REVIEW ARTICLE

DESIGN SCIENCE RESEARCH APPLIED TO HEALTH TECHNOLOGIES: A BIBLIOMETRIC ANALYSIS

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Highlights: (1) DSR can produce technologies to enhance health management and patient treatment and monitoring, improving health outcomes. (2) The geographical distribution of DSR contributions to health, led by Europe and North America, highlights the global imbalance in its production and dissemination. (3) DSR methods can provide a theoretical basis for innovative solutions in healthcare, management, and governance.

PRE-PROOF
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DESIGN SCIENCE RESEARCH APPLIED TO HEALTH TECHNOLOGIES: A BIBLIOMETRIC ANALYSIS

ABSTRACT

This study aimed to identify and analyze the characteristics of scientific articles in the health field utilizing Design Science (DS) and Design Science Research (DSR) as research methods. A bibliometric search was conducted in the Web of Science Core Collection database on June 28, 2023. Two independent researchers reviewed and extracted data from the articles. VOSviewer software was employed for data description and quantitative evaluation. The search yielded 461 documents, of which 127 were included in the final analysis. DS and DSR methods were applied in 91% (n = 116) of the studies, addressing multidisciplinary areas (n = 88). Most studies focused on health treatment/monitoring (n = 46), health management (n = 27), and mobile applications (n = 26). The findings suggest that integrating health technologies with DSR methods can provide a theoretical basis for innovative solutions in healthcare, health management, and governance.

Keywords: Digital Health; Health technology; Telemedicine; Process Assessment, Health Care; Bibliometric Analysis.

PRE-PROOF

Introduction

Health research has faced increasingly complex challenges, requiring innovative methodological approaches to improve patient care through efficient clinical procedures and health information management[1].

A comprehensive array of digital technologies, including mobile apps, social media, wearables, artificial intelligence, and big data, has been adopted to improve health services' speed, efficiency, and cost-effectiveness[2].

Digital technologies advance, and methodological approaches, such as Design Science and Design Science Research (DSR), have gained prominence in designing interventions and technological innovations[1]. DSR is commonly employed in computer science, engineering, business, and management[3]. The DSR method is characterized by an iterative and cyclic process composed of six main activities: problem identification and understanding, definition of solution objectives, design and development of the artifact, demonstration of feasibility, evaluation of the solution, and communication of results[4]. DSR allows exploration across

multiple contexts, including educational[3], software design, clinical settings[5], applications, and artifacts[4], with collaborative and multidisciplinary research[6].

This method facilitates the production of innovative solutions that can be implemented and tested in practice to address real healthcare problems[4], as well as critical issues related to healthcare promotion[5]. The use of DSR in contemporary healthcare challenges is promising.

Multicenter studies, health institutions, and technology institutions have implemented integrated technologies and systems as resources to address health problems and enhance healthcare and management[5,6].

Understanding which health studies using the DSR method are most frequently read and cited is relevant to assessing the current state of the scientific literature. Citation analysis plays a key role in determining the relevance and impact of publications in various areas, providing a comprehensive historical and current overview while offering valuable insights for the future. This analysis recognizes institutions, authors, and journals that have significantly contributed to advancing scientific knowledge in specific fields[7].

Quantitative analysis of publications, such as bibliometric research, can help researchers in historical analysis and identifying emerging trends in a specific topic. It informs policy decisions related to research strategic planning, assesses the impact and influence of a particular research field, maps the collaborative networks between institutions and researchers, and identifies key publications to contribute to theory and practice development[8].

To the best of our knowledge, no bibliometric study has been found that addresses the application of DSR in the health sector. Therefore, this study aims to conduct a bibliometric analysis to examine the characteristics of global scientific production and trends in DSR in health areas based on articles published in journals indexed in the Web of Science database.

Method

A comprehensive electronic search was conducted on June 28, 2023, in the Web of Science Core Collection (WoS-CC) database (https://www.webofscience.com). Initially, a search strategy was defined, considering the Medical Subject Headings (MeSH), synonyms, and relevant terms related to design science research in health. No filters, language restrictions, or date limits were considered. The string search used was the following: (TS= (("Design

PRE-PROOF

Science Research" OR "Design Science Research Study" OR "Design Science Research Approach" OR "Design Science Research Method" OR "DSR" OR "DSRM" OR "Design Science Approach" OR "Design Science") AND ("Healthcare Information Technology" OR "Mobile Health" OR "Health information systems" OR "Health Care" OR "Health" OR "Public Health" OR "health service" OR "e-health" OR "health information" OR "health records" OR "health management")).

For selecting articles, two independent researchers (VM and AOR) read the title, abstract, and full text when necessary. Disagreements were resolved by consensus with the assistance of two additional researchers (ALSM and MC). Articles that used the DSR method in any health area were included, and conference studies, duplicates, and studies that did not address the proposed objective were excluded.

After the selection, the following bibliometric data were extracted from each article by two researchers (VM and AOR): number of citations, year of publication, journal, impact factor (IF) in Journal Citation Reports from Clarivate Analytics in 2022, study method, theme (main objective and area of interest), country and continent, institution (based on the affiliation of the corresponding author), authors and keywords. All data were transferred to Microsoft Excel® 2010 (Microsoft, Redmond, WA, USA) for analysis. It is relevant to note that VOSviewer, as a software for creating collaboration networks, limits the analysis to only one database entry (.txt file), in the present study, WoS-CC.

The studies were classified as literature review, design science, and DSR. The articles were grouped according to the most prevalent themes, as DSR research focus on: health treatment/monitoring, health management, mobile applications, telehealth systems, health diagnostics, and health services integration. The evolution of the occurrence of the themes was analyzed over the years. Regarding the area of interest, the studies were grouped into medicine, nursing, pharmacy, psychology, nutrition, and multidisciplinary areas.

The Visualization of Similarities Viewer software (VOSviewer, version 1.6.17.0, Netherlands) was used to visualize the bibliometric networks of collaboration among authors and the most prevalent keywords (those occurring five or more times). The authors' names associated with the most prominent points, written in conjunction with the most significant sources, showed a higher occurrence in network analysis. On the other hand, the smaller the dot

PRE-PROOF

or the written font, the lower the occurrence of the associated author's name. The lines connecting the authors' names represent their collaboration in the same study. A document co-citation analysis was performed to examine the frequency with which two papers were cited together, indicating the studies that were most frequently mentioned in DSR searches and possible research clusters.

For statistical analysis, the Kolmogorov-Smirnov normality test was initially performed to verify the normality of the data distribution. As they exhibited a non-normal distribution, Spearman's correlation coefficient test was used to determine the correlation between the number of citations and the year of publication, as well as the IF of the journal. Data analysis was performed using SPSS for Windows statistical software (SPSS, version 24.0; IBM, Armonk, USA Corp).

Results

Search results

The main search resulted in 461 documents. The title, abstract, and full text were read when necessary to select the articles. Thus, 127 articles were included (Table 1). Of the excluded articles, 59 were conference papers, one was duplicate, and the remaining 274 did not address the proposed objective (Figure 1).

Table 1: Selected articles.

Position	References	Number of citations
1	Peffers K, Tuunanen T, Rothenberger MA, Chatterjee S. A design science research method for information systems research. Journal of management information systems. 2007;24(3): 45-77.	2,528
2	Greenhalgh T, Jackson C, Shaw S, Janamian T. Achieving Research Impact Through Co-creation in Community-Based Health Services: Literature Review and Case Study. Milbank Q. 2016;94(2):392-429.	437
3	Schnall R, Rojas M, Bakken S, Brown W, Carballo-Dieguez A, Carry M, Gelaude D, Mosley JP, Travers J. A user-centered model for designing consumer mobile health (mHealth) applications (apps). J Biomed Inform. 2016; 60:243-51.	254
4	Grenha TJ, Patrício L, Huang KH, Fisk RP, Nóbrega L, Constantine L. The MINDS method: integrating management and interaction design perspectives for service design. Journal of Service Research. 2017; 20(3): 240-258.	103
5	Lin YK, Chen H, Brown RA, Li SH, & Yang HJ. Healthcare Predictive Analytics for Risk Profiling in Chronic Care. MIS Quarterly. 2017; 41(2): 473-496.	68

PRE-PROOF

6	Patrício L, de Pinho NF, Teixeira JG, Fisk RP. Service design for value networks: enabling value cocreation interactions in healthcare. Service Science. 2018; 10(1): 76-97.	48
7	Miah SJ, Hasan J, Gammack JG. On-cloud healthcare clinic: an e-health consultancy approach for remote communities in a developing country. Telematics and Informatics. 2017;34(1): 311-322.	42
8	Barjis J, Kolfschoten G, Maritz J. A sustainable and affordable support system for rural healthcare delivery. Decision Support Systems. 2013; 56: 223-233.	38
9	Nunez DL, Borsato M. An ontology-based model for prognostics and health management of machines. Journal of Industrial Information Integration. 2017; 6:33-46.	35
10	Ta Park V, Kim A, Cho IH, Nam B, Nguyen K, Vuong Q, Periyakoil VS, Hong YA. Motivation to Participate in Precision Health Research and Acceptability of Texting as a Recruitment and Intervention Strategy Among Vietnamese Americans: Qualitative Study. JMIR Mhealth Uhealth. 2021 Mar 11;9(3):e23058.	33
11	Groop J, Ketokivi M, Gupta M, Holmström J. Improving home care: Knowledge creation through engagement and design. Journal of Operations Management. 2017; 53: 9-22.	31
12	Adam MT, Gimpel H, Maedche A, Riedl R. Design blueprint for stress-sensitive adaptive enterprise systems. Business & Information Systems Engineering. 2017; 59:277-291.	31
13	Dadgar M, Joshi KD. The role of information and communication technology in self-management of chronic diseases: an empirical investigation through value sensitive design. Journal of the Association for Information Systems. 2018; 19(2): 2.	30
14	Klinker K, Wiesche M, Krcmar H. Digital transformation in health care: Augmented reality for hands-free service innovation. Information Systems Frontiers. 2020; 22: 1419-1431.	27
15	Miah SJ, Gammack J, Hasan N. Extending the framework for mobile health information systems Research: A content analysis. Information Systems. 2017; 69: 1-24.	27
16	Neuhauser L, Kreps GL, Morrison K, Athanasoulis M, Kirienko N, Van Brunt D. Using design science and artificial intelligence to improve health communication: ChronologyMD case example. Patient Educ Couns. 2013;92(2):211-7.	26
17	Beinke JH, Fitte C, Teuteberg F. Towards a Stakeholder-Oriented Blockchain-Based Architecture for Electronic Health Records: Design Science Research Study. J Med Internet Res. 2019;7;21(10):e13585.	25
18	Lapão LV, da Silva MM, Gregório J. Implementing an online pharmaceutical service using design science research. BMC Med Inform Decis Mak. 2017; 27;17(1):31.	23
19	Zahedi FM, Walia N, Jain H. Augmented virtual doctor office: Theory-based design and assessment. Journal of Management Information Systems. 2016; 33(3):776-808.	23
20	Zhu H, Samtani S, Chen H, Nunamaker Jr JF. Human identification for activities of daily living: A deep transfer learning approach. Journal of Management Information Systems. 2020; 37(2): 457-483.	22
21	Fitterer R, Rohner P. Towards assessing the networkability of health care providers: a maturity model approach. Information Systems and E-Business Management. 2010; 8: 309-333.	21
22	Sherer SA. Advocating for action design research on IT value creation in healthcare. Journal of the Association for Information Systems. 2014; 15(12): 2.	20
23	Derks YP, Klaassen R, Westerhof GJ, Bohlmeijer ET, Noordzij ML. Development of an Ambulatory Biofeedback App to Enhance Emotional Awareness in Patients	19

PRE-PROOF

	with Borderline Personality Disorder: Multicycle Usability Testing Study. JMIR Mhealth Uhealth. 2019; 15;7(10): e13479.	
24	Simões AS, Maia MR, Gregório J, Couto I, Asfeldt AM, Simonsen GS, Póvoa P, Viveiros M, Lapão LV. Participatory implementation of an antibiotic stewardship program supported by an innovative surveillance and clinical decision-support system. J Hosp Infect. 2018;100(3):257-264.	19
25	Johnson M, Burgess N, Sethi S. Temporal pacing of outcomes for improving patient flow: design science research in a national health service hospital. Journal of Operations Management. 2020; 66(1-2): 35-53.	18
26	Nhavoto JA, Grönlund Å, Chaquilla WP. SMSaúde: Design, Development, and Implementation of a Remote/Mobile Patient Management System to Improve Retention in Care for HIV/AIDS and Tuberculosis Patients. JMIR Mhealth Uhealth. 2015 Mar 9;3(1):e26.	18
27	Cox III J F, Boyd LH. Using the theory of constraints' processes of ongoing improvement to address the provider appointment scheduling system design problem. Health Systems. 2020; 9(2): 124-158.	17
28	Johnson M, Albizri A, Harfouche A. Responsible artificial intelligence in healthcare: Predicting and preventing insurance claim denials for economic and social wellbeing. Information Systems Frontiers. 2021; 1-17.	16
29	Neuhauser L, Kreps GL. Integrating design science theory and methods to improve the development and evaluation of health communication programs. J Health Commun. 2014;19(12):1460-71.	16
30	Sharma, R., Zhang, C., Wingreen, S. C., Kshetri, N., & Zahid, A. Design of blockchain-based precision health-care using soft systems method. Industrial Management & Data Systems. 2020; 120(3), 608-632.	15
31	Marques R, Gregório J, Pinheiro F, Póvoa P, da Silva MM, Lapão LV. How can information systems provide support to nurses' hand hygiene performance? Using gamification and indoor location to improve hand hygiene awareness and reduce hospital infections. BMC Med Inform Decis Mak. 2017 Jan 31;17(1):15.	15
32	Kuipers DA, et al. iLift: A health behavior change support system for lifting and transfer techniques to prevent lower-back injuries in healthcare. Int J Med Inform. 2016 Dec;96:11-23.	15
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34	Kao HY, Wei CW, Yu MC, Liang TY, Wu WH, Wu YJ. Integrating a mobile health application for self-management to enhance Telecare system. Telematics and Informatics. 2018; 35(4), 815-825.	14
35	Nguyen BV, Burstein F, Fisher J. Improving service of online health information provision: a case of usage-driven design for health information portals. Information Systems Frontiers. 2015; 17:493-511.	14
36	Lapão LV, et al. Implementation of Digital Monitoring Services During the COVID-19 Pandemic for Patients With Chronic Diseases: Design Science Approach. J Med Internet Res. 2021; 26;23(8):e24181.	12
37	Ferro DB, Brailsford S, Bravo C, Smith, H. Improving healthcare access management by predicting patient no-show behavior. Decision Support Systems. 2020; 138, 113398.	12
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PREPROOF

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PEER-PROOF

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PREPROOF

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81	Mdletshe S, Oliveira M, Twala B. Enhancing medical radiation science education through a design science research method. J Med Imaging Radiat Sci. 2021;52(2):172-178.	2
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89	Venkatraman S, Sundarraj R. Assessing organizational health-analytics readiness: artifacts based on elaborated action design method. Journal of Enterprise Information Management. 2023; 36(1): 123-150.	1
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PREPROOF

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93	Williams PAH, Lovelock B, Cabarrus JA. A Sense of Coherence Approach to Improving Patient Experience Using Information Infrastructure Modeling: Design Science Research. JMIR Form Res. 2022; 12;6(4):e35418.	1
94	Anderson DC, Teti SL, Hercules WJ, Deemer DA. The Bioethics of Built Space: Health Care Architecture as a Medical Intervention. Hastings Cent Rep. 2022;52(2):32-40.	1
95	Gaspar AGM, Lapão LV. A Digital Health Service for Elderly People with Balance Disorders and Risk of Falling: A Design Science Approach. Int J Environ Res Public Health. 2022;7;19(3):1855.	1
96	Feldman S, Schooley BL, Tipper B. Design Knowledge for Collaborative Health Information Systems for Substance Use Disorder. Communications of the Association for Information Systems. 2022; 51(1): 6.	1
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127	Van der Voorn P, Brand N. Mapping a high-level overview of information flows in the Dutch declaration chain for medical specialist health care. Health Info Libr J. 2020;37(4):329-336.	0

Source: The authors.

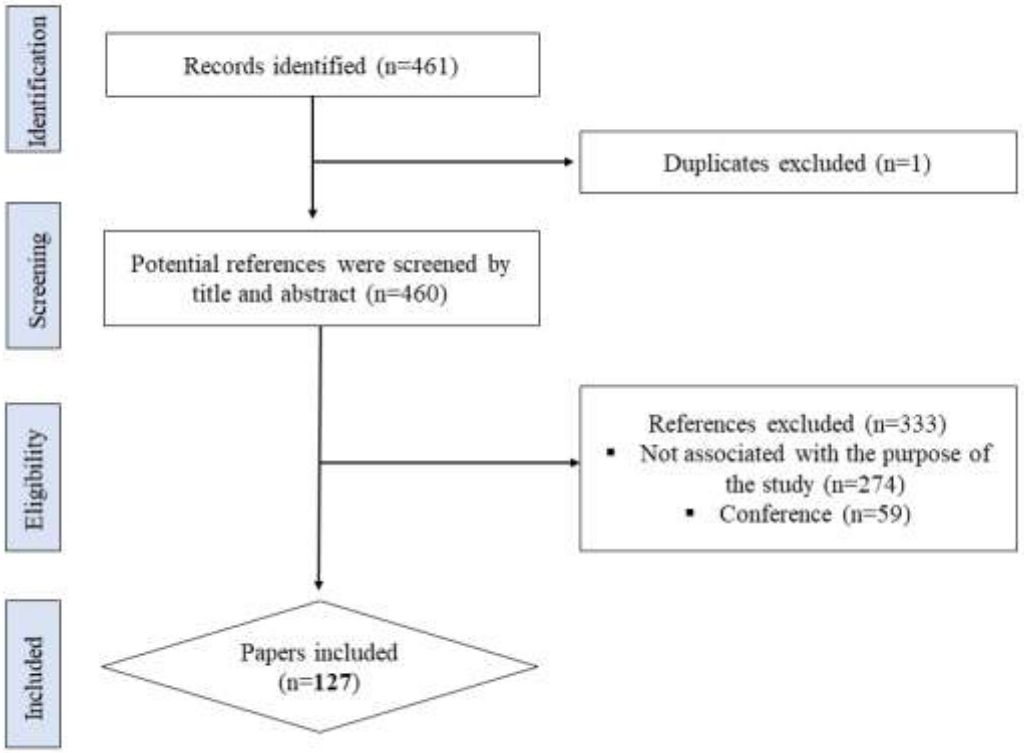

Figure 1- Flowchart of the study selection protocol.

Citation analysis

The selected articles received a total of 4,395 WoS-CC citations. Self-citations accounted for 2.2% of WoS-CC citations (98 self-citations). The most cited article in WoS-CC was "A Design Science Research Method for Information Systems Research", written by Peffers K. and colleagues and published in the Journal of Management Information Systems, with 2,528 citations. According to Spearman correlation, a moderate positive correlation was

observed between the number of citations and the journal's impact factor (2022) (rho = 0.448), and a strong negative correlation between the number of citations and the year of publication (rho = -0.760).

The oldest article was the most cited in this research by WoS-CC, published in 2007, with the title "A Design Science Research Method for Information Systems Research", authored by Peffers K and collaborators. The year 2023 accounted for 12% of the publications, considered the most recent (n = 16). The most significant number of articles (n = 31) was published in 2022. The number of publications and citations each year is described in Figure 2.

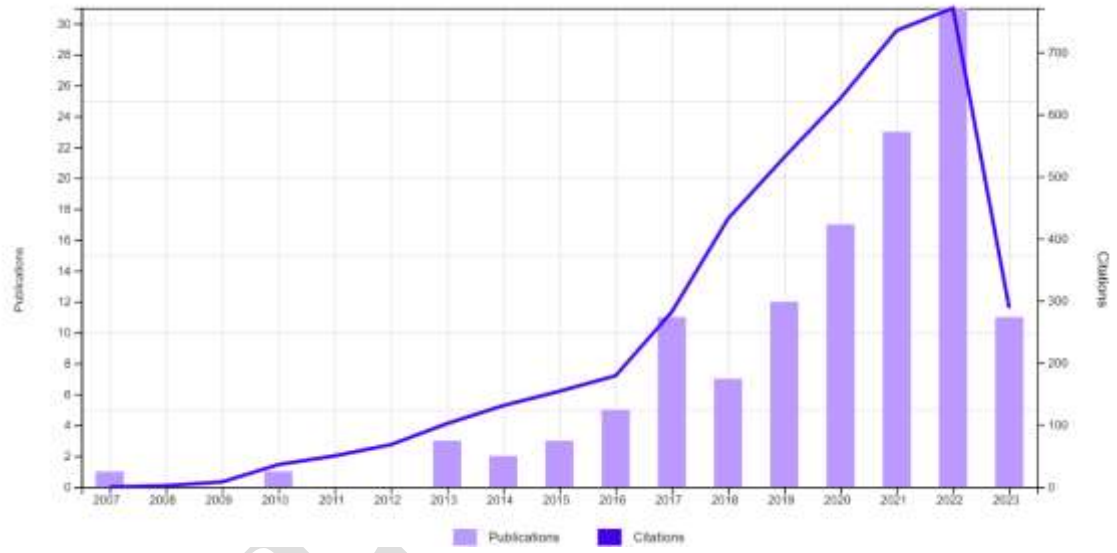

Figure 2- Distribution of the number of publications over the years.

Additionally, the document co-citation analysis identified three main clusters, one of which was composed of articles first authored by Peffers K, followed by Hevner AR, and Gregor S (Figure 3), all authors considered key figures in DSR consolidation as a research paradigm focused on creating and evaluating innovative artifacts to solve real-world problems.

DESIGN SCIENCE RESEARCH APPLIED TO HEALTH TECHNOLOGIES: A BIBLIOMETRIC ANALYSIS

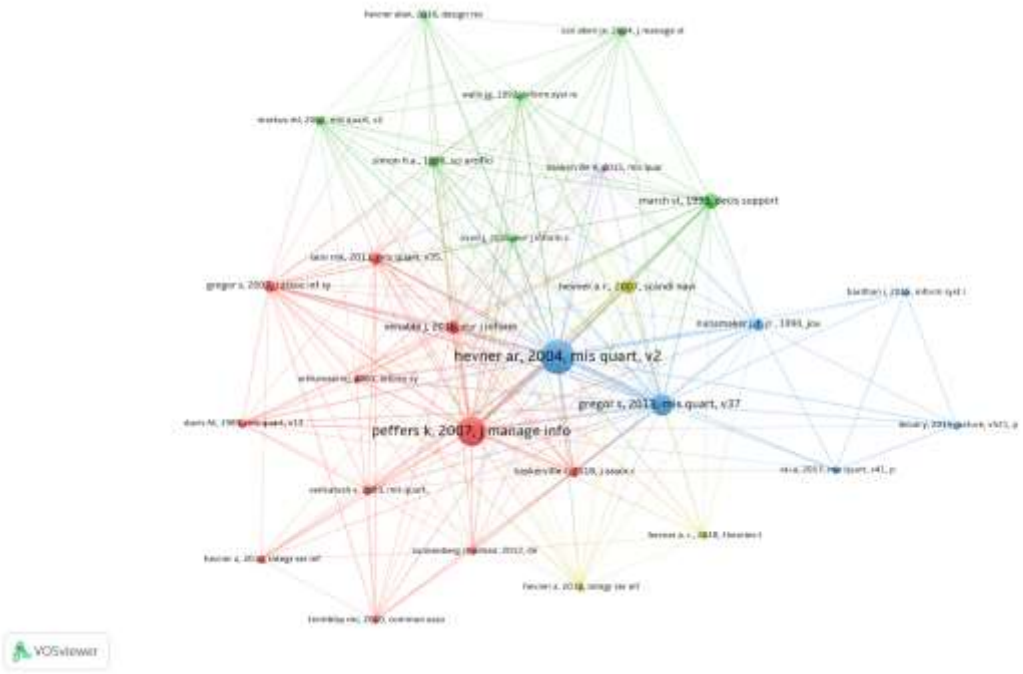

Figure 3 - Document co-citation analysis among DSR articles.

Journals and Impact Factor

The leading journals and respective impact factors (2022) in which articles on DSR were The Journal of Medical Internet Research (n = 8; IF = 7.4), as the most prevalent journal to publish studies related to DSR, followed by JMIR mHealth and UHealth (n = 5; IF = 5.0). According to the Journal Citation Reports, the journals with the highest impact factors (IF) in 2022 linked to this study were the Journal of Service Research (IF 12.4), with one article, and Computers in Human Behavior and Information & Management (IF 9.9), with one article each.

Study method and themes

Most articles addressed the DSR applied method (n = 116), followed by literature reviews (n = 11). The most prevalent themes were health treatment/monitoring (n = 46), health management (n = 27), and mobile applications (n = 26). One article comprised three themes: health management, mobile applications, and integration of health services. An evolution of the themes' occurrence over the years, from 2007 to 2023, can be seen in Table 2. Health treatment/monitoring was the most established, with a higher volume of DSR focus, followed

by health management and mobile applications. Over the years, especially since 2020, these themes have seen a significant quantitative leap as a focus of studies in DSR.

Table 2: Occurrence of DSR themes over the years, from 2007 to 2023.

Themes	2007-2013	2014-2019	2020-2023
Health treatment/Monitoring	2	15	29
Health management	1	6	21
Mobile applications	0	7	19
Integration of health services	1	3	1
Remote healthcare systems	1	4	6
Health diagnosis	0	1	10

The main areas of knowledge comprised multidisciplinary (n = 88), medicine (n = 23), nursing (n = 7), psychology (n = 3), pharmacy (n = 2), nutrition (n = 2), and other areas (n = 2).
Countries and Continents

A total of 31 countries contributed to the DSR-related articles. Considering the number of publications per country, the top three were: the United States (n = 31), Portugal (n = 14), and Australia (n = 12). Among the continents (Figure 4), Europe stands out (n = 45), followed by North America (n = 31) and Asia (n = 18).

PRE-PROOF

DESIGN SCIENCE RESEARCH APPLIED TO HEALTH TECHNOLOGIES: A BIBLIOMETRIC ANALYSIS

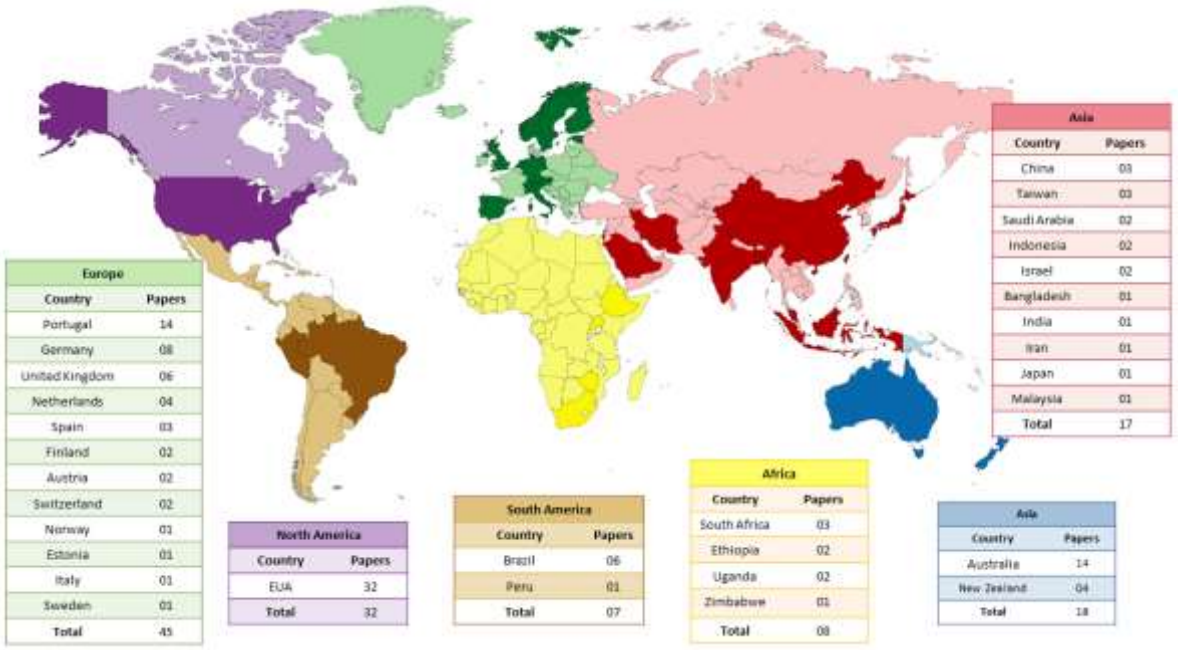

Figure 4 - Worldwide distribution of the origin of publications on DSR.

Institutions

A total of 95 institutions contributed to the articles related to DSR. The institutions with the highest number of publications were the Victoria University (Germany), with eight articles, and the University NOVA de Lisboa (Portugal), with seven articles. The University of Vigo (Spain), Osnabrück University (Germany), the University of Texas at San Antonio (USA), and Florida State University (USA) each have three articles.

Contributing authors and Citations

A total of 441 authors contributed to the DSR articles. The authors with the highest number of publications were Lapão LV (n = 10; H-index = 17), followed by Miah SJ (n = 9; H-index = 19), Chen H (n = 6; H-index = 51), and Gregório J (n = 6; H-index = 22).

Keywords

A total of 865 keywords were identified. Figure 5 illustrates the most prevalent keywords and their collaborative relationships. The most frequent keywords were "design science research" (35 occurrences), followed by "design science" (31 occurrences), "management" (18 occurrences), and "science research" (17 occurrences). In the Figure, the

PRE-PRO

largest dots show the keywords that appear most often, while the words that occur less frequently are associated with the smallest dots. The lines joining the dots indicate the relationship and use of these words in the same studies. In terms of color, words associated with the focus that share the same color indicate greater collaboration.

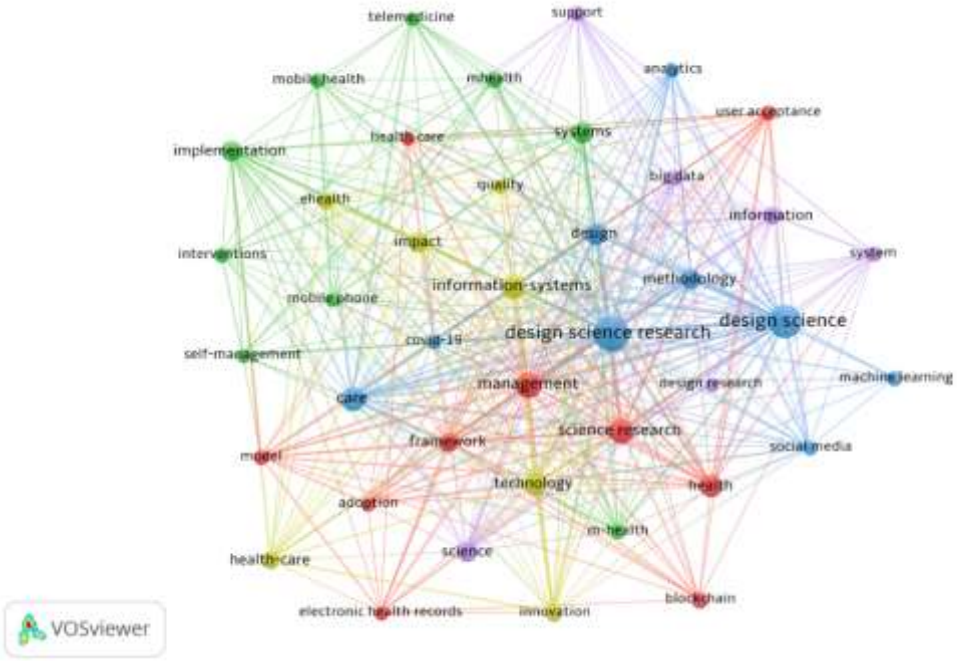

Figure 5 - Frequency and interaction of the main keywords associated with the study. Minimum number of occurrences of keywords: five studies.

Discussion

This study identified and analyzed the main characteristics of scientific articles that applied the Design Science and DSR method in the health field. This knowledge provides a comprehensive view of the subject, mapping the most influential articles and identifying relevance, trends, and gaps in the literature.

The DSR method has the potential to generate intellectual impact through creative ideas and advancements in science, economics, and society[12]. Similarly, the topic's relevance is highlighted in this bibliometric analysis, as the Journal of Medical Internet Research has the highest number of publications and a high impact factor, followed by the Journal of Service Research, Computers in Human Behavior, and Information & Management. These significant

journal metrics may be related to publications using the DSR method in studies focusing on strategies for innovation and the development of technologies that address current and emerging healthcare demands[3].

The results demonstrate that the traditional epistemology in health research, which privileges the observation and discovery of phenomena, can incorporate the creation and intervention logic presented in DSR. This recognition is a scientific legitimacy of projecting and building artifacts (applications, systems, and processes) as a valid form to produce knowledge. Considering that 116 out of 127 articles focus on DSR applied method, it demonstrates that the scientific community is accepting app prototypes, process models, or framework conceptual constitute DSR tangible and valid contributions, not secondary health products. In this way, digital health becomes an interdisciplinary field with its own methodology for innovation.

The investigation of the impact of published articles in a specific scientific domain is often based on analyzing the number of citations. Articles that accumulate numerous citations are usually recognized as “reference works.” 10 The most cited article aimed to demonstrate the application and evaluation of the DSR method in healthcare through a case study. This case study presented the following elements: 1) the design of a database to support assessment methods in health, 2) a measure for software reuse, 3) an internet-based video calling application, and 4) a method for planning information systems in healthcare. This study serves as a reference for interpreting results across different technologies using the same DSR method[11]. Research in the technology segment, utilizing the DSR method, including database evaluation, software reuse, video calling applications, and information systems planning in the healthcare area, serves as a reference for developing healthcare technologies [1,3,5,6].

In general, research focus has exploded around direct patient-care applications, particularly mobile health for treatment and monitoring, fueled by recent technological advances and the COVID-19 pandemic. In contrast, interest in backend challenges, such as system integration, has significantly declined over the years. In this bibliometric study, 26 publications about mobile applications were identified. It was observed that DSR is being used in health technologies, employing technological artifacts as solutions for various segments, including management, health data security[13], assistance, diagnostics[3], communication between

PRE-PROOF

users and professionals[14], public health related to the treatment and prevention of tuberculosis[15], teleconsulting, telemedicine[16], care for chronically ill patients[17], and older adults with wearable technologies and the integration of technologies with the Internet of Things[18]. There are also publications on Artificial Intelligence aiding self-care, such as one aimed at improving the management of Crohn's disease[19]. However, numerous challenges exist in health technologies, particularly those that are more complex. Health technology assessments demonstrate that some data are insufficient to assess the effectiveness of more complex technologies[20]. Nevertheless, technological innovation and productivity in daily use of healthcare or work can expand the impact on multiple health experiences[21]. It is also proposed that health professionals carry out the patent registration process.

The most cited articles were concentrated between 2007 and 2017. However, the most significant number of articles was published in 2022 and 2023 (n = 47), constituting 37% of the total publications, which demonstrates the contemporary nature of the issue. Yet, there is a lack of citations for the most recent articles, which may indicate that, despite many new publications on innovations in health technologies, they are not being referenced, as they originate from the health rather than the technological field.

Other themes with fewer publications include integrating health services, health diagnostics, remote healthcare systems, and data security technologies like blockchain in the health area[13]. There are also solution-oriented studies to help patients with chronic diseases[8], stating that these patients face the risks of a series of adverse health events. The DSR approach enhances knowledge and can promote scientific and technological development to generate solutions for various contexts, thereby reducing the distance between theoretical development and practical repercussions[11]. Applying the DSR method in health can benefit management, education, assistance, diagnosis, treatment, and health data, integrating knowledge from different health professionals in innovation processes and proposals, such as consultancy in e-health for remote communities[5].

The co-citation analysis resulted in the highly influential and foundational works in the field, such as Hevner (2004), Peffers (2007), and Gregor (2013), performing clusters of domains, meaning they are highly cited together. The characteristics of these articles can justify

PRE-PROOF

these results as they present a conceptual framework for DSR, DSR methodological processes, and DSR evaluation and contribution.

Another aspect is that the first authors are generally from the field of information technology. This may indicate a lack of initiative among health professionals in studies involving new technologies. There is a need to train health professionals in patents and intellectual property to overcome their problems directly. Two studies reported how 'others' are indirectly health-related but can impact results. One dealt with universities in information technology governance[22], and another focused on occupational health and security for industry professionals[23]. In this way, it is noteworthy that the author who published the most discussed topics related to digital health and information systems in health is Lapão LV, followed by Miah SJ addressing administration/technology and health management, Chen H with technologies in health, and Gregório J with technologies focused on pharmacy and health services.

Regarding the country, the USA has the most significant number of publications on DSR in the health field. In specific health areas, such as nursing, another bibliometric study found the US to be the most productive country in terms of both funded and non-funded literature production, as well as a positive trend in nursing research literature production. [24] However, Europe was the continent with the most substantial number of publications, followed by North America and Asia. Europe stands out, with institutions that have the most publications. Most studies from Asia focused on solutions to evaluate populations more remotely, monitor health, and promote care[25]. Apart from Asia, production is scarce in countries of the Global South. This may be justified by the lack of financial and structural resources, as well as language barriers and the technological dependency of some of these regions.

Most studies are multicenter, carried out collaboratively, and involve technology, health management, healthcare, and technology-supported self-care. However, the areas of technology and management are the ones that publish the most innovations using the DSR method in the health area. This can be justified because few healthcare professionals know the method[4].

The primary strength of this bibliometric analysis lies in its investigation of the DSR method in the context of health, as no other bibliometric reference in the literature has comprehensively addressed this topic. Corroborating the analysis, no filters were applied for year, language, or number of citations, making this study even more comprehensive. However,

PRE-PROOF

using a single database (WoS-CC) can be considered a limitation of this study. It's relevant to mention that WoS-CC has been considered one of the main bases for this type of study[26].

DSR has made significant contributions to emergent paradigms in health research, primarily by providing a rigorous methodological framework for developing innovative solutions to practical health problems. The growth in publications, particularly since 2020, and the dominant focus on health treatment and monitoring, health management, and mobile applications, reveal a shift towards patient-centric, mobile, and remote healthcare models. This evolution highlights DSR's role in driving the digital transformation of healthcare services, enabling the creation of tangible artifacts, including AI-powered diagnostic tools and personalized mHealth apps, which address challenges such as the increased demand for remote care accelerated by the global COVID-19 pandemic. The negative correlation between publication year and citations suggests that, while the field is rapidly expanding, the most foundational methodological contributions, such as the highly cited work by Peffers et al. (2007), continue to anchor the research field.

Furthermore, the high concentration of publications in leading, high-impact journals means that DSR outcomes are recognized as rigorous, evidence-based, and relevant to both social and practical contexts. However, the geographical distribution of contributions, led by Europe and North America with significant input from institutions in Germany, Portugal, and the USA, highlights the global imbalance in DSR production and dissemination.

The complex challenges of contemporary healthcare require integrating knowledge from multiple areas, which is also a challenge for DSR. Implications for public policies include the possibility of stakeholders and health professionals analyzing good scientific evidence to understand not only whether a health technology works, but also how it can be implemented, considering its costs, barriers, and facilitators.

Ultimately, DSR bridges the gap between theoretical research and practical application, providing the tools and methods necessary to build, evaluate, and implement the next generation of digital health solutions that improve service delivery and patient-centered outcomes.

PRE-PROOF

Conclusion

In conclusion, the production of DSR in the health field demonstrates a clear trajectory towards producing pragmatic, technology-driven solutions for pressing healthcare challenges. The field is characterized by the development of artifacts to improve and expedite diagnoses, monitoring patients across different age groups and health conditions, and specific technologies tailored for certain pathologies. Studies have consistently integrated technologies like the Internet of Things, mobile applications, and software. This consistent output underscores DSR's role in translating technological potential into tangible interventions that aim to enhance the speed, accuracy, and accessibility of care.

However, production is scarce in Global South countries, and particularly in specific areas of health, such as pharmacy and nutrition, indicating a significant gap that researchers can explore. This imbalance fails to address diverse socioeconomic, infrastructural, and cultural contexts.

Health researchers and policymakers should, therefore, strive to integrate technologies with investigative methods such as DSR, which can yield innovative solutions in healthcare assistance, management, and governance. When adapted to local and regional realities, well-applied technologies can promote equity, improve communication, and enhance access to health services.

PRE-PROOF

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PRE-PROOF

DESIGN SCIENCE RESEARCH APPLIED TO HEALTH TECHNOLOGIES: A BIBLIOMETRIC ANALYSIS

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