Health information exchange is often limited by security, privacy, and interoperability concerns [24], [25], [60]. These problems of sensitive data breaches, personal information privacy, leakage, and unauthorized third-party access have made it incredibly difficult for healthcare platforms to achieve the same success as other industries such as automobile, ICT, and e-commerce [24], [25]. Volkov et al. [29]. and Schiavone et al. [11] have further suggested that addressing these challenges requires collaboration between various actors in the healthcare ecosystem and is critical to harnessing the potential of digital technology in healthcare [11], [29].

However, prior research in healthcare ecosystem is yet to fully focus on how this value co-creation approach of the ecosystem can be successfully integrated in the healthcare sector. While we acknowledge that studies on healthcare value co-creation are still in their infancy [56], the knowledge of applications and challenges has not been sufficient in driving progress.

III. SCOPING REVIEW METHODOLOGY

The methods for this study were developed using the Joanna Briggs Institute Guidelines for carrying out scoping reviews [61]. Using this framework, there are five (5) different steps: (i) Protocol, title, background, review questions, and objectives; (ii) Eligibility criteria and comprehensive searching to identify sources of evidence; (iii) Selection of relevant sources of evidence or screening (iv) Extracting and charting the results (v) conclusion and implications [61]. This article followed the steps outlined above.

A. REVIEW QUESTIONS AND OBJECTIVES

Since the study was motivated by the potential value of digital platform-based ecosystems as an improved mechanism for business development in healthcare, this scoping review aimed at identifying critical applications and challenges in the existing knowledge base for healthcare platform ecosystem development. Following this aim, the research question developed for the study is stated as follows: *How can platform ecosystems contribute to overcoming challenges in healthcare and enhancing patient-centric care?* Therefore, the study's objectives were to identify critical applications and challenges in the reports and suggest ways of addressing the challenges in developing healthcare platform ecosystems.

B. SEARCH STRATEGY AND DATABASES

The study employed a two-domain search approach to enhance the search potential. The first domain focused on healthcare and platform ecosystems, while the second domain centered on their applications or outcomes. This selection aimed to explore a specific aspect of healthcare platform ecosystems, ensuring empirical insights for the study. A meticulously designed search strategy was developed, utilizing specific combinations for databases to optimize the search and selection process [62], [63]. Free-text terms were generated for healthcare platform ecosystem outcomes, and electronic databases such as Scopus, Web of Science, and Cochrane Library were extensively searched to encompass a wide range of literature in the field. The search was restricted to English-language publications from 2013 to 2023. The obtained results were analyzed using CSV format and the Bibliometrics software. The search was conducted on the 24th of March, 2023, and the detailed search strategy can be found in Table 2.

TABLE 1. Eligibility criteria for the scoping review.

Category	Inclusion Criteria	Exclusion Criteria
Category 1 – C1 Paper type Language Relevance	Title and abstract focus on the keywords (healthcare ecosystems, healthcare platforms, applications, outcomes, or related fields). Article or conference publications. The report defines keywords and focuses on research questions.	Full text is unavailable. Non-article or conference publications. The report is not in English. The report is not related to the research question.
Category 2 – C2 Empirical soundness Academic rigor	Article methodology. Validity of study. The article compares theories on keywords and shows an actual empirical application.	Duplication of reports from databases. The report fails to meet the inclusion criteria.

TABLE 2. Search strategy for the scoping review.

Concepts	Search Terms
Healthcare Platform Ecosystem and Application	("Healthcare ecosystems" OR "healthcare platforms" OR "healthcare platform ecosystems") AND ("applications" OR "outcomes" OR "prospects" OR "challenges")

C. ELIGIBILITY CRITERIA

The studies, irrespective of their definitions of healthcare platform ecosystems, reported research on the applications or challenges of digital platform-based ecosystems to healthcare and the prospects in healthcare delivery. A study was deemed fit and included if it evaluated any outcome related to healthcare ecosystems, healthcare platforms, and their applications or outcomes. Studies with no result on these outcomes and risks, pitfalls, and prospects of platform ecosystems for healthcare were excluded from the research. Table 1 shows the eligibility criteria for the inclusion and exclusion of reports for the study.

D. STUDY SELECTION

The selection of the review reports followed a search of the combination of terms in the databases previously mentioned. Two levels of screening were done. Level one screening focused on the titles and abstracts of the retrieved reports; level two focused on full-text screening of selected reports following the study's inclusion/exclusion criteria.

1) LEVEL ONE SCREENING

During the initial screening phase, the titles and abstracts of the identified sources were independently evaluated against the predetermined eligibility criteria. This ensured that the criteria effectively identified articles relevant to digital platform-based ecosystems and their prospects in healthcare delivery. The literature search across databases yielded 434 reports, encompassing various publication types such as journal articles, conference papers, book chapters, reviews, and books. In the first screening level, 87 reports were excluded based on paper type, 23 were excluded due to pre-2013 publication dates, and one non-English report was excluded. Consequently, 323 reports advanced to the following screening phase. In the subsequent screening, 260 reports were deemed irrelevant or did not provide the required outcome, and an additional five reports could not be retrieved in full text. This resulted in a remaining set of 58 journal articles and conference papers for the second screening level.

2) LEVEL TWO SCREENING

The articles that passed the first screening level were subjected to independent full-text screening to ensure they met the predetermined selection criteria for inclusion/exclusion, providing the desired outcomes and adherence to study eligibility criteria. In the second screening level, 58 articles were thoroughly examined against the inclusion/exclusion criteria. While some reports fell within the broader topic of ecosystems, they failed to address the potential outcomes associated with the application of platform ecosystems in healthcare, including aspects such as value co-creation and resource integration. As a result, 34 reports were excluded for unrelated outcomes, three duplicates were removed, and one report was excluded due to a lack of adherence to scientific methods necessary for robust and unbiased results. A final set of 20 reports was selected for data analysis and synthesis, as depicted in Figure 1, representing the data selection process for the scoping review.

E. DATA EXTRACTION, CODING AND CHARTING

Following the final selection of 20 papers included in the review, the study data of the reports were extracted and verified from the sources. A cyclic coding process was followed for the review to identify the themes relating to the application of platform ecosystems in healthcare. The first coding cycle involved reviewing the selected reports to generate one-word or short phrase descriptive codes summarizing the primary themes of the reports [65], [66]. Similarly, the second coding cycle involved segregating, grouping, and linking the data to make sense of the codes. This process of codifying and categorizing generates a sense of pattern and focus needed to organize similar codes [65]. The study characteristics

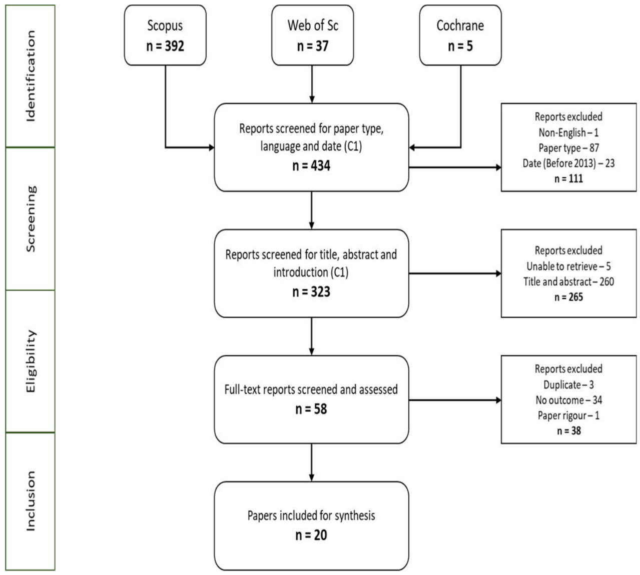

FIGURE 2. Scoping review data selection process [64].

TABLE 3. The different structures of the selected reports.

Data	Analysis	Information Extracted
Study data	Descriptive/bibliometric analysis	Document information Author analysis Sources and citation Study setting Thematic map
	Inferential analysis (using Atlas.ti and MS Word)	Research focus Research methodology/output Platforms/applications/outcomes/challenges Main findings Recommendations Implications Themes/applications/challenges

included author names, publication year, sources, publication type, title, design, keywords, inclusion criteria, setting, population, healthcare platform ecosystems, application, and outcomes. This was also compiled, synthesized, and downloaded into MS Excel sheets for validation. The charts in the results and analysis section include tables and figures to reflect the results.

IV. RESULTS AND ANALYSIS

The first analysis stage for the selected reports was descriptive and was achieved using the RStudio software for bibliometrics (Bibliometrix). Hence, the information extracted was summarised under main document information, author analysis, sources, citation, study setting, and thematic map. Similarly, the second stage analysis utilized Atlas.ti and MS Word to comprehensively analyze and extract the reports' content. The detailed examination of the reports broke down the content structure into research focus, methodology, outcome, main findings, themes, recommendations, and implications.

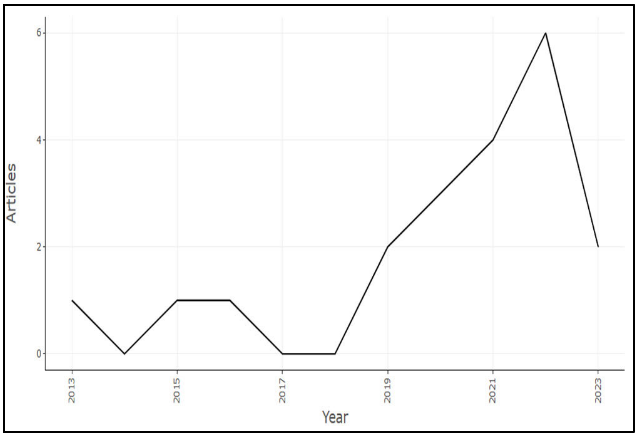

FIGURE 3. Selected reports publication timespan.

A. BIBLIOMETRIC ANALYSIS

The data set of 11 peer-reviewed journal articles and nine conference papers (including lecture notes) comprised reports from 2013 to 2023. Three, four, and six selected reports were published in 2020, 2021 and 2022, respectively. More so, two of the reports were published in 2023. Figure 3 shows the production timespan of the selected reports. The reports show an annual growth rate of 7.18%.

The selected reports were published in 18 different sources, with the Journal of Business Research (JBR) and Technological Forecasting and Social Change accounting for two (2) publications each. Table 4 ranks the most relevant sources and their impact measurement for the review. This evaluates the cumulative impact of the journal's output and performance. Regarding this, the Journal of Business Research has the highest h, g, and m index factors of 2, 2, and 0.667, respectively, while Healthcare has the highest total citations of 218. Ultimately, this shows the local impact of the journals and the selected publications. As many reports have been published recently, the local impact is expected to increase as the field grows. TC, NP, and PY are Total Citations, Number of Publications, and Publication Year, respectively.

In analyzing the setting of the selected studies, Figure 4 shows the countries of author affiliations in the database. This shows the frequency of geographical settings amongst the 68 authors responsible for the studies in our database. As depicted in the figure, the regions denoted by thick blue colors represent geographical locations with a substantial concentration of production activities. Conversely, light blue areas indicate regions with lower report densities observed within the specific reports under consideration. Eighteen countries are represented within this geography, and most authors are from Italy, the USA, China, Germany, and Japan. No study in our sample had a South American or African-affiliated author, indicating lower levels of research activity in our study area in these regions.

Examining trending topics and the evolution of themes within a specific domain is crucial for gaining a comprehensive understanding of the research landscape. Figure 5 categorizes the identified themes into distinct quadrants based on their developmental status and significance within the field.

TABLE 4. Local impact of reported sources.

Element	H Index	G index	M index	TC	NP	PY Start
Journal of Business Research	2	2	0.667	44	2	2021
23rd Annual International Symposium of the International Council of Systems Engineering, INCOSE	1	1	0.091	1	1	2013
ACM International Conference Proceeding Series	1	1	0.250	5	1	2020
California Management Review	1	1	0.500	3	1	2022
Healthcare	1	1	0.125	218	1	2020
Journal of Business and Industrial Marketing	1	1	0.250	22	1	2020
Proceedings – IEEE International Enterprise Distributed Object Computing Workshop, EDOCW	1	1	0.333	3	1	2021
Proceedings of the IEEE International Conference on Software Engineering and Service Sciences, ICSESS	1	1	0.200	2	1	2019
Smart Innovation, Systems, and Technologies	1	1	0.200	2	1	2019
Technological Forecasting and Social Change	1	2	0.333	36	2	2021
Technovation	1	1	0.500	1	1	2022

In the upper-right quadrant, we encounter motor themes that occupy a pivotal position, being well-developed and significant to the research domain [67]. This signifies their established relevance, and the analysis essentially reaffirms their centrality to the broader discourse. These themes likely serve as the backbone of existing knowledge and practices in the field.

Conversely, the upper-left quadrant accommodates niche themes, characterized by their high level of development but marginal importance within the domain [67]. While these themes exhibit a specialized depth, they remain somewhat isolated from the mainstream discourse. Their existence

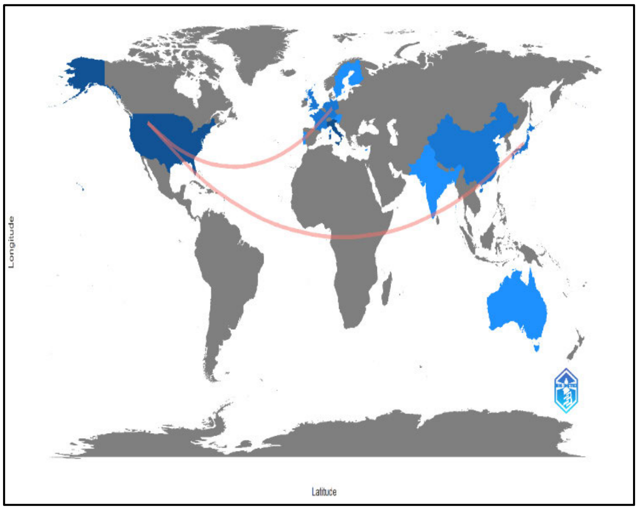

FIGURE 4. Countries' scientific production and collaboration.

outside the central sphere of the field might suggest limited applicability or relevance to broader research endeavors.

The lower-left quadrant provides intriguing insights into emerging or declining themes, occupying a space where themes are weakly developed and only marginally connected to the field's core [67]. This quadrant becomes a fertile ground for exploration as it unveils potential shifts in research focus or identifies themes on the verge of gaining prominence or fading into obscurity. Investigating these themes may uncover opportunities for innovation and novel contributions.

Lastly, the lower-right quadrant sheds light on important basic themes that, despite their significance, may not be thoroughly developed [67]. This implies that while these themes hold intrinsic importance, there is room for further exploration and expansion. This quadrant becomes a target for researchers seeking to delve into foundational aspects of the field, aiming to contribute to the refinement and deepening of essential knowledge.

Given these observations, our study focuses on themes spanning the basic, niche, and emerging categories. By doing so, we aim to contribute to the holistic understanding of the field and position our research to acknowledge the established pillars, explore untapped potential, and anticipate future directions within the domain.

B. INFERENTIAL DATA ANALYSIS

The inferential analysis examines the contextual elements of the sources in our database to discover patterns and arrive at specific research conclusions. It is important to note that two researchers may arrive at different conclusions using the same sample data during inferential analysis. The research focus of the papers revolved around healthcare ecosystems and the applications of digital platform services in healthcare delivery. Several sources [18], [19], [20], [21], [22] focused on digital platform applications in healthcare through the Internet of Things (IoT), smartphones, blockchain, AI, and the barriers towards adoption and usage. Moreover, several scholars have reinforced the significance of data privacy, security, and interoperability concerns as obstacles to the utilization of digital platforms within healthcare delivery [15], [23], [24], [25], [26], [27].

1) DIGITAL PLATFORMS IN HEALTHCARE DELIVERY

Similar to their application in various industries, digital platform ecosystems have found their usefulness in healthcare delivery. These ecosystems are characterized by a wide range of actors; internal (comprising patients, medical practitioners, nurses, government bodies and healthcare institutions) and external (encompassing academic researchers, non-governmental organizations and public institutions). Collectively, these actors are adapting their enterprise architecture to co-create value [68]. Drawing from the early works of Frishammar et al. [21], digital platform ecosystems within the healthcare context can be defined as modular technological structures or infrastructures that facilitate interactions between patients and care providers, adhering to established standards.

Given the development and evolution of healthcare delivery, these PEs offer patients and service providers various services and functionalities, thereby enhancing communication channels and fostering collaborative value creation. The advent of these technological advancements have given rise to opportunities and challenges for enterprises [18]. While the potential pitfalls encompass user resistance, technology adoption hurdles, and concerns surrounding data privacy and security breaches, the benefits include expanded access to information and the facilitation of virtual interactions between patients and healthcare providers [11], [18], [21].

It is therefore important to acknowledge that digital platform ecosystems in the healthcare sector are still in the early stages of their emergence. However, the integration of digital technology into healthcare practices has been a continuous process over time. The common application of technology in healthcare delivery include electronic healthcare records and smartphones [19], [68], [69]. With further technological advancements, the Internet of Things (IoT) [18], [19], artificial intelligence (AI) [20], big data analytics [18] and blockchain technologies [20], [70] are now emerging with the potential to revolutionize healthcare delivery. The primary goals of these applications are to enhance communication and collaboration in the industry, improve access to healthcare, and efficiently manage patient data [19], [27], [69], [70]. Figure 6 represents the frequency of the primary application areas of digital platform ecosystems mentioned in the reported studies. We now further unpack these categories and reflect on them.

a: ELECTRONIC HEALTH RECORDS

Over the past decade, Electronic Health Records (EHR) have become central to digital healthcare systems worldwide, including countries like the United States of America and

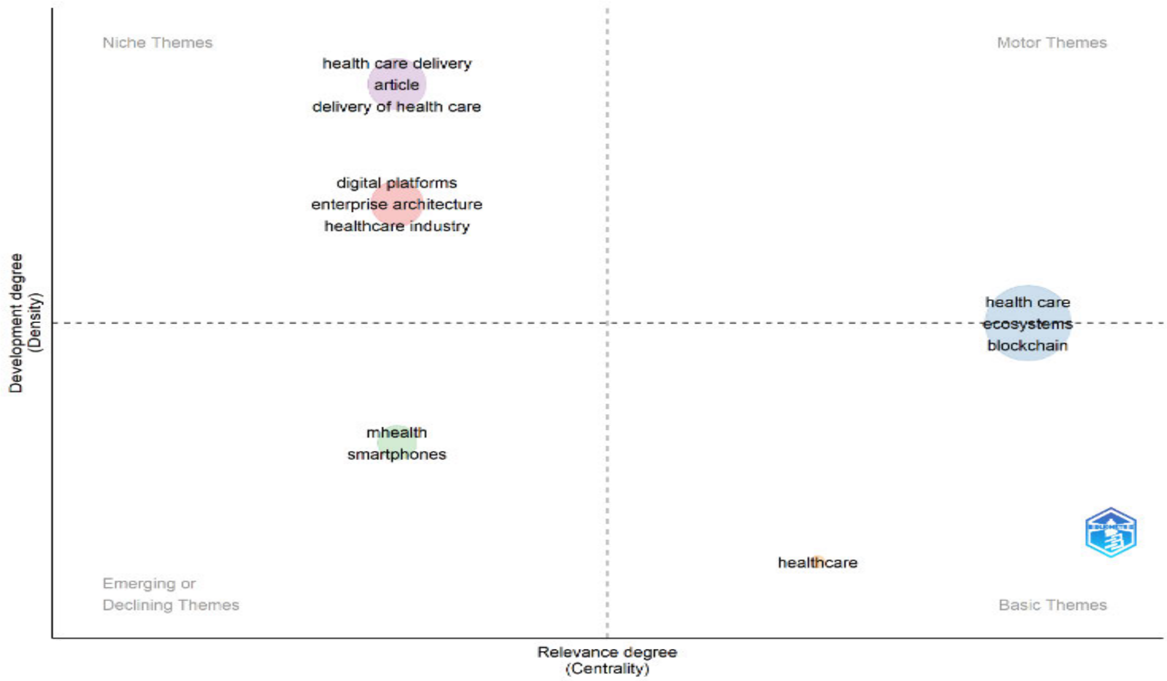

FIGURE 5. Thematic map of the study.

Australia [69]. They are digital representations of essential patient information, encompassing medical history, laboratory results, and medications [69]. As a result, there has been a growing emergence of platforms aimed at tracking clinical data and facilitating collaboration between patients and healthcare providers [20]. These platforms include remote applications designed to monitor patients' health conditions, utilizing available data to provide real-time insights [68]. For instance, Volkov et al. [29] reported that the Apple ecosystem incorporates CareKit, a digital platform facilitating connectivity among healthcare service providers and enabling patient data collection for disease research. Similarly, Microsoft HealthVault, introduced in 2007, plays a pivotal role in incentivizing the transformation of analog medical data into digital formats, securely storing them in readily accessible cloud-based databases [29], [68]. Through incentivizing the conversion of analog data into digital formats and storing them in easily accessible databases, EHRs could be impacting areas such as prescriptions, drug lists, management of allergies, and other related secondary uses [71], [72].

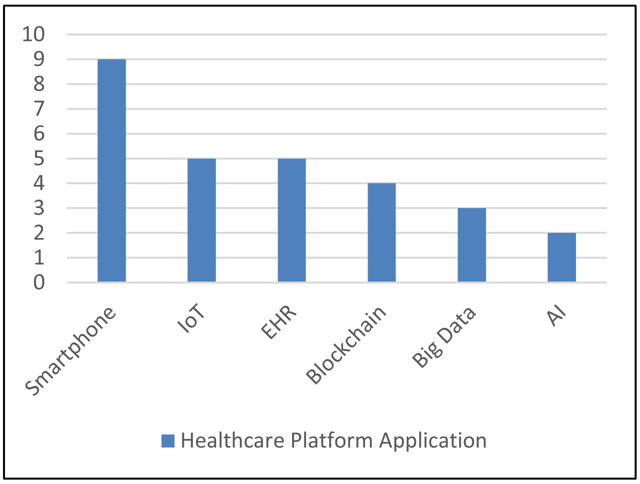

FIGURE 6. Frequency of the application areas mentioned.

b: SMARTPHONES

Smartphone applications have become instrumental in facilitating remote monitoring, tracking health-related behaviors, and fostering communication with healthcare providers [19], [68], [73]. The emergence of smartphone platforms has ushered in a state of pervasive connectivity, extending beyond social networking to encompass a wide range of functionalities and advantages [11], [21]. GoogleFit, a smartphone platform developed in 2014 and still used today, facilitates data access, management, and direct interaction between users and service providers [29]. Through smartphone ownership, individuals can capture health data, access pertinent health information, engage in remote consultations or telemedicine, and fulfill their health and social needs [26], [74], [75]. Furthermore, smartphone platforms have facilitated the integration of other technological applications, including artificial intelligence (AI) and cloud-based services, to develop intelligent healthcare solutions that promote overall patient well-being [75]. Ultimately, these applications offer convenience and enhanced accessibility and empower patients to participate actively in the management of their health [22], [26], [75].

c: BIG DATA

Big data platforms have brought about a significant transformation in healthcare by effectively managing the vast volumes of data collected from various sources across healthcare organizations, resulting in the need to translate them into actionable insights [29]. These platforms enable predicting healthcare-related behaviours and analysing patient outcomes through computerized systems [18]. Data exchange is increasingly vital in modern healthcare and has become a pivotal factor in developing platform ecosystems [20]. For instance, the ResearchKit platform enables the collection of medical indicators of patients with various diseases and the synchronization and analysis of data for research purposes. Notably, ResearchKit has gained traction in collecting information about Parkinson's disease, which can enable the prediction of healthcare-related behaviors and analyze patient outcomes through computerized systems [18], [29]. Open mHeallth, an open-source project from 2011 to 2019, also showcased the limitless possibilities of platform ecosystems in healthcare, as it provided web services to collect and process medical data from various sources. Its prominent use cases include exchanging blood sugar and PTSD data between patients and doctors [20], [29]. By harnessing the power of big data, which refers to data characterized by its magnitude and complexity, there is an emerging opportunity to derive valuable insights about patient populations, identify noteworthy patterns and trends, and facilitate data-driven decision-making processes [18]. Platforms that support big data analytics in healthcare hold immense potential to enhance healthcare delivery and foster collaborative innovations within the industry.

d: ARTIFICIAL INTELLIGENCE

As healthcare value co-creation continues shifting towards a patient-centered approach, digital platforms increasingly incorporate artificial intelligence (AI) methodologies to actively engage patients and augment multiple facets of healthcare, medical research, and administrative outcomes [20]. These AI techniques, often rooted in natural language processing, pattern recognition, and machine learning, enable the emulation and execution of tasks that require human intelligence [18]. Employing AI platforms that foster collaboration among diverse stakeholders, efforts are directed towards enhancing diagnostic processes, therapeutic interventions, and overall healthcare management [20]. One example is HealthBox, a promising open-source project announced in 2020 and currently in development, has great potential for smart healthcare. By serving as a Python-based web service, HealthBox seeks to centralize health data, foster stakeholder collaboration, and enhance healthcare management [20], [29]. These progressive advancements, driven by the integration of AI and value innovation, hold substantial promise in advancing healthcare outcomes, reducing costs, and enhancing the efficiency of healthcare service delivery [20].

e: INTERNET OF THINGS

The concept of the Internet of Things (IoT) describes a network of uniquely identifiable objects that are either embedded in or accessible through internet hosts [18], [74]. Analogous to AI, IoT technologies are assuming a critical role in healthcare transformation by establishing connectivity between devices and wireless sensor networks for real-time data collection, monitoring, transmission, and analysis [18], [19], [76]. Within the domain of healthcare, IoT-based application platforms focus on diverse aspects such as remote health monitoring, fitness programs, management of chronic diseases, and care for the elderly [18], [19], [21]. IoT-based platform ecosystems such as Discovery Health focus on diverse aspects, including remote health monitoring, fitness programs, management of chronic diseases, and care for the elderly [18], [19], [21]. Furthermore, propelled by advancements in cloud computing, substantial volumes of patient data can now be acquired, stored, and shared between patients and healthcare providers, facilitating collaborative care delivery [18], [76].

f: BLOCKCHAIN

Blockchain, derived from the constituent words "block" and "chain," refers to a decentralized database that maintains an incessantly expanding sequence of records known as blocks [76]. As delineated by Cavacece et al. [20], a blockchain comprises "blocks of data linked cryptographic protocols," enabling traceability. The integration of blockchain platforms in healthcare delivery has garnered considerable attention owing to its capacity to foster the formation of peer-to-peer networks, augment interoperability, and enhance the integrity of medical records [20], [70]. While initially gaining prominence in payment-oriented domains, wherein it facilitated accessible and verifiable transactions for all parties involved [70], blockchain technology has increasingly demonstrated its utility in advancing precision medicine and telemedicine initiatives [20]. For instance, the HealthPocket platform provides a secure and transparent ecosystem in which healthcare providers and patients actively participate in dynamic consent data sharing [20], [60]. In essence, blockchain platforms in healthcare offer the possibility of furnishing a secure and transparent ecosystem where healthcare providers and patients actively participate in value co-creation [20].

2) CHALLENGES OF PLATFORM ECOSYSTEMS INTEGRATION IN HEALTHCARE

Integrating digital platform technologies and ecosystems in healthcare has the potential to revolutionize healthcare delivery, but it faces significant challenges. As highlighted by the reported studies, these challenges include the complexity and fragmentation of the healthcare ecosystem, data privacy and security concerns, and financial considerations.

a: PRIVACY AND SECURITY CONCERNS

Privacy in healthcare refers to an individual's entitlement to control the disclosure and utilization of their data in a manner that aligns with their best interests [23], [24], [25]. Particularly, EHRs have attracted significant attention due to concerns related to their security and potential commercial exploitation, considering the inclusion of confidential patient information [25], [69]. Given the sensitivity of the data these platforms handle, unauthorized access and security breaches pose substantial threats to the effectiveness and viability of such technological solutions.

b: INTEROPERABILITY ISSUES

The necessity for interoperability in healthcare platforms and solutions, enabling the effective utilization of medical data, has emerged as a prominent concern [59], [77]. With the proliferation of diverse technologies aimed at data collection and storage in healthcare, the seamless collaboration among care providers necessitates the establishment of clear standards and compatibility across different systems [59], [60]. This challenge lies in facilitating the exchange of data among multiple medical institutions, regardless of the devices or platforms employed, which poses a significant impediment to realizing the envisioned improvements in healthcare delivery [24], [58], [60].

c: USER RESISTANCE AND ADOPTION BARRIERS

Integrating digital platforms in healthcare continues to encounter significant challenges stemming from technological resistance and patient adoption [11], [60]. Despite the accelerated adoption of digital solutions during the COVID-19 pandemic, patients in developing and low-resource countries encounter substantial obstacles and necessitate guidance in implementing and adopting digital health applications and services [15], [24], [25], [26], [27]. Overcoming resistance to change, fostering user engagement, and promoting widespread adoption of digital platforms among care providers remain formidable tasks [45]. Addressing these challenges requires comprehensive strategies considering diverse patient populations' unique needs and contexts to bridge the digital divide, reduce technological anxiety, and promote equitable access to healthcare technologies [21], [26].

d: DATA QUALITY AND MANAGEMENT

The accuracy and precision of diagnostics and therapeutics in EHR systems are intrinsically linked to the quality of the data they contain [24]. In the evolving digital landscape, the potential for misinterpretation of information and unreliable data poses significant risks to patient safety [25]. Consequently, providing accurate health data and trustworthy data management practices have become increasingly imperative for ensuring successful healthcare outcomes [25], [78]. Ensuring the integrity, reliability, and fidelity of health data within EHR systems enables effective decision-making, enhances patient care, and mitigates potential risks associated with erroneous or misleading information.

e: REGULATION

The healthcare sector operates within a framework of rigorous regulations, necessitating clinical data platforms to address the formidable task of adhering to ethical and safety standards prevalent in the industry [25], [57]. Negotiating the intricate landscape of privacy and data protection laws while concurrently fostering innovation and ensuring user-friendly experiences with digital technology presents a significant challenge for participants involved in healthcare platforms [24].

3) ADDRESSING THE CHALLENGES AND INTEGRATING PLATFORM ECOSYSTEMS IN HEALTHCARE

Taking a holistic look at the challenges faced by platform applications within the healthcare sector, this section highlights the potential strategies reported by the studies selected in tackling these challenges effectively. The subsequent analysis aims to provide insights into the plausible approaches for addressing these obstacles and fostering improved application outcomes.

a: DATA GOVERNANCE AND STANDARDS

Data governance policies and guidelines are pivotal in promoting the ethical exchange of health information among patients and diverse healthcare providers [24], [69]. Data privacy and security concerns necessitate establishing robust data protection laws and policies, which dictate the standards governing the collection and exchange of EHR [25], [57]. By adhering to these regulatory frameworks, the healthcare industry can effectively address data privacy and security concerns, fostering an environment of trust and compliance in information management.

b: ADAPTIVE INTEROPERABILITY FRAMEWORKS

To facilitate the cross-border exchange and utilization of diverse digital technologies in the healthcare domain, it is imperative to establish enabling conditions and architectures that steer the market towards developing interoperable digital solutions [24], [29]. Despite the recent emergence of several frameworks, a consensus has yet to be reached regarding the structure of business models for such platforms [11]. Consequently, the design of digital platforms should incorporate adaptive frameworks to mitigate system errors and avoid mis-integrations that impede seamless exchanges in care pathways and shared workflows [24], [68], [78]. By adopting these adaptive frameworks, the healthcare industry can enhance interoperability and optimize the effectiveness of digital platforms in promoting efficient and collaborative healthcare delivery.

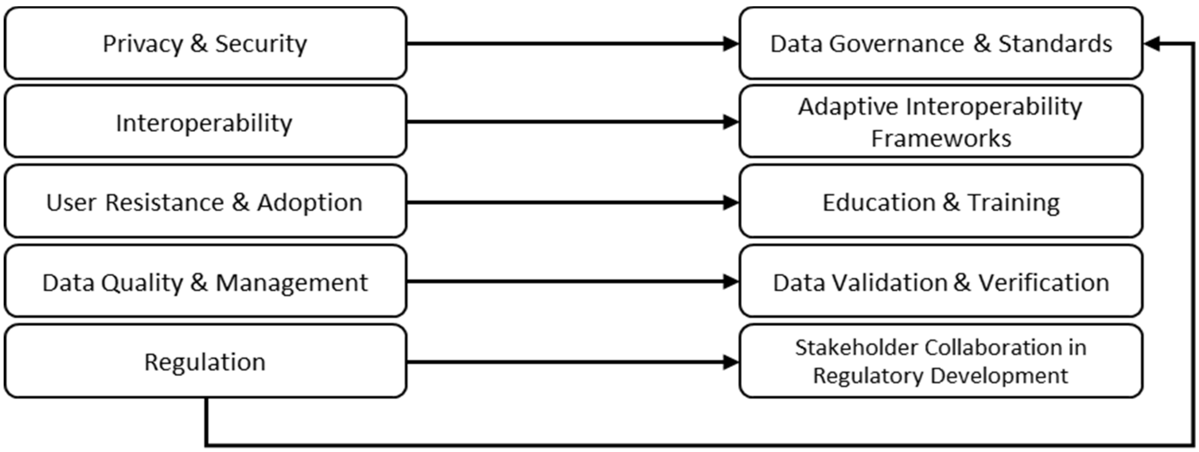

FIGURE 7. **Healthcare platform ecosystem challenges and integration strategies.**

c: EDUCATION AND TRAINING

The development of digital platforms requires significant resource allocation, posing particular challenges in low-resource environments [26]. Nevertheless, the anxiety among care providers regarding technology adoption and the effective utilization of these digital innovations has emerged as a pressing concern [15], [24], [25], [26]. Consequently, it becomes imperative to provide continuous education and training to patients and healthcare providers to foster their engagement through digital platforms [21], [26]. Recognizing that the efficacy of modern medicine relies heavily on the quality of collected data, establishing a robust data management support system is paramount in ensuring precision and accuracy in healthcare delivery.

d: DATA VALIDATION AND VERIFICATION

Effective data management in healthcare necessitates the comprehensive validation and verification of collected data across multiple institutions [15], [60], [72]. This imperative stems not only from the requirements of precision medicine but also from the need to mitigate the potential risks associated with the unintended usage of sensitive data [24], [29]. By implementing rigorous data validation and verification checks by established standards, healthcare systems can successfully identify and rectify data inaccuracies, thereby enhancing the overall quality of healthcare delivery.

e: STAKEHOLDER COLLABORATION IN REGULATORY DEVELOPMENT

The principal objective of platform development lies in fostering collaboration among diverse actors operating within an environment or system. In the context of the healthcare sector, this entails the active engagement of stakeholders, including governmental entities, hospitals, healthcare providers, non-profit organizations, and patients, in formulating regulatory policies [25], [57]. The purpose of such collaboration is to prevent potential barriers to healthcare innovation and optimize user experiences [24], [71], [73], [79]. Given the intricate interconnections inherent in healthcare, attaining favorable outcomes necessitates the seamless engagement and integration of all pertinent systems that influence health. Figure 7 summarises the healthcare platform ecosystem challenges and integration strategies.

V. DISCUSSION

The integration of digital platform ecosystems in the healthcare sector is still in its early stages, yet it holds considerable promise for substantial advancements in healthcare delivery [18], [19], [20], [68], [69]. These platforms, encompassing technologies such as EHR, smartphones, big data analytics, AI, IoT, and blockchain, have the potential to revolutionize communication, collaboration, access to healthcare services and efficiently manage patient data [19], [69], [70]. By bringing various actors, stakeholders, and patients together in ecosystems for resource integration, digital platforms can facilitate collaboration and value co-creation as witnessed in other industries such as ICT, e-commerce, automobile, housing, and education [11], [22], [26], [75].

However, there is ongoing discourse regarding the challenges that these applications may pose to the healthcare system and patients [23], [24], [25]. Given the sensitivity of healthcare data as a fundamental asset requisite for platform interactions, the imminent danger of breaches and unauthorized access by third parties has become a matter of utmost catastrophe [23], [25], [57]. This includes information exploitation, compromising patient safety, and undermining the integrity of healthcare systems [25], [78]. Consequently, concerns over privacy, security, interoperability, management, quality, user resistance, and regulation have continued to impede the healthcare platform's advancement and refinement. Although the complete eradication of the concerns regarding the sensitivity of healthcare data may appear impossible, the results provide insights into the plausible approaches for addressing these concerns and fostering improved application outcomes.

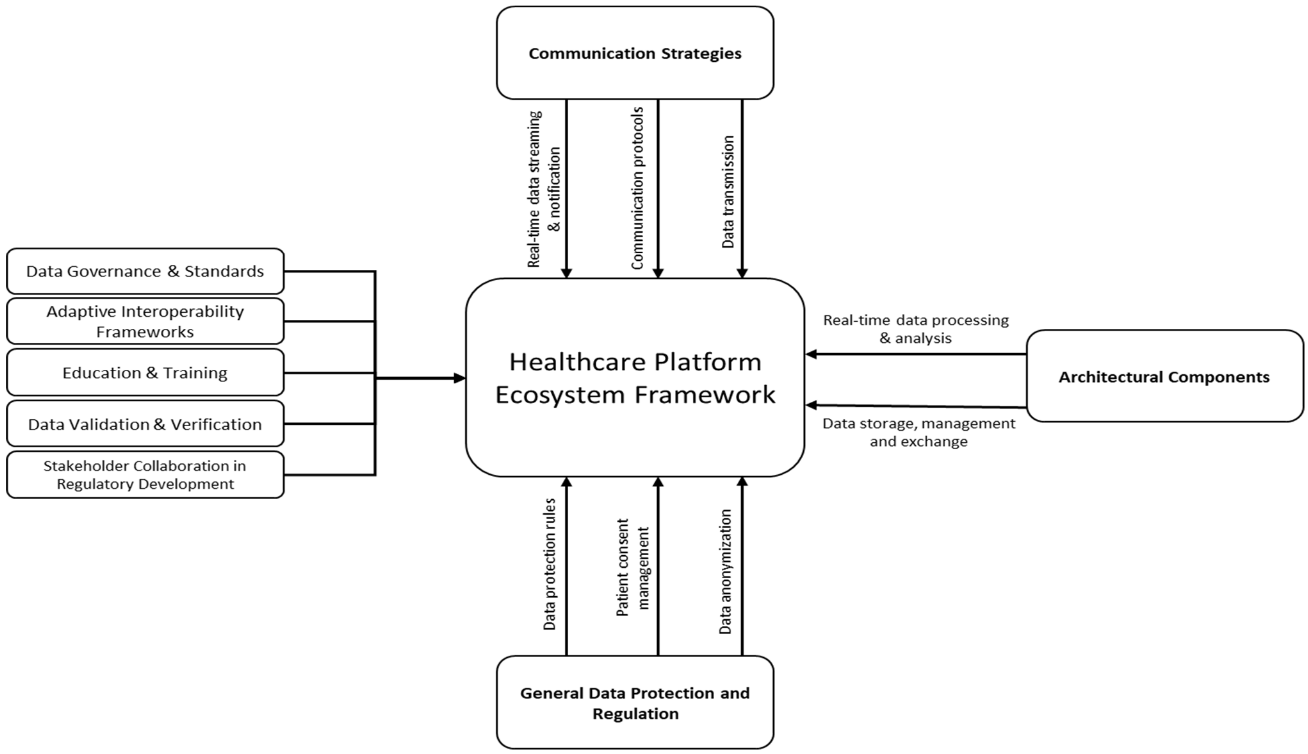

FIGURE 8. **The healthcare platform ecosystem framework.**

Yet, we emphasize that in the evolving landscape of healthcare technology, there is an urgency to amplify the discourse on the significant role of the various factors impeding or enabling digital platform ecosystem integration in healthcare. Given that this path is fraught with challenges and concerns, these areas deserve considerable attention. Beyond the challenges and strategies reported, we delve deeper into aspects including communication strategies, general data protection regulation (GDPR) and architectural components and how they intersect with the previously discussed healthcare technologies.

The implementation of effective communication strategies is crucial in healthcare technology. Ensuring secure and reliable data transmission is central to maintaining the privacy and integrity of patient information. In particular, EHR systems must adhere to robust communication protocols to facilitate data exchange among healthcare entities. This involves using encrypted channels and adhering to established standards like Health Level 7 (HL7) and Fast Healthcare Interoperable Resources (FHIR). Moreover, for smartphone applications and IoT devices, data security is paramount. The utilization of encrypted communication protocols, such as SSL, is indispensable in safeguarding the transmission of sensitive health data. Additionally, real-time data streaming and notifications are critical for remote monitoring, enabling timely interventions.

Furthermore, compliance with data protection regulations, such as the GDPR, is vital in healthcare technology. EHRs, smartphone applications, and IoT platforms must strictly adhere to data protection rules to protect patient privacy. This entails obtaining explicit patient consent for data collection, storage, and sharing. Robust data anonymization techniques should be employed to prevent the identification of individuals through their health data. As discussed in Section IV, Blockchain technology can be instrumental in providing transparent and auditable consent management. Hence, patients can control who accesses their health data and for what purposes, aligning with GDPR principles.

More so, architectural components play a critical role in shaping the landscape of healthcare technology. These include edge computing, cloudlets, cloud computing, and fog computing, each with distinct functions and applications. Edge computing is indispensable for real-time data processing and analysis at the point of care. It reduces latency and enables quick decision-making, particularly in critical care scenarios. On the other hand, cloudlets, situated closer to the network edge, are suitable for more intensive data processing and analytics, making them essential for applications like remote monitoring and telemedicine. Traditional cloud infrastructure remains pivotal in storing, managing, and sharing large volumes of healthcare data, facilitating the scalability and accessibility required for EHRs, big data platforms, and AI applications. Meanwhile, fog computing, situated between the edge and the cloud, is ideal for applications demanding real-time processing and low latency, including telemedicine and remote patient monitoring.

Therefore, within the dynamic landscape of healthcare technology, it is imperative to amplify the discourse on the multifaceted factors influencing the integration of digital platform ecosystems. Beyond the challenges and strategies reported, it is crucial to recognize the interplay of communication strategies, GDPR compliance and architectural components with the application technologies. By addressing these key areas, we can navigate the complex landscape of digital healthcare platforms and pave the way for a more secure, interoperable and patient-centric future in healthcare delivery. The adaptive framework in Figure 7 provides a strategic approach to integrating platform ecosystems in healthcare, incorporating new aspects such as communication, GDPR and architectural components.

VI. CONCLUSION

In this study, we have explored the evolving landscape of digital platform ecosystems in healthcare, recognizing their potential to revolutionize healthcare delivery by integrating technologies such as EHR, smartphones, big data analytics, AI, IoT, and blockchain. These platforms promise improved communication, collaboration, access to healthcare services, and efficient management of patient data, echoing the collaborative and value co-creation principles seen in other industries.

However, as we have discussed, there are challenges and concerns surrounding the integration of these platforms. The sensitivity of healthcare data as a fundamental asset for platform interactions underscores the critical need for robust security and privacy measures. Unauthorized access and data breaches pose serious threats, including information exploitation, compromising patient safety, and undermining the integrity of healthcare systems. These concerns have given rise to issues related to privacy, security, interoperability, data management, quality assurance, user resistance, and regulatory compliance, all of which have acted as barriers to the advancement of digital healthcare platforms.

We emphasize the urgency of amplifying the discourse on the factors enabling or impeding digital platform ecosystem integration in healthcare. The challenges, as are the opportunities, are substantial, underscoring the complexity of integrating digital platform ecosystems in healthcare. Addressing the identified concerns can pave the way for a more secure, interoperable, and patient-centric future in healthcare delivery.

A. THEORETICAL IMPLICATIONS

This study contributes to the overarching and holistic understanding of digital platform ecosystems in healthcare by shedding light on the multifaceted challenges and potential strategies for addressing them. We have emphasized the importance of addressing concerns related to privacy, security, interoperability, and data management to facilitate the successful integration of these platforms. The insights provided in this study can serve as a foundation for future research in digital health. Additionally, the study highlights the significance of integrating communication strategies, GDPR compliance, and architectural components with healthcare technologies. This interdisciplinary approach enriches the theoretical framework for understanding the complex dynamics in the digital healthcare ecosystem.

B. MANAGERIAL IMPLICATIONS

From a managerial perspective, this study offers valuable guidance for healthcare organizations, technology developers, and policymakers. It underscores the critical importance of secure and reliable data transmission, particularly in EHR systems, smartphone applications, and IoT devices. Implementing encrypted communication protocols, such as Secure Sockets Layer (SSL), and adhering to industry standards like HL7 and FHIR are essential to ensure patient data's privacy and integrity. Furthermore, compliance with data protection regulations, like GDPR in Europe, is not only a legal requirement but a fundamental aspect of patient trust and data security. Healthcare organizations and technology developers should prioritize obtaining explicit patient consent for data collection, storage, and sharing and employ robust data anonymization techniques to protect individual identities within health data.

C. LIMITATIONS AND FUTURE RESEARCH RECOMMENDATIONS

As with reviews, there are a few limitations to this scoping review on the application of platform ecosystems to healthcare. Firstly, the researchers acknowledge possible individual biases in the selection and analysis of the studies. Secondly, within this wide and interdisciplinary domain, the study search terms were targeted at only the applications of platform ecosystems, case studies and English reports. Regardless of these limitations, the study collected and analysed available data generating a wholesome range of data for such interdisciplinary research.

For future research, we recommend prioritizing patient-centric perspectives, ethical considerations, and the legal aspects of healthcare data usage in digital platform ecosystems. Further investigations should improve interoperability and standardization to facilitate seamless data exchange, enhance data security through advanced encryption and authentication methods, and explore AI applications for disease diagnosis, process optimization, and personalized patient care. Additionally, blockchain technology's potential in healthcare, beyond consent management, should be explored for secure health record management, pharmaceutical supply chains, and fraud detection. Understanding user acceptance, conducting cost-benefit analyses, and evaluating the long-term impact of digital healthcare platforms are essential. Research can also contribute to healthcare policy and regulation adaptations, user training and education programs, and global health initiatives for addressing health challenges, particularly in underserved areas.

APPENDIX
LIST OF INCLUDED STUDIES FOR THE REVIEW

TABLE 5. Selected reports for the scoping review.

S/N	Author and date	Title
1.	Aftab et al., 2022	Holo-Block Chain: A Hybrid Approach for Secured IoT Healthcare Ecosystem
2.	Akter et al., 2022	Value co-creation on a shared healthcare platform: Impact on service innovation, perceived value and patient welfare
3.	Cavacece et al., 2022	Blockchain technology and Artificial Intelligence for value co-creation in healthcare
4.	Cosimato et al., 2022	Digital Social Innovation: how healthcare ecosystems Face Covid-19 challenges
5.	Frishammar et al., 2023	Digital health platforms for the elderly? Key adoption and usage barriers and ways to address them
6.	Masuda et al., 2019	A vision for open healthcare platform 2030
7.	Masuda et al., 2021	An Adaptive Enterprise Architecture Design for a Digital Healthcare Platform
8.	Mi and Wei, 2018	A CoAP-based Smartphone Proxy for Healthcare with IoT Technologies
9.	O'Neil, 2013	System Engineering Enabling Transformational Change: Engineering a New Healthcare Ecosystem
10.	Pundziene et al., 2022	Value Impedance and Dynamic Capabilities: The Case of MedTech Incumbent-Born Digital Healthcare Platforms
11.	Roberts et al., 2016	A design thinking framework for healthcare management and innovation
12.	Russo-Spena and Cristina, 2020	Practicing innovation in the healthcare ecosystem: The agency of third-party actors
13.	Russo-Spena et al., 2023	Enabling Value Co-Creation in Healthcare through Blockchain Technology
14.	Santarsiero et al., 2022	Digital transformation in healthcare organizations: The role of innovation labs
15.	Schiavone et al., 2021	Digital business models and ridesharing for value co-creation in healthcare: A multi-stakeholder ecosystem analysis
16.	Secundo et al., 2021	Digital technologies and collective intelligence for healthcare ecosystem: Optimizing Internet of Things adoption for pandemic management
17.	Shrivastava et al., 2020	e-Governance for healthcare service delivery in India: challenges and opportunities in security and privacy
18.	Song et al., 2015	Smartphone-Based Healthcare Platform and Challenges
19.	Trkman et al., 2020	The success factors of a national healthcare ecosystems maturation: preliminary results
20.	Vicdan et al., 2021	License to Heal: Understanding a Healthcare Platform Organization as a Multi-Level Surveillant Assemblage

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MBANEFO C. CHIBUIKE received the bachelor's degree in biomedical technology from the Federal University of Technology Owerri, in 2018, the mini-M.B.A. degree in business management and leadership development from the Tekedia Institute, and the Ph.D. degree in biomedical engineering from Stellenbosch University, Stellenbosch, South Africa.

From 2019 to 2020, he was a Graduate Teaching Assistant with the Niger State School of Health Technology Minna before joining the Innovation for Inclusive Development (I4ID) Research Group, in 2021. He is currently a Postdoctoral Fellow in engineering with Stellenbosch University.

Dr. Chibuike has received research and entrepreneurship awards, including the Imperial-SUCI Bursary, in 2023, the Mandela Rhodes Scholarship, in 2021, and the Tony Elumelu Entrepreneurship Program Prize, in 2019.

SARA S. GROBBELAAR received the B.E. degree in electronic, the M.E. degree (Hons.) in computer, and the Ph.D. degree in engineering from the University of Pretoria, Pretoria, South Africa, in 2000, 2001, and 2007, respectively, the M.Phil. degree in technology policy from the Univerity of Cambridge, Cambridge, U.K., in 2011, and the master's Dipl. degree (Hons.) in M&E methods (SU), in 2013. She is currently a Professor with the Department of Industrial Engineering, Stellenbosch University, Stellenbosch, South Africa, where she is also a Research Associate with the Centre for Research on Evaluation, Science, and Technology.

ADELE BOTHA is currently a Chief Researcher with the Council for Scientific and Industrial Research (CSIR), Nextgen Enterprises, and Institutions, with a research interest in socio-technical mobile information systems with the Software Architecture and Solutions (SAS) Research Group. She is also a Professor Extraordinaire with the UNISA College of Science, Engineering, and Technology and the Department of Industrial Engineering, Stellenbosch University. In addition, she is recognized as an NRF-rated Researcher. She holds various advisory roles and has collaborated with many international stakeholders in internationally funded activities. She has presented her research at various national and international forums and she has published around 60 peer-reviewed publications cited more than 2,000 times. She actively mentors master's and Ph.D. students at various tertiary institutions and contributes to advisory and editorial boards, including the HP Catalyst Academy and the X prize. She was the lead author in the Health Normative Standards Framework (HSNF 2020) for the NDoH, gazette, in 2022, forming the groundwork for the Emerging National Health Information Exchange in South Africa.