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Data quality for health sector innovation and accounting management: a twenty-year bibliometric analysis

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ABSTRACT

Continuous cost growth in the healthcare sector is one of the most critical challenges. Several scientists are trying to provide solutions that will include quality of care and cost reduction. First, computerization and then technological digitization has made it possible to store an increasing amount of data and leverage it to improve quality and reduce costs. Although the topic is relevant, no article has expressed how data quality resulting from healthcare innovation can be crucial for lowering healthcare costs. Using the bibliometric approach and benefiting from Zupic and Cater methodological paper, the analysis investigates 159 peer-reviewed English papers. Additionally, the Bibliometrix R package is used in the data analysis part. The results confirm a multidisciplinary literature stream with a few unrelated process variables. We provide evidence of authors, journals, keywords, geographic areas of reference and a framework that links the two research streams. Finally, we argue that a structured data quality process helps value healthcare data adequately and reduces costs. Moreover, quality is fundamental before applying advanced data analytics through big data analytics, IoT and artificial intelligence applications.

La continua crescita dei costi nel settore sanitario è una delle sfide più critiche. Diversi scienziati stanno cercando di fornire soluzioni che includano la qualità delle cure e la riduzione dei costi. L'informatizzazione, prima, e la digitalizzazione tecnologica, poi, hanno permesso di archiviare una quantità crescente di dati e di sfruttarli per migliorare la qualità e ridurre i costi. Sebbene l'argomento sia rilevante, nessun articolo ha esaminato come la qualità dei dati derivante dall'innovazione sanitaria possa essere cruciale per ridurre i costi sanitari. Utilizzando l'approccio bibliometrico e beneficiando degli articoli metodologici di Zupic e Cater, l'analisi esamina 159 articoli inglesi sottoposti a peer-review. Inoltre, nella parte di analisi dei dati viene utilizzato il pacchetto Bibliometrix R. I risultati confermano un flusso di letteratura multidisciplinare con poche variabili di processo non correlate. Esaminiamo autori, riviste, parole chiave, aree geografiche di riferimento e un framework che collega i due filoni di ricerca. Infine, sosteniamo che un processo strutturato di qualità dei dati aiuta a valutare adeguatamente i dati sanitari e riduce i costi. Inoltre, la qualità è fondamentale prima di applicare l'analisi avanzata dei dati attraverso l'analisi dei big data, l'IoT e le applicazioni di intelligenza artificiale.

Keywords: data quality; health sector; costs; innovation; accounting; management

1 – Introduction

The emphasis on data quality has become more pronounced since the digitalization process in many public services. It is widely believed that digital transformation in the health care ecosystem can reduce costs and increase quality (Agarwal et al., 2010; Francesconi, 2009; Rary et al., 2020). In this vein, the quality of care is based on the level of mortality, patient satisfaction, patient safety, procedure-based measures, and medical error. On the other hand, financial efficiency can be assessed in revenues, operating costs, added value and productivity (Agarwal et al., 2010; Bai et al., 2018).

According to Hillestad et al. (2005), health information technology (HIT) is the driver for improving healthcare quality. HIT includes various integrated data sources, including electronic patient records, decision support systems and computerized medical order entry for physicians (Amarasingham et al., 2009; Parssian et al., 2004). Additionally, according to Ilin et al. (2018), the implementation of value-based and needs-based medicine ideas will provide the opportunity to increase the Smart Hospital concept. In this regard, Smart Hospital is a structure based on optimized and automated processes centred on an IT system focused on improving existing procedures and implementing new opportunities for patient treatment and care. As suggested by the European Union mega-trends outlook, integrating technology in health will be more critical in the next ten years (European Commission, 2020).

To examine the main trends, the concept of "4P" medicine cannot be omitted. It is constituted by the following components: preventive medicine, participatory medicine, predictive medicine (Agrawal et al., 2019), personalized medicine (Barak et al., 2009). Following the 4.0 industry concept (Massaro et al., 2020), value-driven treatment is developed in Health 4.0 (Secinaro et al., 2020).

Following the industry 4.0 approach, based on creating smart infrastructures, products and services incorporated into a system that leverages the Internet of things and services (Dey & Kumar, 2010; Stock & Seliger, 2016), value-driven medicine develops Healthcare 4.0 (Rainero & Modarelli, 2021). In particular, this is defined as a continuous process of transformation of the entire healthcare value chain from medicine to healthcare equipment manufacturing, hospital and non-hospital care, medical logistics, healthy living environment for financial and social systems, where a large number of IT and physical systems are closely combined through IoT, intelligent sensing, big data analysis, IA, cloud computing, automatic control, autonomous execution and robotics to create not only digitized healthcare products and technologies but also digitized healthcare services and enterprises (Pang et al., 2018).

According to Kwon et al. (2014), all these applications need rigorous data quality management processes before applying them with big data analytics applications. Additionally, the same comes from the application of technologies like the Internet of things (IoT), cloud computing, machine learning, blockchain, 5G networks and artificial intelligence (AI) based applications (Cobianchi et al., 2020; Gökalp E. et al., 2018; Hasselgren et al., 2020; Lombrano & Iacuzzi, 2020; Rary et al., 2020). Therefore, before using such interesting technology applications, the necessary step is data quality with its theoretical and practical implications (Ben-Assuli et al., 2013; Biancone et al., 2019; Sadoughi et al., 2018).

As Sadoughi et al. (2018) suggested, the lack of timely and accurate information reduces healthcare quality. Such a situation is even more difficult in high public health spending due to a large and very elderly population (Changizi & Kaveh, 2017). However, as Asi & Williams (2018) proposed, the diffusion of new technology practices can help achieve SDG 3 indicators on health and wellness for everyone and at all ages.

According to Ardagna et al. (2018), data quality analysis allows to focus on valuable information for health valorization and is the ability to meet users' needs (R. Y. Wang & Strong, 1996). Due to the general scientific interest in this field, according to Tallon (2013), it lacks a clear

sense of value and how it can change over time, considering data quality costs. The same author argues that organizations easily acquire and store data that may produce little or no value in the short term but may increase in value in the future. Moreover, organisations' challenge is to develop governance mechanisms that balance risk and reward against increasing amounts of data and innovation that offer better, faster, and less expensive storage technology. Therefore, starting from this literature gap, this paper aims to give a comprehensive bibliographic analysis, focus on articles on data quality improvement within the healthcare sector, and reveal existing links with health costs. Emeka-Nwokeji (2012) highlights an essential correlation between data quality and economic events defining in accounting management as a financial transaction that influence the responsiveness of the information system and, at the same time, the business processes. Data quality detects and affects assets, cost accounting and performance through the accounting information system and detecting non-financial information. The topic is among two research streams in the accounting and innovation field, hoping for a fair discussion in the future with more applications and case studies.

In the investigation, the research team addresses the following research questions

(RQ) (1) *What information can be derived from the bibliometric analysis in question?*

(RQ) (2) *What is the trend of scientific publications about data quality applied to reduce costs and improve healthcare quality? and*

(RQ) (3) *What may be the future orientations of research in this area?*

The following paragraph assesses the main related works strengthening the gap that this paper aims to address. Then, researchers give an in-depth analysis of the methodology adopted. Next, the focal point is the results obtained from the study. In the end, the following two sections discuss and conclude the paper.

2 – Background of the study

Our bibliometric analysis is based on the literature data based on the Scopus database. The methodology allows a scientific investigation of the entire field of interest and a global view. Several authors used the same approach in the topic concerned; Table 1 below shows those most relevant keywords involved in this analysis structure. For instance, the first study considered by Terry et al. (2012) is the search for a lack in the literature based on the identification and description of writings in primary healthcare and compared with Canadian and international works on a healthcare theme.

The paper by Whipple et al. (2013) performs a bibliometric analysis to identify scientific articles, journals, and citations on significant contributions to the scientific knowledge base on the impact of information systems in health care. The following two papers by Gu et al. (2017, 2019) discuss the structure and evolution of big data and the development of the health sector's electronic field. Specifically, the first one studies the definition of the trend of the number of co-authors of each work, the distribution of institutions and countries of reference, the distribution of the primary literature, information about prolific authors and innovation paths in the sector, the analysis of co-occurrences by keywords, research hotspots and trends for the future. The second is related to the introduction of information technology in the field of health care. According to the authors, electronic health has become a research focus, but few studies have explored its knowledge structure from a global perspective.

The results show that the number of publications is raised after 2005. According to the trend line, it is expected to continue to increase exponentially in the future, countries/regions researching electronic health have the closest collaborative relationship, among which European countries have the closest collaboration, electronic health records, mobile health, and health informatics are the hotspots of electronic health research. The paper by Churruca et al. (2019)

presents a bibliometric analysis of health systems and organisations. Their paper focuses on changes in articles on the science of complexity in healthcare published over time and their contents. However, as highlighted in the "*Keywords*" column, none of these includes both the topic of data quality is a significant data analysis context and a decrease in costs in the healthcare field as suggested by the SDG 3.8 related to a universal health sector with quality care and accessible costs (Adenle et al., 2020; Asi & Williams, 2018; Tradori et al., 2020) (Table 1). The first framework that combines data quality and cost management highlights the accounting information system's potential effect on performance through financial information (transactions, assets, costs) and non-financial information (Emeka-Nwokeji, 2012). The framework is not in-depth and requires theoretical and practical confirmation of what has been detected and its extension in the health sector. Therefore, the analysis reveals a gap in the research field considering analysis that can join multidisciplinary papers that explore data quality and costs accounting in the healthcare sector.

References	Main field	Keywords
(Terry et al., 2012)	Electronic health records, Primary healthcare	Bibliometric analysis, Healthcare in Business area
(Whipple et al., 2013)	Information dissemination, Medical informatics	Bibliometric analysis, Healthcare, Quality, Data
(Gu et al., 2017) (40)	Big data, Healthcare informatics	Bibliometric analysis, Healthcare, Quality, Data
(Churruca et al., 2019)	Electronic health, Healthcare informatics	Bibliometric analysis, Healthcare, Quality, Data
(Gu et al., 2019)	Health systems and organizations, complexity science	Bibliometric analysis, Healthcare in Business Area

Tab. 1 – Searching criteria and results of related works (Source: Authors' elaboration)

3 – Materials and Methods

This section aims to present the design of the bibliometric process adopted by the researchers. The methodology is based on a rich history of publications (Shaw, 1990) with reference articles in business and management contributed by Zupic & Čater (2015). According to the authors, bibliometric analysis allows a third way of synthesis (compared to structured literature analysis and meta-analysis) to identify disciplines, fields, specialities, and geographical maps. Moreover, the resulting scientific mapping allows a combination of classification and visualisation of results. Therefore, as indicated by the authors, bibliometrics enables studying a specific research flow and will allow scientists to initiate their studies towards even more challenging research methodologies. Also, numerous researches have been conducted in the field under study so far (Churruca et al., 2019; Forliano et al., 2021; Liao et al., 2018; Secinaro, Calandra, Petricean, et al., 2021; Terry et al., 2012; Uluyol et al., 2021).

Our research uses the scientific mapping process described by Zupic & Čater (2015) and taken up by Aria & Cuccurullo (2017). Furthermore, 5 phases have been structured for the implementation: study design, data collection, data analysis, data visualization and

interpretation (Zupic & Čater, 2015) (Figure 1). The first two phases coincide with study design and data collection. They include selecting research questions (as outlined in the introduction), choosing the research database, keywords and inclusion and exclusion criteria (Figure 1).

Our research uses the multidisciplinary analysis database "*Scopus*" suitable for Information Systems (IS) researchers (Okoli & Schabram, 2010). Besides, the keywords adopted a top-down analysis approach to identify bibliometric variables with a high mapping logic (Chen & Xiao, 2016). Research on the dataset showed how both ways of writing "*health care*" and " *healthcare*" are used, and the omission of one of them would not allow a complete scenario. Besides, even the term "*health*" alone included numerous articles on the subject. Cross-referencing these criteria gives a total of 179,000 reports.

Additionally, the keyword "*data*" has been added to the keywords mentioned above to contextualize it in the specific field. This addition allowed the system to refine the search to 70,610 items. Following the analysis, screening was carried out by adding the word "quality" to the previous one, which allowed the system to obtain 22,775 articles. Finally, it was crossed by the previous words with the word "cost" to reduce the search field to 7,289 articles.

To make it easier for readers to identify the research domain's main variables quickly, the bibliometric method has been used in this paper to integrate the missing elements in the literature. Among these, a period like the current socio-economic context has been selected. Work published between 2000 and 2020 has been included, excluding 317 elements. Subsequently, only articles related to the field were selected, including papers published in the "Business, Management and Accounting" section, refining the search to 200 results. According to Wills (2014), this paper operates in an economic context because analysis of hospital data can improve the quality of care on the one hand and reduce costs on the other. Later, all articles not in English and whose source was not a journal were excluded. The process described led to 159 articles that will be analyzed in this document. Data analysis, visualisation and interpretation, was carried out using the "bibliometrix scientific package" developed by Professors Aria & Cuccurullo (2017). The tool can be activated using the R-Studio software and allows a statistical analysis of metadata extracted from the Scopus database. R-Studio is widely used in the literature (Verzani, 2011); in particular, bibliometrix is applied to hundreds of scientific articles published in multidisciplinary journals (Aria & Cuccurullo, 2021; Secinaro, Calandra, Secinaro, et al., 2021; Secinaro, Dal Mas, Brescia, et al., 2021).

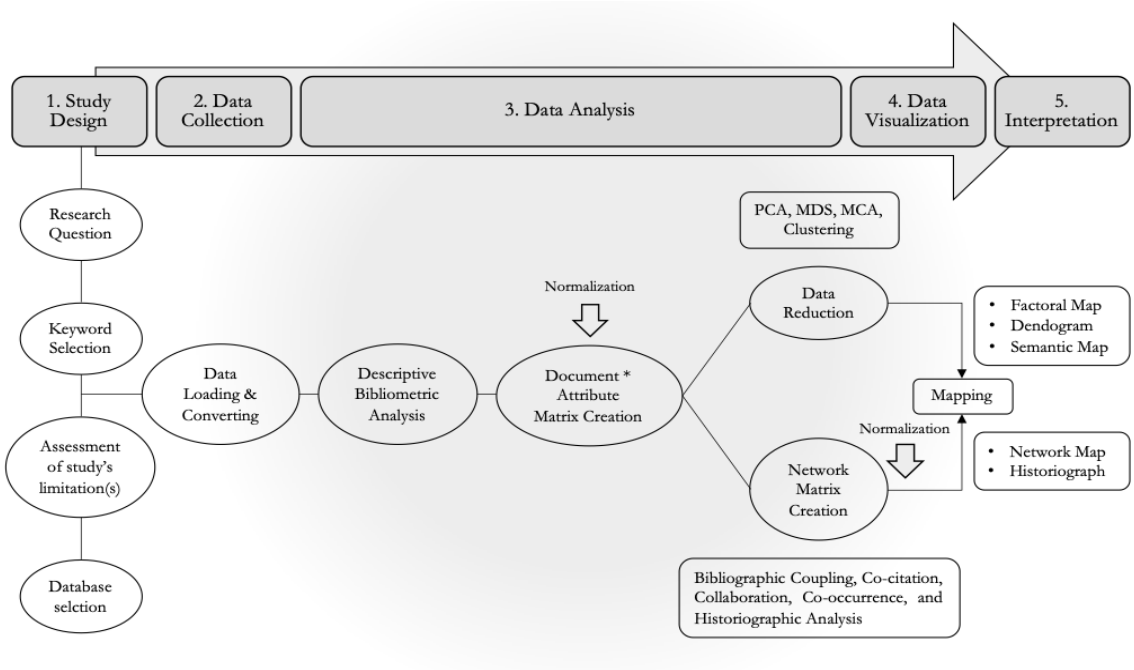

Fig. 1 – Research design (Source: Authors' elaboration)

4 – Results

This section presents the bibliometric variables answering the first research question (Section 1): (1) *What information can be derived from the bibliometric analysis question?* Therefore, the paragraph will investigate the scientific sources; the development of the sources; the number of articles per author; the keywords chosen by the author; the dendrogram of the topic; the map related to the number of contributions; the citations of the articles; the production of the country; the number of sources per country; the map of the collaboration between countries.

4.1 – Main information of the research flow under investigation

This sub-section aims to summarize the basic knowledge of the research stream under investigation. The following Table 2 shows 159 articles published between 2000 and 2020, extracted from the Scopus database.

	Brief explanation	**Number**
Documents	Total number of documents	159
Sources	The frequency distribution of sources as journal	46
Author's keywords	Total n° of keywords	458
Keywords Plus	Total n° of phrases frequently appeared in the title of an article's references	1.334
Period	Year of publication	2000-2020
Authors	Total n° of authors	522
Author Appearances	The authors' frequency distribution	549
Authors of single-authored documents	The n° of single authors per articles	18
Authors of multi-authored documents	The n° of authors of multi-authored articles	504
Authors per Document	Average n° of authors in each document	3,28
Co-Authors per Documents	Average n° of co-authors in each document	3,45
Average citations per document	Average n° of citations in each article	11,28
Collaboration Index	Level of collaboration among authors	3,6

Tab. 2 – Main information (Source: Authors' elaboration)

As shown, the search flow consists of 46 scientific sources. The number of keywords used is 458, which becomes 1,334 in keywords plus, i.e. words or phrases from the articles listed in the bibliography (Garfield, 2004). Additionally, the table shows a research flow with 549 authors. Of the publications, only 18 are signed by a single author. The rest of the papers have multiple authors with an average author collaboration rate of 3.45. The collaboration rate between all authors is 3.6, low for a multidisciplinary field (Ekundayo & Okoh, 2018). Finally, each paper is cited on average 11.28 times.

4.2 – Annual scientific production

The following Figure 2 shows the number of articles per year. Generally, the timeline shows an increase in interest in the scientific world since 2009. According to Wang et al. (1995), the interest in this field began in 1995, when the term "Big Data" (Cox & Ellsworth, 1997) was first used to explain the display of data and the challenges it posed to computer systems. After that start, 2001 to 2008 can be defined as the second evolutionary phase for data development. However, the real revolution in terms of publication trends started in 2009. Researchers predicted that data management and its techniques would move from structured to unstructured data and from a static terminal to a ubiquitous cloud-based environment. According to the prediction of Gartner (2013), the IT trend, leveraging cloud computing services for big data analytics systems that support real-time analytical capability and low-cost storage, will become a preferred IT solution in the future. This prediction has coincided with a significant increase in interest and literature on the topic.

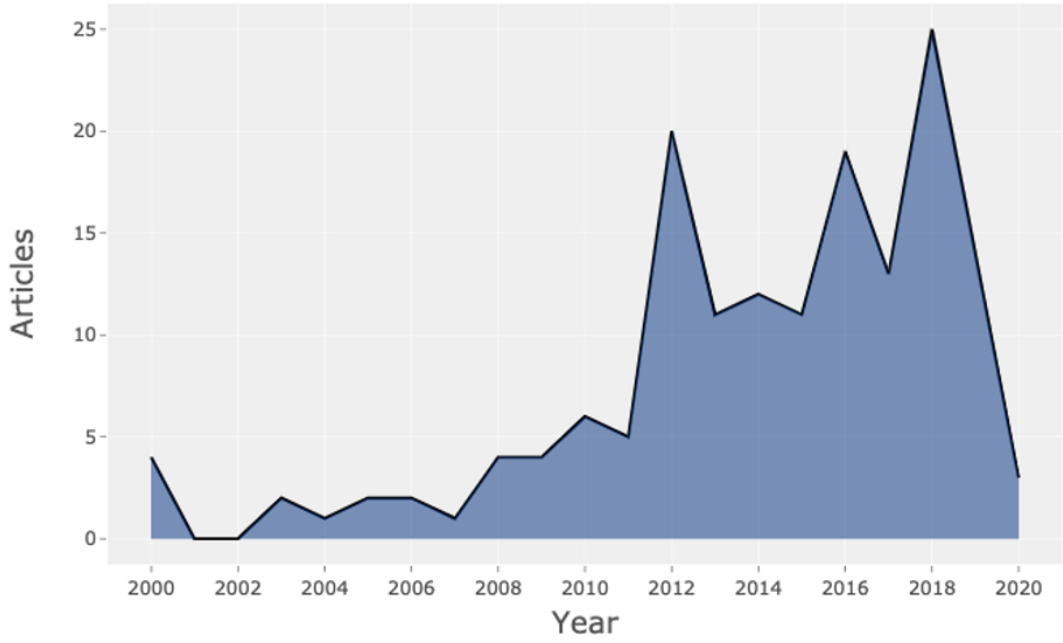

Fig. 2 – Annual Scientific Production (Source: Authors' elaboration)

4.3 – Scientific sources

This paragraph aims to investigate the primary sources in this research field. Table 3 below shows several scientific journals that deal with data quality, considering the managerial view. A total of 44.60% were published by "Journal of healthcare management" and "International Journal of health care quality assurance". The Journal of Healthcare Management (JHM) is the American College of Healthcare Executives (ACHE). The JHM is a peer-reviewed journal

publication dedicated to providing health managers with the information to manage complex health issues and make effective strategic decisions.

Additionally, the International Journal of health care quality assurance is an editorial work that contributes to the continuous improvement of health organisations, providing a forum for current reflection on quality and health management's theoretical and practical aspects. The topics addressed are clinical, managerial, and educational in terms of scope and coverage, including successful quality/continuous improvement projects, the use of quality tools and models in leadership management development, process control issues such as Six Sigma, Leadership, Change Management and Process Mapping. Moreover, the contributions published by the Information Systems Research and Management Science Journals have also enlightened the scientific discussion by promoting methodologies for the definition of data quality and specific methods for estimates of accuracy and completeness.

Top ten Journals	Number of articles
Journal of Healthcare Management	36
International Journal of Health Care Quality Assurance	26
American Health and Drug Benefits	23
American Journal of Pharmacy Benefits	7
Journal of Operations Management	6
Health Care Management Review	5
Information Systems Research	4
Journal of Health Organization and Management	4
International Journal of Recent Technology and Engineering	3
Management Science	3

Tab. 3 – Scientific sources (Source: Authors' elaboration).

Figure 3 below illustrates a decline in the number of publications of the "Journal of Healthcare Management" in the years after 2012, with an increase in publications by the "International Journal of Healthcare Quality Assurance".

4.4 – Authors' production

The paragraph aims to investigate the most cited authors for the subject under discussion. Afterwards, the keywords of each author and the total number of citations are indicated. Table 4 shows among the first twenty authors, the number of publications present:

- Gopal RD;
- Griffith Jr.;
- Ramesh R.;
- Spaulding A.;
- Yaraghi N.

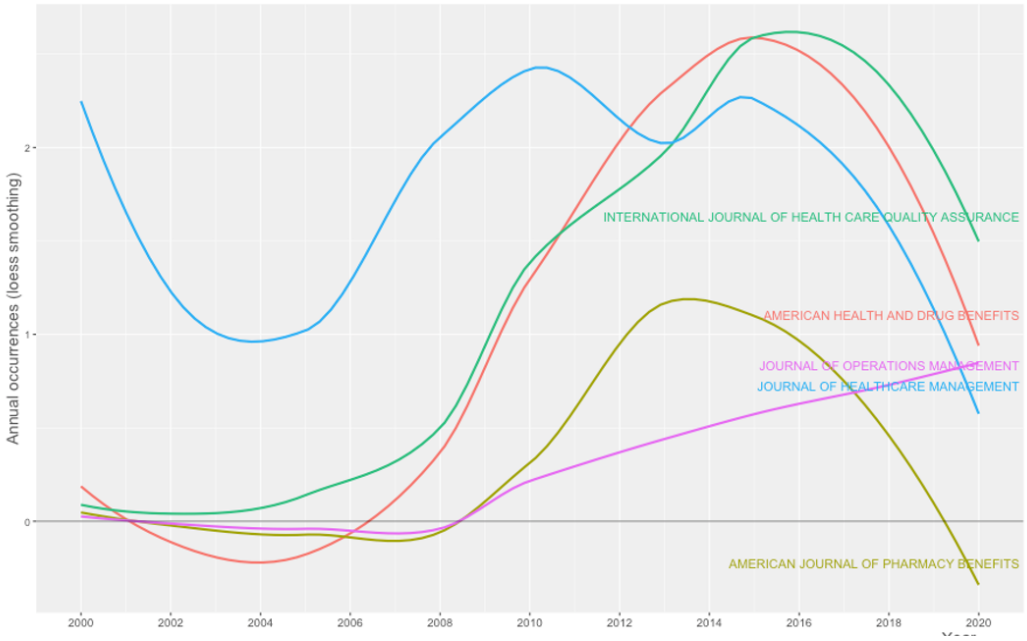

Fig. 3 – Source Growth (Source: Authors' elaboration)

The primary reference authors in the research field are now introduced: Ram D. Gopal is the Distinguished Fellow of the Information Systems Society and Professor of Information Systems and Management at Warwick Business School. He has a broad and varied research portfolio that ranges from extensive data analysis, healthcare IT, financial technology, information security, privacy and valuation, intellectual property rights, online market design, and technology's impact on business. Griffith J.R., Andrew Pattullo Collegiate Professor Emeritus, has spent 40 years training graduate students and practising as a healthcare executive at the Department of Health Management and Policy at the University of Michigan.

The second-ranked author is Sameer Kumar, a professor at the University of ST. Thomas, Professor of CenturyLink Endowed Chair in Global Communications and Technology Management. Ram Ramesh is currently a Professor of Science and Management Systems with SUNY Buffalo, Buffalo, NY, USA. His current research focuses on the analysis of cloud infrastructure availability. He is Editor-in-Chief for Information Systems Frontiers and Area Editor for the INFORMS Journal on Computing for the Knowledge Management and Machine Learning. As a health services researcher at the Health Policy and Research Division of the Mayo Clinic, Aaron Spaulding uses quantitative, qualitative, and mixed approaches to evaluate health care outcomes and organizations. His research focuses on treatment outcomes, evaluating quality interventions, the influence of federal policy on health outcomes, and how organizational characteristics are associated with organizational and patient levels. Yaraghi is an assistant professor of Operations and Information Management at the University of Connecticut's School of Business and a non-resident fellow at the Brookings Institution's Center for Technology Innovation, whose research focuses on the economics of health information technology.

4.5 – Authors' dominance ranking

The following Table 4 illustrates the top twenty rankings of the Dominance Factor (DF) calculation. DF is a ratio that measures the fraction of multi-author articles, in which an author acts as principal (Kumar & Kumar, 2008) and is used to calculate the author's dominance in the production of articles. The calculation is made by putting as the numerator the proportion of the number of multi-author articles. As can be seen from the table, Griffith J.R. is the first author

of three articles, two of which are one author, and one is the first author of a multi-author document. Other authors who have contributed up to two articles each are listed. Other authors have published an article as the first authors of a research group; while descending in the ranking, we find Aaron Spaulding and Niam Yaraghi. The first Spaulding author of three articles as a multi-author, two of them as the first author, and his DF is 0.6666667. The same is true for Yaraghi; then, there are authors with two publications to his credit.

Rank by DF	Author	Top Articles	Single Authored	First Authored	Rank by articles
1	Griffith JR.	3	2	1	18
1	Kumar S.	2	0	2	11
1	Adjerid I.	1	0	1	1
1	Agarwal R.	1	0	1	1
1	Ahmed S.	1	0	1	1
1	Akkan C.	1	0	1	1
1	Al-Amin M.	1	0	1	1
1	Al-Hyari K.	1	0	1	1
1	Alaiad A.	1	0	1	1
1	Alfalah Sfm.	1	0	1	1

Tab. 4 – Authors' dominance (Source: Authors' elaboration)

4.6 – Authors' keywords

This section presents details about the relationship between the following keywords "healthcare", "data quality", and "cost". The information resulting from this analysis is essential to determine the research's progress and discover gaps in the topic's literature. There is an opportunity to identify new fields to be utilized as research subjects among the research findings. As suggested by Table 5, the first word is consistent with the research analysis. The next word, "information technology," underlies the global context of data understanding, use and enjoyment. Then, there are " patient satisfaction" and "customer satisfaction", showing the purpose of combining the three elements selected for the research.

Most common keywords	Occurrences
Healthcare	30
Information technology	6
Patient satisfaction	6
Service quality	6
Customer satisfaction	5
Quality	5
Quality improvement	4
Healthcare utilization	4

Tab. 5 – Authors' keywords Source (Authors' elaboration)

Only towards the bottom of the list is a mention of "healthcare costs", this may be an index of the chance to explore and go deeper into the subject. Considering keywords analysis, it is possible to examine information technology, considering at the same time also the ones related only to the medical field. The health information technology (HIT) systems can significantly reduce medical errors, streamline clinical processes, contain healthcare costs, and ultimately improve healthcare quality (Azam et al., 2012). According to Sharma et al. (2019), health organizations invested significantly in health information technology (HIT) to improve quality. Analysis using a fractional response model indicates that HIT directly impacts reducing the number of lawsuits. This effect is higher for hospitals with higher communication quality scores.

The next topic, dendrogram (Figure 4), aims to relate words to each other and establish a cluster's hierarchy. Additionally, this paragraph seeks to address the first research question on the connections between data quality, costs' reduction, and healthcare quality.

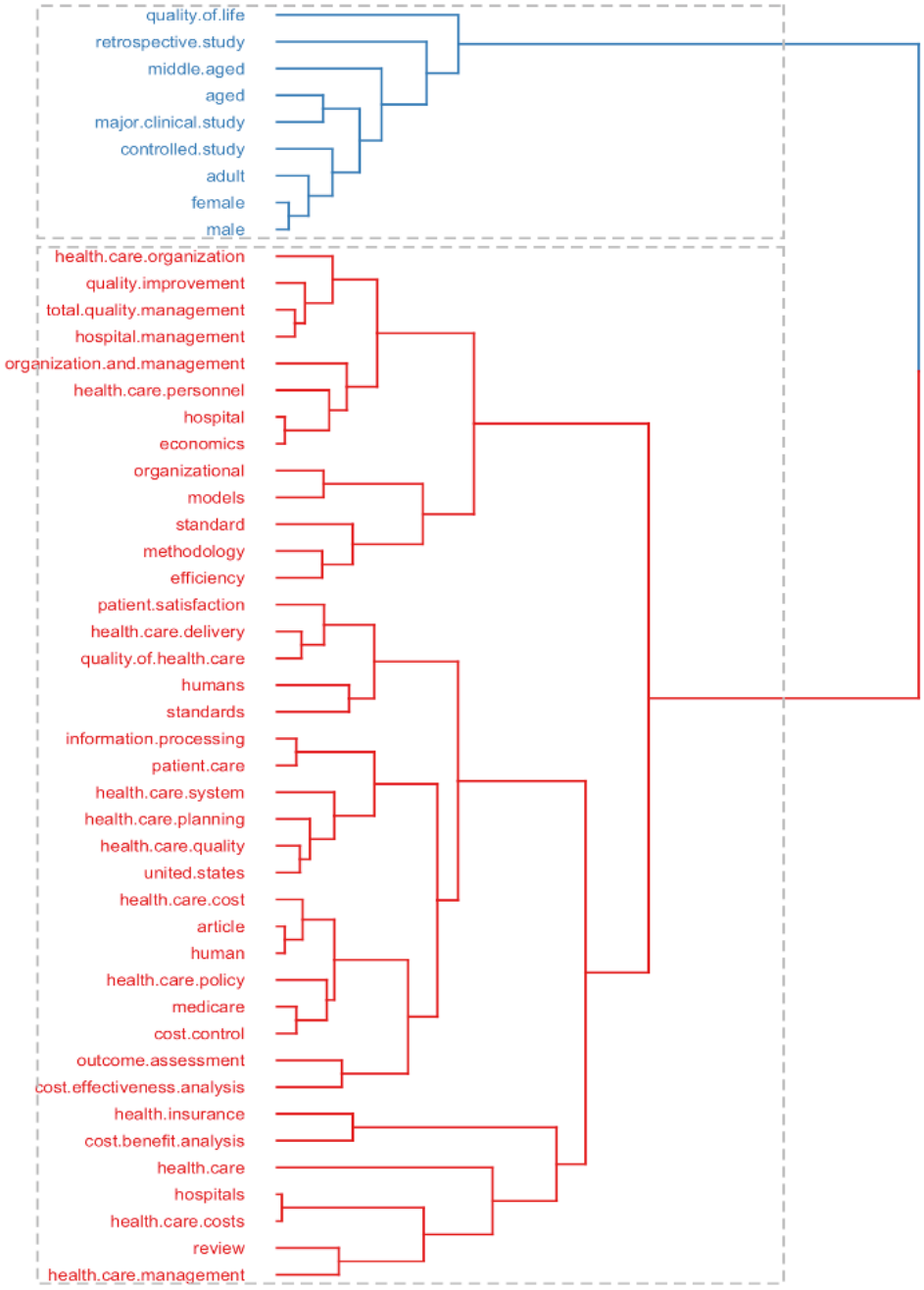

Fig. 4 – Keywords' dendrogram (Source: Authors' elaboration)

Two different clusters of keywords are related to facilitating the discussion: those regarding the demographic aspect of health research in blue. In red, there are some more technical terms characteristic of the topic. The first block identifies the role of data quality within scientific studies, both for determining the correct analysis variables and for coordinated maintenance in the case of wide-ranging analyses (Wang et al., 1995). Besides, the red block integrates data quality in hospital management, opening countless areas for research.

The first research topic is related to research through data quality to hospital structures' efficiency and effectiveness. According to Al-Amin & Ahmed (2016), efficiency has emerged as a central goal to healthcare organizations' operations. The following link is between organization and management, health care personal in a hospital context within an economic scenario. It is formalized in a model that quantifies the economic impacts within the economic environment and assesses the inefficiencies.

The next link, more specific, attempts to frame a way to improve hospital outpatient departments' service quality. To achieve this goal, it is necessary to aim for patient satisfaction and improve health care at the center of this process. Information processing must necessarily be part of a system that cares about planning and quality of care. Naturally, health care quality is linked to patient care.

The last cluster is linked health service costs to health insurance within the hospital context. A study by Hong et al. (2017) examines differences between individuals covered by different types of insurance is essential if healthcare managers develop new strategies in response to the emerging health insurance market.

Considering Figure 5 on-trend topics, the following consideration could be made.

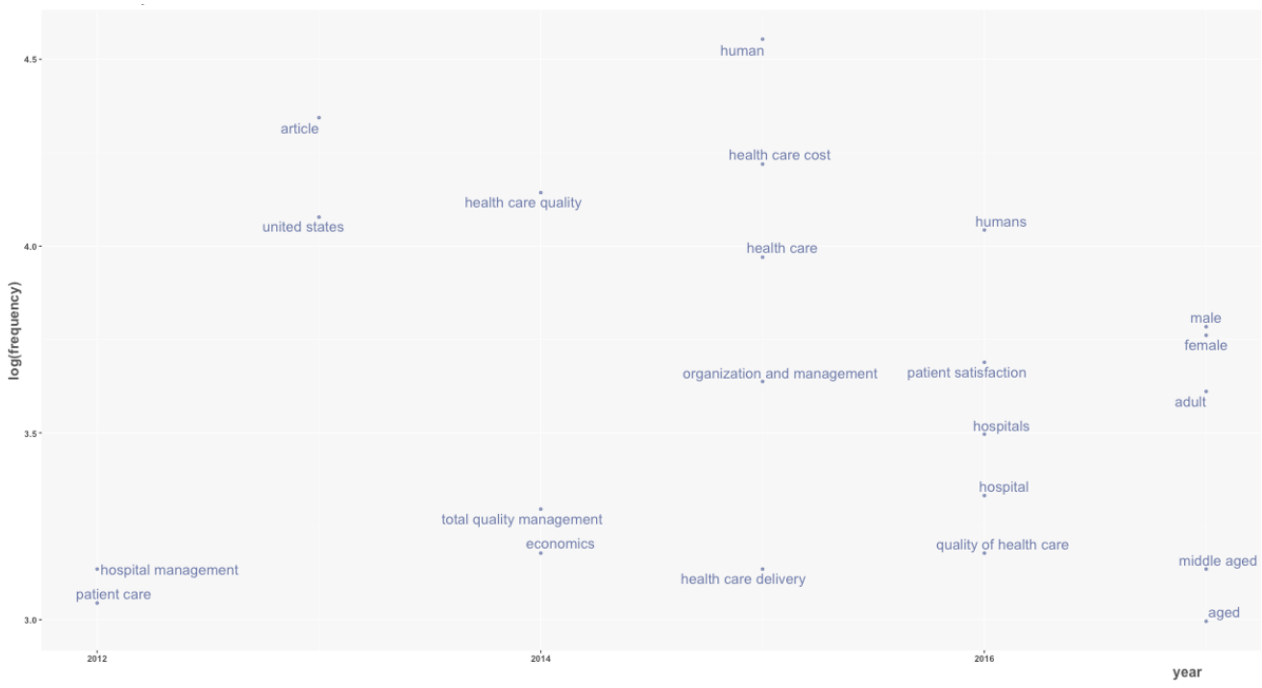

Fig. 5 – The trend topics (Source: Authors' elaboration)

In 2012, the themes of hospital management and patient care were linked. Some articles from previous years focused on cost savings' relevance due to low communication efficiency to improve hospital service quality (Agarwal et al., 2010). The trend continued in 2013; quality functions are implemented with proven process and product development tools, such as QFD (Quality function deployment) (Azadi & Farzipoor Saen, 2013). The authors themselves introduced costs and environmental impact as critical factors that need to be integrated into the

context. The topic is addressed strongly about the United States, especially healthcare managers who manage these environmental barriers with a shared entrepreneurial approach and competitive differentiation.

However, several interest groups - including frontline workers, doctors, and patients - challenge this paradigm as they demand special attention to the quality of care (Payne & Leiter, 2013). In 2014, the hospital environment saw the combination of an economic approach, namely total quality management, an increase in the hospital environment. In the paper by Shaw-Taylor (2014), the Quality Improvement Organization (QIO) Program is presented. The QIO Program was created to address the questionable quality of care. The QIOs examine how care is provided based on performance measures.

The author himself focuses on the internal valuation that highlighted the program's data gaps, the need for a system of specific rules for the conceptualization, collection, distribution, discovery, analysis, and reprogramming of data. In 2015 one of the trend topics is the human one, related to the health system's costs, quality, and organization and management.

Zarei (2015) study on a population of 500 patients aimed to validate a tool to help hospital managers identify areas needing improvement and correction. Based on eight factors significant to outpatient service quality, it showed that the information provided to the patient and the clinic's physical environment were some of the most critical determinants of outpatient services quality.

In 2016, patient satisfaction was studied about the efficiency and organizational performance of hospital operations. According to Al-Amin & Ahmed (2016), efficiency emerged as a central target for processes in healthcare organizations. The same article, which focuses on hospital operations in the United States, does not overlook what was found in previous years. However, achieving organizational efficiency is necessary for healthcare organizations. Given the changes currently taking place in the health care system, health care managers must maintain a certain level of fluency to meet environmental needs and have the resources to improve their performance. In 2017 the cluster articles dealt with statistical studies, which can be seen from the terms involved.

An example is the Campos et al. (2017) document. An investigation is conducted on the expectations and quality gaps of the services provided in public health clinics in Natal, Brazil, from patients and health service providers.

The figure includes singular and plural forms of words as "*hospital*" and "*hospitals*" to enrich and grab more papers on the most critical themes under discussion (Bancheva, 2019; Miau & Yang, 2018).

4.7 – Countries scientific production and collaborations

This paragraph deals with the number of publications per country. As we can see from Figure 6, the USA ranks with a considerable advantage over other countries (74 articles), with 53.23% of publications in the country. Despite this element, it is opportune to observe how many other publications come from the North. In particular, the following ranking shows the first 20 countries in order of publication.

Additionally, the nodes of collaborations created among the countries suggested a few collaborations between researchers in this field. The most important node is created between the USA and Canada despite the private health and public health systems. This difference makes value among the years. Other nodes are visible between the USA and the European Union, and the UK. No mutual studies are implemented considering a partnership with the African continent, Russia, and Australia. Finally, also the mutual collaboration with China is not fully addressed.

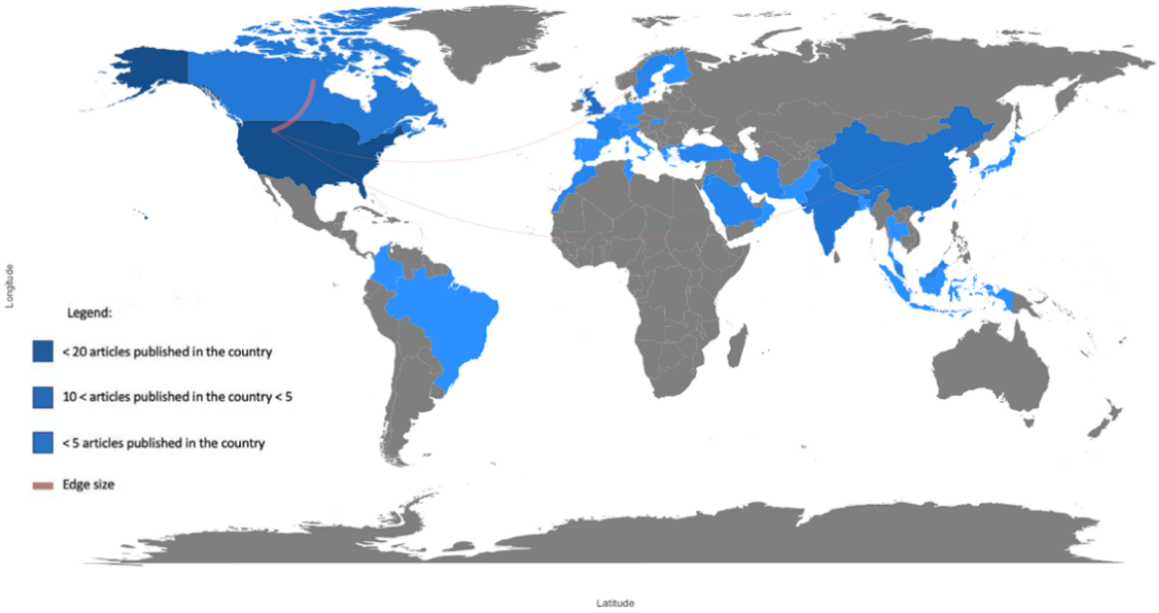

Fig. 6 – Number of publications per country and collaborations
(Source: Author's elaboration)

5 – Discussion

This paragraph aims to determine the features required to develop a framework capable of implementing data quality and allowing cost savings (Figure 7). The section will also show the scientific publications trend topics related to costs and healthcare data quality improvements. The results are obtained considering the topic dendrogram mentioned above, below the discussion for each subtopic.

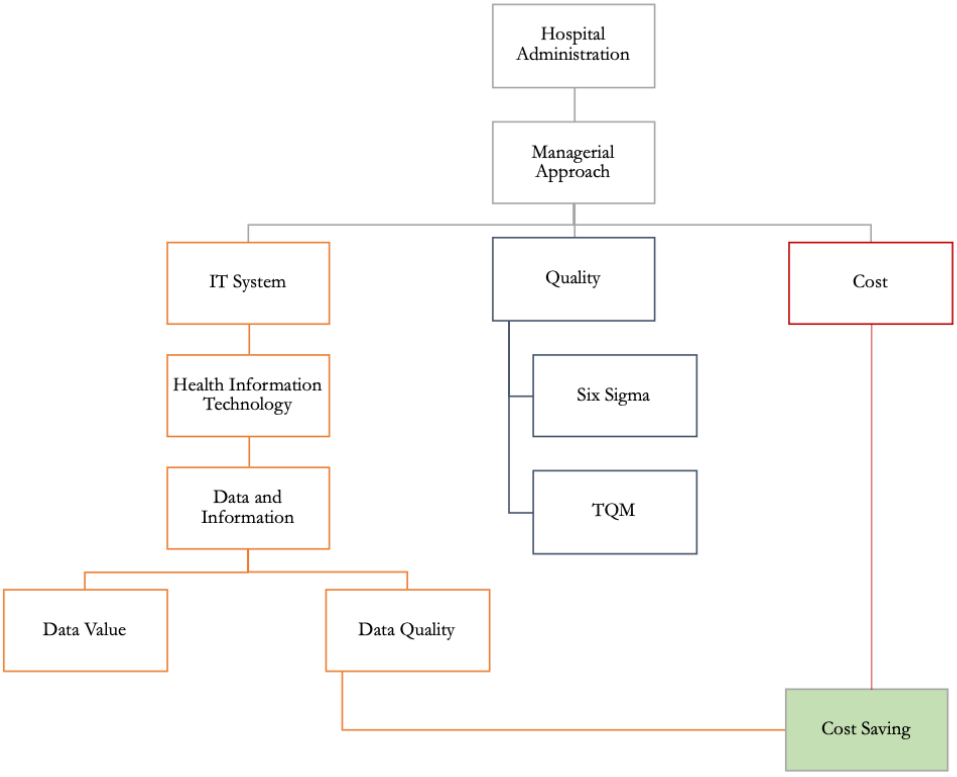

Fig. 7 – Data quality and cost accounting: a holistic framework (Source: Author's elaboration)

5.1 – Managerial Approach

Several times in literature, it has been theorized that the environment impacts organizational activities (Bourgeois III, 1980). Examples are the various measures of environmental availability that influence the strategic behaviour of hospitals. In particular, the focus should be placed on the growing interest and investment in healthcare information technology and its benefits (Menachemi et al., 2011). The healthcare system is not an area where competition for patients can be the management objective. Indeed, by their nature, health care institutions are heavily subsidized by the Government have a moral responsibility to be fully responsible for the efficient use of public resources (Sarji, 1996).

In this context, those involved in management, standard-setting, and resource allocation must be aware of hospitals' priorities to meet their patients' needs (Rose et al., 2004). The same author highlights that it is equally important to pursue investment policies in health promotion and public health education to reduce hospital services dependence. The reduction of hospitalized patients will result in more resources and higher quality.

5.2 – Accounting costs

As many studies related to the US medical system, the focus is on the healthcare industry. The U.S. healthcare industry consumes $2.7 trillion in healthcare resources alone, equivalent to about 18% of its GDP (Khan et al., 2020). Although it is the highest percentage globally, care quality is among the lowest in the ranking. In 2015, a Commonwealth Fund document showed that the United States was performing worse and spending more on health care, mainly due to increased medical technology use and higher prices than other high-income countries. More positively, forecasts for health costs in 2020 need to include the outbreak of COVID-19 worldwide. However, the most notable finding was the positive association between national health expenditure and the deaths of COVID-19. The proportion of spending on health care has not isolated countries from the negative results of COVID-19 (Khan et al., 2020). The authors consider critical factors in this correlation country with relative and absolute higher health budgets than those with larger populations. Countries with higher health budgets can also track cases and deaths more accurately (% of GDP).

5.3 – Quality

As previously illustrated, some management practices such as TQM or Six Sigma may improve critical processes' efficiency and management. However, quality in the health care environment can be expressed in three dimensions: clinical quality', 'economic or financial quality' and 'patient-oriented quality' (Cunningham, 1991). In a broader meaning, the literature has identified quality management as the most critical and enduring strategy to ensure organisations' very survival and pursue business excellence (Wang & Ahmed, 2001). In the pursuit of quality, it is necessary to understand customers' needs and expectations fully. Rather than the above definitions, the relevant documentation offers a different set of quality criteria under (Ovretveit, 2000): "patient quality", "professional quality", and "management quality". “Patient quality” is about giving patients everything they want, professional quality is about giving them what they need, and 'management quality' is about using as few resources as possible without errors or delays in providing patients what they want and need.

A fourth dimension is identified by Rose et al. (Rose et al., 2004) as the “social support factor”: the application of psycho-educational theory in terms of patient education. According to the authors themselves, patients often lack the necessary knowledge to deal with their

condition or illness, which often leads to the perception that the quality of service is unsatisfactory

5.4 – IT System

According to Turan & Palvia (2014), information technology is a critical factor in reducing healthcare costs and improving quality. However, the adoption rate of information technology in healthcare remains low despite lower costs and potential benefits in clinical decision-making, even in the most advanced countries (Christensen & Remler, 2009). As proof, Özata & Altunkan (2010) argue a lack of adequate health sector mechanisms to coordinate patient care, share and monitor information relevant to compliance with the guidelines. Using the IT tool for clinical trial projects provides an opportunity to improve the information management process, subject to the complexity of identifying and assessing relevant IT options (Bérard et al., 2012). It is essential to emphasise that the adoption of technology is closely related to transferring knowledge and information. This is nothing more than a process through which an adopter transmits relevant information about the risks and benefits of new technology to a knowledge recipient. The author himself points out that organisations with a greater capacity for absorbing knowledge can identify and recognize their value more quickly; they are more likely to absorb and assimilate external information.

5.5 – Health Information Technology

Medical computing can be defined as "*the rapidly developing scientific field dealing with the storage, retrieval and optimal use of biomedical information, data and knowledge for problem-solving and decision making*" (Blois & Shortliffe, 1990).

As the capacity and complexity of Health Information Technology (HIT) has expanded, interest and investment have grown significantly, responding to increasing evidence that such efforts will produce significant operational, clinical, and financial benefits for hospitals (Menachemi et al., 2011). Therefore, it is crucial to understand how market conditions are linked to significant hospital HIT management decisions. This will help policymakers better understand new policies' effects to stimulate HIT adoption by suppliers.

Three main HIT management strategies are identified in the literature; the first is the single-vendor approach, which involves contracting with a single supplier. The benefits include avoiding the maintenance of large numbers of highly qualified in-house IT staff because managing single vendor contracts is cheaper system integration between HIT systems in the hospital is more straightforward and is carried out by the supplier (Light et al., 2001; Themistocleous et al., 2001), maintenance and troubleshooting of all HIT applications are typically outsourced to the individual supplier. HIT companies offer solutions for individual suppliers that are usually more extensive, more established, and less likely to fail (Burke et al., 2009). However, there are some limitations to pursuing this single vendor HIT management strategy that may lead to extended and more disruptive installation and customization periods (Hong et al., 2017), or there may be a "push back" by end-users (Burke et al., 2009).

The second strategy is best-of-breed (BoS) and assumes that hospitals select the HIT product considered most appropriate for the organizational unit they adopt, regardless of the supplier. In this approach, end users are more involved in choosing the HIT system, making installation and subsequent training easier (Burke et al., 2009).

The third model is called best-of-suite (BoS) and is a hybrid designed to maximize the two previous strategies' benefits. BoS solutions are somewhat easier to implement than single-source solutions and provide many advantages (Burke et al., 2009).

5.6 – Data Value

According to Kayyali et al. (2013), data exploitation in the health care system may create about $300 billion a year in value in the US healthcare system. Two-thirds would be generated by reducing healthcare spending. Aside from the value in monetary terms, the entire structure could gain benefits, such as the delivery of personalized drugs for the treatment of patients with cancer or other diseases (Beretta & Crea, 2020; Roski et al., 2014) and the use of clinical decision support systems, through the automated analysis of X-rays, computed tomography and MRI images and the extraction of medical literature to adapt treatments to the risk profiles of individual patients (McAfee & Brynjolfsson, 2012). Third, reliance on patient-generated data has been demonstrated by mobile devices to personalize diagnostic and treatment decisions, including educational messages supporting desired patient behaviours (Hodach et al., 2014). However, it should also be noted that population health analyses based on extensive data revealed models that would not have emerged if they had been performed on small batches of patients (Roski et al., 2014).

Although interest in this field has emerged, exploring the path to successful analysis of big data for health transformation is currently one of the most discussed topics in Information Technology, Information Systems (IS) and Healthcare Information Technology (Y. Wang & Hajli, 2017). According to Lim et al. (2018), nine key factors characterizing data-based value creation in the field of services (Figure 11): (1) data source, (2) data collection, (3) data, (4) data analysis, (5) data source information, (6) information provision, (7) customer (information user), (8) value in information use, and (9) supplier network.

Focusing on data analysis, the activity often requires preliminary tasks such as data cleansing, anonymizing, aggregating, integrating, and archiving. This factor plays a crucial role, as the best of these practices and the methods used to influence the quality of service and the data's intrinsic value (Barnaghi et al., 2013).

There are three main typologies of analysis: descriptive, predictive, and prescriptive, each characterized by the kind of data and the purpose of the investigation. The first provides the ability to briefly describe the data and supply answers related to the last time (Goldberg & Kosinski, 2011). The hospital environment allows understanding patients' past behaviours and how they may influence their EHR database (Y. Wang & Hajli, 2017). Predictive analysis will enable users to predict based on a probability estimation, thus allowing the study of unstructured and structured data and supporting real-time data processing (Belle et al., 2015). On the other hand, prescriptive analytics offers optimal solutions or possible action lines to help users understand what to do in the future (Watson, 2016). Prescriptive analytics can continuously forecast and automatically improve predictions' accuracy taking new data sets to develop more in-depth decisions about diagnosis and treatment (Belle et al., 2015).

5.7 – Data Quality

Data quality can have a massive impact on the health sector. According to Kerr et al. (2008), planning and delivery services are based on clinical, administrative and management sources. Notably, as the author suggests, it can be assumed that higher data quality leads to better results in the medical field. However, different and interconnected data needs and decisions lead to inherently complex and challenging healthcare relationships.

Tayi & Ballou (1998) define data as "*the raw material for the information age*" and highlight how data support managerial and professional work and are fundamental to all decisions at all enterprise levels. These are valuable data processed to increase the user's knowledge of the data (McFadden et al., 1999). Briefly, high-quality and derived data are needed to create institutional

knowledge (stored data) and reasoning processes that help an organization extract maximum benefits from resources.

Therefore, it is possible to define quality data as suitable for its intended use in operations, decision-making, and planning. It is free of defects and has the desired characteristics (Redman, 2001).

It is recognized that any data is not wholly accurate. The real concern for data quality is to ensure that the data is not perfect. It is accurate, timely and consistent enough to make appropriate and reliable decisions (Kerr et al., 2007).

The data itself may contain quality information, and this is derived from metadata. It is defined as the set of characteristics known about the data to build databases and applications. However, their analysis is essential. Many heterogeneous databases are brought together in a single system, as their various metadata formalizations need to be homogenized and integrated to support the access planning and delivery system (Hovy et al., 2003). Since decisions in the health sector are often complex, partly due to their nature, sometimes because of the limited resources available, data quality information can support decision making in emergencies and common care. For instance, data quality controls on DNA barcoding (Shen et al., 2013) and surveillance system assessment in different countries (Collins et al., 2020) are tangible applications.

5.8 – Cost Savings

As electronic health records increase, they will allow access to an unprecedented amount of clinical data and offer the potential for cost savings (Xierali et al., 2013). While the amount of such savings is uncertain, the value of EHR in extending health care providers' access to patient records is not questionable (Bassi & Lau, 2013).

Data collection is considered a key value for healthcare organizations, and consequently, data quality activity should be one of the priorities, as mentioned above. According to Malcom (1998), the average cost perceived by low data quality is 10% of an organization's revenue and, thus, the cost grows with increasing data. Within a healthcare organization, the use of big data is still doubtful, although they have shown results in efficiency in other contexts (Bates et al., 2014). The analysis of patient data potentially represents the key to cost reduction. More effective management would be achieved by isolating the patients who contribute most to increased costs and having case managers work with them to improve their care (Nelson, 2012). Big Data analysis has a logical development in predictive systems, which identify potentially high-cost patients using analytical methods and determine patients' specific needs and lack of care (Bates et al., 2014).

Therefore, as suggested by the topic dendrogram (Figure 4), health care cost accounting requires effective quality models. Furthermore, increased data can only be correlated with reduced clinical and medical costs if quality models are in place (Agliata & Tuccillo, 2018; Eppler & Helfert, 2004; Malcom, 1998). Therefore, the bibliometric study highlights how healthcare costs and their accounting within the healthcare world have been a recurring theme for several years through the analysis of the previous literature. Therefore, health care cost accounting is relevant and related to data quality. The increase in data we are witnessing requires order and process that we believe can be partly governed by analysing the variables in Figure 7. Finally, we argue that before applying advanced big data management, IoT and artificial intelligence tools to data, it is necessary for the healthcare world to look at its information systems and assess the cost of inefficient data management. The alternative is non-quality data, which would not save the healthcare system any money and lead to even higher costs.

6 – Conclusion

This section aims to conclude the paper by answering RQ (3) (see the Introduction) about future research directions in this field.

The paper aims to provide an in-depth bibliometric analysis of data quality and cost accounting. The study has revealed an increase in research towards the field of data since 2011 when the theme of big data use became part of numerous economic, social, and scientific dynamics. In the following period, the number of publications on the subject has always been twice as many as seen until that year. The topic has grown in interest because of the rising health care costs, which are expected to be even higher.

The paper derives valuable insights for researchers.

First, keywords analysis reveals a close link between healthcare costs and the quality of care rigorously maintained. The study shows interesting links between technology and sustainable development support even in the health sector put under strain by population and age increases.

Second, in terms of countries' contributions, the United States is the most scientifically active, thanks to the recent Affordable Care Act 2010, which has increased interest in the subject. The United States and Canada show a greater interconnection between their publications as far as connections are concerned.

Third, the article leaves the reader with the first data quality framework in healthcare (Figure 7). The analysis finds that no author to date has investigated the topic of data quality and costs accounting in-depth, although individual elements we systematized are present in numerous publications.

Our paper also derives valuable insights for practitioners as health managers.

First, data quality needs a multidisciplinary approach, as demonstrated in Figure 7. Health care teams should increasingly include health and management approaches to dwell on management aspects in projects involving the use and exploitation of numerous data.

Second, it is necessary to reiterate a unified and holistic approach that looks at the quality of data in medical records, including strategies to assess the economic impact created in terms of science and higher quality of care provided to patients as also established by SDG 3 towards free access to health care and with lower costs.

Third, the article demonstrates to professionals how data quality is the starting point for applying exciting technologies such as blockchain, cloud computing, machine learning and artificial intelligence.

In conclusion, like any research, our article has some limitations that can be resolved in future research. For example, the analysis focuses on a single database that could be extended by checking other databases such as Web of Science and PubMed. Also, as consistent as possible, the keyword search could hide some engaging scenarios not visible to us.

Therefore, as a key to future research, further studies could investigate the level of scientific and academic discussion regarding data quality and healthcare cost accounting. We call for more future research with practical case studies that can demonstrate a correlation between data quality, cost reduction, and increased patient quality. Finally, recalling the results obtained on the collaboration index, more exchange and multidisciplinary research should be conducted among future researchers.

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7 – References

Adenle, A. A., Chertow, M. R., Moors, E. H. M., & Pannell, D. J. (2020). *Science, Technology, and Innovation for Sustainable Development Goals: Insights from Agriculture, Health, Environment, and Energy*. Oxford University Press.

Agarwal, R., Gao, G. (Gordon), DesRoches, C., & Jha, A. K. (2010). The Digital Transformation of Healthcare: Current Status and the Road Ahead. *Information Systems Research*, *21*(4), 796–809. https://doi.org/10.1287/isre.1100.0327

Agliata, F., & Tuccillo, D. (2018). Cost accounting as a decision-making tool in public services delivery. *Economia Aziendale Online -*, *9*(2), 115–126. https://doi.org/10.13132/2038-5498/9.2.1893

Agrawal, A., Gans, J. S., & Goldfarb, A. (2019). Exploring the impact of artificial Intelligence: Prediction versus judgment. *Information Economics and Policy*, *47*, 1–6. https://doi.org/10.1016/j.infoecopol.2019.05.001

Al-Amin, A. Q., & Ahmed, F. (2016). Food Security Challenge of Climate Change: An Analysis for Policy Selection. *Futures*, *83*, 50–63. https://doi.org/10.1016/j.futures.2016.04.002

Amarasingham, R., Plantinga, L., Diener-West, M., Gaskin, D. J., & Powe, N. R. (2009). Clinical information technologies and inpatient outcomes: A multiple hospital study. *Archives of Internal Medicine*, *169*(2), 108–114. https://doi.org/10.1001/archinternmed.2008.520

Ardagna, D., Cappiello, C., Samá, W., & Vitali, M. (2018). Context-aware data quality assessment for big data. *Future Generation Computer Systems*, *89*, 548–562. https://doi.org/10.1016/j.future.2018.07.014

Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*, *11*(4), 959–975.

Aria, M., & Cuccurullo, C. (2021). Our Papers using bibliometrix. *Bibliometrix*.

Asi, Y. M., & Williams, C. (2018). The role of digital health in making progress toward Sustainable Development Goal (SDG) 3 in conflict-affected populations. *International Journal of Medical Informatics*, *114*, 114–120. https://doi.org/10.1016/j.ijmedinf.2017.11.003

Azadi, M., & Farzipoor Saen, R. (2013). A combination of QFD and imprecise DEA with enhanced Russell graph measure: A case study in healthcare. *Socio-Economic Planning Sciences*, *47*(4), 281–291. https://doi.org/10.1016/j.seps.2013.05.001

Azam, M., Rahman, Z., Talib, F., & Singh, K. J. (2012). A critical study of quality parameters in health care establishment: Developing an integrated quality model. *International Journal of Health Care Quality Assurance*, *25*(5), 387–402. https://doi.org/10.1108/09526861211235892

Bai, L., Meredith, R., & Burstein, F. (2018). A data quality framework, method and tools for managing data quality in a health care setting: An action case study. *Journal of Decision Systems*, *27*, 144–154. Scopus. https://doi.org/10.1080/12460125.2018.1460161

Bancheva, A. (2019). A bibliometric analysis of global research on the arctic (with special interest in environmental issues). *Polar Science*, *21*, 233–237. https://doi.org/10.1016/j.polar.2019.04.002

Barak, A., Klein, B., & Proudfoot, J. G. (2009). Defining internet-supported therapeutic interventions. *Annals of Behavioral Medicine: A Publication of the Society of Behavioral Medicine*, *38*(1), 4–17. https://doi.org/10.1007/s12160-009-9130-7

Barnaghi, P., Sheth, A., & Henson, C. (2013). From Data to Actionable Knowledge: Big Data Challenges in the Web of Things [Guest Editors' Introduction]. *IEEE Intelligent Systems*, *28*(6), 6–11. https://doi.org/10.1109/MIS.2013.142

Bassi, J., & Lau, F. (2013). Measuring value for money: A scoping review on economic evaluation of health information systems. *Journal of the American Medical Informatics Association*, *20*(4), 792–801.

Bates, D. W., Saria, S., Ohno-Machado, L., Shah, A., & Escobar, G. (2014). Big Data In Health Care: Using Analytics To Identify And Manage High-Risk And High-Cost Patients. *Health Affairs*, *33*(7), 1123–1131. https://doi.org/10.1377/hlthaff.2014.0041

Bédard, J., & Gendron, Y. (2010). Strengthening the Financial Reporting System: Can Audit Committees Deliver? *International Journal of Auditing*, *14*(2), 174–210. https://doi.org/10.1111/j.1099-1123.2009.00413.x

Belle, A., Thiagarajan, R., Soroushmehr, S. M. R., Navidi, F., Beard, D. A., & Najarian, K. (2015). Big Data Analytics in Healthcare. *BioMed Research International*, *2015*. https://doi.org/10.1155/2015/370194

Ben-Assuli, O., Shabtai, I., & Leshno, M. (2013). The impact of EHR and HIE on reducing avoidable admissions: Controlling main differential diagnoses. *BMC Medical Informatics and Decision Making*,

13(1), 49. https://doi.org/10.1186/1472-6947-13-49

Bérard, C., Cloutier, L. M., & Cassivi, L. (2012). Evaluating clinical trial management systems: A simulation approach. *Industrial Management and Data Systems*, *112*(1), 146–164. https://doi.org/10.1108/02635571211193680

Beretta, V., & Crea, G. (2020). Mapping Chronic Diseases in Italy: Trends from the last 20 years. *Economia Aziendale Online*, *10*(4), 585–606. https://doi.org/10.13132/2038-5498/10.4.1965

Biancone, P., Secinaro, S., Brescia, V., & Calandra, D. (2019). *The Medical Record and the Cycle of Innovation in the Clinical Pathway of Patients Suffering from Pathological Addictions*.

Blois, M. S., & Shortliffe, E. H. (1990). The computer meets medicine: Emergence of a discipline. In *Medical informatics: Computer applications in health care* (pp. 3–36).

Bourgeois III, L. J. (1980). Strategy and environment: A conceptual integration. *Academy of Management Review*, *5*(1), 25–39.

Burke, D., Yu, F., Au, D., & Menachemi, N. (2009). Best of breed strategies–hospital characteristics associated with organizational HIT strategy. *Journal of Healthcare Information Management: JHIM*, *23*(2), 46–51.

Campos, D. F., Negromonte Filho, R. B., & Castro, F. N. (2017). Service quality in public health clinics: Perceptions of users and health professionals. *International Journal of Health Care Quality Assurance*, *30*(8), 680–692. https://doi.org/10.1108/IJHCQA-09-2016-0140

Changizi, M., & Kaveh, M. H. (2017). Effectiveness of the mHealth technology in improvement of healthy behaviors in an elderly population—A systematic review. *MHealth*, *3*. https://doi.org/10.21037/mhealth.2017.08.06

Chen, G., & Xiao, L. (2016). Selecting publication keywords for domain analysis in bibliometrics: A comparison of three methods. *Journal of Informetrics*, *10*(1), 212–223. https://doi.org/10.1016/j.joi.2016.01.006

Christensen, M. C., & Remler, D. (2009). Information and Communications Technology in U.s. Health Care: Why Is Adoption So Slow and Is Slower Better? *Journal of Health Politics, Policy and Law*, *34*(6), 1011–1034. https://doi.org/10.1215/03616878-2009-034

Churruca, K., Pomare, C., Ellis, L. A., Long, J. C., & Braithwaite, J. (2019). The influence of complexity: A bibliometric analysis of complexity science in healthcare. *BMJ Open*, *9*(3). https://doi.org/10.1136/bmjopen-2018-027308

Cobianchi, L., Dal Mas, F., Piccolo, D., Peloso, A., Secundo, G., Massaro, M., Takeda, A., Garcia Vazquez, A., Verde, J., Swanstrom, L., Marescaux, J., Perretta, S., Gallix, B., Dimarcq, J.-L., & Giménez, M. (2020). Digital transformation in healthcare. The challenges of translating knowledge in a primary research, educational and clinical centre. In *International Business Information Management Conference (35th IBIMA), IBIMA, Seville, Spain* (pp. 6877-6888).

Collins, D., Rhea, S., Diallo, B. I., Bah, M. B., Yattara, F., Keleba, R. G., & MacDonald, P. D. M. (2020). Surveillance system assessment in Guinea: Training needed to strengthen data quality and analysis, 2016. *PLOS ONE*, *15*(6), e0234796. https://doi.org/10.1371/journal.pone.0234796

Cox, M., & Ellsworth, D. (1997). Managing big data for scientific visualization. *ACM Siggraph*, *97*, 21–38.

Cunningham, P. A. (1991). The need for cardiac monitoring after electrical injury. *Medical Journal of Australia*, *154*(11), 765–766. https://doi.org/10.5694/j.1326-5377.1991.tb121321.x

Dey, D., & Kumar, S. (2010). Reassessing Data Quality for Information Products. *Management Science*, *56*(12), 2316–2322. https://doi.org/10.1287/mnsc.1100.1261

Ekundayo, T. C., & Okoh, A. I. (2018). A global bibliometric analysis of Plesiomonas-related research (1990 – 2017). *PLOS ONE*, *13*(11), e0207655. https://doi.org/10.1371/journal.pone.0207655

Emeka-Nwokeji. (2012). Repositioning Accounting Information System Through Effective Data Quality Management: A Framework For Reducing Costs And Improving Performance. *International Journal of Scientific & Technology Research*, *1*(10), 86–94.

Eppler, M., & Helfert, M. (2004). A classification and analysis of data quality costs. *International Conference on Information Quality*.

European Commission. (2020). *Shifting health challenges | Knowledge for policy*. Shifting Health Challenges. https://knowledge4policy.ec.europa.eu/shifting-health-challenges_en

Forliano, C., De Bernardi, P., & Yahiaoui, D. (2021). Entrepreneurial universities: A bibliometric analysis within the business and management domains. *Technological Forecasting and Social Change*, *165*, 120522. https://doi.org/10.1016/j.techfore.2020.120522

Francesconi, A. (2009). Technology framework e ruoli organizzativi ad elevata differenziazione nei

processi di cambiamento tecnologico. Il caso dell'ICT per il digital imaging. *Economia Aziendale Online* -, *1*(4), 117–137. https://doi.org/10.4485/ea2038-5498.117-137

Garfield, E. (2004). Historiographic Mapping of Knowledge Domains Literature. *Journal of Information Science*, *30*(2), 119–145. https://doi.org/10.1177/0165551504042802

Gartner. (2013). *Gartner Says by 2020 'Cloud Shift' Will Affect More Than $1 Trillion in IT Spending*. Gartner. https://www.gartner.com/en/newsroom/press-releases/2016-07-20-gartner-says-by-2020-cloud-shift-will-affect-more-than-1-trillion-in-it-spending

Gökalp E., Gökalp M.O., Çoban S., & Eren P.E. (2018). Analysing opportunities and challenges of integrated blockchain technologies in healthcare. *Lecture Notes in Business Information Processing*, *333*, 174–183. Scopus. https://doi.org/10.1007/978-3-030-00060-8_13

Goldberg, M. J., & Kosinski, L. (2011). Activity-Based Costing and Management in a Hospital-Based GI Unit. *Clinical Gastroenterology and Hepatology*, *9*(11), 947-949.e1. https://doi.org/10.1016/j.cgh.2011.08.010

Gu, D., Li, J., Li, X., & Liang, C. (2017). Visualizing the knowledge structure and evolution of big data research in healthcare informatics. *International Journal of Medical Informatics*, *98*, 22–32. https://doi.org/10.1016/j.ijmedinf.2016.11.006

Gu, D., Li, T., Wang, X., Yang, X., & Yu, Z. (2019). Visualizing the intellectual structure and evolution of electronic health and telemedicine research. *International Journal of Medical Informatics*, *130*. https://doi.org/10.1016/j.ijmedinf.2019.08.007

Hasselgren, A., Kralevska, K., Gligoroski, D., Pedersen, S. A., & Faxvaag, A. (2020). Blockchain in healthcare and health sciences—A scoping review. *International Journal of Medical Informatics*, *134*, 104040. https://doi.org/10.1016/j.ijmedinf.2019.104040

Hillestad, R., Bigelow, J. H., Fonkych, K., Bower, A. G., Fung, C., Wang, J., Taylor, R., Girosi, F., Meili, R., & Scoville, R. (2005). *Health Information Technology: Can HIT Lower Costs and Improve Quality?* https://www.rand.org/pubs/research_briefs/RB9136.html

Hodach, R., Chase, A., Fortini, R., Delaney, C., & Hodach, R. (2014). *Population Health Management: A Roadmap for Provider-Based Automation in a New Era of Healthcare*. https://www.exerciseismedicine.org/assets/page_documents/PHM%20Roadmap%20HL.pdf

Hong, Y.-R., Holcomb, D., Ballard, M., & Schwartz, L. (2017). Multigroup path analysis of the influence of healthcare quality, by different health insurance types. *Journal of Healthcare Management*, *62*(2), 93–105. https://doi.org/10.1097/JHM-D-17-00008

Hovy, E., Philpot, A., Klavans, J., Germann, U., Davis, P., & Popper, S. (2003). Extending metadata definitions by automatically extracting and organizing glossary definitions. *Proceedings of the 2003 Annual National Conference on Digital Government Research*, 1–6.

Ilin, I., Iliyaschenko, O., & Konradi, A. (2018). Business model for Smart Hospital health organization. *SHS Web of Conferences*, *44*, 00041. https://doi.org/10.1051/shsconf/20184400041

Kayyali, B., Knott, D., & Van Kuiken, S. (2013). *The 'big data' revolution in US healthcare*. McKinsey & Company. https://healthcare.mckinsey.com/big-data-revolution-us-healthcare/

Kerr, K. A., Norris, T., & Stockdale, R. (2008). The strategic management of data quality in healthcare. *Health Informatics Journal*, *14*(4), 259–266. https://doi.org/10.1177/1460458208096555

Kerr, K., Norris, T., & Stockdale, R. (2007). Data quality information and decision making: A healthcare case study. *ACIS 2007 Proceedings - 18th Australasian Conference on Information Systems*.

Khan, J. R., Awan, N., Islam, Md. M., & Muurlink, O. (2020). Healthcare Capacity, Health Expenditure, and Civil Society as Predictors of COVID-19 Case Fatalities: A Global Analysis. *Frontiers in Public Health*, *8*, 347. https://doi.org/10.3389/fpubh.2020.00347

Kumar, S., & Kumar, S. (2008). Collaboration in research productivity in oil seed research institutes of India. *Proceedings of Fourth International Conference on Webometrics, Informetrics and Scientometrics*.

Kwon, O., Lee, N., & Shin, B. (2014). Data quality management, data usage experience and acquisition intention of big data analytics. *International Journal of Information Management*, *34*(3), 387–394.

Liao, H., Tang, M., Luo, L., Li, C., Chiclana, F., & Zeng, X.-J. (2018). A Bibliometric Analysis and Visualization of Medical Big Data Research. *Sustainability*, *10*(1), 166. https://doi.org/10.3390/su10010166

Light, B., Holland, C. P., & Wills, K. (2001). ERP and best of breed: A comparative analysis. *Business Process Management Journal*.

Lim, C., Kim, K.-H., Kim, M.-J., Heo, J.-Y., Kim, K.-J., & Maglio, P. P. (2018). From data to value: A nine-

factor framework for data-based value creation in information-intensive services. *International Journal of Information Management*, *39*, 121–135. https://doi.org/10.1016/j.ijinfomgt.2017.12.007

Lombrano, A., & Iacuzzi, S. (2020). Comparing health system performance. *Economia Aziendale Online -*, *11*(2), 175–189. https://doi.org/10.13132/2038-5498/11.2.175-189

Malcom, A. (1998). Poor data quality costs 10% of revenues, survey reveals. *Wellington: Computerworld*.

Massaro, M., Secinaro, S., Dal Mas, F., Brescia, V., & Calandra, D. (2020). Industry 4.0 and circular economy: An exploratory analysis of academic and practitioners' perspectives. *Business Strategy and the Environment*, *n/a*(n/a). https://doi.org/10.1002/bse.2680

McAfee, A., & Brynjolfsson, E. (2012). Big data: The management revolution. *Harvard Business Review*, *90*(10), 60–66, 68, 128.

McFadden, F. R., Hoffer, J. A., & Prescott, M. B. (1999). *Modern Data Management*. Addison-Wesley Educational Publisher Inc.

Menachemi, N., Shin, D. Y., Ford, E. W., & Yu, F. (2011). Environmental factors and health information technology management strategy. *Health Care Management Review*, *36*(3), 275–285. https://doi.org/10.1097/HMR.0b013e3182048e7e

Miau, S., & Yang, J.-M. (2018). Bibliometrics-based evaluation of the Blockchain research trend: 2008 – March 2017. *Technology Analysis & Strategic Management*, *30*(9), 1029–1045. https://doi.org/10.1080/09537325.2018.1434138

Nelson, L. (2012). *Lessons from Medicare's demonstration projects on disease management and care coordination*.

Okoli, C., & Schabram, K. (2010). A Guide to Conducting a Systematic Literature Review of Information Systems Research. *SSRN Electronic Journal*, *Sprouts: Working Papers on Information Systems*. https://doi.org/10.2139/ssrn.1954824

Ovretveit, J. (2000). Total quality management in European healthcare. *International Journal of Health Care Quality Assurance*, *13*, 74–80. https://doi.org/10.1108/09526860010319523

Özata, M., & Altunkan, H. (2010). Hastanelerde TIbbi Hata Görülme SIklIklarI, TIbbi Hata Türleri ve TIbbi Hata nedenlerinin Belirlenmesi: Konya Örneği. *TIp AraştIrmalarI Dergisi*, *8*(2), 100–111.

Pang, Z., Yang, G., Khedri, R., & Zhang, Y.-T. (2018). Introduction to the special section: Convergence of automation technology, biomedical engineering, and health informatics toward the healthcare 4.0. *IEEE Reviews in Biomedical Engineering*, *11*, 249–259.

Parssian, A., Sarkar, S., & Jacob, V. S. (2004). Assessing Data Quality for Information Products: Impact of Selection, Projection, and Cartesian Product. *Management Science*, *50*(7), 967–982. https://doi.org/10.1287/mnsc.1040.0237

Payne, J., & Leiter, J. (2013). Structuring agency: Examining healthcare management in the USA and Australia using organizational theory. *Journal of Health, Organisation and Management*, *27*(1), 106–126. https://doi.org/10.1108/14777261311311825

Rainero, C., & Modarelli, G. (2021). Doing communication history in sanitary systems beyond a "shell game": A mirror comparison on silence and managerial delay practices in communicating epidemics. *Economia Aziendale Online -*, *12*(2), 143–169. https://doi.org/10.13132/2038-5498/12.2.143-169

Rary, E., Anderson, S. M., Philbrick, B. D., Suresh, T., & Burton, J. (2020). Smart Sanitation—Biosensors as a Public Health Tool in Sanitation Infrastructure. *International Journal of Environmental Research and Public Health*, *17*(14), 5146. https://doi.org/10.3390/ijerph17145146

Redman, T. C. (2001). *Data quality: The field guide*. Digital press.

Rose, R. C., Uli, J., Abdul, M., & Ng, K. L. (2004). Hospital service quality: A managerial challenge. *International Journal of Health Care Quality Assurance*, *17*(3), 146–159. https://doi.org/10.1108/09526860410532784

Roski, J., Bo-Linn, G. W., & Andrews, T. A. (2014). Creating value in health care through big data: Opportunities and policy implications. *Health Affairs (Project Hope)*, *33*(7), 1115–1122. https://doi.org/10.1377/hlthaff.2014.0147

Sadoughi, F., Nasiri, S., & Ahmadi, H. (2018). The impact of health information exchange on healthcare quality and cost-effectiveness: A systematic literature review. *Computer Methods and Programs in Biomedicine*, *161*, 209–232.

Sarji, A. A. (1996). *The Civil Service of Malaysia: Towards Efficiency and Effectiveness: Improvements and Developments in the Civil Service of Malaysia 1995: Report*. Government of Malaysia.

Secinaro, S., Calandra, D., Cappa, C., & Bignamini, E. (2020). La qualità; dei dati all'interno dell'evoluzione dei servizi territoriali: Il caso del Servizio Dipendenze. *MECOSAN*.

https://doi.org/10.3280/MESA2020-116003

Secinaro, S., Calandra, D., Petricean, D., & Chmet, F. (2021). Social Finance and Banking Research as a Driver for Sustainable Development: A Bibliometric Analysis. *Sustainability*, *13*(1), 330. https://doi.org/10.3390/su13010330

Secinaro, S., Calandra, D., Secinaro, A., Muthurangu, V., & Biancone, P. (2021). The role of artificial intelligence in healthcare: A structured literature review. *BMC Medical Informatics and Decision Making*, *21*(1), 125. https://doi.org/10.1186/s12911-021-01488-9

Secinaro, S., Dal Mas, F., Brescia, V., & Calandra, D. (2021). Blockchain in the accounting, auditing and accountability fields: A bibliometric and coding analysis. *Accounting, Auditing & Accountability Journal*, *ahead-of-print*(ahead-of-print). https://doi.org/10.1108/AAAJ-10-2020-4987

Sharma, L., Queenan, C., & Ozturk, O. (2019). The Impact of Information Technology and Communication on Medical Malpractice Lawsuits. *Production and Operations Management*, *28*(10), 2552–2572. https://doi.org/10.1111/poms.13063

Shaw, A. (1990). B.C. Brookes and the development of information science: A bibliography. *Journal of Information Science*, *16*(1), 3–7. https://doi.org/10.1177/016555159001600102

Shaw-Taylor, Y. (2014). Making quality improvement programs more effective. *International Journal of Health Care Quality Assurance*, *27*(4), 264–270. https://doi.org/10.1108/IJHCQA-02-2013-0017

Shen, Y.-Y., Chen, X., & Murphy, R. W. (2013). Assessing DNA barcoding as a tool for species identification and data quality control. *PloS One*, *8*(2), e57125. https://doi.org/10.1371/journal.pone.0057125

Stock, T., & Seliger, G. (2016). Opportunities of sustainable manufacturing in industry 4.0. *Procedia Cirp*, *40*, 536–541.

Tallon, P. P. (2013). *Corporate Governance of Big Data: Perspectives on Value, Risk, and Cost*. *46*(06), 32–38. https://doi.org/10.1109/MC.2013.155

Tayi, G. K., & Ballou, D. P. (1998). Examining data quality. *Communications of the ACM*, *41*(2), 54–57.

Terry, A. L., Stewart, M., Fortin, M., Wong, S. T., Kennedy, M., Burge, F., Birtwhistle, R., Grava-Gubins, I., Webster, G., & Thind, A. (2012). How does Canada stack up? A bibliometric analysis of the primary healthcare electronic medical record literature. *Informatics in Primary Care*, *20*(4), 233–240. https://doi.org/10.14236/jhi.v20i4.2

Themistocleous, M., Irani, Z., & O'Keefe, R. M. (2001). ERP and application integration. *Business Process Management Journal*.

Tradori, V., Brescia, V., & Biancone, P. (2020). Dal concetto di qualità multidisciplinare in sanità a un modello di verifica. *Economia Aziendale Online -*, *10*(4), 607–625. https://doi.org/10.13132/2038-5498/10.4.1998

Turan, A. H., & Palvia, P. C. (2014). Critical information technology issues in Turkish healthcare. *Information and Management*, *51*(1), 57–68. https://doi.org/10.1016/j.im.2013.09.007

Uluyol, B., Secinaro, S., Calandra, D., & Lanzalonga, F. (2021). Mapping waqf research: A thirty-year bibliometric analysis. *Journal of Islamic Accounting and Business Research*, *12*(5), 748–767. https://doi.org/10.1108/JIABR-01-2021-0031

Verzani, J. (2011). *Getting Started with RStudio*. O'Reilly Media, Inc.

Wang, C. L., & Ahmed, P. K. (2001). *The role of learning and creativity in the quality and innovation process*. Citeseer.

Wang, R. Y., Storey, V. C., & Firth, C. P. (1995). A framework for analysis of data quality research. *IEEE Transactions on Knowledge and Data Engineering*, *7*(4), 623–640. https://doi.org/10.1109/69.404034

Wang, R. Y., & Strong, D. M. (1996). Beyond accuracy: What data quality means to data consumers. *Journal of Management Information Systems*, *12*(4), 5–33.

Wang, Y., & Hajli, N. (2017). Exploring the path to big data analytics success in healthcare. *Journal of Business Research*, *70*, 287–299. https://doi.org/10.1016/j.jbusres.2016.08.002

Watson, A. (2016). Impact of the Digital Age on Transforming Healthcare. In *Healthcare Information Management Systems: Cases, Strategies, and Solutions: Fourth Edition* (pp. 219–233). https://doi.org/10.1007/978-3-319-20765-0_13

Whipple, E. C., Dixon, B. E., & McGowan, J. J. (2013). Linking health information technology to patient safety and quality outcomes: A bibliometric analysis and review. *Informatics for Health and Social Care*, *38*(1), 1–14. https://doi.org/10.3109/17538157.2012.678451

Wills, M. J. (2014). Decisions through data: Analytics in healthcare. *Journal of Healthcare Management*, *59*(4),

254–262.

Xierali, I. M., Hsiao, C.-J., Puffer, J. C., Green, L. A., Rinaldo, J. C., Bazemore, A. W., Burke, M. T., & Phillips, R. L. (2013). The rise of electronic health record adoption among family physicians. *The Annals of Family Medicine*, *11*(1), 14–19.

Zarei, E. (2015). Service quality of hospital outpatient departments: Patients' perspective. *International Journal of Health Care Quality Assurance*, *28*(8), 778–790. https://doi.org/10.1108/IJHCQA-09-2014-0097

Zupic, I., & Čater, T. (2015). Bibliometric methods in management and organization. *Organizational Research Methods*, *18*, 429–472. https://doi.org/10.1177/1094428114562629