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UNRAVELING THE MAIN ASPECTS OF KEY PERFORMANCE INDICATORS APPLIED TO THE HEALTHCARE SECTOR: A LITERATURE REVIEW

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Dissertation submitted to the Master Degree in Engenharia de Produção e Sistemas of the Federal Center for Technological Education of Rio de Janeiro, CEFET/RJ, as partial fulfillment of the requirements for the degree of master.

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RESUMO

Desvendando os principais aspectos dos Indicadores Chave de Desempenho aplicados ao setor de Saúde: uma Revisão da Literatura

A multiplicidade e complexidade do Setor de Saúde (SS) no cenário atual chamam a atenção para a importância e correlação entre as práticas de Gestão de Performance (GP) e o sucesso das organizações nele inseridas. Os Indicadores Chave de Desempenho (KPI) destacam-se por serem uma importante e conhecida ferramenta de GP que pode ser aplicada isoladamente ou integrada a diversas metodologias de metrificação, monitoramento, avaliação e gestão de desempenho de distintas áreas do SS. O uso adequado de KPIs para avaliação de desempenho não é apenas uma questão de "como eles são definidos", mas também "o que é medido", "quais indicadores medem" e "como eles estão medindo". No entanto, o saber não facilita a prática. A incompletude e a inconsistência dos KPIs ao longo da teoria e da prática somada ao elevado número de variáveis das quais depende levantaram algumas preocupações sobre como melhor utilizar os KPIs. Para resolver esses problemas, o principal objetivo deste trabalho é (i) determinar quais KPIs estão sendo utilizadospara avaliar e monitorar o desempenho de qualquer instância dentro do SS, (ii) categorizar e (iii) propor uma definição e descrição exclusivas desses KPIs para tentar reduzir a inconsistência. Para tanto, esta pesquisa realizou uma revisão de literatura com base no Protocolo PRISMA. Hospitais, considerado o coração do setor, e Departamentos de Emergência, sua principal porta de entrada, foram o foco principal do GP-SS na maioria dos estudos. Em seguida, considerando a natureza e o objetivo dos KPIs encontrados, este trabalho propôs classificá-los com base em suas abordagens em: Acessibilidade, Cadeia de Suprimentos, Recursos, Stakeholder, Financeiro, Operacional, Ambiental, Educacional e Farmacêutico. Como a abordagem Operacional abrange a maioria dos indicadores e estudos, e a lotação e os tempos de espera dos DEs são considerados um grande problema internacional, 10 KPIs operacionais para o ED-PMM foram normalizadoscom base no Foco, Atividade, Estatística, Escala e Referência.

Palavras-chave: Gestão de Performance; KPI; Departamento de Emergência

ABSTRACT

Unraveling the main aspects of Key Performance Indicators applied to the Healthcare sector: a Literature Review

The multiplicity and complexity of the modern Healthcare Sector (HCS) have brought attention to the importance and co-relation between Performance Measurement and Management (PMM) practices and the success of HCS organizations. Key Performance Indicators (KPI) stand out for being an important and well-known PMM tool that can be applied alone or integrated into many methodologies for measuring, monitoring, evaluating, and managing the performance of distinct HCS fields. Properly using KPIs for performance assessment is not only a matter of “how they are defined”, but also “what is measured”, “which indicators measure it” and “how they are measuring it”. However, knowing it does not make it any easier. Incompleteness and inconsistency of KPIs throughout the literature and practice summed to the high number of variables on which it depends have raised some concerns about how to put KPIs to better use. To address these issues, the main goal of this work is to (i) determine which KPIs are being used to assess and monitor the performance of any instance inside the HCS, (ii) categorize, and (iii) propose a unique definition and description of them to try and reduce the inconsistency factor. To this end, this research has conducted a literature review based on the PRISMA Protocol. Hospitals, the heart of the sector, and Emergency Departments, its main point of entry, were the main focus of PMM-HC in most studies. Then, by considering the nature and objective of the KPIs found, this work proposed classifying them based on their approaches into: Accessibility, Supply Chain, Resources, Stakeholder, Financial, Operational, Environmental, Educational, and Pharmaceutical indicators. As the Operational approach comprehends most indicators and studies, and EDs crowding and waiting times are considered a major international problem, 10 operational KPIs for ED-PMM were normalized based on the Focus, Activity, Statistic, Scale type, and Reference Framework.

Keywords: Performance Measurement; KPI; Emergency Department

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1. Introduction

The HealthCare Sector (HCS) is an interconnected system of organizations, medical and research instances, technologies, facilities, industries, and service providers that share a large variety of resources with the sole objective of guaranteeing the welfare, health, and safety of a population (AMOS; MUSA; AU-YONG, 2020). All these attributes are surrounded by a scenario of intense patient inflow, individualized and high-performance service demand, rigorous regulations, technological advances, strict budgets, resource constraints and medical research and development systems (ÁLVAREZ et al., 2019; RAHIMI et al., 2018; TRABERG; JACOBSEN; DUTHIERS, 2014).

The nonlinear behavior of these attributes, its surroundings over multiple dimensions and systems, the number of stakeholders and its conflicts of interest, the scenario of unexpected outcomes, and the dependence on big shares of data are what makes the HCS a large, heavy, and complex ecosystem (ROCHA et al., 2021; PISHNAMAZZADEH; SEPEHRI; OSTADI, 2020). As what best characterize the HCS are the interactions among its multiple entities, attributes and dimensions, Dai and Tayur (2020) developed the HCS Ecosystem Map to highlight and better illustrate the key entities in the healthcare ecosystem, helping consultants, researchers, entrepreneurs, and policymakers to gain a full picture of it. Figure 1 represents the main entities of the HCS and how their interests and relationships overlap each other with the patient and care being its central point.

Properly managing this complexity is not without its challenges and not doing it right can endanger patients and jeopardize the quality of care delivery. When it comes to the HCS, effectively delivering clinical care must be combined with operational efficiency (KO et al., 2019). Doing so, HCS can move towards a scenario of value-based healthcare (VBH) (KO et al., 2019). The combination of operational efficiency with VBH contemplates the reduction of costs and wastes by properly managing assets (personnel, equipment, locations, availability) and their relationships with themselves as well as with the environment they are embedded (KO et al., 2019). In this scenario, they strive to achieve the best possible health outcomes and the best possible care at the lowest cost (MENEAR et al., 2019).

However, even though the importance of managing theses aspects are well-known,

the healthcare sector is still struggling. For instance, according to Braithwaite (2018), only 60% of care is based on evidence or guidelines, about 30% of all health expenditure is waste and approximately 10% of all patients have negative experiences during the provision of health services.

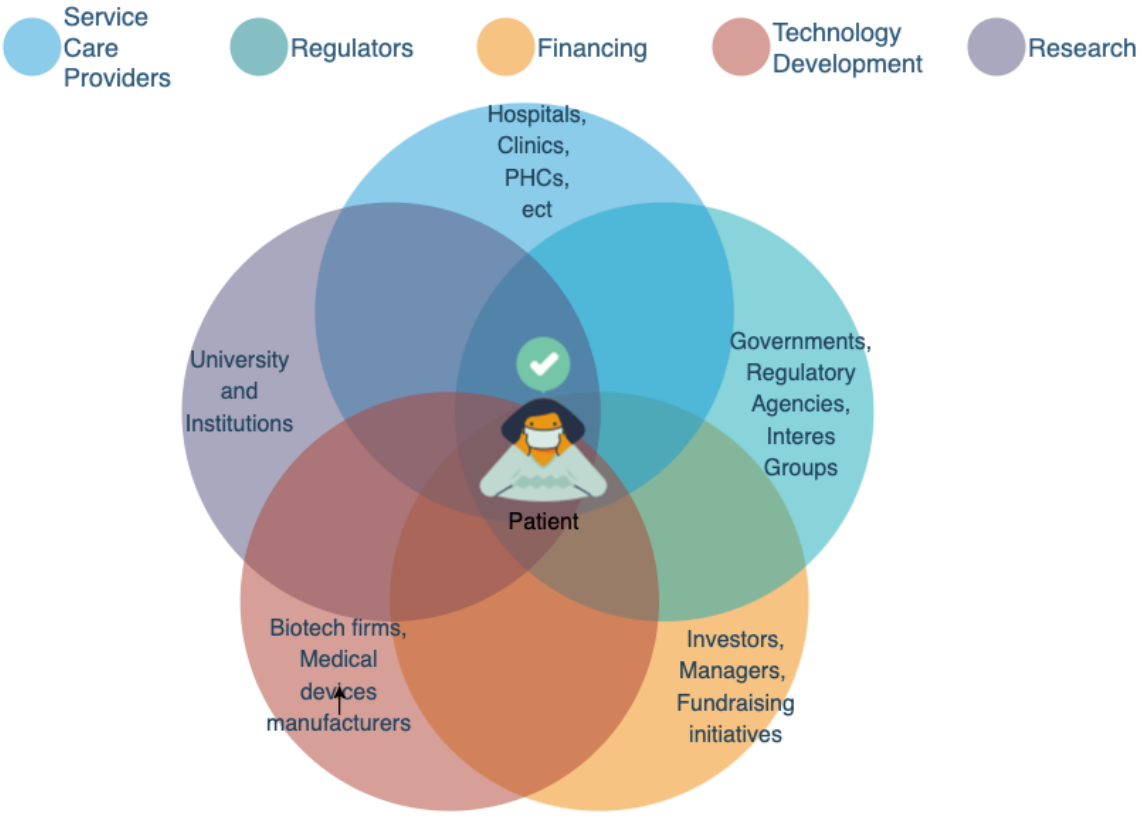


Figure 1 – Map of overlapping relationship between healthcare entities
Source: Addapted from Dai and Tayur (2020)

It is the multi-dimensionality of the modern HCS that has brought attention to the relevance of performance measurement and management (PMM) to the healthcare sector (ÁLVAREZ et al., 2019; RAHIMI et al., 2018; TRABERG; JACOBSEN; DUTHIERS, 2014; TORABI et al., 2020). According to Johanson, Almqvist, and Skoog (2019), PMM helps to translate all the relevant aspects of organizational performance into a coherent set of financial and non-financial measures and target estimates and manage trade-offs to avoid conflicts between different performance dimensions as well as to manage consensus and ensure a thorough understanding of multiple and diverse measures. In the context of healthcare, aspects such as operational efficiency, safety, service quality, working conditions, stakeholder satisfaction and resource administration must be appropriately managed to any healthcare organization successfully accomplish its goals (GU; ITOH,

2018; SI et al., 2017; PRADO-PRADO et al., 2020; TORABI et al., 2020).

Therefore, PMM systems help create and support improvement measures to better healthcare employees' conditions and performance, clinical care as well as organizational operations by drawing strategies and developing competencies that can be used to enhance both care delivery and the operational process that surrounds and supports it (JIANG et al., 2020; MUNAR et al., 2019; DIMITROPOULOS, 2017). Not only PMM plays a central role in HCS management, but it grants great improvement in assessing the performance of healthcare, which is a concern for managers and stakeholders (JIANG et al., 2020).

The academic literature presents multiple suitable methods and procedures employed in the HCS-PMM (LLOYD et al., 2016; POURMOHAMMADI et al., 2018). The utilization of Key Performance Indicators (KPI) stand out for being an important and well-known tool. It can be used independently or integrated to several methodologies, leading to framework development for monitoring, evaluating, and managing the performance of distinct HCS fields (PRADO-PRADO et al., 2020; RATNOVSKY et al., 2021). Besides, the measurable nature of KPIs, which are often influenced by numerous variables and indicators, is emphasized by its ability to translate collected data into quantifiable information to support decision-making (LLOYD et al., 2016; RAHMAN, M. H. et al., 2019; PRADO-PRADO et al., 2020).

Although being an excellent alternative for assessing and monitoring performance on an ongoing basis, KPIs also presents some concerns. For instance, finding a complete KPI definition, selecting the proper amount of KPIs, and which aspects, activities, and sectors that will be covered by them can be challenging (JIANG et al., 2020; NUTI; VAINIERI; VOLA, 2017; RAHMAN, M. H. et al., 2019). In terms of number, on one hand, a large set of KPIs could be superficial, redundant, and flawed in efficiently and effectively finding the source of problems while a narrow and directive set might be more assertive in providing a more discerning information (HARVEY et al., 2016; JIANG et al., 2020; SI et al., 2017). However, on the other hand, a too narrow set of performance indicators can leave out of the equation important and crucial data, variables, outcomes and relationships, preventing a more informed decision-making and reinforcing one that is potentially at odds with goals and strategies (CATUOGNO et al., 2017; GU; ITOH, 2018; SI et al., 2017). Thus, inadequate defined indicators can discredit a performance measurement strategy. In terms of definition, performance indicators should be reliable and valid. Without clear

and thorough definitions, it is hard to adequately determine the true relevance or utility of a particular indicator to any specific environment or situation. However, what is present in literature today is an increasing number of indicators with several definitions each (TORABI et al., 2020).

Thus, properly using KPI's for performance assessment is not only a matter of *"how they are defined"*, but also *"what is measured"*, *"which indicators measure it"* and *"how they are measuring it"*. Therefore, by considering the high number of defined KPIs, the incompleteness of theses definitions, and the several contexts and aspects covered by them, the following research questions arise:

1. **What are th KPIs that have been more often applied for measuring and assessing performance in the HCS?**
2. **How these KPIs can be classified throughout the HCS based on PM dimensions?**
3. **How to reduce the inconsistency issue of KPI definition?**

To address these issues, this research covered 68 articles that applied or defined KPIs to assess and monitor the performance of any instance inside the HCS. All these articles were published between 2014 and 2021 in journals indexed by the Scopus or Web of Science (WoS) databases. The aim is to present a survey of a substantial literature defining or applying KPIs and perform a qualitative analysis to determine the most recurrent KPIs for assessing performance of HCS, its most common application environments, and definition methodologies. Finally, the KPIs were classified based on PMM approaches and application focus and, based on these approaches as well as most recurring HCS, a set of KPIs were chosen to be normalized by defining a standard nomenclature, description, objective and formula to them.

We structured this work as follows. After this introduction, Chapter 2 presents the Background Research about Performance Measurement and KPIs, to highlight their importance and current classifications. Chapter 3 explains the methodology used to conduct the literature review. Chapter 4 presents the bibliometric analyses and Chapter 5 the qualitative analyses. And, finally, Chapter 6 presents the proposed dimensions as well as the normalized KPIs. Chapter 7 closes this work presenting its conclusion followed by the references that supports it.

2. Backgound Literature

2.1. Performance Management and Measurement System

Even though the terms ”Performance Measurement” and ”Performance Management” are related and sound very similar, they are not equals. Each one of them is a entirely separate strategic practice, which complement each other. Both concepts were popularized and endorsed by Johnson and Kaplan between the late 80’s and early 90’s (JOHNSON; KAPLAN, 1987; KAPLAN; NORTON, 1992; TEICHGRÄBER et al., 2021; DE WAELE et al., 2021). However, up until then, a lot was discussed and researched over time about how to appropriate deal with the desire to quantify performance (TATICCHI; TONELLI; CAGNAZZO, 2010; MELNYK et al., 2014; SMITH; BITITCI, 2017).

This desire emerged from the fact that, usually, there was - and still is - a difference between how managers think a business or a process works and how it actually does (BITITCI et al., 2018). Performance Measurement plays the role of providing managers and companies the information needed to make improvements and have more control of where their business really stands and what they actually do (KAYDOS, 2020). Doing so, Performance Measurement reports the current level of performance, and compares it with a standard desired level of performance (MELNYK et al., 2014; BITITCI et al., 2018).

Therefore, as its name clearly states, the Performance Measurement deals specifically with measures and is generally defined as the quantitative assessment of outcomes and results, which generates reliable data on the effectiveness and efficiency of individuals, teams, corporations, and systems(MELNYK et al., 2014; BITITCI et al., 2018). Performance measures must not only be quantifiable, but also verifiable, can be either internal or external, and cover both financial and non-financial business aspects (BITITCI et al., 2018; KAYDOS, 2020).

However, performance measures will improve quality, productivity, and profits only if they are properly used. According to Folan and Browne (2005), performance measures must have top management support, be relevant to managers and employees in performing their day-to-day jobs, be part of a feedback loop, are intended to foster

improvement rather than just monitoring, and change at the same pace as the company needs or chooses to change. This last recommendations opens to the discussion of how Performance Measurement - to be effective - must be aligned with the company's strategy. There is where Performance Management comes to light (BITITCI et al., 2018; MELNYK et al., 2014).

Although performance measurement activities are important, it is not sufficient to manage an enterprise performance in an holistic and integrated manner. In addition to it, there is a complementary need for conducting performance management activities as well (SARDI et al., 2020). While performance measurement tries to answer the question of "how a business assess its performance in a quantifiable and strategic manner?" by gathering, elaborating and analysing performance, Performance Management asks "how do we translate the business core objectives into quantifiable measures in order to manage the strategy and the measures we've established?" by communicating, learning and improving performance. This is a subtle (but very important) distinction (BITITCI et al., 2018; MUNAR et al., 2019; AKHTAR; SUSHIL, 2018)

The concept of Performance Management arose along with the concept of Performance Measurement to deal with the - sometimes unintended - consequences of setting measures and the complexity to define them and their clear objectives. As the Performance Management literature states, business and organisational control and management practices rely on the fact that companies are a dynamic entity which operates in a unpredictable and changing environment. Therefore, it is not a secret that successfully executing business strategies and performance measures is a must in the competitive environment all companies live in (FROLICK; ARIYACHANDRA, 2006; RAFFONI et al., 2018). However, knowing it does not make it any easier. It is the job of a business Performance Management to assist businesses to define strategic goals and measures in order to manage performance against those goals (FROLICK; ARIYACHANDRA, 2006; AKHTAR; SUSHIL, 2018).

To do so, Performance Management must work on the basis of measuring, comparing, analyzing, and correcting measures by acting on and reacting at the environment the business is embedded and the strategies they are putting into place continuously. This cyclic behavior, which is based on the extensively known PDCA (Plan-Do-Check-Act) model is what makes Performance Measurement and Performance Management a system (ALMEIDA PRADO CESTARI et al., 2018; SMITH; BITITCI, 2017; BITITCI et al., 2018;

Table 1 – Key definitions and concept evolution of PMMS

Concept	Definition
Performance	Efficiently and effectively carrying out an established action or task.
Measure/Indicator	Measurement, either qualitative or quantitative, of the condition of something.
Performance Measure	Measurement, both quantitative and qualitative, of how effective or efficient is a task or a set of tasks.
Performance Measurement System	Setting, collecting, reporting, and analyzing performance measures and indicators that help in the decision-making process and assuring a company to achieve what it is expected by the managers.
Performance Management System	It is the idea of how use Performance Measurement System to make decisions and manage an organization or process.
Performance Measurement and Management System	It is the combination of both Performance Measurement and Management concepts, in which the measures defined are reliable, aligned with the core business objectives, and oriented to understand and improve performance.

Source: Adapted from Bititci et al. (2018) and Munar et al. (2019)

MATONDANG; SITOMPUL, 2019).

At this point, the relationship between Performance Measurement and Performance Management is clearer and both concepts start coming more and more together highlighting their complementary characteristics. These two components form one integrated system – a system that it is not strange from organisational, strategic, or environmental contexts. That is, any changes or oscillation in organisational structure, culture, corporate strategy or the environment in terms of technology, regulations, competitiveness, or social behavior should directly impact the Performance Management and Measurement System (MELNYK et al., 2014).

So, the so-called Performance Management and Measurement System (PMMS) is the result of the integration of the Performance Measurement and the Performance Management strategies. It is a wide and manifold concept that have been helping organizations to survive and triumph in the well-known, highly changing competitive market environment over time (AKHTAR; SUSHIL, 2018; HELMOLD; WARDA, 2019). Table 1 helps understanding all the key definitions and their evolution from the understanding of what is Performance all the way to what is the Performance Management and Measurement System.

To give more historical context on the PMMS concept, early on its development,

companies put all their efforts into using the PMMS for measuring the performance of their business as a whole. That is, managers only measure the performance of the entire business at the highest possible level (TUDOSE; RUSU; AVASILCAI, 2021; MELNYK et al., 2014). However, PMM scope have become more broad over time and it went from being a measurement model with a unique central focus point approach to covering and prioritising decision-making processes, organizational roles, work maturity, business environment, increased competition, and advanced technology at every single level of the business (TUDOSE; RUSU; AVASILCAI, 2021). To do so, it uses comprehensive frameworks and models as well as technical and social indicators (SHABANINEJADA; MIRSALEHIANB; MEHRALIAN, 2014). Therefore, business success depends on both the quality of methods and techniques used for deploying a Performance Measurement and Management System as well as the ability of managers to manage the internal state and results of the company (TUDOSE; RUSU; AVASILCAI, 2021).

As PMM systems aim to facilitate and ensure that businesses successfully achieve their goals, they align individual, team, and process performance with strategic objectives (SHABANINEJADA; MIRSALEHIANB; MEHRALIAN, 2014). To accomplish its goal, PMM unfolds in different phases that allow it to better integrate processes in the companies' strategies (HRISTOV et al., 2021). The strategic plan, which defines the roles, competences and high-level targets of a company, is the first phase of PMM. Then, it is time to set the implementation steps and connect the definition of a strategy to its operational execution. Turning strategic plans into action plans in line with the company's strategic guidelines is essential to achieve high performance (JOHANSON; ALMQVIST; SKOOG, 2019).

In addition, establish monitoring systems that provides regular and timely feedback from the company and the environment enables management to efficiently manage the system more effectively (HRISTOV et al., 2021). It is the role of the plan-action-track-review cycle to be used to refine the strategic plan based on the feedback received during the implementation process, facilitating the assessment and review of the strategic plans, the mission of the organization and the strategic objectives. Therefore, this circular approach needs to be continuously improved based on the internal and external environmental context (JOHANSON; ALMQVIST; SKOOG, 2019). Figure 2 shows how theses phases interact with each other.

To this point, we have focused on the positive aspects of PMMS as well as their

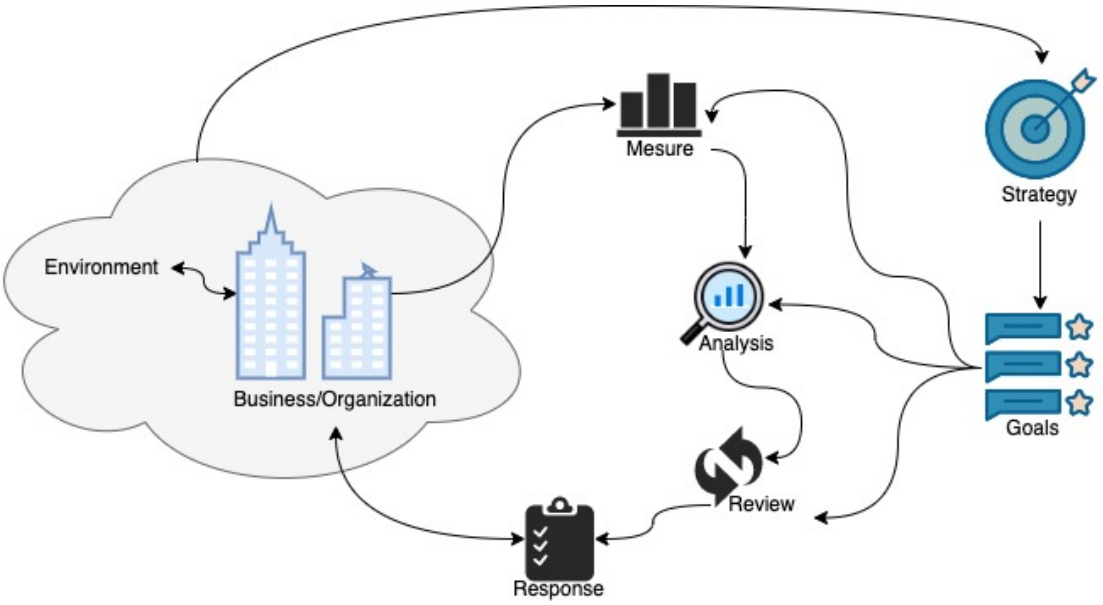


Figure 2 – Illustrative uderstanding of how PMMS works

main characteristics. However, PMMS are not without its critics. For PMMS to become a better practice within companies, more awareness is needed regarding not only the role of monitoring business performance through performance measurement, but also to how define and choose better measures (TUDOSE; RUSU; AVASILCAI, 2021). Over time, as it became more clear the multi-faceted aspects of companies and business environment, it became harder to understand which measures better describe and, consequently, better translate the strategic objectives of a company to be able to demonstrate whether it is or not in the right path. That is, the focus evolved from ”knowing what to measure” to ”how to define proper measures and appropriately use them to manage performance” (NUDURUPATI; GARENGO; BITITCI, 2021). Therefore, the most practical definition of PMMS we will focus on is: ”PMMS is - and must be - the translation of an organization’s mission into strategic goals on which is based the process of setting, collecting, calculating, reporting, and analyzing performance measures and indicators that help managers to learn, adapt and make decisions with the ultimate goal of assuring a company to achieve its objectives” (LOPES; MARTINS, 2021; NUDURUPATI; GARENGO; BITITCI, 2021).

Usually, PMMS are planned and proposed through the development of frameworks by practitioners and scholars. Lots of frameworks have been being developed through the course of time. Their main objective is giving a steady foundation on which organizations can build their evaluation systems and unfold their objectives by taking into consideration their particularities, internal and external context, data, collective norms, processes, and

so on (MUNAR et al., 2019; SHABANINEJADA; MIRSALEHIANB; MEHRALIAN, 2014; CHORFI; BENABBOU; BERRADO, 2018). Therefore, measuring performance can help organizations to understand a variety of aspects, such as: where they are being successful, whether customer's needs are being met, how their processes work and how they impact each other, where are their main gaps and wastes, and whether improvement actions are generating results (LOPES; MARTINS, 2021). The extent of PMMS also surpasses the boundaries of an organization's internal management. Investors, financial and regulatory institutions, and even the government, are interested in measuring the performance of organizations. Usually, the degree on which an organization met their performance goals, help thirds to decide on whether an organization is a good investment, is up to date regulatory-wise, or how it is perceived by its peers and customers, for example (LACHMANN; TRAPP; WENGER, 2015).

To obtain all this information and reach the PMMS objective, the first step is to define appropriate performance indicators that fit into the company's strategies, or, as known, their Key Performance Indicators (KPI). KPI is a quantifiable measure of performance over time for a specific objective. KPIs provide targets for teams, milestones to gauge progress, and insights that help people across the organization make better decisions. Key performance Indicators help every area of the business move forward at the strategic level.

Historically, PMMS KPIs had been mostly financially driven. The reason is that businesses' success was often a sign of profit and measured based solely on economic and monetary results (CHORFI; BENABBOU; BERRADO, 2018). However, over time, this perception had changed and so did the way Performance Measurement and Management started being planned and implemented. As the market, technology, and society developed, the way value was perceived developed too, which has been directly and constantly affecting how business' strategies are defined (NUDURUPATI; GARENGO; BITITCI, 2021). Thus, PMMS needed to evolve and comprehend all types of organizations, behaviors, and strategies as it became more and more targeted by managers and scholars. As a result, among public, private, and hybrid organizations, PMMS had become commonplace. Literature nowadays covers the study of the planning and implementation of PM in diverse settings, such as non-profitable organizations, banks (TERESIENĖ, 2018; TARIQUE; ISLAM; MOHAMMED, 2021), small, medium, and large industries and businesses, and even complex and extensive systems as healthcare (DE WAELE et al., 2021; ZAADOUD;

CHBAB; CHAOUCH, 2021) – which is the focus of this work.

2.2. PMMS and KPIs in the Healthcare Sector: State of Art

Performance Measurement and Management in the Healthcare sector organizations is structured over multiple dimensions since they have several stakeholders and are surrounded by different entities with conflicting or overlapping interests. There is a separation between patients, general population, providers, regulators, investors, etc. Furthermore, HCS organizations are imposed great pressure to implement effective management tools and frameworks in order to avoid excessive costs and wastes, better manage resources and follow regulations while providing great care. Consequently, PMMS implementation on HCS can ensure assistance on tracking non-value creating activities, control expenses and enhance the efficient utilization of scarce resources (DIMITROPOULOS, 2017).

Chorfi, Benabbou, and Berrado (2018) explain that - as suggested by the Health Resources and Services Administration - healthcare organizations performance measures aim (i) to describe how service provision and patient-centered initiatives are quantified, (ii) to describe how clinical care affects the populations health status, (iii) keep balanced thread-offs, and (iv) to describe whether a HC organization has the capacity to deliver the care it is supposed to. With that idea in mind, many PMMS frameworks have been being designed and proposed to all nature of healthcare organizations and instances. The complexity of the HCS and its parts as well as how PMMS and their techniques can fit in their particularities have been - and still is - extensive explored by scholars.

Taking the nature of a healthcare organization into consideration, Lachmann, Trapp, and Wenger (2015) explored and compared how PMMS behave in public, private and non-profit (NP) hospitals by conducting a multiple case-study approach. After analysing the context of three different hospitals (each hospital for each ownership type), the authors assured that there is differences between ownership types and that these differences affect how they prioritize performance indicators dimensions. Whereas NP hospitals main focus are on medically effective treatment, private hospitals are concerned about the weight of financial performance and focused on trying to find a balance between medical

effectiveness and efficiency. As for public hospital, Diagnosis-Related Group-related targets imply on reputation due to bench-marking, and regardless of its nature, financial focus has high acceptance.

These findings are in accordance to Behrouzi and Ma'aram (2019), who conducted a research to define a appropriate set o KPIs for a private hospital in Malasya by using BSC and its four dimensions. As expected, financial and customer indicators were perceived as more valuable than process and learning indicators. Also, for the financial dimension, the 4 KPIs based mainly on profit and return of investments stood out from the others according to the perspective of hospital's managers. As for customers, all 9 KPIS were evaluated equally in importance. On the other hand, Chorfi, Benabbou, and Berrado (2018) concentrated their efforts on the same dimensions of BSC, but on a public healthcare setting. In their research the authors analyzed the KPIs for public healthcare supply chain and, as a result, they determined only 4 KPIs for both financial and learning indicators. More weigh were given to processes (13 KPIs) and customer (6 KPIs) indicators, which were perceived to better translate the strategic objectives of this type of organization, which must be patient-centered and process-oriented. Financial aspects for public organizations are more related to decreasing wastes and cutting costs.

As healthcare organizations are diverse not only in nature, but also in strategies, serving different purposes based on their capabilities and specialties, Teichgräber et al. (2021) proposed a goal-oriented measurement system based on Balance Scorecard (BSC) to be applied in the radiology department of a health institution. By definition, the BSC is a multidimensional system developed by Kaplan and Norton (already cited in this work as the ones responsible to spread the concept of PMMS) that defined 4 intertwined dimensions for analyzing the performance of a organization: finance, customer, process, and learning & growth. The authors highlighted the importance of specific departments to set their own strategic objectives besides the ones set for the entire organization. Also, they explore the importance to adapt the main concepts and measures of the entire system that are already established to the intrinsic reality of a sector. For this, for example, they proposed unfolding the measures that are categorized in the 4 dimensions of the BSC and taking them into consideration separately, controlling and analyzing them daily, monthly and annually depending on which strategic objectives they are describing.

Taking another context of the HCS into consideration, Zaadoud, Chbab, and Chaouch (2021) explored PMMS' frameworks in primary healthcare (PHC) worldwide

through literature review. After discussing and evaluating whether the framework resulted in positive improvements and quality outcomes, the authors came up with 8 dimensions for performance measurement of PHC: effectiveness, safety, accessibility, equity, efficiency, acceptability, patient-centeredness and timeliness. For the authors, categorizing the KPIs help managers better understand which aspects demand more effort and open to the possibility that more indicators can be add or reconsidered depending on the main objectives and characteristics of the PHC or any other setting being analyzed.

3. Methodology

This literature review was carried out based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol - a structured and widely applied guideline for reporting and conducting scientifically rigorous systematic reviews and meta-analyses studies (MDF et al., 2018; MOHER et al., 2015; TAM et al., 2019). The usage of the PRISMA protocol - which is extensively employed in the health field - is encouraged for assuring more transparency and comprehensiveness of the results. It also helps reducing unnecessary records duplication, selection as well as incorrect reporting (CROITORU et al., 2020; TAM et al., 2019). This protocol is divided into 4 major phases: (i) identification of the sources and definition of search strategies, (ii) data collection, (iii) screening, and (iv) eligibility assessment.

Elsevier's Scopus and Clarivate' Web of Science (WoS) were the sources selected and qualified for this study as both are considered the most notorious and broadly used multidisciplinary scientific databases for bibliometric research. While WoS (over 13.000 journals) is the standard source for generating citation data and has a broad coverage, Scopus (over 20.000 journals) retrieves more citation per article and currently is the largest bibliometric database (MARTÍN-MARTÍN et al., 2018; ZHU; LIU, 2020). For this work, the WoS' Core Collection was accessed along with its emergent bases (Derwent Innovations Index, KCI, and SciELO Citation Index) to obtain a broader coverage (BIRKLE et al., 2020). The first search was limited to retrieving documents published in the last 8 years, from January 2014 to December 2021.

A primary search was carried out to test some commonly used terms related to healthcare and performance indicators. From its results, a group of keywords referring to the central topic of this work and its main synonyms (KPI, "performance indicators" and "key success indicator") as well as keywords related to the healthcare field, its different spelling possibilities, and corresponding expressions (healthcare, "health care", "health-care", "health system", "health facility" and hospital) were selected and used to compound the first search strategy. The quotation marks allowed the terms to be found just as stated. The Boolean operators OR and AND were used to combine the search terms and to enable the intersection of results, respectively. After browsing through some of the articles

found, three more strategies were proposed.

These additional strategies intended to retrieve the largest possible number of articles that may help meeting this research objective. Therefore, the concept of KPI were expanded to keywords related to the Performance Measurement and Management domain as the context of the healthcare sector were narrowed down to more specific healthcare settings, such as pharmacies, “emergency room”, “trauma center” and operation rooms. The combination of these keywords and the corresponding total of records retrieved for each one in each database are shown in Table 2.

Table 2 – Search strategies used in Scopus e WoS databases

Strings	Search strategies	Databases	
		Scopus	WoS
#1	((kpi OR “performance indicator” OR “key success indicator”) AND (healthcare OR “health care” OR “health-care” OR “health system” OR “health facility” OR hospital))	1,629	408
#2	((kpi OR “performance indicator” OR “key success indicator”) AND (clinic OR pharmacy OR “emergency room” OR nursing OR “trauma center”))	300	74
#3	((“performance management” OR “performance measurement” OR “performance measure”) AND (healthcare OR “health care” OR “health-care” OR “health system” OR “health facility” OR hospital))	3,152	1,424
#4	((“performance management” OR “performance measurement” OR “performance measure”) AND (clinic OR pharmacy OR “emergency room” OR nursing OR “trauma center”))	550	261
Total		5,631	2,167

As a result, a total of 7,798 records were retrieved. However, 2,621 duplicated documents were identified and removed by using the Mendeley Reference Management Software and Microsoft Excel. Therefore, a sample of 5,177 records were manually reviewed in the Screening phase of the PRISMA protocol.

Screening was undertaken based on three different approaches. Approach 1 excluded 864 papers based on two criteria: type of document and language. Conference papers, chapters, books, editorials, and non-English articles were removed. Therefore, the first sample was limited to only English-written research articles and review papers published in scientific journals indexed in either database. The next two approaches were

determined to assure the articles are in accordance with the research objective. Thus, papers focusing on specific procedures, treatments, diseases, personnel, equipment, examination, or any evaluation or measurement based on a clinical or medical approach were excluded. Due to the large sample of articles, Approach 2 screened only the titles of the documents and 3,250 papers were excluded. Next, in Approach 3, the abstracts and keywords of the 1,063 reminiscent articles were analyzed and 701 articles were excluded.

Finally, 362 records were assessed in the Eligibility stage. A total of 168 papers were excluded for not being available online, for addressing clinical KPIs or for not validating (review articles) or applying (research articles) operational KPIs in the HCS. Of the 194 remaining papers, 126 were excluded for not presenting a descriptive definition or a formula of their KPIs. Therefore, a total of 68 articles properly described or mathematically defined the operational KPIs addressed for performance measurement purposes and were assessed as eligible and relevant for the qualitative analyses. The PRISMA flow diagram is presented in Figure 3.

Each article assessed as eligible for the qualitative analysis (n=68) was first classified into two categories: Descriptive or Applied. The descriptive articles (n=29) focused on selecting, defining, and validating KPIs for PM-HCS by using simulations, frameworks (such as AHP or BSC) or mathematical analysis. The applied articles (n=39) were case studies focused on calculating the KPIs to measure the performance in real HCS environments by collecting real data. Besides this differences, all 68 articles presented a comprehensive description of the indicators, whether by giving a verbal definition or presenting a mathematical formulation. To better describe each article found in this research, Table 3 presents a summary of all articles assessed as eligible for the qualitative analysis.

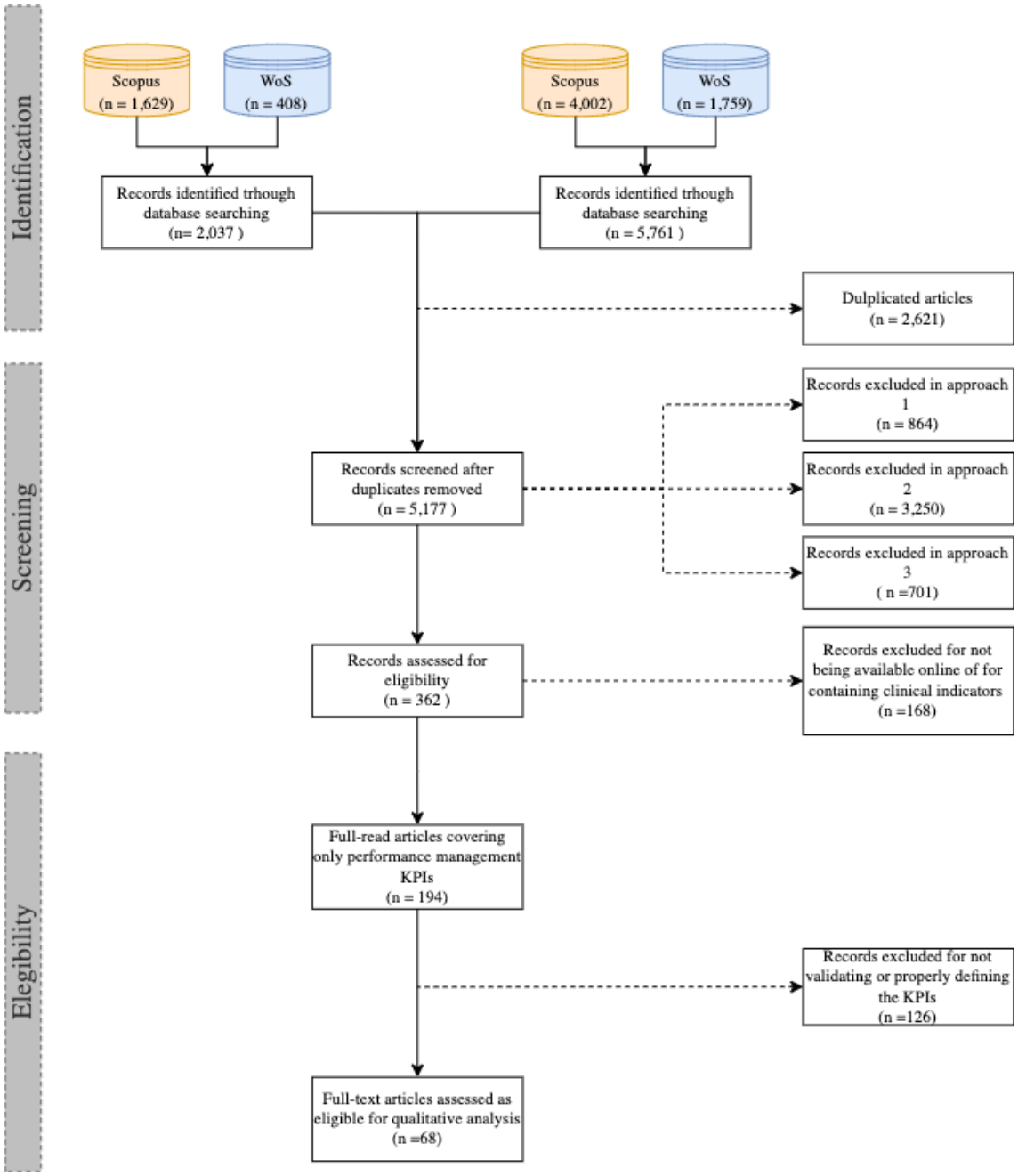


Figure 3 – PRISMA workflow diagram

Table 3 – Summary of all 68 articles containing their specific research objectives

Year	Title	Focus of research This paper...	Scopus	WoS
Traberg, Jacobsen, and Duthiers (2014)	Advancing the use of performance evaluation in health care	... develops a framework for health care performance evaluation that enables decision-makers to identify areas indicative of corrective actions.	1	3
Shabaninejada, Mirsalehianb, and Mehralian (2014)	Development of an integrated performance measurement (PM) model for pharmaceutical industry	...tries to design an integrated PM model for pharmaceutical companies	19	23
Meena and Thakkar (2014)	Development of Balanced Scorecard for healthcare using Interpretive Structural Modeling and Analytic Network Process	...develops a Balanced Scorecard-based performance measurement framework for health care system	35	4
Barliba and Tita (2014)	Important bioindicators for health management in Romania	...illustrates the applicability of hospital performance indicators	2	2
Ali and Hegazy (2014)	Multicriteria assessment and prioritization of hospital renewal needs	... introduces a practical multicriteria performance assessment framework for hospitals	22	0
Wiler et al. (2015)	Emergency department performance measures updates: Proceedings of the 2014 emergency department benchmarking alliance consensus summit	... review and updates key definitions and metrics for emergency department (ED) performance and operations.	71	1

Table 3 continued from previous page

Year	Title	Focus of research This paper...	Scopus	WoS
Enshassi and Shorafa (2015)	Key performance indicators for the maintenance of public hospitals buildings in the Gaza strip	... identifies and assess the key performance indicators (KPIs) for the maintenance of public hospital buildings in the Gaza Strip.	20	5
Ramos et al. (2015)	Performance evaluation of hospitals that provide care in the public health system, Brazil	To analyze if size, administrative level, legal status, type of unit and educational activity influence the hospital network performance in providing services to the Brazilian Unified Health System	13	0
YA et al. (2015)	Value and impact of international hospital accreditation: A case study from Jordan	... assess the economic impact of Joint Commission International hospital accreditation on 5 structural and outcome hospital performance measures in Jordan.	17	4
Nwagbara, Rasiah, and Aslam (2016)	An approach toward public hospital performance assessment	... examines the impact of the average length of stay (ALOS) and bed turnover rates (BTR) on bed occupancy rates (BOR)	0	6

Table 3 continued from previous page

Year	Title	Focus of research This paper...	Scopus	WoS
Christodoulakis et al. (2016)	Big data in health care Assessment of the performance of Greek NHS hospitals using key performance and clinical workload indicators	... examines how common KPIs change when clinical workload indicators of hospitals, based on diagnosis-related group data are incorporated in the measurement analysis.	3	5
Askari, Shafii, and Baghian (2016)	Comparing Performance Indicators of Obstetrics and Gynecology Ward at Yazd Educational Hospitals with Expected Limits of Indicators, 2015	... evaluates the performance indicators for obstetrics and gynecology wards in Iran.	1	1
Frosini et al. (2016)	Development of a web based monitoring system for safety and activity analysis in operating theatres	...designs an analyses a dashboard capable of monitoring the efficiency of the operation room usage and its safety parameters	2	13
Mohammadi et al. (2016)	Emergency department performance evaluation indicators in pre and post-health care reform in kermanshah public hospitals	... surveys emergency department's performance by means of mentioned indicators during pre and post-health care reform	2	2

Table 3 continued from previous page

Year	Title	Focus of research This paper...	Scopus	WoS
Shohet and Nobili (2016)	Enterprise resource planning system for performance-based-maintenance of clinics	... developed a performance-based model for clinic facilities by integrating eight KPIs into an enterprise resource planning system for the maintenance of public clinic facilities.	19	2
Madsen et al. (2016)	Selection of quality indicators for hospital-based emergency care in Denmark, informed by a modified-Delphi process	...describes the Delphi process that contributed to the selection of quality indicators for a new national database of hospital-based emergency care in Denmark	26	8
Moreira and Günther (2016)	Solid waste management in primary healthcare centers: Application of a facilitation tool	... proposes a tool to facilitate diagnosis, formulation, and evaluation of the Waste Management Plan in Primary Healthcare Centers and to present the results of the application in four selected units	2	9

Table 3 continued from previous page

Year	Title	Focus of research This paper...	Scopus	WoS
Di Leva and Sulis (2017)	A business process methodology to investigate organization management: A hospital case study	... focus on the business analysis of an Emergency Department, by considering a wide a methodological framework to analyze care pathways for patients.	7	5
Yousefi and Ferreira (2017)	An agent-based simulation combined with group decision-making technique for improving the performance of an emergency department	... presents an agent-based simulation modeling in an emergency department	16	24
Gannon et al. (2017)	An economic cost analysis of emergency department key performance indicators in Ireland	... estimates the relative cost of collecting the additional minimum data set elements for 11 KPIs.	4	1
Soranz, Pinto, and Camacho (2017)	Analysis of the attributes of primary health care using the electronic medical records in the city of Rio de Janeiro	... evaluates the trend of selected pay-for-performance indicators that measure the health care process in the city's PHC.	8	12

Table 3 continued from previous page

Year	Title	Focus of research This paper...	Scopus	WoS
Shohet and Nobili (2017)	Application of key performance indicators for maintenance management of clinics facilities	... assess the reliability of a set of hybrid KPIs for assessing performance and maintenance management, as well as for providing the basis for establishing the strategic and tactical policy of community clinics	28	7
Bahadur et al. (2017)	Assessment of performance indicators of a radiotherapy department using an electronic medical record system	... assess the performance indicators of a radiotherapy department and their temporal trends by using an electronic-medical-record system.	1	6
Catuogno et al. (2017)	Balanced performance measurement in research hospitals: The participative case study of a haematology department	... reviews, designs, and implements a multidimensional performance measurement system for a public research hospital in order to address the complexity of its multifaceted stakeholder requirements and its double institutional aim of care and research.	14	7

Table 3 continued from previous page

Year	Title	Focus of research This paper...	Scopus	WoS
Bittencourt, Verter, and Yalovsky (2017)	Daily capacity management for hospitals: A Brazilian case study	... proposes a dashboard that is designed to measure the hospital performance on a daily basis, based on the input-throughput-output conceptual model, related to admissions, capacity, and discharges.	3	7
Porporato, Tsasis, and Marin Vinuesa (2017)	Do hospital balanced scorecard measures reflect cause-effect relationships?	... investigates whether first-level measures in the Balanced Scorecard (BSC) declaring a cause-effect relationship by design are composite indices of lower measures, and if they converge into a single factor as is traditionally accepted in the BSC literature	-	12
Lloyd et al. (2016)	Hospital pharmacists' perspectives on the role of key performance indicators in australian pharmacy practice	... explores hospital pharmacists' perspectives on the role of KPIs and to use their perspectives to suggest a set of KPIs for use in Australian hospital pharmacy practice.	6	12

Table 3 continued from previous page

Year	Title	Focus of research This paper...	Scopus	WoS
Si et al. (2017)	Identifying key performance indicators for holistic hospital management with a modified DEMATEL approach	... proposes a hybrid multiple criteria decision making approach to identify key performance indicators (KPIs) for holistic hospital management.	39	14
Hassanain et al. (2017)	Use of Lean methodology to improve operating room efficiency in hospitals across the Kingdom of Saudi Arabia	... assess whether intervention on process efficiency using the Lean methodology leads to improved utilization of the operating room (OR), as measured by key performance metrics of OR efficiency	13	1
Ryan et al. (2017)	Using key performance indicators to reduce perceived perioperative complexity and improve patient workflow	... examines KPIs across all perioperative sub-processes for use in traditional BPM practices that provide a framework to target and measure improvement as well as maintain perioperative patient end-state goals	5	4
Dubois et al. (2017)	Which priority indicators to use to evaluate nursing care performance? A discussion paper	A discussion of an optimal set of indicators that can be used on a priority basis to assess the performance of nursing care	16	3

Table 3 continued from previous page

Year	Title	Focus of research This paper...	Scopus	WoS
Oueida et al. (2018)	An edge computing based smart healthcare framework for resource management	...proposes a resource preservation net framework using Petri net, integrated with custom cloud and edge computing suitable for ED systems.	92	7
Chorfi, Benabbou, and Berrado (2018)	An integrated performance measurement framework for enhancing public health care supply chains	...introduces a framework based on the Balanced Scorecard and the SCOR model to engineer an integrated performance measurement system for managing public healthcare supply chains	8	70
Núñez et al. (2018)	Emergency departments key performance indicators: A unified framework and its practice	...improves the performance of EDs using key performance indicators (KPIs)	9	16
Penverne et al. (2018)	Key performance indicators' assessment to develop best practices in an Emergency Medical Communication Centre	... describes the activity on an EMCC and to explore the associations between different key performance indicators	5	0

Table 3 continued from previous page

Year	Title	Focus of research This paper...	Scopus	WoS
Urick et al. (2018)	Lessons learned from using global outcome measures to assess community pharmacy performance	... describes the process used to design and implement a performance measurement process for a group of enhanced services pharmacies in North Carolina	12	10
Peixoto, Musetti, and Mendonça (2018)	Multivariate analysis techniques applied for the performance measurement of Federal University Hospitals of Brazil	... applies the multivariate analysis techniques of principal components and cluster analysis in the performance measurement of Federal University Hospitals	6	1
Du (2018)	Performance Measurement of Healthcare Service and Association Discussion between Quality and Efficiency: Evidence from 31 Provinces of Mainland China	... discussws the association between quality and efficiency based on the effect of quality on relative efficiency	11	4
Tadlaoui, Chafi, and Ennadi (2018)	The lean six sigma in a public hospital	... describes the methodology adopted that of the DMAIC method and in the end to implement the first 3 steps of this method in a public hospital.		2
M H Rahman et al. (2019)	A grey approach to predicting healthcare performance	... analyze and predict the indicators of healthcare performance using grey systems theory.	28	4

Table 3 continued from previous page

Year	Title	Focus of research This paper...	Scopus	WoS
Faten Ajmi et al. (2019)	Agent-based dynamic optimization for managing the workflow of the patient's pathway	... aims to study and develop an orchestration architecture that drives the patient's pathway workflow in real-time, thus improving KPIs step by step during its execution.	7	14
Alishahi Tabriz, Trogdon, and Fried (2019)	Association between adopting emergency department crowding interventions and emergency departments' core performance measures	... estimates the association between adopting emergency department crowding interventions and emergency departments' core performance measures	10	0
Lima, Aguiar, and Storpirtis (2019)	Development and validation of key performance indicators for medication management services provided for outpatients	... develops and validates KPI instrument for medication management services provided for outpatients in Brazilian context.	14	5
Iadanza et al. (2019)	Evidence-based medical equipment management: a convenient implementation	...verifies the feasibility of implementing an evidence-based method (i.e. based on the history of failures) for maintenance.	14	2
Behrouzi and Ma'aram (2019)	Identification and ranking of specific balanced scorecard performance measures for hospitals: A case study of private hospitals in the Klang Valley area, Malaysia	...identifies and rank a specific set of performance measures that are feasible and relevant for private hospitals.	8	16

Table 3 continued from previous page

Year	Title	Focus of research This paper...	Scopus	WoS
Almusawi, Almagtome, and Shaker (2019)	Impact of lean accounting information on the financial performance of the healthcare institutions: A case study	...explores the impact of lean accounting information on the financial performance of healthcare institutions	1	31
Raj, Creaton, and Phillips (2019)	Improving emergency department trauma care in Fiji: Implementing and assessing the trauma call system	... audits the trauma call procedure at the hospital over a period of 12 months.	4	1
Suriyawongpaisal et al. (2019)	Relevance of using length of stay as a key indicator to monitor emergency department performance: Case study from a rural hospital in Thailand	... explores factors related to the length of stay (LOS) in a rural public hospital in Thailand and assesses the feasibility of using LOS as an ED key performance indicator.	5	10
Vanbrabant et al. (2019)	Simulation of emergency department operations: A comprehensive review of KPIs and operational improvements	...structures the scientific literature on ED simulation based on KPIs and improvement options	22	3

Table 3 continued from previous page

Year	Title	Focus of research This paper...	Scopus	WoS
Ahmed et al. (2019)	Technical efficiency of public district hospitals in Bangladesh: a data envelopment analysis	...aimed to estimate the technical efficiency of the District hospitals in Bangladesh. It used input-oriented data envelopment analysis method to estimate the variable returns to scale (VRS) and constant returns to scale (CRS) technical efficiency of the DHs using data from Local Health Bulletin, 2015.	2	4
Ayyoubzadeh et al. (2020)	A study of factors related to patients' length of stay using data mining techniques in a general hospital in southern Iran	... adopts a comparative approach of data mining techniques for investigating effective factors and predict the length of stay in hospital in Iran.	4	10
Dehghanimohamma and Kabadayi (2020)	A two-stage ahp multi-objective simulation optimization approach in healthcare	... aims to propose a combined Simulation-Optimization and AHP approach to accurately assess the impact of quality improvement initiatives on different facets of healthcare systems.	5	5

Table 3 continued from previous page

Year	Title	Focus of research This paper...	Scopus	WoS
Sariyer, Ataman, and Kiziloglu (2020)	Analyzing main and interaction effects of length of stay determinants in emergency departments	... analyzes both the main and interaction effects of four widely-used independent determinants of ED-LOS using secondary data from an ED of a large urban hospital in Turkey, and the method ANOVA.	5	5
Khalilabad et al. (2020)	Assessment of clinical and paraclinical departments of military hospitals based on the Pabon Lasso Model	... aimed to investigate and evaluate the performance indicators of military hospitals and measurement of performance by using the Pabon Lasso model.	1	5
Staib et al. (2020)	Digital transformation of the emergency department-inpatient interface (EDii): Integration for future innovation	...describes the impact of digital transformation of the EDii of a large tertiary hospital on process measures and clinical outcomes for patients requiring emergency admission to a hospital.	0	3

Table 3 continued from previous page

Year	Title	Focus of research This paper...	Scopus	WoS
Valent, Di Chiara, and Di Bartolomeo (2020)	Emergency Key Performance Indicators in the Italian Region Friuli Venezia Giulia	...develop and calculate a set of KPI in the Italian Region Friuli Venezia Giulia by using a modified Delphi process among Emergency care experts.	0	21
Imran Hasan, Esmaeil Bahalkeh, and Yuehwern Yih (2020)	Evaluating intensive care unit admission and discharge policies using a discrete event simulation model	...investigates the impact of a set of operational policies on ICU behavior and performance.	9	1
Torabi et al. (2020)	FASStR: A framework for ensuring high-quality operational metrics in health care	...develops a unifying framework that could be used by administrators, practitioners, and investigators to help define and document operational performance measures that are comparable and reproducible	3	66

Table 3 continued from previous page

Year	Title	Focus of research This paper...	Scopus	WoS
Prado-Prado et al. (2020)	Increasing competitiveness through the implementation of lean management in healthcare	... aims to design a participative methodology that facilitates lean management implementation in healthcare by adopting the action research approach. This implementation involved the personnel, processes, and key performance indicators pillars as well as putting in place improvement actions to achieve the objectives defined by the KPIs.	8	11
Andreata et al. (2020)	Operating room efficiency and timing during coronavirus disease 2019 outbreak in a referral orthopaedic hospital in Northern Italy	... aims to analyse the impact on surgical block utilisation and efficiency in an orthopaedics reference centre in Northern Italy. Number and type of procedures, first case delay, occupancy rate, and turnover time were used as indicators to benchmark the activities.	11	3

Table 3 continued from previous page

Year	Title	Focus of research This paper...	Scopus	WoS
Hidayat et al. (2020)	Response time, waiting time and service quality in emergency department	...sheds light on important factors contributing to service quality in the emergency department of Indonesian public hospitals by utilizing a cross-sectional design.	2	0
Vainieri, Panero, and Coletta (2020)	Waiting times in emergency departments: A resource allocation or an efficiency issue?	... aims at providing a logical diagnostic framework to support managers in investigating specific solutions to be applied to their EDs to cope with high ED waiting times. The framework is based on the ED waiting times and ED admission rate matrix.	4	0
Duarte, Walshaw, and Ramesh (2021)	A comparison of time-series predictions for healthcare emergency department indicators and the impact of COVID-19	... compares how 3 models, which can forecast relevant KPIs, behave facing the abrupt changes the COVID-19 caused in the regular patterns and seasonal trends of the dataset formed of four hourly valued KPIs from a UK hospital.	3	10

Table 3 continued from previous page

Year	Title	Focus of research This paper...	Scopus	WoS
Bin Mohamed Ebrahim et al. (2021)	Contemporary evaluation of adverse outcome risks associated with 'did not wait' emergency department presentations	Did not wait (DNW) is a frequently cited ED key performance indicator. While a proportion of DNW patients re-presented within 72 h, an excess prevalence of poor outcomes were not observed.	0	32
N.H.N.A. Rahman et al. (2021)	Determination of service key performance indicators for emergency departments of teaching hospitals in malaysia: A fuzzy delphi method	... demonstrates the Fuzzy Delphi Method (FDM) as a scientific approach to consolidating consensus agreement within a panel of experts pertaining to each service-related KPI item's appropriateness for ED.	0	4
Di Laura et al. (2021)	Efficiency measures of emergency departments: An Italian systematic literature review	... reviews the literature on the problems encountered in the efficiency of EDs around the world in order to identify an organizational model or guidelines that can be implemented in EDs to fill inefficiencies and ensure access to optimal treatment both in terms of resources and timing.	1	7

Table 3 continued from previous page

Year	Title	Focus of research This paper...	Scopus	WoS
Argaw et al. (2021)	Implementing a social accountability approach for maternal, neonatal, and child health service performances in Ethiopia: A pre-post study design	... assessed the effects of community scorecard implemented by primary health care units on health system performance in Ethiopia. The effects of implementing CSCs on health system performance were evaluated against selected key performance indicators (KPIs).	0	19
Pereira et al. (2021)	Incorporating preference information in a range directional composite indicator: The case of Portuguese public hospitals	... presents a formative measurement model to evaluate the latent variable representing hospitals' overall performance, considering access to healthcare, quality of care, and consumption of resources.	10	17

As previously stated, the main objective of the qualitative analysis conducted in the next sections of this work is to extract information about how Key Performance Indicators are being used for assessing the performance of the HCS. Therefore, the first information extracted from the articles were the techniques applied to determine and choose the KPIs. Then, the HCS's fields assessed by the KPIs proposed in the articles were discussed. By the end, it is proposed the classification of the KPIs based on their objectives and a parallel between the HCS fields and the classifications domains is drawn.

But before going into the qualitative aspects of this discussion, the next chapter will better describe the sample used to conduct this research.

4. Sample Analysis

4.1. Scientific Production

A concise bibliometric analysis was conducted to summarize the article sample used to conduct this work (Table 4).

Table 4 – Summary information about the article sample

Documents	68
Sources (Journals, Books, etc.)	60
Keywords Plus (ID)	597
Author's Keywords (DE)	264
Period	2014-2021
Average citations per documents	9.15

Figure 4 presents the number of publications over the years. It is possible to notice an increase in the number of publications between 2016 and 2017 and again in 2019 and 2020, with its peak in 2017. Thus, even though there was a decline on the subject in 2021, healthcare management KPIs has kept being a subject of academic interest in the recent years. According to data, the annual scientific production growth rate for this sample is 2.64%.

The analysis of total citations per year (Figure 5a) shows conformity when compared to the analysis of average citations per article (Figure 5b), with increases and decreases in the same years for both graphics. However, they both show a single disparity with the publication rate, as the number of citations increase in the years that the number of publications dropped. The number of citations per articles is higher than the number of overall citations because in the years that there was a decrease in the number of publications, the citations were concentrated on the same articles.

The ten most cited articles are presented in Fig. 4. The three most cited articles in both bases are ”An edge computing based smart healthcare framework for resource management”, ”Emergency department performance measures updates: Proceedings of the 2014 emergency department benchmarking alliance consensus summit”, and

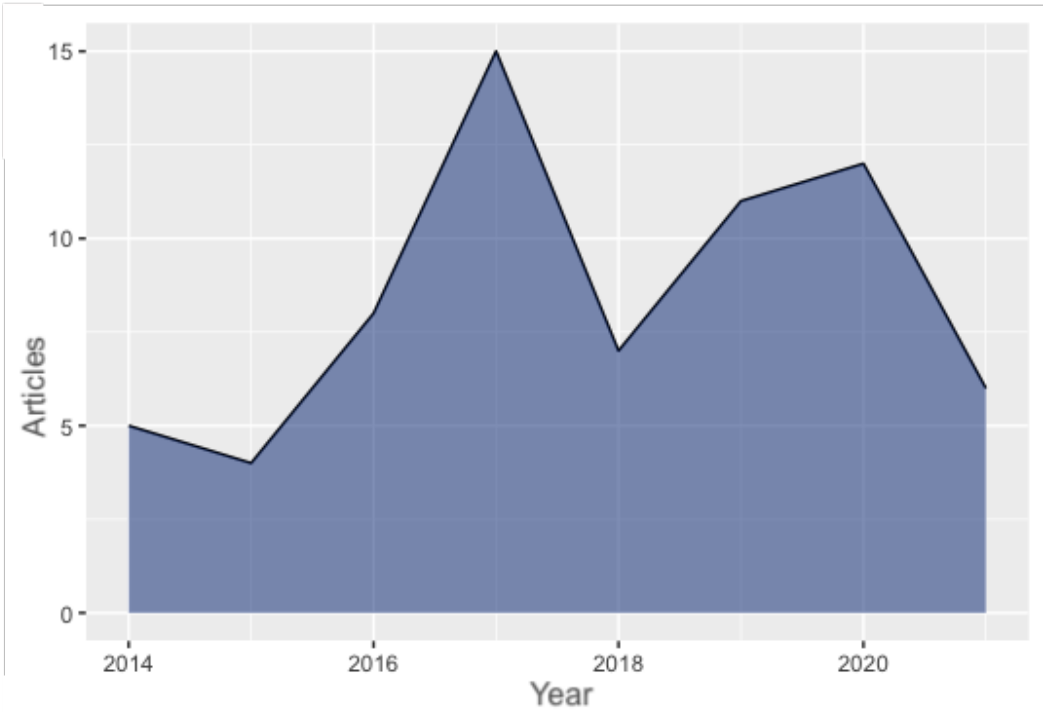


Figure 4 – Annual Scientific Production



(a) Average Total Citations per Year (b) Average Article Citation per Year

Figure 5 – Citations over the year

”Identifying key performance indicators for holistic hospital management with a modified DEMATEL approach”, which 70, 66, and 32 citations, respectively (OUEIDA et al., 2018; WILER et al., 2015; SI et al., 2017). The author Igal M. Shohet published 2 of the most cited articles. Also, articles from all years of analysis are present in the list of most cited articles and none year stood out.

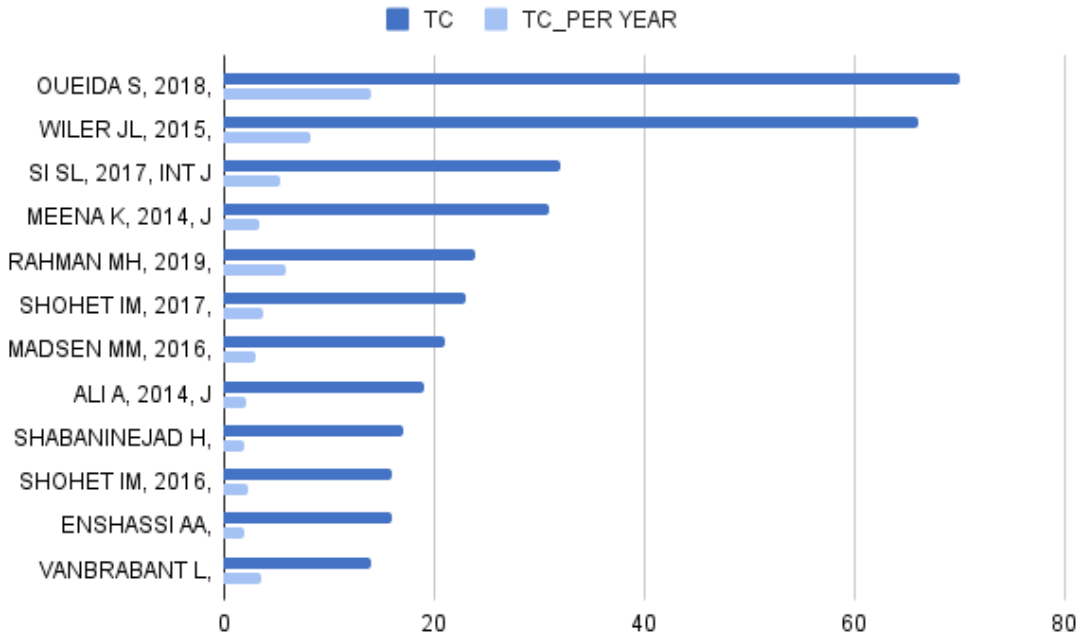


Figure 6 – Most cited articles over the years

4.2. Journals

The 68 articles analyzed in this study were published in 60 journals, with a rate of 0.88 articles per journal. This finding might be related to the comprehensiveness of this work, which addresses a variety of HCS environments, methodologies, objectives and applications, which are covered by the scope of different journals. Table 5 presents the journals with more publications.

Table 5 – Sources of publication by number of articles

Journals	Articles	Citations	Most Cited
Emergency Medicine Australasia	3	8	Suriyawongpaisal et al. (2019)
International Journal of Health Planning and Management	3	24	Hassanain et al. (2017)
BMC Health Services Research	2	10	Catuogno et al. (2017)
Computers and Industrial Engineering	2	19	Vanbrabant et al. (2019)
European Journal Of Emergency Medicine	2	9	Penverne et al. (2018)
International Journal of Environmental Research and Public Health	2	40	Si et al. (2017)

As presented in Table 5, there are only 6 journals with more than one published article. The “Emergency Medicine Australasia” is the most published source with only 3 articles published on the subject (BEHROUZI; MA’ARAM, 2019; HASSANAIN et al., 2017; NÚÑEZ et al., 2018). Since there is a low rate of articles per journal, it understands why

the most relevant sources identified in this work have so few publications (between 2 and 3 articles, each).

When comparing the data from Table 5 to Figure 7, it is possible to see that for this sample the number of articles are not related to the number of citations per journal. The most cited source is ”Sensors (Switzerland)” (OUEIDA et al., 2018), which only have a single publication on the subject with 70 total citations followed closely by ”Academic Emergency Medicine”, with 66 citations and also 1 publication (WILER et al., 2015). Only 3 journals that are in the list of most publishing sources are in the list of most cited: ”International Journal of Environmental Research and Public Health”, ”International Journal of Health Planning and Management”, and ”Computers and Industrial Engineering”, with 40, 24, and 19 citations, respectively.

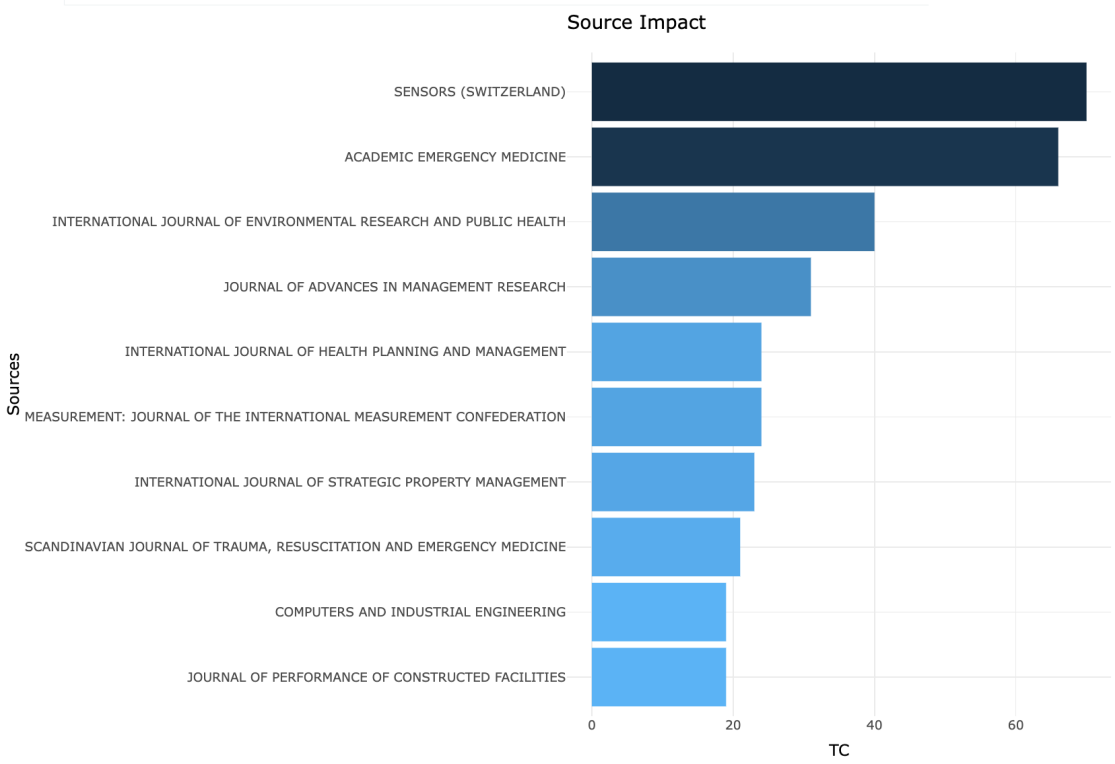


Figure 7 – Most cited sources over the years

4.3. Countries

Corresponding authors are from 29 countries. Eleven countries have published more than one article addressing KPIs for performance measurement in healthcare settings. As seen in Table 6, Italy, USA, Brazil, Canada, and Iran are the most productive countries covered in this study. Italy and the USA share the highest number of publications, with 7 articles published in the last 8 years. Brazil is the second most productive countries, with 6 articles. In third place comes Canada and Iran, with 4 articles each.

Table 6 – Most relevant countries

Country	Articles	Frequency
Italy	7	0.115
USA	7	0.115
Brazil	6	0.098
Canada	4	0.066
Iran	4	0.066
Australia	3	0.049
China	3	0.049
Malaysia	3	0.049
Bangladesh	2	0.033
Irael	2	0.033

The USA and Canada are also the most cited countries. However, the USA is the highest, with 115 citations from 2014 to 2021, followed by Canada with 105 citations. Even though Denmark and India have only one article, they appear in the top 10 most cited countries.

4.4. Tools and Methodologies

Four different strategies and methodologies were used to select the KPIs that have been explored and discussed in the 68 articles analyzed (Figure 8).

Five articles used a combination of techniques to define KPIs. Faten Ajmi et al. (2019) set up a working group and applied a survey to hospital practitioners to define and evaluate KPIs based on the Database of the Pediatric Emergency Department of CHRU

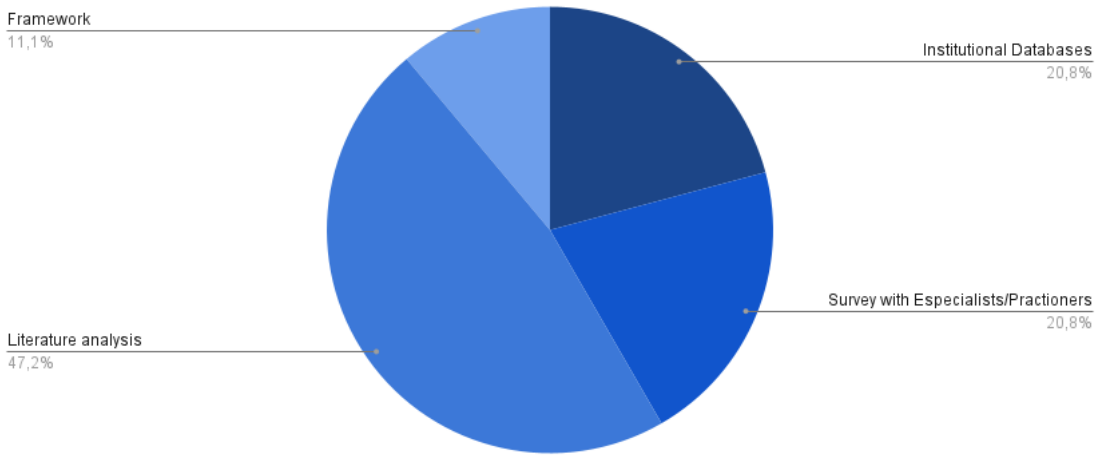


Figure 8 – Methodologies used to select KPIs

of Lille in a Database (also see: Ajmi et al. (2017)). The indicators were validated through simulation. Alishahi Tabriz, Trogdon, and Fried (2019) defined the KPIs discussed in their work based on the suggestion of the Canadian Association of Emergency Physicians and by consulting previous studies found in the literature.

Almost 50 percent of the articles used analysis of literature as means to define and indicate the set of KPIs to be explored. Of the 33 articles, 13 used Literature Analysis/Review to validate the KPIs by discussing their use and efficiency and 20 conducted performance analysis by calculating KPIs to get information about a how a process or department is performing. Thus, this methodology can be perceived as an efficient method to select sets of indicators suitable to distinctive settings in the HCS and distinctive applications.

4.5. HCS Fields

About seventeen assorted HCS fields were discussed as an object of study or application in the 68 papers analyzed. Six different settings were addressed in descriptive papers, five on applied papers, and five settings were seen from both perspectives. Figure 9 presents the number of articles analyzed for each healthcare field regarding descriptive and applied analysis. In general, Hospitals and Emergency Departments (ED) are the most common fields studied concerning the application of KPIs for PM assessment.

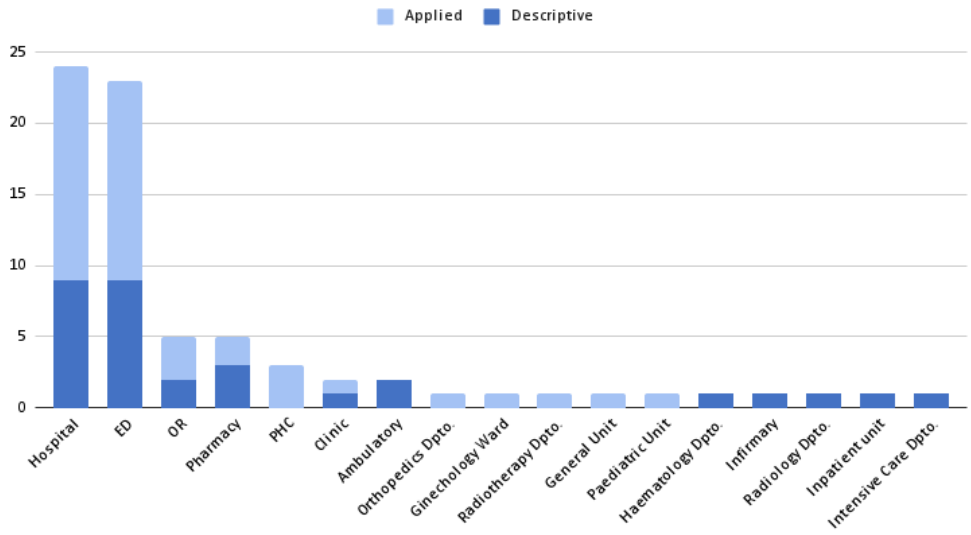


Figure 9 – Healthcare fields/settings/facilities explored in the sample

About 32% of the articles analyzed conducted a holistic performance measurement evaluation in hospitals (descriptive = 9 and applied = 15). According to Pourmohammadi et al. (2018) and Rahimi et al. (2018), hospitals are the main focus of studies regarding operational and management control practices for being considered the center of the healthcare system as they provide essential services, are costly, and have much effect on the overall healthcare system efficiency.

It is important to notice that there is a variety of hospitals in which the studies were conducted. They usually differ from each other concerning their structure (general, teaching, specialized, community, etc) and administration nature (public and private). These distinctions influence the types of KPI used in the PM assessment and help to understand the complexities and peculiarities of each specific setting by indicating a set of indicators that are more suited for a determined field. For example, university hospitals usually present KPIs regarding educational performance and research impact, which is not seen measuring performance of general hospitals. Therefore, of the 24 studies carried on hospitals, 3 were conducted in university hospitals (PEIXOTO; MUSETTI; MENDONÇA, 2018; SI et al., 2017; RAHMAN, N. et al., 2021), and 2 in general hospitals (YA et al., 2015; RAMOS et al., 2015). Specialized, community, acute, and military hospitals were mentioned in 1 article each (YA et al., 2015; PORPORATO; TSASIS; MARIN VINUESA, 2017; RAMOS et al., 2015; KHALILABAD et al., 2020). The remaining 13 articles do not specify their structure type and as expected, defined general KPIs.

The administrative nature of the hospitals also impacts on the nature of KPIs. There are 26 articles focused on public hospitals (AHMED et al., 2019; CHRISTODOULAKIS et al., 2016; ENSHASSI; SHORAFA, 2015; FAKHRI et al., 2018; NWAGBARA; RASIAH; ASLAM, 2016; PEIXOTO; MUSETTI; MENDONÇA, 2018; PORPORATO; TSASIS; MARIN VINUESA, 2017; RAMOS et al., 2015; RAHMAN, M. H. et al., 2019) and 9 focused on private hospitals (BEHROUZI; MA'ARAM, 2019; YA et al., 2015; RAHMAN, M. H. et al., 2019). Thirty seven papers did not specify their administrative nature. It is noticed that private hospitals are more concerned with their financial aspects than public hospitals as their efficiency is more associated with financial outcomes (ALMUSAWI; ALMAGTOME; SHAKER, 2019). Behrouzi and Ma'aram (2019) and M H Rahman et al. (2019) assess the financial performance of private hospitals and YA et al. (2015) weight the economic impact of their performance measurement and indicators. Public spending, the quality of care reflecting the efficiency of the national healthcare system, and stakeholder satisfaction are paramount in public hospitals as the main objective of these institutions relies on meeting the needs of the society rather than profit (NWAGBARA; RASIAH; ASLAM, 2016). Therefore, the use of KPIs for PM in public hospitals are more in congruence with internal objectives and dimensions and public policies.

Emergency Departments (ED) is also highlighted as a extensive study field as its present in 23 papers (one less than hospitals). ED facilities have been increasing in interest as EDs' performance has the highest impact on patient care and is highly relevant in public opinion (public debate on excessive waiting time or misdiagnosis are often). Therefore, as hospitals are the center of the HCS, EDs are considered its central point of entry (WHO, 2021).

According to the World Health Organization (WHO), emergence-based facilities are usually perceived as secondary-type care facilities (ALISHAHI TABRIZ; TROGDON; FRIED, 2019; DI LEVA; SULIS, 2017; GANNON et al., 2017; MOHAMMADI et al., 2016; OUEIDA et al., 2018; SURIYAWONGPAISAL et al., 2019; VANBRABANT et al., 2019; WILER et al., 2015; YOUSEFI; FERREIRA, 2017). Even though EDs do not require referral nor specialized care, it does not include preventive care, which is the role of primary care settings (WHO, 2021) (REYNOLDS et al., 2017). However, EDs inside tertiary hospitals offer tertiary care and are, therefore, classified as tertiary care settings as well (AJMI, Faten et al., 2019; MADSEN et al., 2016; NÚÑEZ et al., 2018; RAJ; CREATON; PHILLIPS, 2019).

As seen, the HCS classifies its services — and therefore, its settings — into three levels of care: Primary Care (focused on preventive and overall patient wellness), Secondary Care (urgent, specialized and referral care), and Tertiary Care (highly specialized and complex care and treatments). Given this classification, this paper discusses the 15 remaining settings addressed in this work by taking into consideration the levels of care they are situated in the HCS. There are 09 Primary, 07 Secondary, and 11 Tertiary care settings or facilities in 27 papers. Figure 10 shows the settings in each level and the number of papers addressing each setting.

Each setting was classified according to the information granted by the authors about its role in the HCS, the level of care provided to patients, and the organization of the HCS in each country. By these means, we tried to rule out any possibilities of subjection.

It is possible to notice that, as for EDs, even though some settings or specialties are, in a general context, perceived as part of a specific level of care, they have been classified according to the setting they are within as a department or unity. For instance, Orthopedics and Radiotherapy usually provides second-type care. However, Almusawi, Almagtome, and Shaker (2019) and Bahadur et al. (2017) presented them as singular departments within Tertiary hospitals. Therefore, they were classified as Tertiary Care. Similarly, Gynecology (ASKARI; SHAFII; BAGHIAN, 2016) and Pediatric (BITTENCOURT; VERTER; YALOVSKY, 2017) specialties are usually seen as Primary Care for providing basic assistance to specific groups of people, and Pharmacies are at the first level of contact with patients in a community (CHORFI; BENABBOU; BERRADO, 2018; SHABANINEJADA; MIRSALEHIANB; MEHRALIAN, 2014; TADLAOUI; CHAFI; ENNADI, 2018; URICK et al., 2018). However, when these settings are located inside Tertiary Care hospitals, they are also classified as Tertiary Care (LLOYD et al., 2016)

The number of papers addressing each level of care increases throughout the pyramid (Figure 10). Thus, KPIs of more complex settings are more explored in the literature. However, the importance of assessing performance in settings from different levels are highlighted in some papers. For example, when stating how scarce is the validation of KPIs for ambulatories, Lima, Aguiar, and Storpirtis (2019) discusses the increasing importance of the assessment of the quality of the care to every actor playing a role in the HCS.

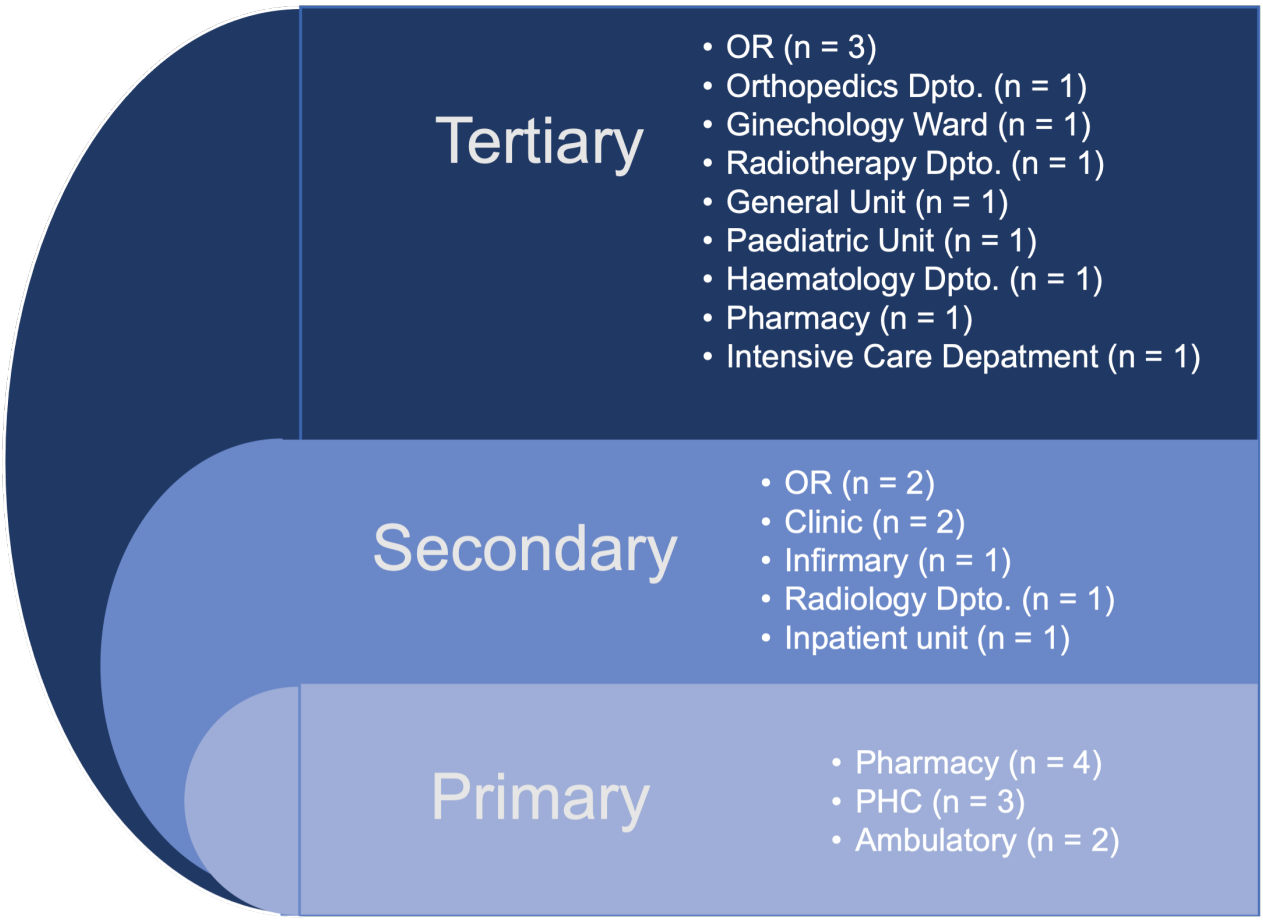


Figure 10 – HCS settings throughout the Primary, Secondary and Tertiary levels of care
Source: Author (2022)

5. KPI Classification

As previously stated, each of the 68 articles analyzed discussed KPIs in different healthcare fields and environments with different objectives and distinct strategies to measure performance. Therefore, to better understand how indicators have been being used in the literature, each KPI from each article was classified based on what aspect of healthcare they were intending to measure without referring to any particular setting.

Therefore, the KPIs were classified into 9 categories regarding 9 different approaches: Accessibility, Educational, Environmental, Financial, Operational, Pharmaceutical, Resources, Stakeholders, and Supply Chain. Table 7 presents what is covered by each category.

Approaches	**"It covers KPIs that measure..."**
Accessibility	... the continuity of care, and availability of healthcare to the patients and population
Supply Chain	... the logistic aspects of healthcare processes, such as distribution and procurement of resources
Financial	... the financial costs and profits associated to healthcare services, treatments, and processes.
Stakeholders	... the impact of healthcare services and processes to their stakeholders (personnel, patient, investors, community, government, etc).
Resources	... personnel, equipment (bed, machines, etc), facilities, allocation and management
Pharmaceutical	... the aspects of medication usage and management
Operational	... the performance of care processes and operational support process that make a healthcare instance able to provide its service as well as its quality .
Educational	... the training capacity of healthcare personnel, continuous education perspectives, and contribution of healthcare fields and practitioners to the literature.
Environmental	... environmental aspects of healthcare, such as waste generation, disposal, and treatment.

Table 7 – Definition of each approach based on what type of KPI they cover

Additionally, some approaches (except for Pharmaceutical and Environmental) were unfolded into categories. These categories grouped together indicators that have similar objectives (focus) and activity type (whether they focus on measuring waiting or productivity on the Operational approach, costs or profits on the Financial approach, human resources or physical resources on the Resources approach). Figure 11 illustrates

the relationship among each approach and its categories.

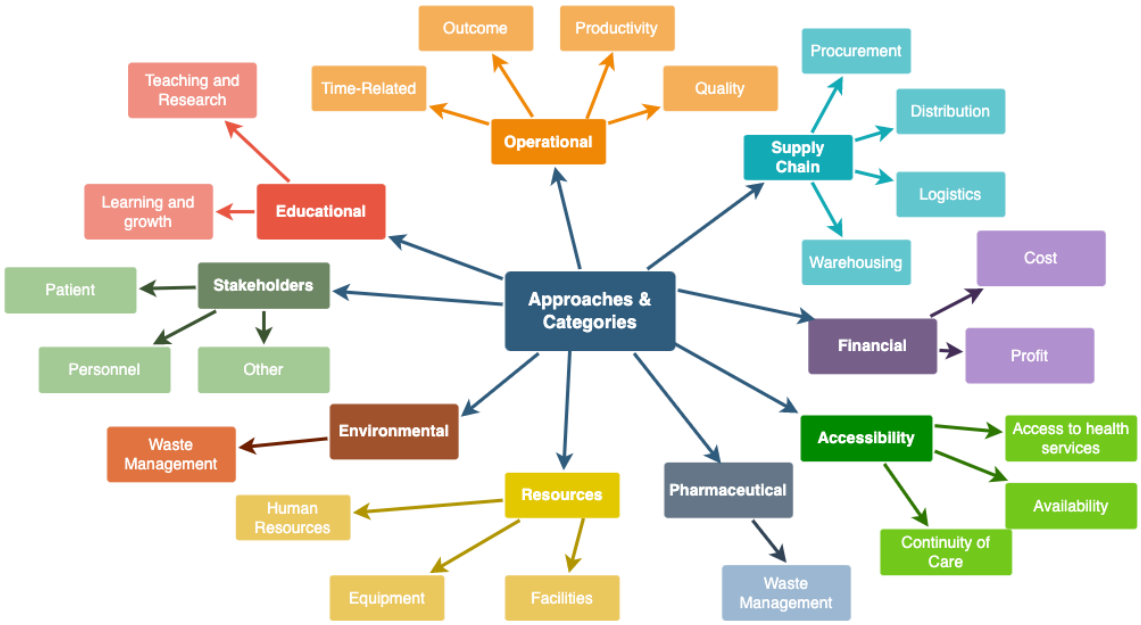


Figure 11 – Main Approaches and Categories of KPIs

Table 8 presents the main approaches, their respective categories, the number of indicators for each category and how many articles from the sample addressed each category.

The three most predominant approaches are Operational, Resources, and Financial. Operational includes categories addressing Time-Related, Outcome, Efficiency, and Quality measures. The Time-Related KPIs measure the time patients spent in different departments and process as extended waiting times are broadly recognized as having negative effects on patients and on processes' efficiency, being highly recommended to be monitored (VANBRABANT et al., 2019). Therefore, KPIs such as "Length of Stay", "Time for Room Change", and "Average Admission Time" (FROSINI et al., 2016; MEENA; THAKKAR, 2014; NÚÑEZ et al., 2018) are covered by this category. Outcome indicators are related to the effectiveness of the internal processes and the care provided (ASKARI; SHAFII; BAGHIAN, 2016; CHORFI; BENABBOU; BERRADO, 2018). Thus, there are two types of Outcome KPIs: Process (that includes KPIs such as "Left Without Being Seen", "Rate of readmission within 30 days of discharge", and "Bed Turnover Rate") and Care (that includes KPIs such as "Remaining Patient Care Load", and "Nursing interventions for prevention and promotion" (AJMI, Faten et al., 2019; DI LEVA; SULIS, 2017; DUBOIS et al., 2017; YA et al., 2015; NÚÑEZ et al., 2018; WILER et al., 2015).

Approach	Category	Number of KPIs	Number of Articles	Most Cited Article
Accessibility (n = 10)	Access to health services Continuity of care Availability	7 1 2	6	Soranz, Pinto, and Camacho (2017)
Supply Chain (n = 30)	Procurement Warehousing Distribution Logistics	8 5 6 11	3	Chorfi, Benabbou, and Berrado (2018)
Financial (n = 73)	Cost Profit	60 13	21	Meena and Thakkar (2014)
Stakeholders (n = 35)	Patient Personnel Others	17 15 3	13	Lima, Aguiar, and Storpirtis (2019)
Resources (n = 104)	Facilities Equipments Human Resources	20 43 41	33	Shohet and Nobili (2016)
Pharmaceutical (n = 12)	Medication management	12	4	Lloyd et al. (2016)
Operational (n = 432)	Time-Related Outcome Quality Productivity	161 130 33 66	57	Wiler et al. (2015)
Educational (n = 14)	Learning and growth Teaching and Research	8 6	6	Shabaninejad, Mirsalehian, and Mehralian (2014)
Environmental (n = 5)	Waste Generation	5	1	Moreira and Günther (2016)

Table 8 – Number or articles addressing each approach and number of KPIs for each category

Productivity KPIs are related to the demand and capacity of internal processes per time or resource, such as ”The number of births attended by skilled health personnel” or ”Number of admissions per day” Bittencourt, Verter, and Yalovsky (2017) and Argaw et al. (2021). Finally, the Quality measures, on the other hand, refers to the overall quality of care and compliance of health services in health facilities and are represented for KPIs indicating outcome rates of general recovery, patient and environment safety, incidents, risks, etc. “Number of notifications of undesirable effects”, “Mortality rate”, and “Quality improvement index” (CHORFI; BENABBOU; BERRADO, 2018; DI LEVA; SULIS, 2017; YA et al., 2015).

Resources addresses all KPI's related to Human, Equipment, and Facilities (structure) assets, their utilization rate, maintenance, capacity, and management. They can help with the follow up of the resource capital used to provide health care. Resource management is crucial in the healthcare sector due to its complex and unpredictable behavior and can help in critical situations, such as overcrowding caused by unexpected demand as the one occurs in pandemic situations, for instance (OUEIDA et al., 2018; LEE et al., 2020). Indicators such as “Proportion of doctors from total hospital staff”, “Urgent repair request indicator”, and “Bed Occupancy Ratio” are some KPIs from the Resources dimension (BARLIBA; TITA, 2014; ENSHASSI; SHORAFA, 2015; RAMOS et al., 2015).

Besides patient safety and quality of service, healthcare organizations have been paying more attention to their financial performance (ALMUSAWI; ALMAGTOME; SHAKER, 2019). In light of this interest, KPIs can help monitor and keep costs, investments, and acquisitions under observation. The 66 financial KPIs found on the 50 articles examined in this study were divided into two categories: Costs and Profits. Costs refers to all indicators monitoring expenditures and expenses such as “Mean cost per patient” or “Annual maintenance expenditure” (CHRISTODOULAKIS et al., 2016; ENSHASSI; SHORAFA, 2015) and Profits indicates KPIs measuring earnings and returning such as “Productivity and profitability” and “Net Profit Margin” (BEHROUZI; MA'ARAM, 2019; MEENA; THAKKAR, 2014).

Stakeholders are individuals or businesses with a special interest or concern for an organization or its service provided. In healthcare organizations, they can be perceived as patients, personnel, community, government, or supply chain players, for instance. Once they influence and are influenced by how the organizations perform, it can be of interest to follow more closely how they respond to the service provided and operational

performance (NÚÑEZ et al., 2018; SHABANINEJAD; MIRSALEHIAN; MEHRALIAN, 2014). The dimension Stakeholder takes into account all KPIs described in the literature found willing to provide data, and therefore, information about patients', personnel, and other stakeholders' satisfaction, such as departmental and home care services (CATUOGNO et al., 2017; PORPORATO; TSASIS; MARIN VINUESA, 2017).

Even though the KPIs for the supply chain appear less frequently in this study, they cannot be dismissed, as supply chain management is a crucial foundation for health care organizations. According to Chorfi, Benabbou, and Berrado (2018), it improves the quality and responsiveness to patients' wants and needs. Here, Supply Chain is divided into its identified processes: Warehousing, Procurement, Distribution, and Logistics. All KPIs related to Supply Chain dimension in this work are closely related to support processes of the pharmaceutical industry as 3 out of all three articles containing their indicators are considering this sector as mainly application or observation setting (CHORFI; BENABBOU; BERRADO, 2018; SHABANINEJADA; MIRSALEHIANB; MEHRALIAN, 2014; TADLAOUI; CHAFI; ENNADI, 2018).

On the other hand, the KPIs classified exclusively as Pharmaceutical indicators are related to either its industry or to the pharmacy's role within hospitals and are separated into two categories: Industry and Medication Management. Pharmacies, in general, have a great contribution to patient's care and monitoring them can help to enhance and allow a scenario of professional and quality improvement, better workload allocation and management (LLOYD et al., 2016). As for Medication Management indicators, the literature presents "Medication dosages", "Pharmaceutical consultations provided", and "percentage of patients who have a complete and accurate list of their current medications" (LIMA; AGUIAR; STORPIRTIS, 2019; LLOYD et al., 2016; WILER et al., 2015).

The Educational dimension refers to both the ongoing training and improvement of healthcare employees and the use of hospitals for research and academic practice. Thus, the KPIs were split into two categories: Learning and Growth and Teaching and Research. KPIs such as "Training rate", "Percentage of employees trained", and "Number of training hours on improvement culture" show the concern of healthcare institutions with employee development and instruction (BEHROUZI; MA'ARAM, 2019; NÚÑEZ et al., 2018). This concern is justified not only because well-trained employees contribute to efficient internal processes and quality of care, which are a sign for competitive advantage, but also because the healthcare sector is constantly changing and evolving in terms of

practices, technology and procedures, for instance (NÚÑEZ et al., 2018). Otherwise, “Supervision of Internship and Residence” and “Number of existing financed research projects” are some indicators only regarding teaching and academic research performed within healthcare organizations (CATUOGNO et al., 2017; MOHAMMADI et al., 2016).

Accessibility category contains KPIs indicating the level of healthcare access, coverage, and continuity of care and it appears in 6 articles. Even though they address different scenarios, they covered very similarly indicators. “Proportion of spontaneous vs. scheduled demand”, “Rate of service portfolio items implemented”, “Rate of health coverage”, and “Rate of basic health insurance coverage” helps to monitor possible demand and coverage of the healthcare institutions (CHORFI; BENABBOU; BERRADO, 2018; SORANZ; PINTO; CAMACHO, 2017). Information about the demand of healthcare institutions can support strategic and operational planning and decision-making, which are crucial for both supply chain players and PHCs. The only KPI specific to a single configuration is “Proportion of consultations performed by own family doctor”, which is specific for PHCs. As stated by Soranz, Pinto, and Camacho (2017), it allows the verification of the extent of the family doctor’s involvement and monitoring of individuals who reside in the areas covered by the [family health] teams.

Lastly, Environmental dimension is only covered by one article that appears in this study. Moreira and Günther (2016) discussed how primary healthcare facilities should plan, implement and monitor waste management actions to avoid environmental impacts. Waste generator indicators such as “Daily amount of total generation”, “Daily amount of total generation by group of waste”, “Generation rate per outpatient assistance”, “Rate of infectious and sharps waste generation”, and “Waste generation rate per outpatient procedure performed in critical areas” were the KPIs presented as used in the literature to assess whether measures for reducing waste production and improve waste management are adopted.

5.1. Healthcare Settings x KPIs

By analyzing the approaches that most appear in each healthcare facilities, it is possible to know which aspects stood out more for each one. Figure 12 presents

the parallel between the healthcare facilities and the KPI dimensions addressed in this work. Each color represents a dimension and the size of each bar is the frequency each dimension appears for each healthcare facility.

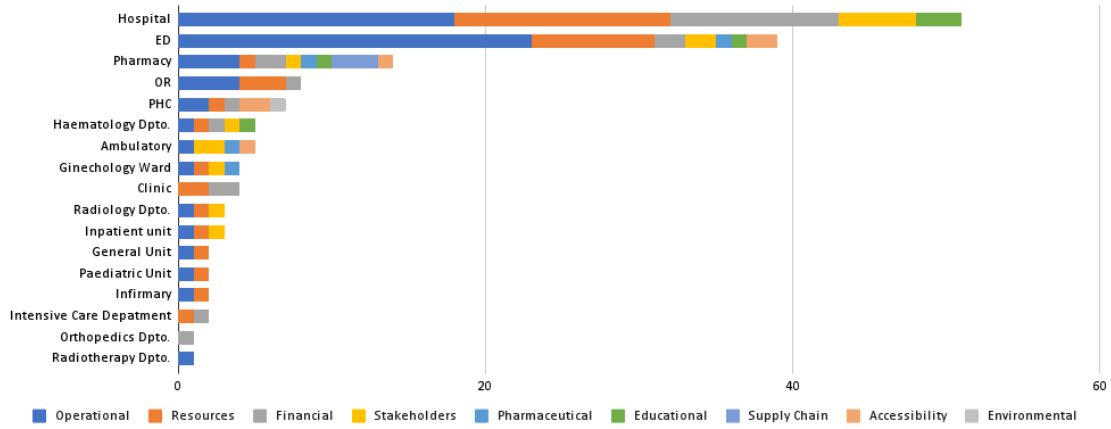


Figure 12 – Number or articles addressing each dimension and number of KPIs for each setting

Even though Hospital is the most addressed healthcare setting regarding KPI measurement (as seen in Section 4.2), it does not cover the greatest number of categories. On the other hand, it is the one in which the categories covered appear more frequently. Thus, the 5 categories that appear in the articles analyzing hospitals are Operational (18), Resources (14), Financial (11), Stakeholders (5), and Educational (3), in which the value in parenthesis represent the frequency in which each category appears.

The second most studied setting (ED) is also the second setting covering more categories (6 categories). The dimensions Operational (23), Resources (8), Stakeholders (2), Accessibility (2), Financial (1), Pharmaceutical (1), and Educational (1) are also the second appearing more frequently. All 23 articles analyzing EDs presented Operational indicators, which can be related to the fact that resource management and time-related measures (such as personnel utilization, occupancy, and length of stay) are subjects of interest of emergency services as they directly impact its quality of care and health outcomes.

Pharmacy is the setting with more types of KPIs, being monitored by 7 categories. Only Environmental and Stakeholder KPIs were not applied in the articles studying pharmacies. Operational (4), Supply Chain (3), Financial (2), Pharmaceutical (1), Stakeholders (1), Accessibility (1), Resource (1), and Educational (1) KPIs were used to measure the performance of pharmacies.

Operational and Resources are the categories appearing in more settings: 14 settings each. The only settings not containing Operational KPIs are Intensive Care Department, Orthopedics Department, and. Clinics. Ambulatory, Radiotherapy Department, Orthopedics Department do not have any KPIs monitoring their resources. In contrast, Supply Chain and Environmental are the dimensions appearing in less settings: one setting each. Even though Supply Chain KPIs were covered in 3 articles, all 3 were applied in pharmacies.

6. KPI Normalization

As seen in Chapter 5, all 23 articles analyzing EDs addressed Operational indicators, showing that guaranteeing the best performance of EDs is a common objective of HC researchers and practitioners. This result is in accordance with the fact that time-related and outcome measures are subjects of interest of emergency services as they directly impact the perception of quality of care and patient satisfaction. According to Di Leva and Sulis (2017) and Vanbrabant et al. (2019), EDs have been facing shortage of resources, long waiting times, and overcrowding, which leads to a high-stress environment filled with dissatisfaction and inefficiency. This combination is dangerous to the quality of healthcare as ED is its main point of entry, offering non-stop care and being responsible for the triage of patients, taking care of their first needs and referring them to more specialized fields and facilities if needed.

From the 23 articles, we retrieved 210 performance Operational indicators related to ED performance measure. Figure 13 shows how these indicators fall into the Operational categories.Time-Related and Outcome measures, as stated before, stood out as the focus of Operational ED performance measures studies.



Figure 13 – Number of KPIs classified into Time-Related, Outcome, Productivity and Quality categories

All the 210 indicators were more deeply analyzed to understand how they were being defined, what they were measuring and how they were measuring it. Each indicator

were read, listed, and redefined 3 times to decrease subjectivity, and each time a seemingly defined KPI was found in terms of nomenclature, description or mathematical formula, they were classified as the same metric. Each KPI was ranked as they attended the following criteria:

1. Reliability and Validity: it can measure its target regardless of time and context
2. Goal-Oriented: its formulation translates the goal to which it was applied
3. Consistency: it should be as general as possible without reducing its utility or specificity

After the analysis, it was noticed 15 indicators with similar name and purposes with more than 1 definition, which met all criteria. As known, inconsistencies in the definition of seemingly identical KPIs negatively impacts its generalizability, which causes benchmarking, comparability, reliability, and certainty more challenging. Table 9 presents the indicators and how many different inconsistencies of name or definition were found for each one in the analyzed sample.

Indicator	Number of inconsistencies
Length of Stay	17
Left without being Seen	15
Admission Rate	14
Door-to-Treatment Time	10
Average Admission Time	09
Door-to-Doctor time	08
Average Waiting Time	07
Average Triage Time	05

Table 9 – Number inconsistencies of name or definition found for each KPI

The most recurrent definitions for each indicator is presented below. Length of Stay (LOS) have a total of 17 different definitions. Usually, it is most described as the time a patient spent in the ED. However, for instance, Faten Ajmi et al. (2019) and Vanbrabant et al. (2019) defined the LOS time as ”the time window spent by the patient in the ED from admission to discharge”. On the other hand, defined as ”the total time patients spent in the ED before even being admitted” (ALISHAHI TABRIZ; TROGDON; FRIED, 2019; WILER et al., 2015; AJMI, Faten et al., 2019; AJMI et al., 2017; VANBRABANT et al., 2019; ALISHAHI TABRIZ; TROGDON; FRIED, 2019; DI LEVA; SULIS, 2017; OUEIDA et al., 2018; YOUSEFI; FERREIRA, 2017). Left without being Seen (LWBS) is usually

defined as ”the percentage of patients who drop out of the ED during the time between the triage process and before the first consultation regardless of whether or not they have been to triage”, ”the total number of patients who choose to leave the ED against the advice of the physician”, ”the number of patients that leave the ED when they find long queues and have to wait longer than what they can tolerate”, ”the number of patients who arrive in the main entrance but leave because of either a long waiting time or a full waiting area” or ”a triaged patient who is not medically reviewed or treated under a recognised model of care prior to leaving the ED” (AJMI et al., 2017; AJMI, Faten et al., 2019; WILER et al., 2015; YOUSEFI; FERREIRA, 2017; DEHGHANIMOHAMMADABADI; KABADAYI, 2020).

Throughout the literature, Admission Rate is perceived as the ”Average daily census: number of patients per day at emergency unit”, ”Patient rate: the patient rate per time of day”, ”Overall patient admission: % admissions to the observation unit”, and ”Admission ratio: the ratio of patients who were admitted to the patients who requested admission” (DI LEVA; SULIS, 2017; NÚÑEZ et al., 2018; VAINIERI; PANERO; COLETTA, 2020; DEHGHANIMOHAMMADABADI; KABADAYI, 2020). As for Door-to-Treatment Time, the most recurrent definitions were ”the time between arrival and diagnosis”, ”time to receive first analgesic”, ”time to receive first antibiotic”, ”average time for medical or nursing procedures” or ”arrival to treatment space time” (GANNON et al., 2017; DI LEVA; SULIS, 2017; GANNON et al., 2017; NÚÑEZ et al., 2018; WILER et al., 2015; DEHGHANIMOHAMMADABADI; KABADAYI, 2020; HASAN, I.; BAHALKEH, E.; YIH, Y., 2020).

Average Admission Time was constantly defined as ”Boarding time: time from admission decision to ED departure for admitted patient”, ”Average boarding time: the difference between admission start time and patient arrival time over the number of patients” or ”Average admission waiting time: the admission end time (collection) minus the admission start time (collection)) over the total number of patients” (ALISHAHI TABRIZ; TROGDON; FRIED, 2019; NÚÑEZ et al., 2018; VANBRABANT et al., 2019).Door-to-Doctor Time presented the following definitions: ”First Consultation Time: the time interval spent by the patient between the arrival in the ED and his/her first consultation by a physician”, ”Waiting Time (doctor): time from door to diagnostic evaluation by a qualified medical professional, including triage”, ”Time to bedside consultation: timeliness of bedside consultation by a (any) doctor”, ”Average waiting time to arrive to the internal consulting

physician: (time of arrival to internal consulting physician calling time of internal consulting physician) / No of patients cared for by consulting physician", and "Door-to-doctor time: mean time to see a physician, from patient registration to documented time of physician encounter for all patient" (AJMI, Faten et al., 2019; ALISHAHI TABRIZ; TROGDON; FRIED, 2019; DI LEVA; SULIS, 2017).

Average Waiting Time presented the following definitions: "ED waiting times: the average time patients spend waiting in queues", "Waiting times: the average patient total time in the ED minus the average patient treatment time over the number of discharged patients" or "Total waiting times: the total time a patient is in the ED not receiving any attention from staff"(GANNON et al., 2017; NÚÑEZ et al., 2018; OUEIDA et al., 2018).Average Triage Time is usually defined as the "median of triage time in each triage level" or as the "total time required for a patient's triage in each level over the total number of patients in same triage level" or "time interval from when the triage or intake is initiated by an institutionally credentialed provider to the time when triage is completed" (DI LEVA; SULIS, 2017; MOHAMMADI et al., 2016; NÚÑEZ et al., 2018; WILER et al., 2015).

Therefore, to diminishes the inconsistency of these metrics, they were chosen to be normalized based on the FASStR (Focus, Activity, Statistic, Scale type, and Reference) Framework, proposed by Torabi et al. (2020). Reference was not used as it makes more sense to be defined for application purposes according to each ED strategy. Each dimensions of this framework is presented in Figure 14 bellow.

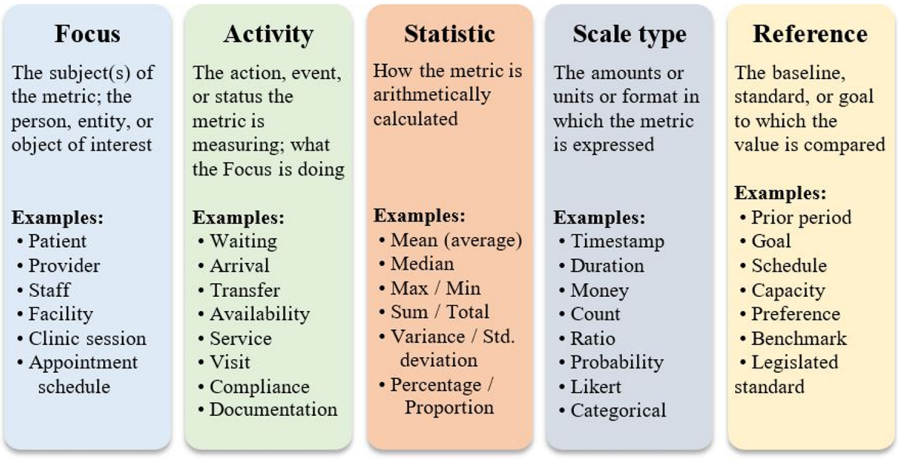


Figure 14 – Dimensions of the FASStR Framework
(Source: Torabi et al. (2020))

The result of the normalization of the KPIs is presented in Table 10:

Metric	Focus	Activity	Statistic	Scale type
Lenght of Stay	Patient	The total time a patient waits from the time he is registered in the front desk to the time he is discharged, admited, transfered or referred	Total	Time Stamp
Left Without Being Seen	Patient	The percentage of patients who registers in the front desk but leave because of either a long waiting time. It includes patients who complete the triage process.	Percentage	Ratio
Door-to-Treatment Time	Patient	The total time a patient waits from the time he is registered in the front desk to the time he receives the starts medication/procedure.	Total	Time Stamp
Admission Rate Capacity	ED utilization capacity	The amount of patients per day admitted in the ED over the bed capacity of the ED	Proportion	Ratio
Door-to-Doctor time	Patient	The total time a patient waits from the time he is registered at the front desk to the the time he is first seen by a physician	Total	Time Stamp
Average Waiting Time	Patient	Average patient Length of Stay minus average patient treatment time over average number of discharged patients	Mean	Time Stamp
Average Triage Time	Patient	Sum of total time all patients spend in the triage room over the number of patients who entered the triage room. It is better measured if it is calculated by the level of urgency.	Mean	Time Stamp
Average Wait Time for a Bed	ED utilization capacity	The sum of the difference in the time a patient spent waiting for a bed after the decision of being admitted minus the time he was actually admitted over the number of patients admitted	Mean	Time Stamp

Table 10 – Application of FASStR for each Operational ED-PMM KPI with recurring inconsistencies

7. Conclusions

This work sought to gather information about how Key Performance Indicators have been used in the past 5 years in the healthcare sector by means of a systematic analysis of the literature using the PRISMA protocol. Therefore, a qualitative analyses was carried out to achieve the main objective of this research: to understand the state of the art of Key Performance Indicators in healthcare and delineate not only which types of KPIs have been being employed, but also what aspects are being monitored within several healthcare institutions. These aspects are were translated into dimensions in which the KPIs were categorized on.

First of all, it is important to understand that the use of indicators in healthcare is a vast field of research and addresses both clinical and operational approaches. However, performance measurement by means of KPIs in healthcare institutions focusing on their internal, operational, and business processes is a crescent. The temporal analysis stated its importance in the academic field as there was an increase in both the number of publications and citations in the last 5 years.

The qualitative analysis showed that the KPIs explored by the articles could be categorized into 9 approaches based on their purpose and definition: Accessibility, Supply Chain, Resources, Stakeholder, Financial, Operational, Environmental, Educational, and Pharmaceutical. Operational KPIs, which monitor internal processes, outcomes, and time-related measures, were the most frequent approach followed by Resource (monitoring human, facility, and equipment resources) and Financial (monitoring costs and profits) KPIs. These three approaches reflect the three pillars that are constantly addressed in the overall management of the health system: care, service, and business.

Within this context, we observed that Hospitals and Emergency Departments stand out as the main healthcare settings of study where KPIs are explored. This finding is in accordance with the role of these institutions in the healthcare settings: while emergency departments are the main point of entry of the sector, hospitals concentrate the biggest share of resources and efforts. Thus, their performance reflects directly on the performance of the health system they are part of. Pharmacy also is highlighted as an important healthcare setting as it is industry and service (medication management) is

directed related to patient care.

An additional find of this work during the analyzes made is that KPIs have been described and defined differently by many scholars and practitioners. Thus, a same KPI have been found to have multiple formulations and descriptions, which make it difficult to compare performance between different healthcare organizations and to understand the main objective of these measures. Therefore, to diminishes the inconsistency of the retrieved metrics, Operational KPIs applied to ED-PMM were chosen to be normalized based on the FASStR (Focus, Activity, Statistic, Scale type, and Reference) Framework. As the normalization was done in a conceptual level, the Reference dimension was not included. Length of Stay, Left without being Seen, Admission Rate, Door-to-Treatment Time, Average Admission Time, Door-to-Doctor time, Average Waiting Time, and Average Triage Time were the most frequent KPIs with most different definitions or nomenclature among all the 211 Operational ED-PMM KPIS and therefore chosen to be normalized. As future research, we recommend the validation of these definitions as well as the establishment of the Reference dimension of the FASStR in a working ED environment. Also, we suggest an analysis about how to measure these KPIs by applying Industry 4.0 technologies and elaborating solutions based on the current conceptual methods of the cloud-assisted internet of things applications.

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