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The contribution of information and communication technologies on performance management and measurement in healthcare: a systematic review of the literature

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Abstract

Purpose – This article aims to provide the current state of the art of the literature on the contribution of information and communication technologies (ICTs) on the measurement and management of performance in the healthcare sector. In particular, the work aims to identify current and emerging ICTs and how these relate to the performance measurement and management (PMM) cycle of healthcare organizations.

Design/methodology/approach – To address the research objective, we adopted a systematic literature review. In particular, we used the preferred reporting items for systematic reviews and meta-analysis (PRISMA) methodology to select articles related to the investigated topic. Based on an initial screening of 560 items retrieved from Scopus and ISI Web of Knowledge, we identified and analyzed 58 articles dealing with ICTs and PMM in the healthcare sector. The last update of the dataset refers to February 2024.

Findings – Although we attempted to address a relevant topic for both research and practice, we noticed that a relatively small sample of articles directly addressed it. Through this literature review, in addition to providing descriptive statistics of research on ICTs and PMM in healthcare, we identified six theoretical clusters of scientific streams focusing on the topic and eleven categories of ICTs effectively tackled by the literature. We then provided a holistic framework to link technologies to the different PMM phases and functions.

Practical implications – Nowadays, the availability of ICTs to support healthcare organizations' processes and services is extensive. In this context, managers at various organizational levels need to understand and evaluate how each ICT can support different activities to benefit most from their adoption. The findings of this study can offer valuable insights to top and line managers of healthcare organizations for planning their investments in both existing and emerging ICTs to support the various stages of development and functions of PMM.

Originality/value – Most of the current literature focusing on ICTs in the healthcare sector refers to the contribution that technology provides to clinical processes and services, devoting limited attention to the impact of ICTs on administrative processes, such as PMM. To the best of the authors' knowledge, this represents the first literature review on the contribution of ICTs to PMM in the healthcare sector. The review, differently from other research focused on specific ICTs and/or specific PMM functions, provides a holistic perspective to understand how these technologies may support healthcare organizations and systems in measuring and managing their performance.

Keywords ICT, Performance management, Performance measurement, Healthcare, Hospital, Technology

Paper type Literature review

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Introduction

According to a widely shared definition, performance management and measurement (PMM) is defined as an area of scientific and practical interest that focuses on the planning and implementation of appropriate tools and devices for the measurement, monitoring and evaluation of organizational results (i.e. outputs and outcomes) and underlying methods (namely, the means) used to obtain these (Anthony, 1965; Otley, 1980; Lebas, 1995; Bititci *et al.*, 2012). Taticchi *et al.* (2010) identified three phases (or stages) of PMM, namely, the development of performance indicators, measurement frameworks and management frameworks. As technology advances, PMM systems have become increasingly linked to information and communication technologies (ICT) and, more generally, to information systems (Geddes, 2020).

The healthcare sector and related organizations have not escaped the introduction of PMM systems aimed at supporting decision-makers at various levels in the achievement of desired performance results (Nuti *et al.*, 2018; Vainieri *et al.*, 2020).

As a matter of fact, recent decades have been characterized by the introduction of new emerging ICTs which are supporting healthcare organizations toward improving the processes, collection, analysis and management of data (Laurenza *et al.*, 2018; Ciasullo *et al.*, 2022a). Consequently, several scholars have begun to concentrate on how this new type of technology is contributing to healthcare organizations and systems (Marques and Ferreira, 2020; Tortorella *et al.*, 2022; Ciasullo *et al.*, 2022b, c; Lim *et al.*, 2024). According to these scholars, the adoption of ICTs in healthcare may foster both clinical and administrative processes – such as PMM (Tortorella *et al.*, 2020). Due to the fact that many of these ICTs have only recently been introduced in the healthcare sector, the need to both rationalize and contextualize the studies undertaken on this topic up until now has become increasingly relevant. Moreover, it is important to highlight that most of the extant literature focuses on the overall impact of ICTs in healthcare (Aceto *et al.*, 2018; Dal Mas *et al.*, 2023), with a particular emphasis on clinical processes and services (Rouleau *et al.*, 2017; Laurenza *et al.*, 2018; Saigì-Rubiò *et al.*, 2021) and devoting limited attention to the effects of the different ICTs adoption on administrative processes and activities, such as PMM.

As such, the aim of this study is to shed light on the state of current literature concerning the link between PMM and ICTs within the broad field of healthcare. More specifically, our investigation is aimed at highlighting evidence useful for cataloguing and showing the work undertaken so far in this field. As such, this article provides the identification and analysis of current and emerging ICTs and how these relate to the PMM phases identified by Taticchi *et al.* (2010).

In order to achieve this, we have carried out a systematic review of the literature adopting the preferred reporting items for systematic reviews and meta-analysis (PRISMA) method, which allowed us to obtain a set of articles and data to be analyzed and compared. In particular, our research aimed at identifying and contextualizing trends in the key contributions of ICTs in the management and measurement of performance in the healthcare sector, both at the organizational and system level.

This article is structured into different sections. The next section provides a theoretical background on the evolution of PMM in healthcare, taking into account the technological progress. The third section describes the adopted methodology for developing the systematic review of the literature. In the fourth section, results are developed and outlined. In the last sections, discussion and conclusions are presented.

Theoretical background: the evolution of PMM in the healthcare sector

PMM systems are described as structured information-based processes and methods that steer an organization or social system toward realizing objectives and targets to fulfill its

mission and strategy (Ouchi, 1979). While performance measurement is the activity of collecting data, defining indicators and computing such indicators to evaluate the ability of a certain entity to achieve strategic goals, performance management is instead focused on the utilization of such information in decision-making processes (Lebas, 1995; Bititci *et al.*, 2012). Taticchi *et al.* (2010) identified three stages of development of PMM: performance indicators – which refer to the ability to measure specific items/dimensions of organizational performance; measurement framework – which deals with the arrangement of data and performance indicators in an evaluation framework and management framework – focusing on the utilization of data to support decision-making in organizations.

PMM holds significant importance for any healthcare organization or system, as it facilitates evidence-based management (Prenestini and Noto, 2023). Decision-makers should rely on concrete data and facts rather than intuition and hunches. Furthermore, PMM establishes crucial mechanisms for overseeing and managing resources and is ultimately accountable for sustaining the alignment and coordination of the entire organization (Simons *et al.*, 2000).

PMM systems have been widely introduced in Western public and healthcare sectors starting from the New Public Management (NPM) reforms introduced so as to overcome the limits of the Weberian bureaucratic model previously adopted (Hood, 1991; Nuti *et al.*, 2018). This last began to show signs of weakness in the 1980s and 1990s, not due to the use of rules as the main tool in the management of labor and external relations, but rather due to the failure to adopt more modern and flexible methods of coordination with respect to standardization and hierarchy (Hood, 1991; O'Flynn, 2007).

The objects of control of the first PMM systems adopted in healthcare organizations were originally those related to the traditional accounting measures such as inputs – e.g. financial and human resources – and outputs – e.g. the volume of services provided (Nuti *et al.*, 2018). After the year 2000, various shortcomings and unintended consequences emerged in different sectors due to the initial focus of PMM (Bevan and Hood, 2006; Wadmann *et al.*, 2013). This led to the development of a new generation of PMM systems, claiming to enhance the complexity of measures for greater comprehensiveness (in terms of multiple dimensions) and to support inter-organizational performance as well as collaborative activities among different units within the same organization (Kaplan and Norton, 2005; Bititci *et al.*, 2012; Nuti *et al.*, 2018). To achieve this, new tools and devices were required to facilitate goal alignment, information exchange and collaborative actions among healthcare providers, marking a paradigm shift in healthcare system management. As such, during the last decades, PMM systems of healthcare organizations have progressively adopted measures and indicators related to outcomes both at the individual (De Rosis *et al.*, 2020; Ferrè, 2024) and societal level (Vainieri *et al.*, 2020; Noto *et al.*, 2023).

Another noteworthy transformation in PMM systems involves the evolution of the performance concept tied to value (Porter and Teisberg, 2006; Porter, 2010; Gray *et al.*, 2017; De Rosis *et al.*, 2023; Ferrè, 2024). Consequently, this novel concept translated into the development of new measurement and accountability tools. Lastly, periods of crisis, such as the recent fiscal crisis and the COVID-19 epidemic, emphasized that performance should also encompass the principles of sustainability and resilience (Vainieri *et al.*, 2020; Kaswan *et al.*, 2022, 2024; Rathi *et al.*, 2023).

The measurement and assessment of the above-mentioned concepts (i.e. outcomes, value, sustainability and resilience) mark a significant departure from traditional accounting systems (Bititci *et al.*, 2012) and pose multiple challenges mainly related to the ability to collect and analyze data and to attribute the related responsibilities at the organizational and system level (Geddes, 2020; Noto *et al.*, 2023). In this sense, new ICTs may represent a driver to foster the collection, analysis and reporting of data to perform outcome measurement and assessment (Aceto *et al.*, 2018; Brusati *et al.*, 2018; Dal Mas *et al.*, 2023).

ICTs were introduced in the healthcare sector in the early 1990s, impacting positively on the access, efficiency and quality of virtually any process related to healthcare (Aceto *et al.*, 2018) and are becoming even more relevant in the last decade (Marques and Ferreira, 2020). Moreover, the COVID-19 pandemic accelerated the digital transformation of healthcare organizations (Tortorella *et al.*, 2022), such as in other sectors (Kumar *et al.*, 2023a, b). Despite the topic having been widely studied, there are still some gaps in the literature. In particular, although most studies have focused on the introduction of ICTs to address specific clinical needs and processes (Corny *et al.*, 2020; Rolls *et al.*, 2020), fewer studies focused on how ICTs might improve managerial processes (Behkami and Daim, 2012). Among these, PMM is deemed of great interest to scholars due to its relevance both in theory and in practice.

The advent of ICTs and computer-based software for PMM, particularly in the late 1980s and early 1990s, significantly propelled the development of new tools and frameworks for performance evaluation (Paolini, 2022). Health ICTs are digital technologies applied in the field of healthcare to improve the management, delivery and accessibility of healthcare services and to improve communication and information exchange between patients and healthcare providers (De Rosis *et al.*, 2020; Wyers, 2024). This technological shift aimed to enhance the timeliness and accuracy of measurement and reporting as well as forecast the impacts of actions on desired performance through cause-and-effect relationships (Noto *et al.*, 2023). In particular, according to Porter and Teisberg (2006), every ICT provides the backbones for collecting, compiling and utilizing information on patients, activities, methods, costs and results. However, ICTs are not an end themself but should be conceived as an enabler of value-based healthcare that brings together clinical, administrative and financial information together (Porter and Teisberg, 2006; Feeley *et al.*, 2020). The implementation of multidimensional PMM frameworks required support from integrated ICT systems. These played a crucial role in governing the complexity of the PMM function, given the elevated number of performance indicators, facilitating the arrangement of measures to establish cause-and-effect chains and ensuring the quality and accuracy of data and information (Tortorella *et al.*, 2020). The emergence of new ICTs like Big data, Business intelligence systems, Artificial intelligence (AI), Cloud computing, Blockchain, etc. underpins this further evolution of PMM systems.

In the realm of health systems and organizations, ICTs have the potential to contribute significantly by enabling the collection, management and analysis of new and large datasets (Deveraj *et al.*, 2013; Kamble *et al.*, 2018; Hasselgren *et al.*, 2020; Secundo *et al.*, 2021). However, there is a notable gap in the literature, as few studies have framed the contribution that ICTs offer and may provide to decision-making and accountability in healthcare. Most published studies tend to focus on the introduction of specific technologies addressing clinical needs, lacking a holistic view. Consequently, there is a pressing need to design strategies that support the successful adoption of ICTs in the health sector at every governance level, including health systems, health authorities and public and private healthcare providers.

Methodology

This literature review concerning the link between PMM and new ICTs in the healthcare sector was conducted via a systematic approach (Tranfield *et al.*, 2003; Denyer and Tranfield, 2008; Kumar *et al.*, 2023a, b). The need for a systematic review stems from a desire to minimize bias by adopting a replicable, meaningful and transparent process (Tranfield *et al.*, 2003). This approach has made it possible to establish conceptual boundaries that help us in the selection of relevant contributions from literature which may answer our review questions. However, the limitations of such a method may make the search process too rigid, leaving no space for exceptions during the article selection procedure (Wang and Chugh, 2014). The risk

of excluding articles that have abstract or misleading titles is also present (Pittaway *et al.*, 2004; Wang and Chugh, 2014). To overcome this rigidity, some authors (Lee, 2009; Wang and Chugh, 2014) have considered the SR process as a "guiding tool." Our work, in reference to the SR process, was constructed with the specific needs of our research in mind.

Similar to our study, other research adopted the SR to address similar topics and similar research purposes (see, for instance, Lettieri and Masella, 2009; Rouleau *et al.*, 2017; Marques and Ferreira, 2020; Chatterjee *et al.*, 2021; Kumar *et al.*, 2023).

Our research protocol is defined by three macro-phases: identification of the literature; screening and analysis.

The first phase aimed at identifying those articles to be subsequently processed. This phase represents the start of the literature review, beginning with the definition of the boundaries relevant to the research topic and ending with the extraction of initial results. As a data source, we used Scopus and ISI Web of Science, inserting the following search criteria into data sources:

TITLE-ABS-KEY (technolog* AND healthcare OR "health care" AND "performance manag*" OR "performance measur*") AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English")).

The search was carried out first in July 2023 and then updated in February 2024. As one may notice, we used general and broad terms to avoid exclusions of relevant literature. The research string was refined through multiple tests and by presenting the preliminary work to two international conferences.

After the extraction, the initial results gave us a total set of 589 items (351 results on Scopus and 238 results on WoS). On the basis of the aforementioned criteria, duplicate items were eliminated (142), providing a total of 447 items. The first set of articles were then filtered twice on the basis of their scientific content during the screening phase by following the PRISMA method. In particular, once the set of articles had been identified, we read their abstracts, leading to the exclusion of 279 articles. For the remaining 168 articles, the full text was examined. To address possible biases, our team employed a thorough and methodical strategy for selecting articles. The process began with two authors independently selecting articles, which was then followed by collaborative brainstorming meetings. These meetings aimed to reach a consensus on the articles for which there was initially no unanimous agreement. To ensure efficient decision-making, we scheduled these review and update sessions to occur regularly. This structured approach allowed us to refine our selection process continuously and to optimize decision-making.

The results allowed us to confirm a final selection sample of 58 scientific articles (see Appendix). Exclusion criteria mainly concerned articles just mentioning PMM in their abstract but not focused on this perspective; articles exclusively focused on clinical results; articles not referring to ICTs but focused on clinical technology (e.g. medical devices). The process described above is listed in Figure 1.

The third phase of the research protocol is related to the analysis of the sample selected. In this section, we have further detailed the process that allowed us to formulate descriptive statistics concerning the characteristics of the analyzed articles.

Following a careful reading of the articles contained in our set, this phase involved the selection of all basic information on which an accurate analysis could be constructed. From a general point of view, the characteristics that we identified are: the year of publication and the geographical location of the study (i.e. the country where the first author's university/ research institute is based).

A second distinctive feature among the scientific articles analyzed concerned the methodology used. We distinguished work undertaken according to theoretical or empirical research, subdividing the latter into subclasses: qualitative, quantitative and mixed model. Moreover, we detailed the specific research tools adopted.

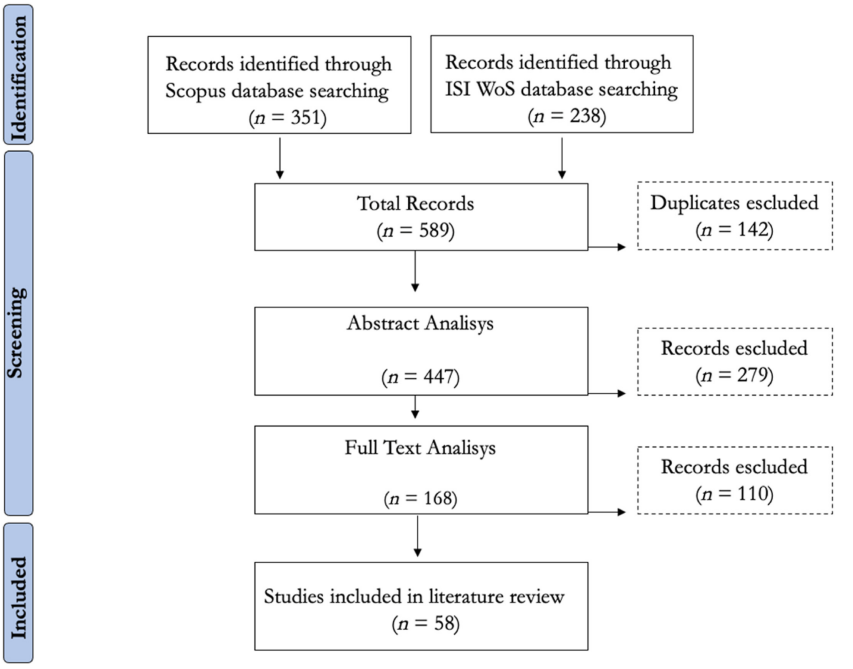

Figure 1.
Selection of the relevant literature following the PRISMA method

Source(s): Figure by authors

Last, we analyzed the theoretical background and the technologies analyzed and discussed in the articles selected, identifying the most relevant theories contributing to the topic. To do this, authors first organize brainstorming sessions to establish shared guidelines. Then, two separate groups of authors identified the theoretical backgrounds and the technologies adopted by each article. Last, two final sessions of brainstorming were organized to group both theories and technologies in homogeneous clusters.

As a final step, we developed a framework to provide a holistic representation of the contribution that ICTs provide to PMM in healthcare, addressing our research objective.

Results

The first type of data acquired when searching for information is the year of publication of the articles belonging to our set. Observing the number of articles published in reference to the year of their publication as identified in our survey provides us with a preliminary understanding of the contribution interval of research in the relationship between PMM and ICTs in the healthcare sector. In particular, this investigation has given us the opportunity to understand when scientific interest in our research topic began and increased as well as how scientific contribution trends in this subject matter have evolved (see Figure 2).

Figure 2 shows that research started to focus on the link between PMM and ICTs quite recently. In fact, the first publication in our set is the one by Bomba *et al.* (1995). This article addresses one of the main administrative dilemmas facing the national health system in Australia, namely, the need to reform practices associated with substantial data and information overload. The authors of this theoretical research discuss the use of ICTs in beginning the digitalization process. In particular, the adoption of ICTs was expected to bring

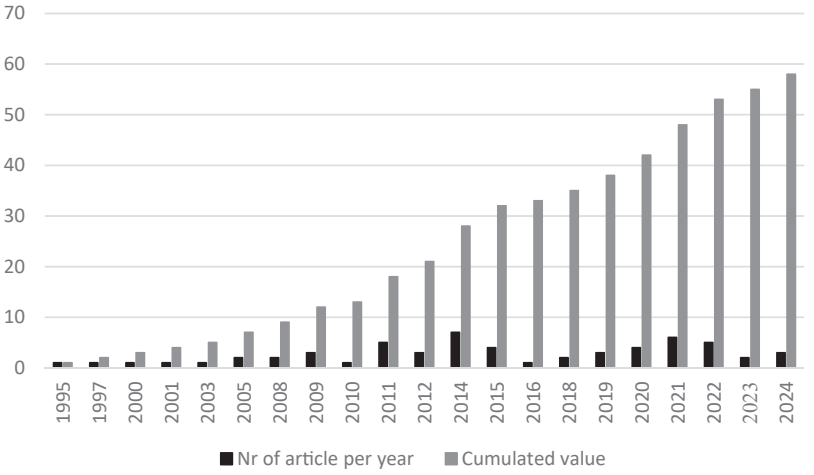

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Figure 2.
Temporal distribution of scientific products

benefits through better identifying and understanding community healthcare trends and applying ICTs to the efficient collection of data for the development of more appropriate definitions of performance measures and indicators (Bomba *et al.*, 1995).

Continuing the study of historic publication trends, we observed that 2014 was the year when interest in this field first peaked. We found articles such as Rosen *et al.* (2015) about the use of sensors to measure teamwork performance in healthcare that resulted to be one of the most cited of our sample.

After a couple of years of decreasing interest, the last five years (2020–2024) show a rising scientific production in this field. In this sense, the COVID-19 pandemic may have represented a driver to focus scholars' attention on this topic. In 2022, most of the research considered has been published in management journals – i.e. Spanò and Ginesti (2022), Tortorella *et al.* (2022) and Srivastava and Srivastava (2022). A similar trend can be noted in 2023 (Ippolito *et al.*, 2023; Korhonen *et al.*, 2023). Last, even though only the first two months of 2024 have been analyzed, the trend of published research appears promising with three articles already published.

We noticed that the investigated topic has collected contributions published in several journals belonging to different research areas (see Figure 3).

We also classified the journals publishing this research based on their main topics' disciplinary areas, identifying "Health and Medicine," "Management and Economics" (that includes healthcare management) and Information Technology "IT." "Health and Medicine" groups journals that are mainly referring to public health and other medical disciplines. "Management and Economics" is the category to which all scientific journals focused on management, accounting, operations, economics and so on belong. Last, "IT" mainly hosts journals that focus on technical issues related to ICT development and design.

As one may notice from Figure 3, most of the articles of our sample have been published in "Health and Medicine" journals; also, in the last years, the interest in the topic has also spread to "Management and Economics" journals.

Another interesting analysis is related to the geographical location of the studies, in terms of the countries of the universities where the authors conducting the study belong. This type of information provides us with an understanding of how scientific interest is distributed

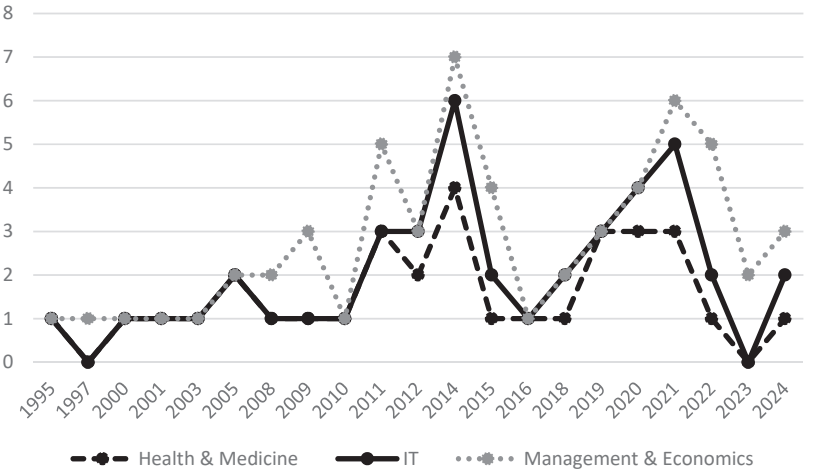

Figure 3.
Distribution of articles per research area

Source(s): Figure by authors

according to territorial boundaries. The idea seeks to identify the nations and therefore the researchers who are contributing the most to scientific literature. In Figure 4, we are able to identify the distribution of the 58 articles in relation to their country of origin.

The USA represents the driving country for scientific research in this field, counting an overall number of articles published equal to 29 results. Among the major countries for publications pertinent to our line of research, we find Italy with five publications. Italian research mainly focuses on two theoretical strands: PMM, as exemplified by the study of Spanò and Ginesti (2022) and operation management, e.g. Lettieri *et al.* (2008). Also, Canada,

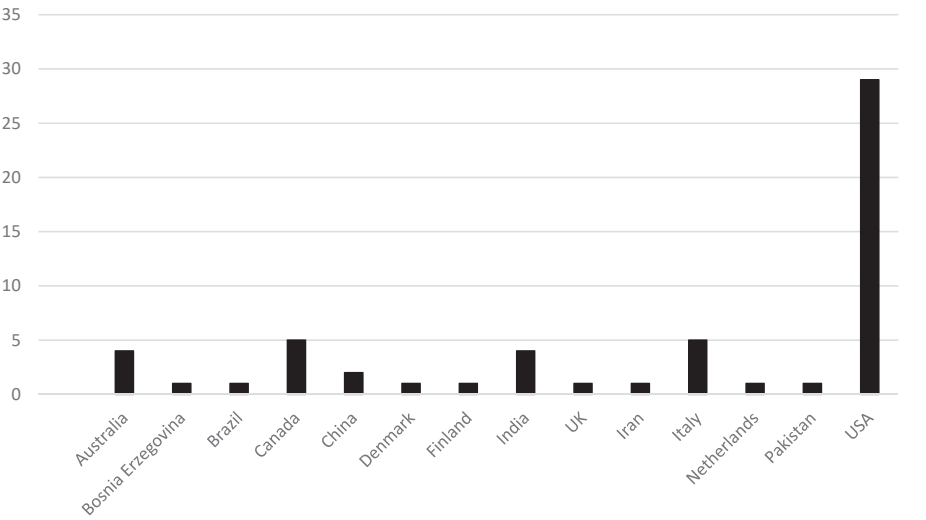

Figure 4.
Geographical distribution of the studies

Source(s): Figure by authors

Australia and India appear to be among the nations which have contributed most to current literature, with five and four (Australia and India) publications each on this topic. As stated in the previous paragraph, the first article of our set originated in Australia.

Methodological perspective

Another useful piece of information acquired to perform our analysis concerns the method used by scholars in conducting their research.

First of all, we distinguished between theoretical and empirical research. The first one is concerned with studying a phenomenon through the analysis of the theories that characterize this, leading to theoretical conclusions – e.g. literature reviews and conceptual analysis. Empirical research, on the other hand, is concerned with the collection and analysis of observable data to answer specific research questions or test hypotheses. In our sample, 34 out of 54 articles refer to empirical research, while the remaining 20 adopt theoretical approaches. This high percentage of theoretical research can be explained by the novelty of the topic. In fact, to run empirical analysis, technology should be already implemented, and most of the theoretical papers have been published in the first period, i.e. 1995–2010, when the adoption of many of these technologies was not spread.

Empirical research can be performed through qualitative, quantitative or mixed methods. In our sample of articles, we noticed that the investigated topic has been analyzed with both quantitative (17 articles) and qualitative methods (14 articles) as well as mixed methods (seven articles).

The research technique adopted the most (15 articles) is the case study by both qualitative and quantitative studies. Another widely used research tool is the survey that has been employed in eight articles. Advanced statistical tools, such as multivariate analysis and regression on panel data, were employed in four research.

The adoption of different tools and methodological approaches grounded in different epistemological approaches is consistent with the complexity and multidisciplinary embedded in the topic that requires contributions from both the hard and social sciences.

Theoretical perspective

As we continue to examine our data, we can compare the different theoretical backgrounds used by the scientific community in carrying out this research.

In order to homogenize our results as much as possible, we have created clusters of similar theoretical backgrounds so as to obtain unique results. These are "Management Control", "Digital Transformation," "Operation Management," "Quality," "Health Technology Assessment" and "Evidence-Based Management."

The most populated clusters emerging from the analysis of our results are "Management Control" (MC) and "Digital Transformation" (DT).

In the MC cluster, we included all the articles that aim to contribute to the literature on how to design, develop and implement PMM systems and how ICT can contribute to this function in healthcare systems and organizations. Examples of articles in this cluster are the ones written by Rosen *et al.* (2015), Spanò and Ginesti (2022), Ippolito *et al.* (2023) and Korhonen *et al.* (2023). Rosen *et al.* (2015) focused on sensor-based technology as a methodology to measure and evaluate teamwork in healthcare organizations. Spanò and Ginesti (2022) studied the role of Big data in fostering acceptance of PMM in healthcare organizations. Ippolito *et al.* (2023) outlined the contribution of technological innovations in PMM in a public university hospital through the implementation of a multidimensional management dashboard. Last, Korhonen *et al.* (2023) contribute to the literature on management control by showing how financial and well-being anchors influence horizontal performance measurement in a healthcare digitalization project. Overall, these articles

highlight how ICTs and digitalization foster planning and cybernetic controls within healthcare organizations and between stakeholders and health governance levels.

The other frequently adopted theoretical framework has been named "Digital Transformation," defined as the use of new ICTs to enable major organizational improvements (Fitzgerald *et al.*, 2014). In this cluster, we find articles mainly focused on the adoption process of ICT in performing or contributing to PMM in healthcare systems and organizations. Belonging to this cluster is the work of Holden *et al.* (2011), who studied how health information technology (HIT) may transform the work process and system, impacting the outcomes achieved. Other examples of articles belonging to this cluster may be found in Restuccia *et al.* (2012), Zhao *et al.* (2019) and Mishra *et al.* (2022), which focused on how HITs impact quality and performance through PMM processes. Last in this cluster, the study by Zhang (2024) focuses on how quantum healthcare models may allow the best use of data collected from Internet of Things (IoT) technologies.

A third cluster is defined as "Operation Management" and includes articles aiming at contributing to this specific managerial discipline. In particular, the papers of Lettieri *et al.* (2008) and Nagy *et al.* (2008) focus on how HITs allow gathering and managing data that can be used to measure and monitor health processes and operations, improving their performance. Mettler and Vimarlund (2009), Li *et al.* (2021) and Mukherjee *et al.* (2021) focus on how ICTs may support health organizations in pursuing compliance, patient safety and satisfaction through their support of the healthcare organization's operations. Testi *et al.* (2009) and Pennathur *et al.* (2011) deal with well-known operation management topics, i.e. waiting lists and emergency departments.

The "Quality" cluster includes articles focusing on how ICTs may support PMM to foster quality improvement and better outcomes for patients and/or the population. The most cited article in this cluster is Wechsler *et al.* (2017), which focuses on telestroke and, in particular, on how telestroke may enhance the possibility of measuring and monitoring quality of care. Another relevant article in this cluster is the one drafted by Weiner *et al.* (2012), which studied the impact of electronic health records (EHR) and other related HIT in defining and computing quality measures.

An emerging cluster identified by our analysis is the "Health Technology Assessment" (HTA) one. HTA is an emerging stream of literature that focuses on methods to produce information to guide decision-making regarding technologies' adoption, reimbursement and utilization (Banta, 2003). Belonging to this cluster are the articles of Sideman and BenDak (1997), Hebert (2001) and Badnjević *et al.* (2019). These articles have been considered relevant for our literature review as investigating the poorly explored twofold relationship between PMM and HTA. On the one hand, HTA uses information coming from PMM systems to perform the evaluation of new technologies – this is the case of Hebert (2001) performing HTA for telehealth implementation using performance measures; on the other hand, HTA informs PMM processes on what should be measured to guide decision-making in healthcare organizations – see Sideman and BenDak (1997). Badnjević *et al.* (2019) focus on the contribution that machine learning may provide to PMM in supporting HTA processes.

Last, another cluster resulting from our analysis is "Evidence-based management" (EBM). This refers to a well-know "evidence-based" paradigm used both by medicine (Sackett *et al.*, 1996) and management scholars (Aloini *et al.*, 2018). The articles belonging to this cluster are the ones by Minard *et al.* (2014) that focus on the incorporation of information on EHRs to create performance measures that can be used as evidence-guiding decisions and Siddiqui *et al.* (2021) that focus on generating and using quality data for evidence-based decision-making to overcome barriers inherent in immunization systems.

Figure 5 displays the representation of the theoretical cluster above described.

The graph in Figure 6 confirms how management disciplines (Management control and Operation management) are progressively raising their attention on the investigated topics.

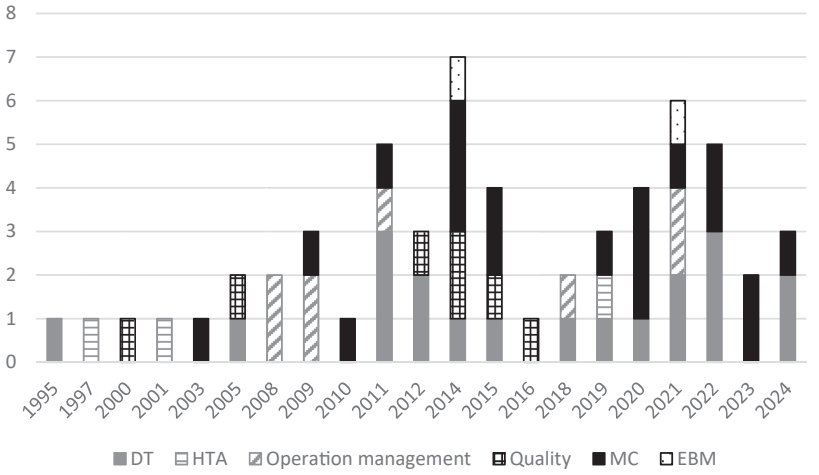

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Figure 5. Theoretical background composition and evolution

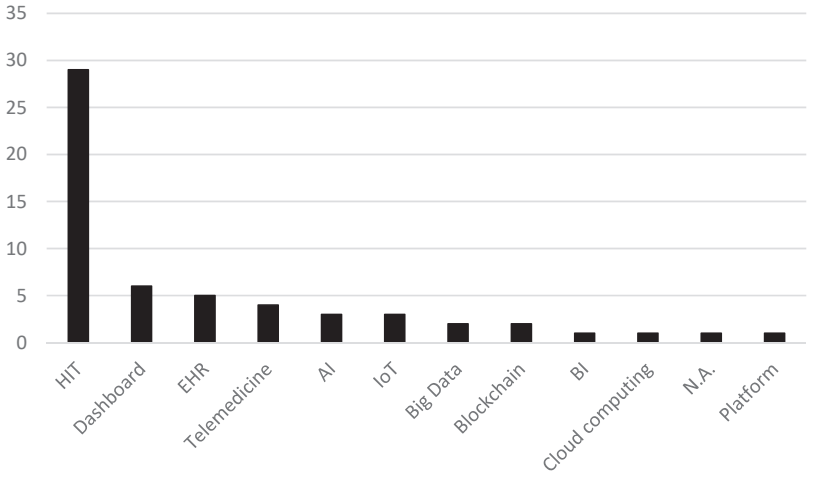

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Figure 6. Technological focus

Technological perspective

Finally, the last analysis performed refers to the identification of the technologies analyzed and mentioned by the articles selected. As one may notice from Figure 6, most of the papers refer to the general denomination of HIT, an umbrella term that includes all the ICTs specifically used in healthcare.

Among the specific technologies mentioned, the most recurrent is the dashboard (Nagy *et al.*, 2008; Ward *et al.*, 2014; Barbazza *et al.*, 2021; Watkins *et al.*, 2022; Ippolito *et al.*, 2023). Overall, these articles explain how ICTs applied to healthcare enable the creation of a dashboard that results in being effective in guiding and supporting decision-making processes at different governance levels.

Another frequently mentioned technology is the EHR (Weiner *et al.*, 2012; Hirsh *et al.*, 2014; Minard *et al.*, 2014; Landis-Lewis *et al.*, 2015; Nicola *et al.*, 2018). Based on our analysis, EHR appears to be a pre-condition to foster PMM in healthcare through ICTs that may impact on the payment system, stratification of population needs, etc.

Telemedicine is also mentioned in four contributions (Hebert, 2001; Wechsler *et al.*, 2017; Sasikala *et al.*, 2018; Bui *et al.*, 2021). Although telemedicine – including telemonitoring, telehealth, telementoring, etc. – is a wide discipline mainly concerned with the provision of care through health technology, we included these articles as they provide interesting insights for PMM, especially for data production and quality measurement purposes.

Other mentioned technologies are IoT (Rosen *et al.*, 2015; Li *et al.*, 2021; Zhang, 2024), Artificial intelligence (AI) (Hou *et al.*, 2014; Badnjević *et al.*, 2019; Soltan *et al.*, 2024), Big data (Wehrens *et al.*, 2020; Spanò and Ginesti, 2022), Blockchain (Mukherjee *et al.*, 2021; Srivastava and Srivastava, 2022), Cloud computing (Eze *et al.*, 2020); Business intelligence (BI) (Mettler and Vimarlund, 2009) and Platforms (O'Connell and Cherry, 2000).

Discussion

The main purpose of the research is to report and examine the state-of-the-art literature on PMM and ICTs in the healthcare sector and, in particular, to identify current and emerging technologies and how these relate to PMM. This is considered to be a relevant research area as digital transformation in healthcare is providing new opportunities not only at the clinical level but also at the administrative and managerial levels (Tortorella *et al.*, 2020). However, to the authors' knowledge and consistently with the results obtained by this systematic literature review, this last aspect has been poorly considered by the scientific literature. In fact, differently from other literature reviews focusing on ICTs in healthcare that focus on the broader impact of technologies on healthcare organizations with a clear emphasis on the clinical processes and services context – see, for instance, Aceto *et al.* (2018), Marques and Ferreira (2020), Dal Mas *et al.* (2023) – our review addresses a less explored topic, that is the contribution of ICTs on PMM in healthcare. This review aimed at performing a systematization of the existing knowledge to address and foster future research on the topic.

Our review identified 58 scientific articles that directly deal with the contributions that ICTs provide to PMM in the healthcare sector. These articles adopt different theoretical perspectives and focus on different technologies.

What emerged from our study is that the journals that first focused on the investigated topic were the health and medicine ones. Public health journals are the ones that first understand and deepen the opportunities that new ICTs could have provided on quality measurement and how this improved function may have contributed to the production of evidence for decision-making purposes. Besides the constant interest of these journals in the contribution of ICTs on PMM in healthcare, in the last years, a growing interest has also been demonstrated by management, economics and IT. Studies on these disciplines may be needed to further advance knowledge on the topic.

For what concerns the theoretical perspective adopted in these studies, a consistent share of the articles directly contributes to the measurement and management of healthcare performance (i.e. Management control), investigating how ICTs may contribute to the related systems design, functioning and implementation. These results confirm the relevance of the first future research perspective outlined by Marques and Ferreira (2020) in their review concerning the integrated management of ICT to support information exchange within healthcare organizations. The same amount of studies have been classified within the DT framework, which includes research aimed at understanding the impact of the introduction of new ICTs in healthcare organizations.

Two other relevant clusters relate to the management of processes and operations to improve quality and other performance results, consistent with what was outlined back in 2006 by Porter and Teisberg. These clusters are "Operation management" and "Quality." This last, in particular, is linked to diverse public health contributions, as in this discipline the concept of quality of care is well-known and debated. Public health scholars are also contributing by using the theoretical perspective of EBM.

Moreover, an interesting result of our research is related to the emergence of HTA as a promising theoretical perspective relevant to this topic. In particular, from the studies belonging to this cluster, it emerged a possible synergy between HTA and PMM that healthcare management could leverage to improve their decision-making processes. This relationship is certainly mediated by the adoption of ICTs.

For what concern the technologies that these studies take into account, we may notice that much of the literature generally refers to HIT. This is even more evident in the first contribution published on the topic (Bomba *et al.*, 1995). Considering that most of these articles adopt a theoretical methodological perspective, we can explain this by referring to the fact that in those years most of the technologies were not widely spread and implemented worldwide, with few exceptions. Another interesting result emerging from the analysis of the specific technologies treated by these studies is that the EHR can be considered an enabler for the adoption of other ICTs (Weiner *et al.*, 2012). This result is consistent with what was highlighted by Feeley *et al.* (2020) that EHR is "the sole source of costing information so that accurate costs for every encounter can be tracked, aggregated, shared and used for improvement" (p. 1). From this evidence, we may derive the policy recommendation that EHR implementation represents the key priority to foster ICT adoption in PMM and to get the best value from their adoption. Other ICTs studied in the selected sample of articles range from "traditional" ones, such as dashboards and BI, to emerging ones, such as IoT, AI, Blockchain, etc.

Based on the results previously outlined, we developed a framework that outlines the key contribution that each ICT provides to PMM in healthcare according to the framework provided by Taticchi *et al.* (2010) that distinguishes three main phases, namely performance indicators, measurement framework and management framework (see Table 1). The purpose of this framework is to provide a holistic view of the contribution of ICTs to PMM in healthcare that may support both theory – in advancing research on specific technologies or PMM functions – and practice – in supporting investment in ICTs.

Table 1 attempts at providing a holistic view of what type of technology can support what stage of PMM, providing a novel contribution to the topic, as most of the studies focus on individual technologies. For each technology, the framework outlines in what phase of PMM

ICT	PMM phase	PMM function
EHR	Performance indicators	Production of new data
IoT		Production of new data
Telemedicine		Production of new data
AI	Measurement framework	Analysis of data
Big data		Collection and analysis of data
Platform		Collection and analysis of data
BI	Management framework	Management of data
Blockchain		Management of data
Cloud computing		Sharing and management of data
Dashboard		Use and reporting of data

Source(s): Table by authors

Table 1. Linking ICTs and PMM

the ICT contributes the most – i.e. measurement or management; and what specific PMM function may be empowered by the use of technology.

In particular, ICTs that provide an important contribution to the creation of specific and new performance indicators are EHR, IoT and Telemedicine. These have been linked to this PMM phase as, consistently with what emerges from the studies mentioning them, they allow the production of new data that can be used for performance measurement purposes. For example, with the use of sensors and telemedicine applications, it is possible to produce data relevant to PMM (Wechsler *et al.*, 2017; Sasikala *et al.*, 2018). Having access to new data in a timely manner is key to supporting results monitoring and thus to pursuing better patient outcomes.

For what concerns the development of measurement frameworks, what emerged from our review is that the technologies mainly contributing to this phase are AI, Big data and Platforms. In particular, within the measurement phase, our search outlined that AI (including machine learning) may support the analysis of evidence to identify emerging patterns and trends that may be used for decision-making purposes (Hou *et al.*, 2014). On the other hand, Platforms and Big data support healthcare organizations in the collection of existing data that can be digitalized and/or included in PMM systems (O'Connell and Cherry, 2000; Spanò and Ginesti, 2022). In particular, ICTs allow us to interpret the data obtained in a faster and less biased way, thus contributing significantly to decision-making processes.

For what concern the management phase, that is utilization of performance measures in decision-making processes (Lebas, 1995; Bititci *et al.*, 2012), Blockchain has been useful in the management of data in terms of storing and processing health data (Mukherjee *et al.*, 2021; Srivastava and Srivastava, 2022). Other ICTs supporting the management and analysis of data are BI and Cloud computing. This last may be employed to correlate shared data from multiple stakeholders into a common PMM system (Eze *et al.*, 2020). Last, dashboards may be effective in using and analyzing data as well as reporting performance measures to internal (Ward *et al.*, 2014) and external (Barbazza *et al.*, 2021) stakeholders.

The overall take-home message of these studies is that ICTs enable and/or empower the collection of data and measurement abilities of healthcare providers. Also, ICTs support managers in analyzing and understanding performance results; this allows them to improve decision-making processes. Last, ICTs improve reporting activities and, more in general, the use of data for quality improvement and efficiency gains.

Conclusions

This article attempts to fill a gap in the systematization of existing research regarding the contribution of ICTs to PMM in the healthcare sector.

Besides the identification of the most relevant and adopted ICTs that support the measurement and management of the performance of healthcare organizations and systems, this article aimed to contribute to theory by providing a holistic framework that links technologies with PMM phases and most recurring management, economics and public health theories.

In summary, the integration of technologies in healthcare performance management offers significant opportunities to improve the quality of care, operational efficiency and transparency of healthcare organizations. However, it is crucial to advance research so as to ensure the success of these initiatives and to continue to explore new avenues for the further improvement of the healthcare sector.

Future research may focus specifically on the emerging technologies that, once EHR is fully implemented, may release all the potential support to PMM functions. In particular, future research should address the following research questions:

(1) How do ICT-enabled PMMs support quality improvement initiatives in healthcare, such as patient safety, clinical outcomes and patient satisfaction?

(2) What are the perspectives of healthcare professionals and administrators regarding the usability, acceptance and perceived benefits of ICT-based performance management systems?

(3) What are the main barriers and challenges associated with the implementation and adoption of ICT for performance management and measurement in healthcare, and how can these be addressed?

(4) How are privacy and security concerns addressed in ICT systems used for performance management and measurement in healthcare, especially considering the sensitivity of patient data?

Moreover, future research may deepen the relationship between PMM and HTA, understating how ICTs may provide new sources of data and measurement to support related decision-making processes.

The contribution to practice is mainly linked to the provision of insights to healthcare organizations' top and line managers for planning their investments in ICTs to support the various stages of development and functions of PMM. In particular, our framework may support decision-makers in choosing the "right" ICT for the "right" purpose.

Limitations of the study are mainly related to the limits of the systematic review approach. In fact, despite efforts to create comprehensive search strategies, it is possible that some relevant studies may be missed. Moreover, the process of data extraction and synthesis involves subjective decisions by the research team, leading to potential bias.

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Appendix

The supplementary material for this article can be found online.

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