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Scientific Radiography of Healthcare System Process Efficiency Digitalisation

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Abstract: *Digitalisation remains a complex process in terms of integration into healthcare, a significant challenge worldwide. This study aims to identify the most influential trends in terms of authors, sources, countries, affiliations, and highly engaged documents that significantly contribute to the healthcare system's digitalisation. To perform a comprehensive science mapping analysis, a logical data frame of 336 Web of Science database recent papers published between 2018 and 2022 are analysed using R-Bibliometrix. Our results highlighted throughout a scientific mapping and visual framework that digitalisation of the healthcare system is a revolutionary, actual, and pervasive concept, considered a new research area recognised by evolution and consistent growth. Moreover, the results provide different types of networks and highlight the keywords, authors, documents, and countries with the highest interest in the subject of the digitalisation of healthcare.*

Keywords: Health system; Digitalization; Biblioshiny; Bibliometric and visual analysis

JEL Classification: I10, O30

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Introduction

As a global strategy for digital health, the digitalisation of the health system has aroused great interest in the last few years, and a growing number of related research has been published on this topic.

In this regard, Reich and Meder (2021) state that advances in new digital technologies have great potential to transform healthcare delivery fundamentally. The digitalisation of the health system is a process that has the potential to have a double impact on individuals, communities, and nations. Thus, McKee et al. (2019) suggest that along with the benefits and opportunities of the digital health revolution, some risks may be the biggest challenges facing the public health community, especially the health system.

The consolidation and the digitalisation of people-centred health systems are based on a key component that aims to address various goals, such as improving the performance and efficiency of the health system, achieving public health goals, and ensuring that new technologies do not create social inequities. The components of the digitalisation of the healthcare system require complex actions, various ways to implement them in the fields of healthcare, as well as a series of technical guidelines for providing the necessary support in terms of digital health. Thereby, Jarvis et al. (2020) found that although the movement toward people-centred health systems is increasing, there are still significant gaps in achieving this goal.

Along these lines, many challenges are arising for the healthcare systems alongside an increase in the demand for high-quality public services. Nevertheless, our paper also highlights and discusses a series of crucial and pragmatic existing gaps in knowledge and strengthens the current healthcare system process efficiency digitalisation literature with an updated complex assessment of the implications of process digitalisation upon health systems and further upon the EU digital healthcare services quality and performance, namely, digital transformation of health services. The main challenges posed by the increasing need for high-quality and digital healthcare services are, on the one hand, an economic perspective and, on the other hand, of social nature, where governments urgently need to cope with additionally increasing the financing of the long-term health systems and sustaining the process of digitalisation that can significantly boost efficiency and resilience of health systems around the EU Member States. The main outstanding gaps identified in the current literature focus on how the issues regarding the digitalisation of health systems need to be updated. In this light, we have determined that the new technologies, alongside the ongoing process to sustain the achievement of multiple and complex digital skills by the management and professionals, can be considered as a new asset to attain and increase the quality of public healthcare services and to increase the performance, sustainability and resilience of health systems (Crăciun et al., 2023). Hence, the government must suggest the proper way in which the EU Member States align the

proper and pervasive integration of technologies with integrated working processes and professionals with well-defined skills in using and incorporating digital processes to offer and deliver different and complex healthcare services and operations for the whole society (Țăran et al., 2021).

The research objectives are to collaborate on the existing literature on the digitalisation of the healthcare system by identifying the gaps and presenting a comprehensive examination and evaluation of the published documents over the last five years.

Based on the underpinnings previously mentioned, the general research objectives of the paper are as follows: i) to determine the trends of the scientific publications and the average of the citations per year; ii) to identify the most significant contributions in the digitalisation of the healthcare system field in terms of authors, affiliations, sources, countries, and cited references; iii) to highlights different network analysis, respectively: world cloud, treemap, co-occurrence of keywords, and thematic evolution. Our comprehensive bibliometric analysis provides a clear picture of the main strategies that can be adapted to rethink the healthcare system's digitalisation. The methodology applied consists of an R-tool package, namely Bibliometrix, implying biblioshiny, the shiny app for bibliometrix, to assess the research objectives significantly.

Our research is based on the "Diffusion and Innovation Theory" (Rogers, 1962) – considered because this theory identifies influencers that help spread innovative ideas, including social systems, time, and various channels of communication. Therefore, the diffusion of innovations is applicable to the compounded health-system context, where high-quality healthcare is defined by the adoption of continuous innovation and the elimination of outdated practices.

Therefore, a comprehensive bibliometric analysis of these publications provides insights into emerging trends related to the digitalisation of the healthcare system in the health sector. The impact of digitalisation on the healthcare system is analysed based on a bibliometric analysis approach as a qualitative method to document and justify the most appropriate contributors in the field and visualise different types of collaboration networks.

The rest of the paper is structured as follows. After the Introduction, the section Literature review entails a theoretical framework where the most relevant studies on the digitalisation of the healthcare system are summarised. Section Methodology and Data introduces and describes the dataset and the methodology applied. Further, Section Empirical Results reports the main findings that reflect our study design, followed by the concluding remarks, some implications, and the main perspectives and challenges for future research in Section Conclusions.

Literature review

Nowadays, digitalisation is attested as the process through the healthcare systems can significantly increase their efficiency. Medical technologies, as a result of the

efficiency of digitalisation in health processes, allows the radical transformation of health systems, and whose efficiency is categorically analysed, on the one hand, from the perspective of patients in terms of the adoption and use of new digital services, and, on the other hand, to stimulate patients to participate in the decision-making process regarding their health (Iyawa et al., 2016).

"Diffusion and Innovation Theory" is also considered in the research paper of Kaminski (2011), being defined by some essential characteristics that led to the empowerment of the guidance of the technological innovation process. Alongside, the adoption process considers two well-defined conditions, respectively, a high degree of communication among the involved actors and peer networking within the whole levels. Zhang et al. (2015) suggest that healthcare providers are facing many challenges, considering that the response to such difficulties could be the adoption of digitalisation in health services, especially an integrative health system that can have a major positive impact through the integration of innovation alongside technological development. Furthermore, Zhang et al. (2015) also consider the "Diffusion and Innovation Theory" in their study to better reflect, identify and understand the outliners factors that can impact patient acceptance and use of innovative e-health services.

Globally, the number of academic publications has a growing trend, making it increasingly difficult to keep up with everything published. However, empirical contributions have intensified, leading to voluminous and split research. Moreover, this issue decreases the ability to collect evidence actively and accumulate new knowledge through a spectrum of previous academic publications.

Thus, the crucial role of the synthesis of the results of prior research findings belongs to the efficient literature reviews, which allow the use of the existing and previous knowledge base, offering a perspective based entirely on evidence in practice, advancing a line of research, and supporting professional expertise (Rousseau, 2012). Researchers can use qualitative or quantitative literature reviewing approaches to organize, synthesise, and understand earlier findings. Bibliometrics allows an objective and reliable analysis and a review process that can be a transparent review process, systematic, and reproducible based on statistical measurements of scientific activity (Broadus, 1987; Diodato, 1994; Pritchard, 1969). The prominent role of bibliometrics is accentuated by the existence of an extensive volume of new data, information and theoretical developments that provide structured analysis in case of a wide range of evidence research topics, detecting the most influential scientists, journals, institutions, and countries and presenting the "overview" of existing research (Crane, 1972).

Zimmermanova et al. (2022) state that the different levels of management in the medical units consider digitalisation as an essential information resource. Moreover, Nataliia et al. (2021) grounded these findings because their results suggested that in the COVID-19 pandemic context, the digitalisation of the healthcare system of medical institutions and their management benefited from various facilities. Therefore, the results indicated that based on the pandemic crisis in the health system caused by the spread

of the COVID-19 virus, technological change has accelerated, bringing benefits related to the exchange and storage of information by medical unit management through the implementation of various digital technologies in the healthcare system. Furthermore, Țăran et al. (2022) examined health, digitalisation, and COVID-19 in European Union Member States and argued that the digitalisation of health systems should be a primary goal, especially during and after the COVID-19 pandemic, with significant potential to improve health systems and providing high-quality medical services.

Analysing the level of integration of information and communication technology in health systems, Luca et al. (2021) identified that many European countries are still in need of digital medical services.

In terms of challenges that countries deal with regarding the digital transformation of the healthcare system, the WHO (2018) underlines that achieving real progress in the digitalisation of the healthcare system requires that human resources be adequately trained in the process of transition to the new digital approach, which means significant changes in the roles of professionals in the medical field, a need for rapid country adoption in terms of management, and proper governance of ITC integration into the healthcare system. Accordingly, countries worldwide need a permanent understanding of the challenges, barriers and influencers that can reduce the gap in the digitalisation of the healthcare system process, not just by examining political issues but also through changes in the law and the issue of interoperability, significantly changing the perception of the population. In other words, the results show that European countries are engaging on a series of issues regarding the implementation of digital health, and they must have a strong focus on opportunities to create partnerships (e.g., public-private partnerships).

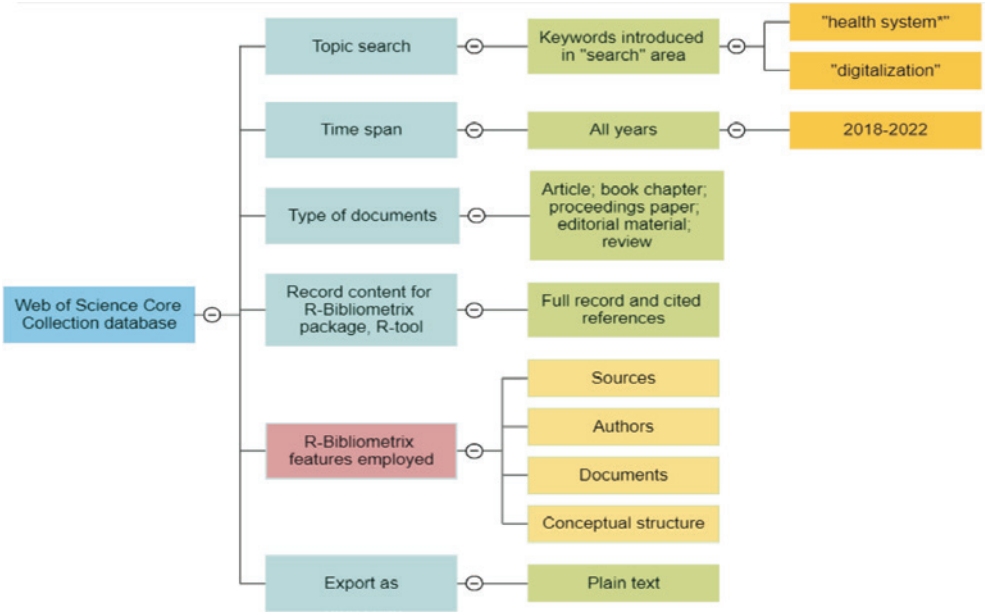
Methodology and Data

Bibliometric analysis is known mainly for quantifying the production and measuring the quality and impact of academic publications, helping to display and analyse the conceptual, social structure, and intellectual of research and the evolution of their dynamic aspects.

The global literature about the relationship between digitalisation and health systems published between 2018 and 2022 was scanned in the Web of Science database, and "health system*" and "digitalisation" were used as the keywords to reach the relevant publications. The Web of Science returned 336 academic documents on our subject of research. In order to process the analysis and create the maps, the records were collected through Plain text; then the bibliographic data was uploaded to R-Bibliometrix. The study began in 2018, taking into account the first signs of changes in the medical system and the entire period of the Covid-19 pandemic, with the aim of describing systems and surprising reforms in progress.

Furthermore, the scenario is developed through R software, employing R-Bibliometrix tool features (1) sources; (2) authors; (3) affiliations; (4) countries; (4) documents and references; (5) keywords; and (6) conceptual structure. This different type of analysis allows us to organise articles developed in our field of research by observing the most used keywords, the main authors with significant contributions, but also the top collaborations between certain countries and affiliations and consider the state of the digitalisation of the healthcare system in all countries is different, with gaps that have major implications for public health. Moreover, for each of the proposed types of analysis R-Bibliometrix allows scientific mapping by constructing bibliographic data networks of different visualisation approaches: conceptual structure, maps, and scientific networks, as presented in Figure 1.

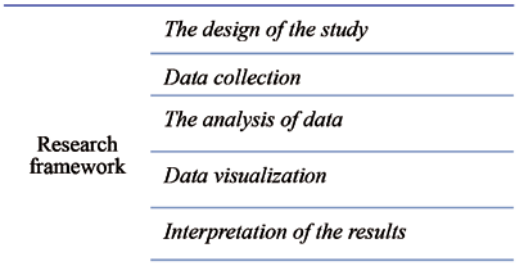
Figure 1: Stages to process econometric networks



Source: Authors' own compilation using SmartDraw software and the R-software, Package 'bibliometrix'

The workflow specific for science mapping is based on five steps (Zupic and Čater, 2015), as presented in Figure 2.

Figure 2: The research framework



Source: Authors' compilation after the synthesis of Zupic and Čater, 2015, https://doi.org/10.1177/10944281145626

In the study design, the research question is defined, and the bibliometric methods are chosen: (i) selecting the knowledge base and conceptual framework of the issue or study field of the digitalisation of the healthcare system; (ii) examining the conceptual framework (or research front) of the research; (iii) creating a structure of social networks for the digitalisation of the healthcare system-specific scientific groups.

The data collection process comprises two steps. Although, this stage can involve creating own databases (Waltman, 2016). First, the bibliographic data about health systems and digitalisation was derived from a popular comprehensive academic database – Web of Science Core Collection. WOS Core Collection covers many records and peer-reviewed journals. Secondly, to yield the number of records in the research field, the search terms were: "health systems*" AND "digitalisation", which produced 336 documents between 2018 and 2022.

The data analysis comprises network extraction.

Data visualisation includes both intuitive visualisations and maps that represent various methods of visualisation analysis, namely social network, treemap and bi-dimensional maps that allow the extraction, visualisation and mapping of valuable features from the set of analysed documents. In order to identify the different measures of the networks or to measure the overlap of the distinct clusters, the network analysis allows performing statistical analyses on the generated maps, dendrograms, and networks. By employing visualisation techniques, the software enables the representation of scientific maps and the results of different types of analysis.

Last but not least, the interpretation of the results includes the stage in which the results are interpreted in a logical structure, considering the different types of analysis and the various units of measurement of the analysis.

Empirical Results

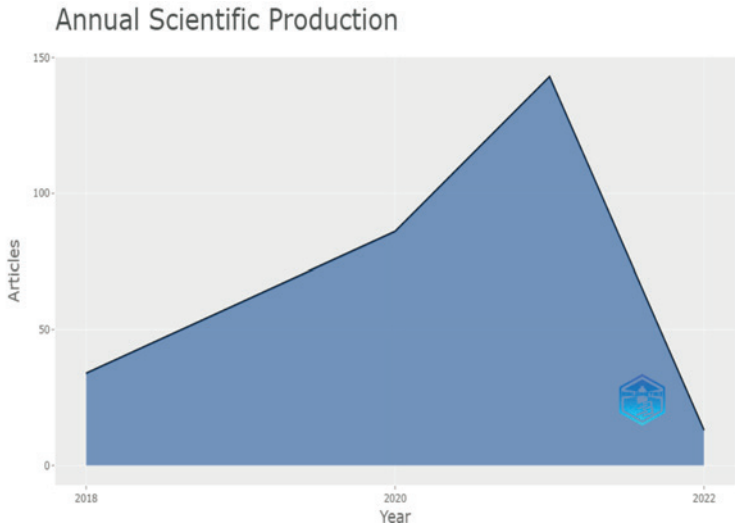
This section includes comprehensive and concise research results for the various performance parameters in order to capture the specific unit of analysis, namely authors,

sources, countries, affiliations, documents, keywords, thematic evolution, scientific production, word cloud, treemap, and evolution trends, along with the interpretations.

Results of the annual scientific production and average citations per year of documents

Figure 3 highlights the most productive years in terms of documents. Moreover, it can be observed that the scientific publications related to the digitalisation of the healthcare system field have grown substantially over the year 2019, the fact that can be associated with the acceleration of the digitalisation due to the problematic issues and the gaps that the virus COVID-19 has outlined in public health, respectively in health systems, being an urgent need of digital skills, cooperation between medical staff and patients, and health financing for digital tools.

Figure 3: Chronological growth of related documents regarding the digitalisation of health systems, 2018-2022



Source: author's computation using R-Bibliometrix

As shown in Table 1, numerous documents are presented for the 2018-2022 sample, but the results indicate the year 2021 associated with the highest number of scientific documents (143), being followed by 86 documents by the year 2020. Also, 2019 presents a significant number of documents (60). There are essential documents in 2018 which underline the fact that the digitalisation of the health system is a concept conceived before the outbreak of the pandemic of COVID-19, but which did not have high applicability, adoption, integration, and success in the medical domain.

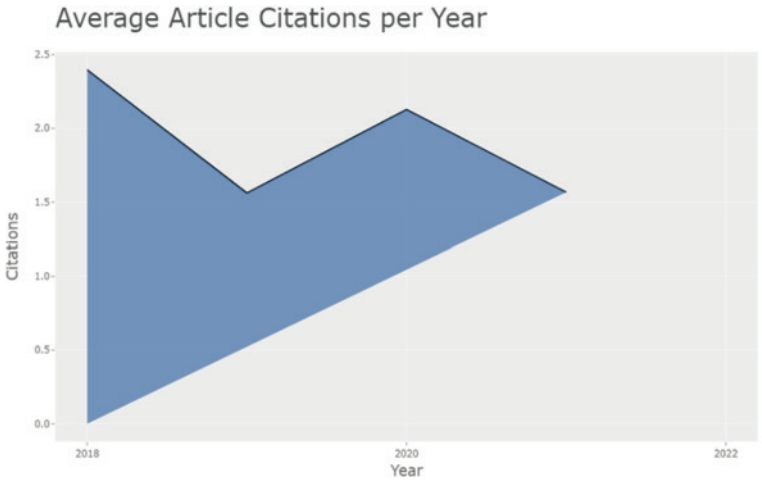
Table 1: The number of scientific documents published between 2018-2022

Year	Articles
2018	34
2019	60
2020	86
2021	143
2020	13

Source: author's own process

On the back of accurate average citations per year analysis findings, the new research setting allowed us to observe the intensity of citations over the period 2018-2022. The results regarding citations per year are deployed also based on the published articles (Figure 3). Hence, 2018 presents a significant average of citations (2.4 mean total citations per year), which is further linked with a substantial number of average citations (2.1 mean total citation per year) in 2020, as evidenced in Figure 4.

Figure 4: Dynamic changes in average regarding the citations per year of documents, 2018-2022

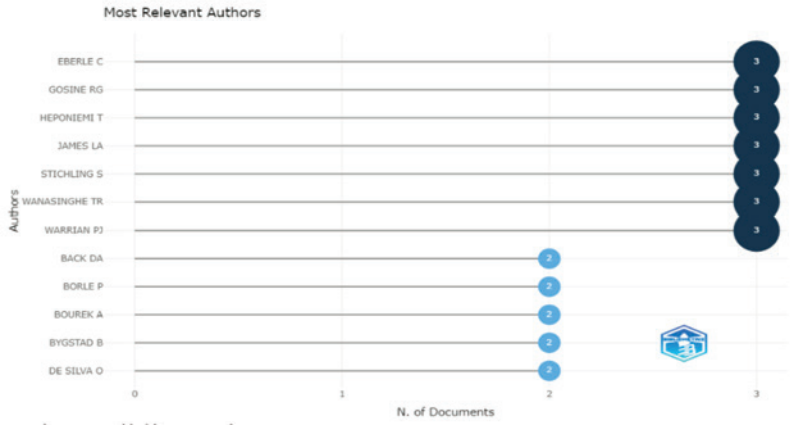


Source: author's computation using R-Bibliometrix

Most productive authors and active affiliations

Regarding the number of documents, Figure 5 highlights the most productive and prominent 12 authors that have significant contributions to our research. This type of analysis allowed us to obtain new insights into the number of documents of the top authors listed in the Web of Science (WOS) database.

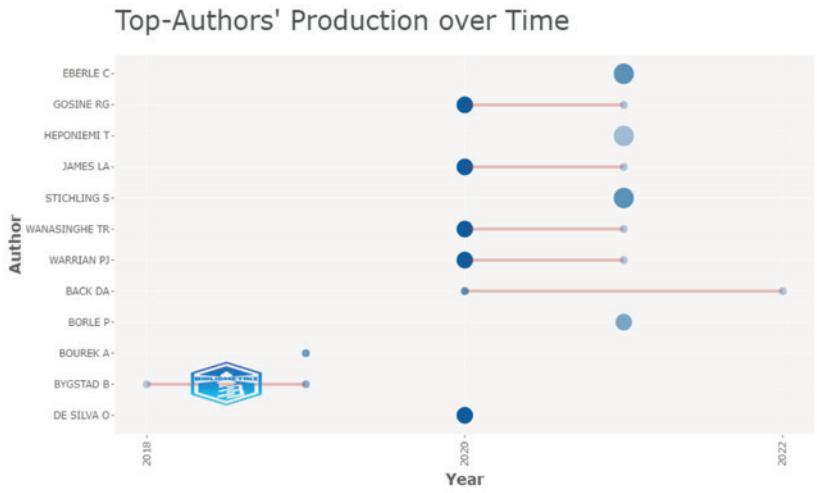
Figure 5: The most significant twelve authors by the number of articles (2018-2022)



Source: own process in R-Bibliometrix

Figure 6 highlights the decreasing order of the top authors used in our research based on the total number of documents as a frequency measure. In the field of the digitalisation of the healthcare system, the authors with the highest number of records that are highly impacting our research and have high visibility are the following: Eberle C, Gosine RG, Heponiemi T, James LA, Sitchling S, Wanasinghe TR, and Warriand PJ with a number of 3 documents. The 2nd position is occupied by several authors, namely Back DA, Borle P, Bourek A, Bygstad B, and De Silva O, with a number of 37 citations.

Figure 6: The trend of the top-authors production (2018-2022)

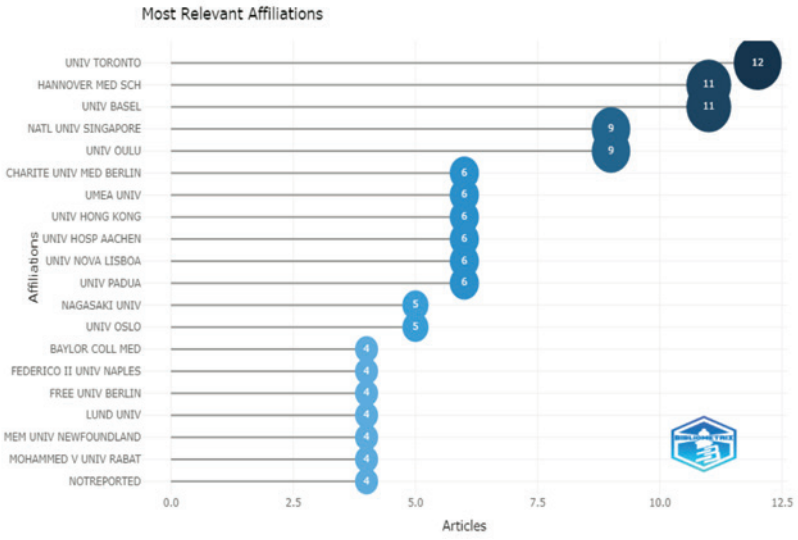


Source: own process in R-Bibliometrix

The results obtained after processing the authors' production analysis reveal significant contributions of the authors upon time coordinates. On the other hand, the author trends diagram indicates the authors' substantial production during the analysis period, thus providing an overview of the authors' production at different times. Also, the authors that are, in terms of production, of current interest in our field of research were observed. Thus, it can be attested that having the authors' production in relation to the analysed period, as a result of 2021, Figure 6 reveals the top authors' production, as follows: Back DA, Borle P, Eberle C, Gosine RG, Heponiemi T, James LA, Wanasinghe TR, and Warrian PJ. Hence, we can observe that only one author's production tends to influence 2022. Still, considering 2022 is an ongoing year, further conclusions can be drawn at the end of the analysed period. Overall, as regards the most prominent authors in our field of research with high production over time, we can state that they are located in the period between 2019 and 2021.

In Figure 7, from the perspective of the top 5 most productive affiliations in terms of articles, we can consider the following: Univ Toronto (with the highest number of articles – 12), followed by Hannover Med Sch (with 11 articles), and at the end of the top, the analysis highlights two more affiliations: Natl Univ Singapore and Univ Oulu (both with 9 articles).

Figure 7: Critical path of the distribution regarding the most relevant affiliations

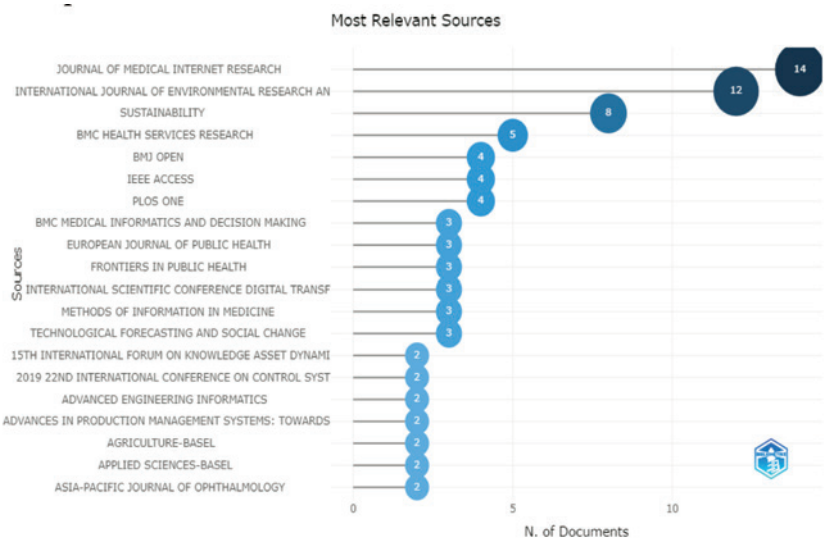


Source: own process in R-Bibliometrix

Predominant sources of scientific publications and the most prolific countries

Figure 8 depicts the most influential sources of scientific publications and lists the top 20 sources by the number of articles. A total number of 20 active sources in our research field were selected, finding the "Journal of Medical Internet Research" (with 14 articles) and "International Journal of Environmental Research and Public Health" (with 12 articles) as the top source in terms of published articles.

Figure 8: Sources impact evolution

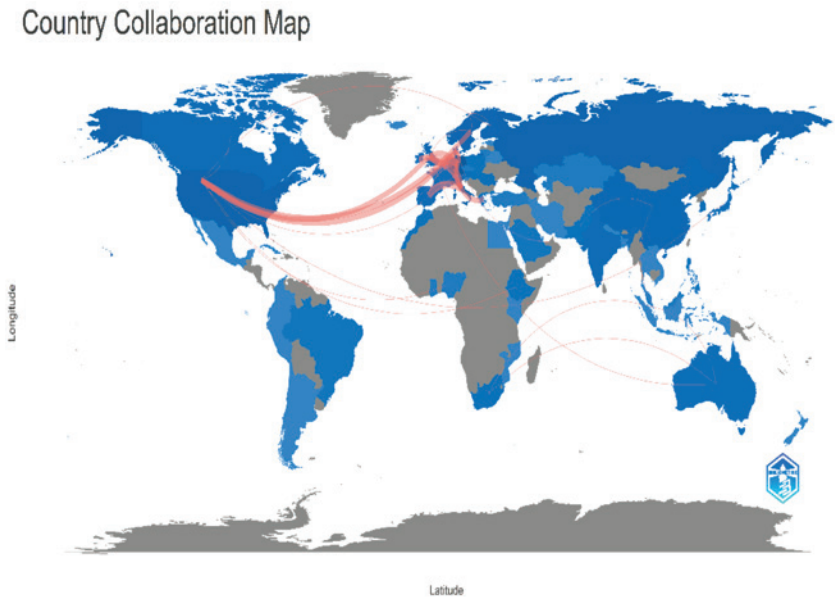


Source: own process in R-Bibliometrix

Further, the most productive countries are identified based on the citations received and the number of published documents. The analysis of the most productive countries is designed from a dual presumption, namely the country collaboration map and the most cited countries. Regarding the map of the collaboration between countries, there are 267 entries underlying an important nation collaboration. Figure 9 addresses the nation collaboration map, where the countries are linked through thick or thin links. On the other hand, Mougenot and Doussoulin (2022) state that the thicker the links, the stronger the collaboration between countries. The results reveal significant collaboration between countries, especially links between European Union countries, as follows: i) Germany and Netherlands (frequency 4), Netherlands and Belgium, and Italy and Spain (frequency 4); ii) Italy and Netherlands, Italy and Ireland, and Italy and Greece, (frequency 3); on the other hand, we have a high degree of collaboration and a significant level of links strength between European Union countries and the other countries, respectively between USA and Sweden

(frequency 3), Denmark and United Arab Emirates (frequency 2), and between the countries worldwide, where we identify Australia and Singapore/South Africa, and China and Pakistan/Singapore.

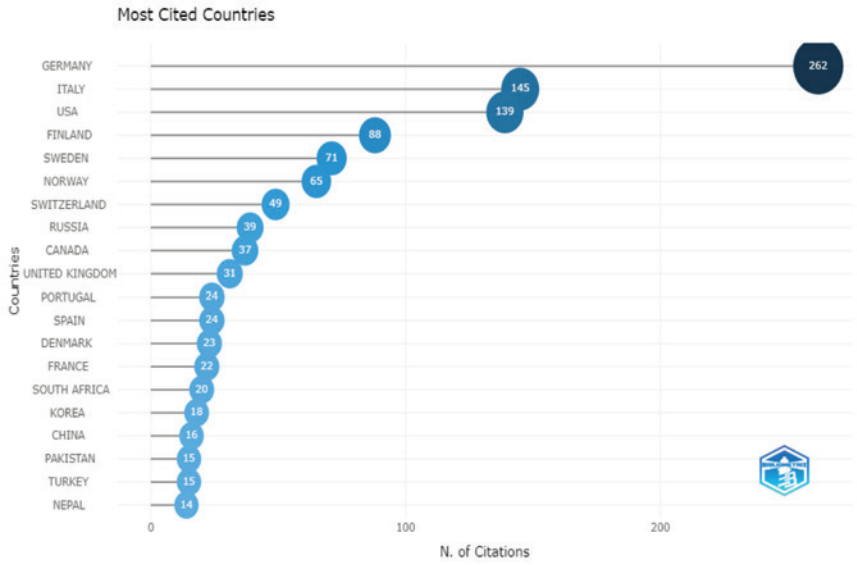
Figure 9: Mapping of the network regarding countries' collaboration



Source: own process in R-Bibliometrix

Figure 10 depicts the top productive and prolific countries in terms of health systems digitalisation between the period 2018-2021. Nepal, Turkey, Pakistan, and China have a relatively low number of citations. At the same time, Germany, Italy, Finland, Norway, and Sweden are identified as important countries in terms of the citation number of the published documents. The results show that Germany has the highest number in terms of citations (with 262 citations) being the most cited country, followed by Italy (with 145 citations), the USA (with 139 citations), Finland (with 88 citations), and Sweden (with 71 citations).

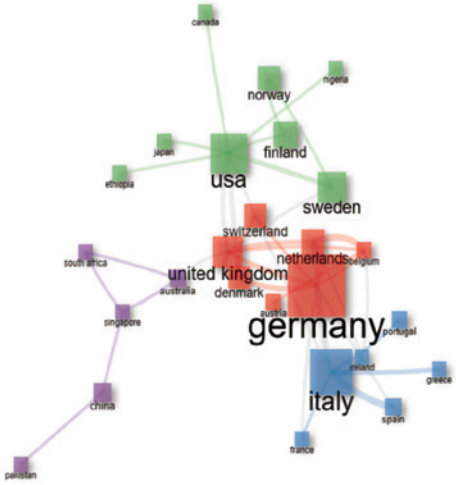
Figure 10: The dynamic of cited countries



Source: own process in R-Bibliometrix

Based on the collaboration network of the countries, the results shown in Figure 11 offers four clusters with different colours, as follows: i) clusters 1 (red), contains countries European Union countries (Germany, Netherlands, Denmark, Belgium, and Austria), except Switzerland and the United Kingdom; ii) clusters 2 (blue), with the only EU-27 Member States; iii) cluster 3 (green), and clusters 4 (purple) with a mix of EU MS and other countries, such as Nigeria, South Africa, Pakistan, Japan, and many others. From a different perspective, we can state that the collaborations are between EU countries, but they are not limited only there, the collaboration being beyond the borders and presents a strong worldwide trend of collaborations between different countries worldwide.

Figure 11: The network of the most relevant countries.

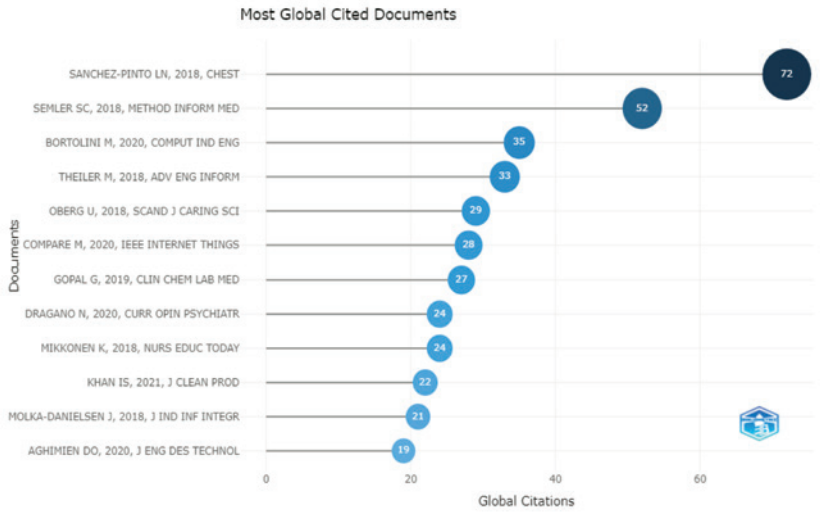


Source: own process in R-Bibliometrix

Most referenced documents

Analysing the document's citations concerning most referenced documents, Figure 12 shows that the publications connected to the digitalisation of the healthcare system have a significant number of citations, between 19 and 72 citations per article.

Figure 12: Global citations of the documents



Source: own process in R-Bibliometrix

In this light, the results identify the research of the author Sanchez-Pinto LN (2018) published in the Chest, with a number of 72 received citations, the article that was the most frequently cited. With the reference to the number of citations, Semler SC (2018) received a number of 52 citations. Within the frame of documents Figure 12 depicts a considerable number of citations, where the document of Bortolini M (2020) received 35 citations, and the document of Theiler M (2018) received 33 citations. Also, the results can help researchers to identify the most suitable and milestone scientific publications.

Cluster analysis networks

Word cloud and treemap analysis of the abstracts

A detailed synopsis of the world could and treemap analyses, including the frequency of appearances and trigrams, are presented in the maps below. Moreover, when considering the frequency of appearances of an abstract's word, specific terms appeared to have a high frequency over the observed period in Figure 13, as follows: health (788 frequency), data (554 frequency), digital (449 frequency), care (344 frequency), digitalisation (338 frequency), and system (332 frequency). As expected, health, data, and digital appear to be the most used words in the abstracts of the analysed documents.

Figure 13. Word cloud

Source: own process in R-Bibliometrix

The treemap of the most frequent trigrams entails a high number of pairs that contains three words, also being used to identify the most used group of three words that appear together in abstracts. Figure 14 depicts the most used combination of three words; the highest frequency was observed in both areas of the interest, namely health systems with three pairs, respectively "health care system" (frequency 29), and "health information systems" (frequency 15), and digitalisation with many important pairs, such as: "digital health services" (frequency 14), and "artificial intelligence ai", and "electronic patient records" with frequency 8.

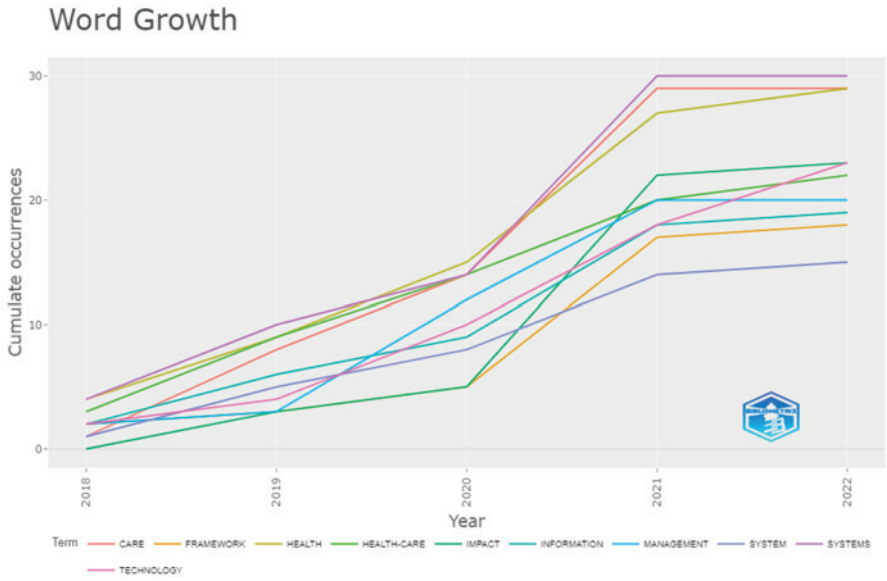
Figure 14: The most used combination of words

Source: own process in R-Bibliometrix

Co-occurrence analysis of the main keywords and the dynamic of the thematic evolution

Figure 15 highlights the keyword co-occurrence network. Further, the authors' 10 most frequently used terms were selected as a threshold. The terms which have the higher rise in terms of co-occurrences are presented further: "systems", "care", "health", "impact", and "technology".

Figure 15: Word growth regarding the digitalisation of the healthcare system publications



Source: own process in R-Bibliometrix

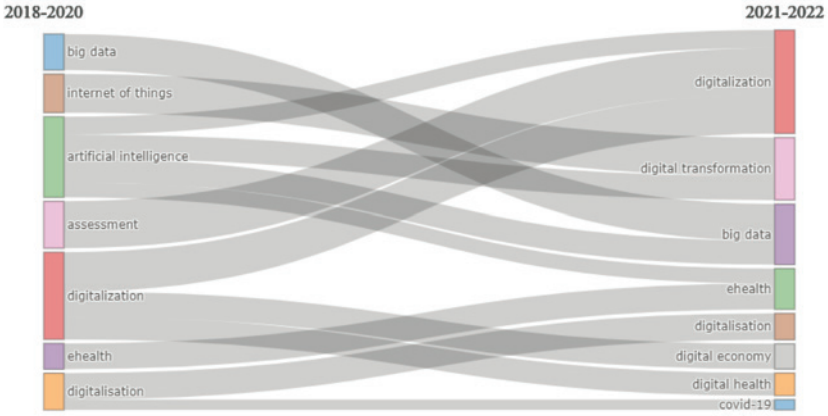
The co-occurrence analysis of the authors' keywords is presented in Figure 16. Likewise, the relation of co-occurrence between keywords is offered through the links, and the nodes represent the keywords. As the nodes are more prominent, the co-occurrence of that keyword is higher, and when the lines of the links are thicker, the keywords are more connected to each other. Four clusters are thus identified, with "digitalisation", "e-health", "digital transformation", "artificial intelligence", and "digital health" as the most significant nodes.

Figure 16: Clusters of authors' keywords

Source: own process in R-Bibliometrix

Chen et al. (2008) state that the authors' keywords are used to identify the thematic trends. Thus, in order to determine the evolution of themes in the digitalisation of the healthcare system field of research, the analysis was based, in a longitudinal framework, on an in-depth examination of relevant keywords used by the authors. Sankey diagram (Figure 17) presents the following results: "digitalisation", "eHealth", "artificial intelligence"," digital transformation", "big data", and "internet of things". Further, the results present that the keyword "digitalisation" appears in both analysed sub-periods (2018–2020) and (2021–2022).

Figure 17: Change of authors' terms



Source: own process in R-Bibliometrix

Conclusions

The study performed a scientometric mapping analysis, considering a link between digitalisation and the healthcare system, focusing on providing a comprehensive and in-depth examination by evaluating 336 documents retrieved from the Web of Science (WOS) database, published between 2018 and 2022.

In order to draw out the overall results, the research methodology relied on a bibliometric analysis conducted in R-tool, namely Bibliometrix, which is an R package, using the Rshiny app. In this light, several innovative features of R Biblioshiny were applied, including a trend of the annual scientific production, dynamic changes in average regarding the citation per year of each document, network analysis, thematic evolution, social structure, and intellectual structure.

The subject of the digitalisation of the healthcare system is identified as a revolutionary, actual, and pervasive concept, being considered a new area of research that is recognised by evolution and consistent growth. Thereby, according to the obtained

results, Back DA, Borle P, Eberle C, Gosine RG, Heponiemi T, James LA, Wanasinghe TR, and Warrian PJ are considered the most productive authors that address research topics related to the digitalisation of the healthcare system with the highest number of published documents. Furthermore, results also reveal the principal affiliations by the number of documents and citations. Thus, "University of Toronto", "Hannover Meg Sch", and "Univ Basel" are the most prominent affiliations with 12, respectively 11 documents. Concerning the most prolific sources, the results identify, by the number of articles, the Journal of Medical Internet Research as the top journal with 14 documents. Moreover, analysing the most prominent sources can help researchers identify the most relevant journals in the field of the digitalisation of the healthcare system to publish their findings.

The European Union Member States (EU MS) are critical drivers in the health systems digitalisation research field. In contrast, Germany, Italy, Finland, Sweden, Norway, Portugal, Spain, Denmark, and France are important emerging actors in our research field, having the highest number of citations. On the opposite side, non-European countries, such as Korea, Nepal, Turkey, Pakistan, and China, stand out in terms of citation, with a relatively low number of citations per country. Thus, European Union Member States (EU MS) have shown to be prolific and an essential source of scientific production, while the non-European countries are still lagging, requiring future progress in the health systems digitalisation field of research.

Consequently, the main contribution of our results relates that thematic evolution allowed us to observe the development of the digitalisation of the healthcare system research over time. In this light, in a set of 100 different keywords of the authors, a few of them were observed that appear many times, meaning that these keywords are likely to have a considerable impact on the core themes of the health systems digitalisation research, as follows: "digitalisation", "digital transformations", "artificial intelligence", "COVID-19", "public health", and "big data". Thus, digitalisation of health systems initiatives is present over time in many countries, demonstrating that the process of e-health has started, is also accelerated by the pandemic of COVID-19.

Because improving and accelerating the digital transformation of the health systems is a key to promoting and ensuring public health, the scientometric analysis offers and supports a series of practical implications, that can facilitate in many ways the setting of the priorities in policymaking and public institutions, respectively: i) amplified path towards the digitalization of the healthcare systems, which will be accelerated by increasing the number of digital initiatives in all the countries, fact that will demand in the future a change in the institutional framework which coordinate and regulate the health systems; ii) significant obstacles are faced by many countries all around the world regarding the implementation of ITC in public health, especially in health systems; iii) the modernization and the digitalization of the healthcare system should be the major concerns of the governments of all states, and there is a need to rethink the functioning of the public health system by integrating technology

in the medical field, which should have already been accelerated by the COVID-19 pandemic, which plays the leading role in revealing the gaps and integration needs of terms such as artificial intelligence, big data, technology, and frameworks in health systems.

This paper conducted a comprehensive scientometric analysis of the digitalization of the healthcare system publications that can be added to the existing scientific knowledge and offers support to countries' governments to pursue a common strategy toward a digitised future of health systems. It is evident that continuous innovation and the elimination of outdated practices are necessary for the process of digitalisation. Digitalisation refers to converting analogue processes to digital format, but also to ensure the personalisation and configuration of the healthcare technology, with organisational and cultural aspects related to public health services improvement, centred on the needs of the public. Because innovation and technology are both expensive, the long-term strategy for improving the health system should benefit from supporting public policies. Governments have to invest in infrastructure with high-speed internet and cloud computing to ensure access to large databases and ease of share of medical data. For a quick development of the public system, governments could offer tax incentives for healthcare providers and companies offering intelligent solutions to optimise the digital health infrastructure. Governments should also support education for healthcare services, promoting digital literacy among patients.

The main limitations of the research related to the fact that for the selection of the relevant documents, only the Web of Science database was considered. Future research should aim to also include other relevant databases, including COVID-19 as a new key term, and consider analysing the period that comprises the pandemic crises. As long as digital public health has grown significantly during the COVID-19 pandemic, future research should also overview different national strategies to evidence the best practices and strategies that improve public health systems.

Declarations

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Conflicts of interest/Competing interests

There is no conflict of interest/Competing interests.

Availability of data and material

The data that support the findings of this study are openly available in the website of Web of Science (www.webofscience.com).

Code Availability

The computer program results are shared through the tables and figures in the manuscript.

Authors' Contributions

Oana-Ramona Lobonț: Conceptualization, Writing - Original Draft, Writing - Review & Editing, Supervision.
Alexandra-Mădălina Țăran: Formal analysis, Data Curation, Methodology, Writing - Original Draft, Writing - Review & Editing.
Sorana Vătavu: Formal analysis, Data Curation, Writing - Original Draft, Funding acquisition.
Iulia Para: Writing - Original Draft, Writing - Review & Editing.

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