Business Models for Digital Health Solutions: A Bibliometric and Systematic Review of Financial, Regulatory, and Adoption Dimensions

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ABSTRACT

Digital health solutions (DHSs) have significant potential to improve the efficiency, accessibility, and patient-centeredness of healthcare delivery. However, many initiatives fail to progress beyond the pilot stage due to the absence of sustainable business models (BMs) that ensure financial, regulatory, and operational viability. This study combines bibliometric analysis with a systematic review of 34 peer-reviewed articles published between 2020 and 2025 to examine how DHS BMs are structured and to identify key gaps in the literature. The bibliometric analysis reveals a shift in research focus from foundational technologies such as telemedicine and personalized medicine toward strategic dimensions, including business models, value creation, data privacy, and healthcare policy, indicating a maturing research field. Nevertheless, reimbursement remains comparatively underexplored despite its practical importance. The systematic review shows that value proposition, resources, and partnerships are the most frequently addressed business model components, whereas cost structure, licensing, customer feedback, and customer relationships receive significantly less attention. This imbalance limits the scalability and long-term sustainability of DHS initiatives. Overall, the findings highlight a structural gap in current DHS BM research, where value creation is well developed but the financial and regulatory mechanisms required for sustainable implementation remain insufficiently addressed. These insights guide researchers, policymakers, and practitioners in advancing more balanced and sustainable digital health business models.

KEYWORDS

Digital health solution (DHS), business model (BM), bibliometric analysis, systematic review, healthcare innovation

1. Introduction

Digital health solutions (DHSs) are transforming healthcare using technology, leading to improved patient care [1], and have the potential to improve the health and well-being of individuals and communities [2–4]. To fully unlock the potential of DHSs, having a clear and sustainable BM is essential [5]. A BM defines an organization's value logic, detailing how it creates and captures customer value. It is represented by an interrelated set of elements encompassing the customer, value proposition, organizational architecture, and economic dimensions [6, 7]. These elements provide a strategic framework that helps organizations navigate market complexity, adapt to an evolving business environment, and sustain long-term competitive advantage [8–10]. Lack of established sustainable and innovative BMs limits the development and successful commercialization of DHSs [5, 11].

Research Goal and Questions

This study employs a combined approach of bibliometric analysis [12, 13] and a systematic literature review [14–16] to examine the current landscape of BMs in DHS. The aim is to identify limitations, uncover key gaps in existing knowledge, and highlight essential components of BM frameworks to address the following questions and inform future research on the development and scaling of DHSs.

1. How do current DHS BMs manage financial sustainability and stakeholder alignment through cost control, revenue generation, and incentive structures?
2. How do current DHS BMs address regulatory frameworks and requirements, including medical device classification and compliance obligations?
3. How do current DHS BMs overcome adoption barriers in a dynamic healthcare ecosystem?

The remainder of this paper is structured as follows. The next section outlines the bibliometric analysis and systematic literature review methodology. The Results section presents findings organized around financial sustainability and stakeholder alignment, regulatory frameworks, and adoption barriers. The Discussion addresses limitations and gaps in the current literature, and the paper concludes with key insights and directions for future research.

2. Materials and Methods

2.1 Systematic Review

This study followed a three-phase selection process including identification, screening, and eligibility, consistent with PRISMA 2020 reporting guidelines [14], to narrow the initial pool of records to those most relevant to BMs in digital health.

In the identification phase (Figure 1), records were retrieved from five databases such as Scopus, PubMed, Web of Science, IEEE, and Google Scholar using the following Boolean search string: ("business model"*) AND ("hospital"*) AND ("digital health"*) AND (("value-based care"*) OR ("adoption"*) OR ("financial performance) OR ("data privacy"*) OR ("healthcare compliance"*)). This query returned 19,649 records, distributed across databases as shown in Table 1.

Database	Number of Records
Scopus	484
PubMed	217
Web of Science	112
IEEE	127
Google Scholar	19,300
Total	**19,649**

Table 1: Search results by database.

The second phase, known as the screening phase in Figure 1, involved filtering the identified articles based on certain inclusion and exclusion criteria. The following inclusion and exclusion criteria were applied, as shown in Table 2. Applying these criteria resulted in the removal of 4,892 records. A further refinement of the search query, restricting results to titles and abstracts, reduced the dataset to 1,249 records. The extracted articles were stored as a comma-separated values (CSV) file. After eliminating duplicates (n = 107), 1,142 records remained. Research review records (n = 77) were subsequently excluded, leaving 1,065 records for further screening.

Inclusion	Exclusion
Published in journal	Published before 2020
Reported in English	Research review
Published on or after 1st January 2020 and before the date of research, 1st March 2025.	Reported as conference papers, commentaries, theoretical papers, dissertations, book chapters, or editorials.

Table 2: Inclusion and exclusion criteria

In the final step, which includes a detailed review of the articles for relevance and quality. During this phase, the titles and abstracts of the remaining articles were evaluated to ensure they met the study's objectives. Articles that were not directly relevant were excluded. After this step, the final set of articles for inclusion in the study totaled 34, as shown in the "Included" section of Figure 1.

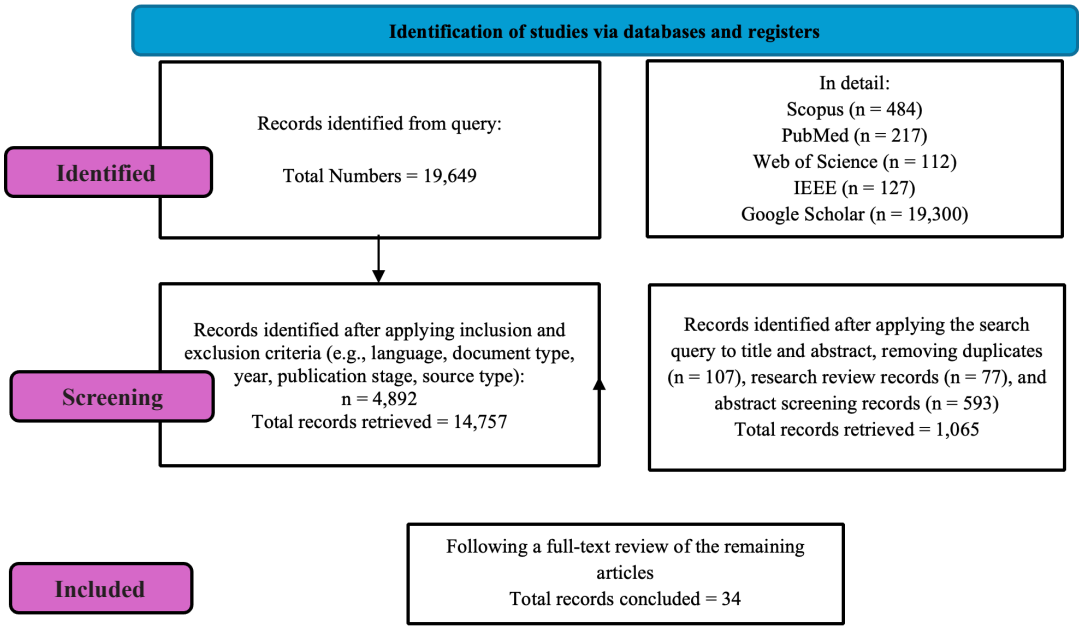


Figure 1: PRISMA flow diagram showing the study selection process.

2.2 Bibliometric Analysis

VOSviewer (version 1.6.20), developed by Leiden University [17], was used to construct and analyze the bibliometric network, including a keyword co-occurrence map and a keyword density map [12, 13]. To illustrate macro-level applications of BM research in DHS, keywords from article titles and abstracts were mapped as a co-occurrence network (Figure 2), and a separate map was generated for author keywords (Figure 3). In both maps, circle size reflects keyword frequency and distance between circles reflects co-occurrence strength; a minimum keyword frequency threshold of 3 was applied to ensure

relevance and clarity. A density visualization (Figure 4) was also produced, where point density reflects the number and weight of neighboring items, and a timeline visualization (Figure 5) shows keyword color as average year of publication, enabling identification of emerging trends within the DHS BM landscape [12, 13, 17].

3. Results

3.1 Systematic Literature Review Findings

The reviewed literature encompasses diverse range of methodologies, including qualitive research such as case studies and interview based research [5, 18–30], mixed-methods research [31], and conceptual or theoretical analyses [18, 32, 33]. These studies collectively provide insights into how BMs are structured, adapted, and implemented across various DHS contexts. Some focus on defining core BM components [26, 28, 29], as illustrated in Table 3, while others examine how external pressures such as regulation [21, 32] or innovation barriers [19, 23] influence BM design and implementation.

Several contributions explore how BMs generate value through DHSs (e.g., blockchain, AI, remote monitoring), highlighting both opportunities and structural challenges [18, 33–35]. Others propose refinements or novel BM designs to meet evolving healthcare demands [24, 27, 31, 36]. Christie et al. [19, 20] focus on implementation strategies, integrating BM components with contextual organizational insights to enhance adoption and sustainability. Fürstenau et al. [22] propose a multi-sided platform to improve personalized care and leverage real-world data. Similarly, Tekkis et al. [36] address the integration of 3D printing technology within the NHS, noting organizational and physical constraints that future BMs must overcome. Lokman et al. [25] and Saheb [31], explore telehealth and social enterprise models, highlighting pricing strategies like flat rates, subscriptions, and cross-subsidization.

Across these studies, there is a clear trend toward multi-component BMs [22, 25, 29] and ecosystem-driven BMs emphasizing stakeholder collaboration [21, 33, 35], digital infrastructure [18, 32, 36], and adaptive governance [21, 35]. However, common limitations such as small sample sizes [29], geographic constraints [26], and a predominance of qualitative or secondary data [22, 23] suggest the need for more rigorous, longitudinal, and multi-contextual studies. Table 3 illustrates the most commonly recurring components of BMs in DHS, as identified in recent studies that focus on developing or enhancing BMs in this field [19–22, 24–26, 29–31, 33, 36] .

Model components / Publication	Value proposition	Value creation	Partnetwork	Service channel	Resources	Delivery	Governance	Key activities	Cost structure	Customer relationships	Feedback	licenses	Customer segments	Provider	channel	Revenue
Viswanadham, 2021 [33]	×	×	×	×	×	×	×									
Essen et al., 2022 [21]	×	×	×	×	×	×	×									
Christie et al., 2020 [19]	×		×		×			×	×	×					×	×
Vimarlund et al.,2021 [30]	×	×	×							×			×			
Hongdao et al., 2022 [24]	×				×			×	×				×		×	
Saheb, 2020 [31]	×	×	×		×			×			×	×	×			×
Christie et al., 2021 [20]	×		×		×			×	×	×			×		×	×
Lokman et al., 2021 [25]									×		×					×
Fürstenau et al., 2021 [22]	×	×				×		×					×			
Velayati et al., 2021b [29]	×	×	×		×			×			×	×	×			×
Lupiáñez-Villanueva et al., 2020 [26]					×									×	×	×
Tekkis et al., 2022 [36]	×															
Sum	10	6	7	2	8	3	2	6	4	3	3	2	6	1	4	6

Table 3: Overview of key BM components in selected publications

As shown in Table 3, the most emphasized BM element for DHSs is the value proposition [19–22, 24, 29–31, 33, 36]. Value proposition plays a crucial role in defining BM and differentiating between various types of models [24]. A value proposition explains why customers should choose a company's products or services over competitors [21]. A strong value proposition could highlight unique features and benefits that provide additional value to customers [37, 38] and solve a customer problem or satisfy a customer need differently [39]. A well-crafted value proposition not only sets a business apart from its competitors but also captures the desires and preferences of consumers [38].

Resources, the second most frequently mentioned component [19–21, 24, 29–31, 33], refer to the essential assets such as physical assets (buildings, vehicles, equipment), financial assets, intellectual assets (brands, copyrights, patents, customer databases), and human resources, which determine the success of BM operations [38, 39]. Among these, intellectual resources are particularly critical as they are difficult to replicate [31, 38].

Partnership, as a help to an organization's operation [38, 39], is mentioned as another prominent component [19–21, 29–31, 33]. Partnerships have become important for cost savings [38], risk reduction [38, 39], acquiring resources [38, 39], and gaining knowledge [38].

Some components appeared the same number of times such as value creation [21, 22, 29–31, 33], revenue models [19, 20, 25, 26, 29, 31], customer segments [22, 24–26, 29–31] , and key activities [19, 20, 22, 24–26, 29–31]. Value creation outlines how the platform delivers on its promises [21]. Revenue represents how organizations generate income from specific customer segments, forming the foundation of business sustainability [38, 39]. Additionally, understanding different market and customer segments is crucial. It refers to the groups of individuals or entities that utilize an organization's products or services and generate revenue for the organization [38, 39]. Key activities determine the success of a BM [38, 39] by playing a crucial role in realizing the value proposition [38].

Finally, provider [26], governance, service chain [21, 33], licenses and permissions [29, 31] were among the least frequently mentioned components. Building on the identified BM components, the following thematic analysis explores how prior research has addressed critical dimensions of DHS BM.

Financial Sustainability and Stakeholder Engagement in DHS BM

Financial sustainability requires coordinating cost efficiency, rather than merely reducing costs [27]. Cost structure is a key component of DHS BMs [20], encompassing the expenses incurred by the business, including resource acquisition, regulatory compliance, clinical validation, workforce training, and hosting costs [19, 28, 40]. Reported cost structure strategies include combining grants with subscription-based models, fixed pricing with grants, fixed-cost models funded by caregivers or organizations, and research-project funding [20]. Stakeholder engagement is integral to these financial strategies, as BMs must address the needs of diverse actors, including healthcare providers, insurers, patients, and regulators [28]. Furthermore, shareholder support may be strengthened when digital transformation is perceived as enhancing financial performance [35]. A notable example of shareholder alignment is the "win–win" BM proposed by Ilan [41], in which pharmaceutical companies share revenues while insurers capture cost savings, aligning the incentives of patients, clinicians, insurers, and manufacturers to improve health outcomes while reducing systemic costs.

Revenue models present a related challenge, particularly pricing [16], which is a key component of the revenue model [16, 33]. Pricing strategies should balance affordability, market competition, and production costs to remain viable [16, 33]. Recommended pricing mechanisms include pay-as-you-go, subscription, buffet-model, and micropayment approaches [16, 42]. Some BMs also advocate tailoring revenue structures to country-specific conditions, such as self-payment, insurer reimbursement, and individual insurance schemes. Accordingly, start-ups are encouraged to align their revenue models with national health policies and reimbursement systems to support long-term viability and scalability [5].

Regulatory Frameworks and their Requirements in DHS BM

The healthcare sector is classified as highly regulated [21]. Regulatory considerations are a foundational component in the architecture of DHS BMs [5], and businesses can be positively or negatively affected by regulation and policy [43]. The absence of relevant standards, licenses, and related policies constitutes a legal barrier for DHS [16, 34], alongside barriers such as the need to prove value, secure partners, and educate the wider ecosystem [43]. Regulatory gaps can impact market entry, causing delays in the launch period and the adoption of innovations [21, 27, 43]. Since no dedicated regulatory class exists for DHS, outdated frameworks are often applied [44]; however, compliance has in some cases driven regulatory reform, as seen in Sweden [21]. Consequently, regulatory frameworks shape DHS BMs by influencing classification, compliance complexity, and market readiness, requiring organizations to balance innovation with regulatory adaptability.

Adoption Barriers in DHS BM

Despite the growing use of DHS, adoption challenges persist [45] at the human, social, and organizational levels [27, 46]. DHS adoption has not yet reached scale, although COVID-19 accelerated uptake through shifts in funding models and reduced reliance on in-person contact [23, 27]. Likewise, technologies with reputational benefits, such as 3D printing, continue to face adoption barriers [36]. Reported barriers include data security concerns [23, 26, 31], ease of use and access to technology [31, 47], regulation [33, 48], age [27], revenue, recommendation, and provider models [26], psychological factors such as technology anxiety, health consciousness, hedonic motivations, and habits [31], and cultural differences [27]. Inadequate implementation strategies and atheoretical deployments further hinder scaling [19], although increasing adoption among patients and healthcare professionals can strengthen the sociopolitical legitimacy of DHS [21].

Adoption can be strengthened through the development of digital complementary assets, such as hospital-based technological expertise, which often has a greater influence than the regulatory environment itself [48]. Additional enablers include clear evaluation and reimbursement strategies [23], public funding structures [27], future pricing models [19], and the integration of big data and social media [31]. A strong business case is also a direct driver of adoption [27]. Furthermore, strategic positioning and governance aligned with policy and stakeholder expectations can help build legitimacy by clarifying the value of DHS to employers, clinicians, and patients, although these approaches do not replace formal validation [43]. DHS adoption typically follows an S-curve, beginning slowly before accelerating as the technology matures [33].

3.2 Bibliometric Analysis Results

Figure 2 presents the co-occurrence network of 124 (of 647) high-frequency title and abstract keywords, organized into four thematic clusters. Cluster I (red) includes artificial intelligence (AI), adoption, communication, COVID-19, data privacy, decision making, digital health, healthcare, healthcare policy, human, medical information, public sector, and reflects a strong focus on the adoption and regulation of digital technologies, particularly AI in public health, especially in response to the COVID-19 pandemic. The inclusion of human and medical information further underscores ethical considerations such as data privacy and the responsible management of digital health information. Cluster II (green) includes article, big data, qualitative research (with a focus on demographic features like gender), risk assessment, work experience, patient engagement, marketing, and social media, reflecting patient-centered care, market research, and social behavior in the context of digital health, pointing to empirical studies of adoption dynamics. Cluster III (blue) includes healthcare cost, healthcare delivery, health plan implementation, incentive, investment, stakeholder, and telemedicine centers on the financial and organizational dimensions of DHS delivery. Terms like healthcare cost, health plan implementation, and investment highlight financial strategies that directly influence stakeholders' willingness to adopt telemedicine and invest in related technologies, speaking to RQ1's focus on cost control, revenue, and incentive structures. Cluster IV (yellow) includes business model, digital transformation, dynamic capability, sustainability, and value creation, emphasizing strategic transformation within healthcare and related industries through digital technologies. Also, a separate map was generated for author keywords, where 37 out of 297 keywords met the inclusion threshold, as illustrated in Figure 3.

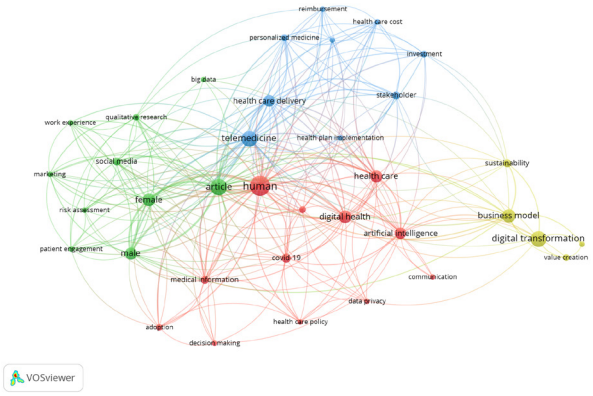


Figure 2: Network visualization map of co-occurrence - title and abstract keywords.

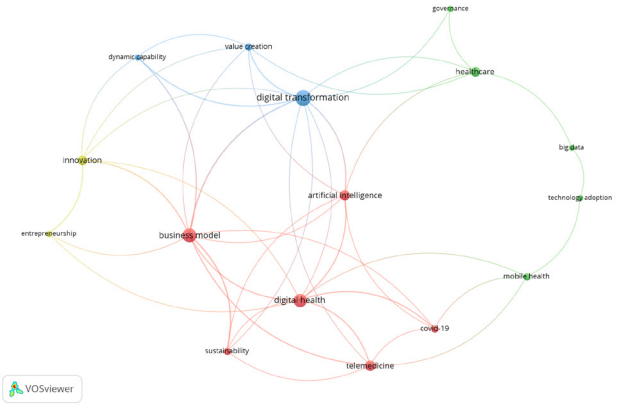


Figure 3: Network visualization map of co-occurrence – author keywords.

We created a density visualization of the high-frequency keywords, as shown in Figure 4, where the density of each point is influenced by the number of neighboring items and their respective weights. The more items that surround a point, and the higher their weights, the more yellow the point appears [49]. At the center of the map, the terms "human," "article," and "telemedicine" appear with the highest density (in yellow), indicating their central role in the research landscape and their pivotal contribution to knowledge production within the field. On the right side of the map, "business model" and "digital transformation" also show relatively high density, underscoring their importance in the related literature. Other keywords such as "healthcare delivery," "digital health," "artificial intelligence," "healthcare," and "gender" appear with moderate density, reflecting their notable but comparatively lesser presence in the research body. Towards the periphery of the map, keywords appear in shades of blue, suggesting that while these concepts are part of the overall network, their frequency and influence are relatively lower compared to the core terms. This analysis helps researchers identify both prominent and underexplored areas within the DHS domain, providing valuable guidance for more targeted and impactful future research and development.



Figure 4: Density visualization map of co-occurrence - title and abstract keywords.

Figure 5 presents a timeline-based visualization of prominent keywords, where the color of each circle represents the average publication year of the associated term, the lighter the color, the more recent the keyword [49]. This visualization enables researchers to trace the evolution of high-frequency keywords over time and identify emerging trends within the DHS business model (BM) landscape. The figure reveals that topics such as digital transformation, digital health, AI, BM, stakeholder, sustainability, adoption, data privacy, value creation, patient engagement, and healthcare policy have garnered significant, sustained research attention, particularly from 2022 onward, as these nodes are colored in shades of light green to yellow. There is also a noticeable rise in interest around 2022 in keywords like healthcare delivery, marketing, big data, work experience, and social media, reflecting a growing emphasis on the communication and implementation strategies of DHS during that period. In contrast, nodes colored in purple and blue reimbursement, personalized medicine, health plan implementation, telemedicine, risk assessment, human, and public sector suggest these themes were more central to earlier studies, primarily those published in 2021 or earlier, forming the foundational basis of DHS research. This temporal mapping illustrates the field's evolutionary trajectory between 2020 and 2025: earlier work centered on foundational technologies such as telemedicine and personalized medicine, while more recent research has shifted toward strategic and systemic concerns, including the implementation of digital technologies through BMs, cost structures, value creation, and policy frameworks, signaling a maturing DHS research landscape.

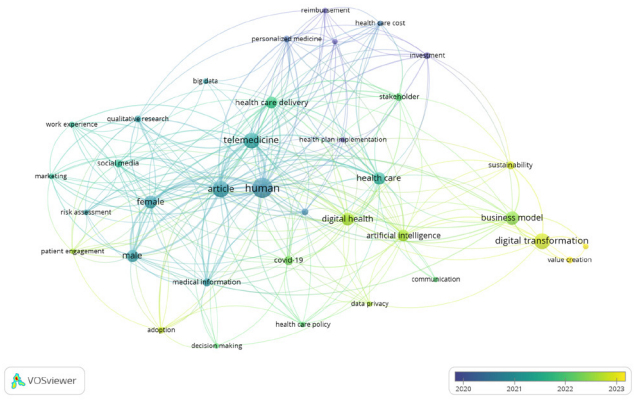


Figure 5: Visualization map of the evolution of keyword frequency over time - title and abstract keywords.

These macro-level bibliometric patterns broadly corroborate the thematic findings from the systematic review (Section 3), while also highlighting reimbursement as a comparatively under-researched term compared with its regulatory and financial aspects.

Discussion

The findings highlight the importance of BM structure in the implementation of DHS. The strong emphasis on value proposition aligns with the need to justify the utility and relevance of innovations to stakeholders and end-users. Similarly, resources (e.g., funding, infrastructure, expertise) and partnerships between organizations (including providers, regulators, and insurers) are recognized as two key components enabling the effective delivery of DHS.

However, limited attention to components such as cost structure, licensing, and feedback suggests a missed opportunity to align implementation strategies with scalable and sustainable BMs. These overlooked elements are critical for long-term viability, shaping not only how innovations are financed and governed but also how they evolve in response to user needs, regulatory change, and market dynamics. Cost structure, including pricing mechanisms, expenses, and revenue model, is crucial for ensuring DHS remains financially viable and creates value for both providers and users as they scale. Licensing plays a critical role in ensuring regulatory compliance and facilitating broader dissemination across regions and systems, and can also provide a competitive advantage; however, the lack of clear regulations specific to DHS, combined with high licensing costs, remains a significant barrier. Feedback mechanisms and customer relationships, though mentioned in only a few articles, not only improve the functionality and responsiveness of DHS but also foster user engagement and trust, thereby promoting greater adoption and sustained use.

The bibliometric analysis reveals a strong focus on telemedicine, humans, digital transformation, and BMs, underscoring their pivotal roles in the existing literature. However, there is comparatively less emphasis on the value DHS creates, its adoption barriers and solutions, related policies, costs, or reimbursement issues. Timeline visualizations show an evolution from foundational topics such as telemedicine and human factors toward a more recent focus on strategic themes, including BMs, sustainability, adoption, value creation, data privacy, and healthcare policy.

This uneven emphasis raises concerns about whether current research fully addresses the complete range of BM components, particularly given that DHS must be integrated into complex, resource-constrained health systems. Despite meaningful progress, strengthening BMs for DHS will require deliberate attention to the underexplored components identified above, including cost structure, licensing, and feedback mechanisms, alongside the broader financial, regulatory, and adoption-related conditions examined throughout this review.

Limitations

This review has several limitations that should be considered when interpreting its findings. First, the temporal scope was restricted to studies published between 2020 and March 1, 2025; earlier foundational work and the most recent developments in this fast-moving field may therefore be underrepresented. Second, the final sample of 34 articles, while consistent with the review's inclusion criteria, is relatively small and may be concentrated in a subset of national and organizational contexts, which could limit the generalizability of the identified BM patterns. Finally, the bibliometric analysis relies on keyword co-occurrence within a single Boolean search string; studies describing similar phenomena using different terminology (e.g., "digital health technology," "eHealth," "mHealth") may not have been captured, and the minimum keyword-frequency threshold of 3 may have excluded low-frequency but conceptually important themes.

Conclusion

This review set out to examine how current BMs DHSs manage financial sustainability and stakeholder alignment, navigate regulatory frameworks and requirements, and overcome adoption barriers in a dynamic healthcare ecosystem. Across the 34 reviewed studies, financial sustainability remains constrained by an over-reliance on limited revenue models and underdeveloped cost structures, despite their centrality to long-term viability; where stakeholder alignment is addressed, it is largely framed around collaborative arrangements between providers, insurers, and technology developers. Regulatory frameworks, particularly medical device classification and compliance obligations, shape which BM archetypes are viable in practice, and while compliance is costly, it can also drive legitimacy and market access when navigated proactively. Adoption barriers persist at technological, organizational, and behavioral levels and are most directly addressed through BM components such as value proposition, customer relationships, and feedback mechanisms, which remain comparatively underexplored in the literature. Taken together, these findings indicate that BM research on digital health has matured in describing structural components but has not yet adequately connected those components to the financial, regulatory, and behavioral conditions needed for DHS to scale sustainably. As an ageing society presents both a major challenge and a significant market opportunity, closing this gap is essential for turning promising digital health innovations into durable, adopted solutions.

Building on these findings, future research should proceed in four directions. First, more rigorous cost estimation and assessment of the financial and societal benefits of DHS are needed to offer researchers, policymakers, service providers, and industry stakeholders a clearer basis for investment and adoption decisions. Second, given the dynamic and uncertain nature of this field, future work should examine how platform-based and hybrid digital-physical BMs can adapt to evolving regulatory and reimbursement environments [34], including which BM components are most sensitive to regulatory change and how these can be optimized for resilience. Third, greater attention should be paid to the BM components that most directly shape adoption, such as value proposition, customer relationships, feedback mechanisms, and delivery channels, as these drive user engagement, trust, and long-term use. Finally, future studies should more directly integrate patient perspectives into BM design [28], ensuring that efforts to scale and sustain DHS in dynamic healthcare environments remain grounded in end-user needs alongside financial and regulatory considerations.

References

[1] Rønn C, Wieland A, Lehrer C, Márton A, LaRoche J, Specker A, Leroy P, Fürstenau D. Circular business model for digital health solutions: protocol for a scoping review. JMIR Research Protocols. 2023;12:e47874. https://doi.org/10.2196/47874.

[2] Bouabida K, Lebouché B, Pomey MP. Telehealth and COVID-19 pandemic: an overview of the telehealth use, advantages, challenges, and opportunities during COVID-19 pandemic. Healthcare (Basel). 2022;10(11):2293. https://doi.org/10.3390/healthcare10112293.

[3] Fagherazzi G, Goetzinger C, Rashid MA, Aguayo GA, Huiart L. Digital health strategies to fight COVID-19 worldwide: challenges, recommendations, and a call for papers. Journal of Medical Internet Research. 2020;22(6):e19284. https://doi.org/10.2196/19284.

[4] Mumtaz H, Riaz MH, Wajid H, Saqib M, Zeeshan MH, Khan SE, Chauhan YR, Sohail H, Vohra LI. Current challenges and potential solutions to the use of digital health technologies in evidence generation: a narrative review. Frontiers in Digital Health. 2023;5:1203945. https://doi.org/10.3389/fdgth.2023.1203945.

[5] Weimar SN, Martjan RS, Terzidis O. Business venturing in regulated markets: taxonomy and archetypes of digital health business models in the European Union: mixed methods descriptive and exploratory study. Journal of Medical Internet Research. 2025;27:e65725. https://doi.org/10.2196/65725.

[6] Fielt E. Conceptualising BM: Definitions, frameworks, and classifications. Journal of Business Models. 2014;1(1):85–105.

[7] Wirtz BW, Müller WM, Langer PF. The concept of business models: Development and research perspectives. International Journal of Innovation Management. 2022;26(7):2250056. https://doi.org/10.1142/S1363919622500566.

[8] Snihur Y, Markman G. Business model research: Past, present, and future. Journal of Management Studies. 2023;60(8):2177–2207. https://doi.org/10.1111/joms.12928.

[9] Business process change. In: Elsevier eBooks. Amsterdam: Elsevier; 2019. https://doi.org/10.1016/C2017-0-2868-9. Cambridge Service Alliance. Service business model innovation: the digital twin technology [Internet]. Cambridge: University of Cambridge; 2018. https://cambridgeservicealliance.eng.cam.ac.uk/system/files/documents/digitaltwins.pdf.

[10] Niemimaa M, Järveläinen J, Heikkilä M, Heikkilä J. Business continuity of business models: Evaluating the resilience of business models for contingencies. International Journal of Information Management. 2019;49:208–216. https://doi.org/10.1016/j.ijinfomgt.2019.04.010.

[11] Schoormann T, Schweihoff J, Jussen I, Möller F. Classification tools for business models: Status quo, comparison, and agenda. Electronic Markets. 2023;33(1):31. https://doi.org/10.1007/s12525-023-00639-2.

[12] Mathew PC, Joseph D, Zacharia A, Thomas AC, Oommen SE, Joseph J. Visualizing scholarly trends in electronic health (eHealth) business models: A bibliometric analysis. Cureus. 2024;16(11):e71337. https://doi.org/10.7759/cureus.71337.

[13] Pascarelli C, Colucci C, Mitrano G, Corallo A. Business models in digital health: Bibliometric analysis and systematic literature review. In: *2022 IEEE Symposium on Computers and Communications (ISCC)*; 2023. p. 1–4. https://doi.org/10.1109/ISCC58397.2023.10218237.

[14] Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ. 2021;372:n71*. https://doi.org/10.1136/bmj.n71.

[15] Tawfik GM, Dila KAS, Mohamed MYF, Tam DNH, Kien ND, Ahmed AM, et al. A step by step guide for conducting a systematic review and meta-analysis with simulation data. Tropical Medicine and Health. 2019;47(1):46. https://doi.org/10.1186/s41182-019-0165-6.

[16] Velayati F, Ayatollahi H, Hemmat M, Dehghan R. Telehealth business models and their components: Systematic review. Journal of Medical Internet Research. 2022;24(3):e33128. https://doi.org/10.2196/33128.

[17] Van Eck NJ, Waltman L. Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics. 2010;84(2):523–538. https://doi.org/10.1007/s11192-009-0146-3.

[18] Abdollahi A, Sadeghvaziri F, Rejeb A. Exploring the role of blockchain technology in value creation: A multiple case study approach. Quality & Quantity. 2023;57(1):427–451. https://doi.org/10.1007/s11135-022-01348-2.

[19] Christie HL, Boots LMM, Peetoom K, Tange HJ, Verhey FRJ, De Vugt ME. Developing a plan for the sustainable implementation of an electronic health intervention (Partner in Balance) to support caregivers of people with dementia: Case study. JMIR Aging. 2020;3(1):e18624. https://doi.org/10.2196/18624.

[20] Christie HL, Boots LMM, Hermans I, Govers M, Tange HJ, Verhey FRJ, et al. Business models of eHealth interventions to support informal caregivers of people with dementia in the Netherlands: Analysis of case studies. JMIR Aging. 2021;4(2):e24724. https://doi.org/10.2196/24724.

[21] Essen A, Frishammar J, Cenamor J. Entering non-platformized sectors: The co-evolution of legitimacy debates and platform business models in digital health care. Technovation. 2023;121:102597. https://doi.org/10.1016/j.technovation.2022.102597.

[22] Fürstenau D, Klein S, Vogel A, Auschra C. Multi-sided platform and data-driven care research. Electronic Markets. 2021;31(4):811–828. https://doi.org/10.1007/s12525-021-00461-8.

[23] Kelley LT, Fujioka J, Liang K, Cooper M, Jamieson T, Desveaux L. Barriers to creating scalable business models for digital health innovation in public systems: Qualitative case study. JMIR Public Health and Surveillance. 2020;6(4):e20579. https://doi.org/10.2196/20579.

[24] Hongdao Q, Bibi S, Mu D, Khan A, Raza A. Legal business model digitalization: The post COVID-19 legal industry. SAGE Open. 2022;12(2):21582440221093983. https://doi.org/10.1177/21582440221093983.

[25] Lokman L, Chahine T. Business models for primary health care delivery in low- and middle-income countries: A scoping study of nine social entrepreneurs. BMC Health Services Research. 2021;21(1):211. https://doi.org/10.1186/s12913-021-06225-6.

[26] Lupiáñez-Villanueva F, Folkvord F, Vanden Abeele M. Influence of the business revenue, recommendation, and provider models on mobile health app adoption: Three-country experimental vignette study. JMIR mhealth and uhealth. 2020;8(6):e17272. https://doi.org/10.2196/17272.

[27] Oderanti FO, Li F, Cubric M, Shi X. Business models for sustainable commercialisation of digital healthcare (eHealth) innovations for an increasingly ageing population. Technological Forecasting and Social Change. 2021;171:120969. https://doi.org/10.1016/j.techfore.2021.120969.

[28] Sibalija J, Barrett D, Subasri M, Bitacola L, Kim RB. Understanding value in a healthcare setting: An application of the business model canvas. Methodological Innovations. 2021;14(3). https://doi.org/10.1177/20597991211050477.

[29] Velayati F, Ayatollahi H, Hemmat M, Dehghan R. Key components and critical factors for developing a telehealth business framework: A qualitative study. BMC Medical Informatics and Decision Making. 2021;21(1):362. https://doi.org/10.1186/s12911-021-01707-3.

[30] Vimarlund V, Nikula N, Nøhr C. Business models and eHealth social innovations for social care services: Serving the two sides of the market. Health Policy and Technology. 2021;10(4):100555. https://doi.org/10.1016/j.hlpt.2021.100555.

[31] Saheb T. An empirical investigation of the adoption of mobile health applications: Integrating big data and social media services. Health and Technology. 2020;10(5):1063–1077. https://doi.org/10.1007/s12553-020-00422-9.

[32] Visconti RM, Morea D. Healthcare digitalization and pay-for-performance incentives in smart hospital project financing. International Journal of Environmental Research and Public Health. 2020;17(7):2318. https://doi.org/10.3390/ijerph17072318.

[33] Viswanadham N. Ecosystem model for healthcare platform. Sadhana. 2021;46(4):226. https://doi.org/10.1007/s12046-021-01708-y.

[34] Condry MW, Quan XI. Remote patient monitoring technologies and markets. IEEE Engineering Management Review. 2023;51(3):59–64. https://doi.org/10.1109/EMR.2023.3285688.

[35] Ivaninskiy I, Ivashkovskaya I. Are blockchain-based digital transformation and ecosystem-based business models mutually reinforcing? The principal-agent conflict perspective. Eurasian Business Review. 2022;12(4):643-670. https://doi.org/10.1007/s40821-022-00209-0.

[36] Tekkis NP, Richmond-Smith R, Pellino G, Kontovounisios C. Facilitating the adoption and evolution of digital technologies through re-conceptualization. Frontiers in Surgery. 2022;9:840595. https://doi.org/10.3389/fsurg.2022.840595.

[37] Lee A. A comprehensive review and investigation of business models. Enigma in Economics. 2024;1(2):49-54. https://doi.org/10.61996/economy.v1i2.31.

[38] Osterwalder A, Pigneur Y. Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. Hoboken (NJ): Wiley; 2010.

[39] Taipale-Erävala K, Salmela E, Lampela H. Towards a new business model canvas for platform businesses in two-sided markets. Journal of Business Models. 2020;8(3):107-125. https://doi.org/10.5278/jbm.v8i3.4621.

[40] Weimar SN, Martjan RS, Terzidis O. Conceptualizing the landscape of digital health entrepreneurship: a systematic review and research agenda. Management Review Quarterly. 2024. https://doi.org/10.1007/s11301-024-00417-0.

[41] Ilan Y. Improving global healthcare and reducing costs using second-generation artificial intelligence-based digital pills: a market disruptor. International Journal of Environmental Research and Public Health. 2021;18(2):811. https://doi.org/10.3390/ijerph18020811.

[42] Arkwright BT, Leslie M, Light M. Telehealth finance variables and successful business models. Telehealth and Medicine Today. 2019;3. https://doi.org/10.30953/tmt.v3:140.

[43] Cozzolino A, Geiger S. Ecosystem disruption and regulatory positioning: Entry strategies of digital health startup orchestrators and complementors. Research Policy. 2024;53(2):104913. https://doi.org/10.1016/j.respol.2023.104913.

[44] Iqbal JD, Biller-Andorno N. The regulatory gap in digital health and alternative pathways to bridge it. Health Policy and Technology. 2022;11(3):100663. https://doi.org/10.1016/j.hlpt.2022.100663.

[45] Tarricone R, Petracca F, Cucciniello M, Ciani O. Recommendations for developing a lifecycle, multidimensional assessment framework for mobile medical apps. Health Economics. 2022;31(Suppl 1):73–97. https://doi.org/10.1002/hec.4505.

[46] Mosconi P, Radrezza S, Lettieri E, Santoro E. Use of health apps and wearable devices: survey among Italian associations for patient advocacy. JMIR Mhealth Uhealth. 2019;7(1):e10242. https://doi.org/10.2196/10242.

[47] Shiferaw KB, Mengiste SA, Gullslett MK, Zeleke AA, Tilahun B, Tebeje T, Wondimu R, Desalegn S, Mehari EA. Healthcare providers' acceptance of telemedicine and preference of modalities during COVID-19 pandemics in a low-resource setting: An extended UTAUT model. PLoS One. 2021;16(4):e0250220. https://doi.org/10.1371/journal.pone.0250220.

[48] Steinhauser S, Doblinger C, Hüsig S. The relative role of digital complementary assets and regulation in discontinuous telemedicine innovation in European hospitals. Journal of Management Information Systems. 2020;37(4):1155-1183. https://doi.org/10.1080/07421222.2020.1831778.

[49] van Eck NJ, Waltman L. VOSviewer Manual: Manual for VOSviewer version 1.6.20. Leiden: Leiden University; 2023. https://www.vosviewer.com/documentation/Manual_VOSviewer_1.6.20.pdf.