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Trends in research on healthcare facility management: an overview of the last decades

Tendencias en la investigación sobre gestión de establecimientos de salud: un panorama de las últimas décadas

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Abstract

The authors have carried out a review of facility management in the health sector researches, through a detailed analysis of the most important publications of recent decades, to identify the main topics developed. The authors obtained more than 200 documents with the bibliographic searches in several databases after consolidating and filtering them. This led the authors to design a methodology to analyze a more select group of publications: the evolution of the most recurrent themes according to the year of publication, the countries and the institutions involved. The results of the analysis of the select group of publications show that interest in facility management in the health sector is on the rise, as well as the number of institutions and authors interested in at least 11 research topics. However, the authors estimate that the topics published in recent decades still do not cover the current demands of hospital institutions.

Key words: Trends, Facility management, Healthcare institutions, Review.

Resumen

Los autores han llevado a cabo una revisión de las investigaciones sobre facility management en el sector sanitario, a través de un análisis detallado de las publicaciones más importantes de las últimas décadas, para identificar los principales temas desarrollados. Los autores obtuvieron más de 200 documentos con las búsquedas bibliográficas en varias bases de datos luego de consolidarlas y filtrarlas. Esto llevó a los autores a diseñar una metodología para analizar un grupo más selecto de publicaciones: la evolución de los temas más recurrentes según el año de publicación, los países y las instituciones involucradas. Los resultados del análisis del selecto grupo de publicaciones muestran que el interés por el facility management en el sector salud va en aumento, así como el número de instituciones y autores interesados en al menos 11 temas de investigación. Sin embargo, los autores estiman que los temas publicados en las últimas décadas aún no cubren las demandas actuales de las instituciones hospitalarias.

Palabras clave: Tendencias, Gestión de Instalaciones, Instituciones de Salud, Revisión.

Introduction

The Facility Management (FM) discipline has been linked to the architecture, engineering, and management professions since the early 1970s in the United States of America, when the first professional association was created. Currently, FM is considered a discipline that integrates different professions "...in order to influence the efficiency and productivity of the economies of societies, communities and organizations, as well as the way in which individuals interact with the environment built" (UNE, 2018). In other words, FM brings together all the activities and support services, as well as providing solidity to organizations through added value to the management of real estate assets (Castellanos-Moreno, 2014). According to Madroñal-Ortiz, Cuartas-Ramirez, Benavides-Velasco, and Osorio (2022), the scope of FM functions within organizations encompasses both hard and soft FM areas. The hard FM areas include Facilities Services Management, Energy and Sustainability Management, and Maintenance and Asset Management. On the other hand, the soft FM areas comprise Property and Real Estate Management, Corporate Project Management, and Workplace Management.

In the case of health institutions, FM competencies have been assumed by the clinical, hospital or physical infrastructure engineering departments (Noor, Magray & Chawla, 2016). On the one hand, these FM competencies are focused, in large part, on

reducing the fixed costs of the secondary activities of health institutions (associated with the maintenance and support of the main activity) that represent the 5-17% of the main annual expenses. According to the German Hospital Society (Banedj-Schafii, 2010), that 34.6% of the expenses of a hospital are within the support services (non-assistance) covered by the FM. On the other hand, FM has focused on the life cycle of the infrastructure of health institutions to face different challenges of adapting their physical infrastructure (buildings, green areas, roads, etc...) due to new medical technologies and techniques, as well as organizational and demographic changes in the population. Related to this topic, the level of adaptability of a building varies depending on a complex range of economic, political and technological factors, whose interaction can lead to design results that are not necessarily rational or optimal if they are analyzed in retrospect or if they are taken out of context (Pinder, Schmidt & Saker, 2013). In addition, the impact of modern construction methods and stakeholders concerning the compromise of the first use of a building must be weighed.

For decades, it has been possible to identify a mere operational position of hospitals, focused on maintenance, as opposed to a strategic focus of the FM that allows a more holistic vision and the interaction of the stakeholders of health institutions (Bjørberg & Verweij 2009). To understand the scope of FM in the health sector, it is important to consider that this discipline involves more areas of the organization than the sole functions usually performed by the so-called General Services, Maintenance Service or Clinical Engineering; since this discipline aligns support activities with organizational goals, strategies, and plans. This FM alignment has been gaining space in health institutions to take a more strategic role in support activities and, therefore, it is necessary that the same alignment be reflected in hospital infrastructure management models (Støre-Valen, Larssen & Bjørberg, 2014). In any case, FM offers alternatives in health institutions to overcome the challenges of the sector, exposed above, and for this reason it is important to review the research trends on its application in this sector worldwide.

The authors of this work estimate that the needs of FM during the last decades have been changing according to the needs of the organizations and the introduction of this discipline in the different industrial sectors. It is even estimated that research topics have evolved over time. Therefore, the objective of this work has been to identify the recurrence of research on FM in the health sector in recent decades to identify patterns in the themes, the different scenarios, and the maximum exponents of FM in this sector.

Materials and methods

Search and filtering of studies

This work began with a literature review that offered a vision of academic research and its contribution to the knowledge of the field of study (FM in the health sector) carried out in last decades. This bibliographic review on FM at the international level in the health sector took into consideration the following aspects:

- The analysis of the documents published in various categories since the recognition of FM as a discipline from the 70s to 2018 in the databases (Scopus and Web of Science).

- The assessment of the importance of publications through impact indicators: impact of papers, citations, and impact of indexed journals.

- The analysis of evolution, status, trends and potential areas of future research related to FM in the health sector, using methods and bibliographic indicators.

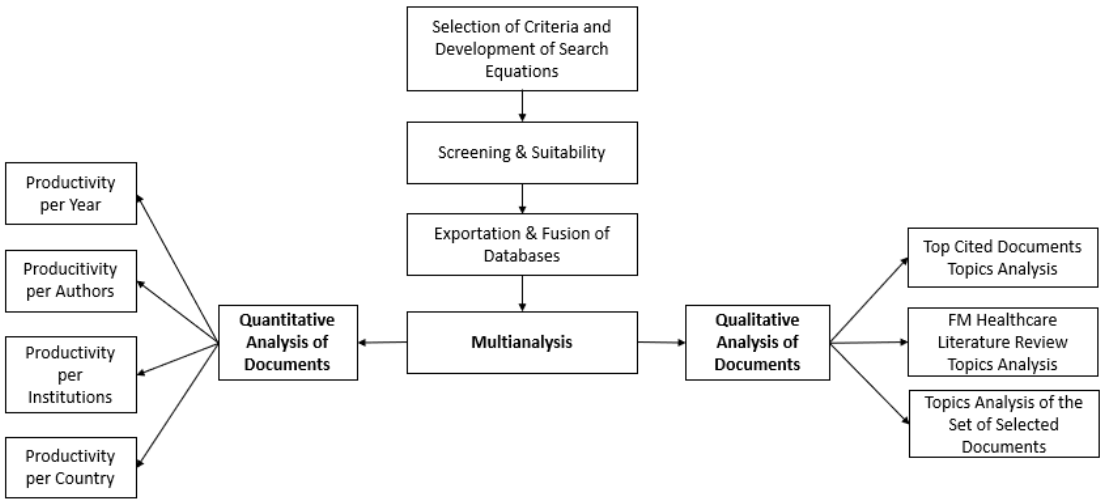
In this work, the English language was used exclusively for the searches due to its hegemony in the dissemination of publications and, more specifically, to obtain a greater number of citations received by these FM research works. Therefore, the search equations in the different databases were the following:

- In Scopus: [("Facilities Management" OR "Facility Management") AND (Healthcare OR "Health-care" OR "Health" OR Clinic* OR Hospital)]

- In Web of Science: ("facility management" OR "facilities management") AND (hospital OR healthcare OR clinic*)

The authors of the work designed a methodology to obtain the most suitable results on the searches in the databases (Scopus & Web of Science), as shown in Figure 1. Firstly, the previously mentioned search equations that reported interim results. Secondly, a screening of the provisional results was carried out, discarding those records without a summary, anonymous or of another subject. Thirdly, those selected who had the entire text were ordered to be analyzed in later phases. Fourth, those suitable records selected in the previous step were merged with specialized software (VantagePoint™). Fifth, the duplicate records were reviewed after the merger and, therefore, discarded to finally obtain the definitive results of publications appropriate to the research topic.

Figure 1. Flowchart of the work methodology



Source: Authors

Matrix of results

Next, the authors estimated that if the number of definitive results was too large to be able to carry out an adequate analysis, the most representative group of records had to be selected. For this, an analytical system of the most important documents of this review was developed, with the elaboration of a square matrix made up of the number of definitive results in rows and columns to cross the citations of each of the records. In this way, the records could be sorted by publication date, in ascending order according to age. On the one hand, a review of the references of each of the "definitive results" documents was carried out to identify if they were cited in the documents of this group later and were reflected in the "Y" column with the sum of citations.

On the other hand, in the most recent publications, it was reviewed if documents from this same selected group appeared previously published in their references and they were reflected in row "X" with the sum of citations. Therefore, in column "Y" is the sum of the most influential records within the set of selected documents "definitive results" and in row "X" is the sum of the records of the most influenced publications of the same set. Once the document matrix was developed, the most cited documents and the most influenced documents within the group were identified, in addition, the documents with the most citations from both databases and the reviews of the literature on FM in health services. All these documents would be added, merged and those duplicates would be deleted to carry out the subsequent analysis.

Document Analysis

The resulting documents were analyzed through a detailed reading of their summary, the identification of the methodology used, the results obtained and the conclusions of the investigation. This analysis allowed the authors to determine not only the specific topic of the document but also to associate it with a specialty or field of research within the FM in health, since it was necessary to condense the number of topics carried out in several decades.

Results

The authors were able to obtain a total of 243 documents for the analysis of the international literature review of the FM in health in the search and filtering works in the two bibliographic search engines. Table 1 shows the number of records obtained in each of the phases of the screening process until obtaining the appropriate information on the subject, with the suitability, fusion and duplicate checking subprocesses to avoid repetitions in the databases of Scopus and Web of Science (WoS).

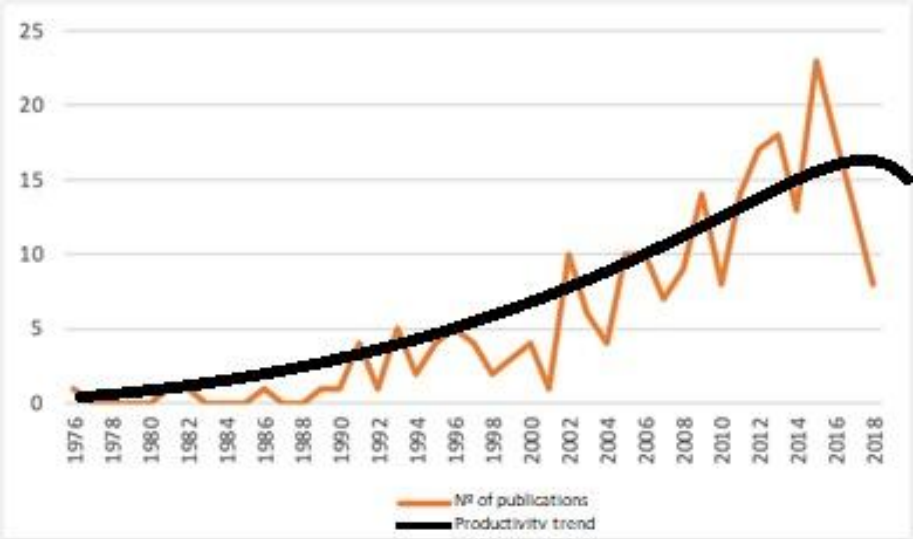
Table 1. Summary of the records found in the screening process

Provisional Results	Records identified in WoS database (n = 224)	Records identified in Scopus database (n = 396)
Screening	Anonymous and non-summary records (n = 26) Records by theme (n = 67) Total records excluded (n = 93)	Records by theme and without summary (n = 193) Patent records (n = 23) Total records excluded (n = 216)
Suitability	Records available for selection (n = 131)	Records available for selection (n = 180)
Database Fusion	Merged records (WoS - Scopus) n = 311	
Duplicate Check	Duplicate records in both databases (n = 68)	
Definitive Results	Records merged for analysis (n = 243)	

Source:Authors

In this selection of 243 records, it was possible to identify a growth pattern in the publication of scientific articles in various journals and conference abstracts from 1976 to 2018 (Figure 2). This means that interest in the FM discipline in the health sector has been growing gradually in the last four decades at the international level.

Figure 2. Productivity trend and number of publications per year



Source: Authors

In this selection of the 243 documents of the literature review, it was possible to identify the authors, research centers and countries that set the research trends in the FM discipline in the health sector. Table 2 presents the most relevant authors of the selection of documents that mainly come from Anglo-Germanic speaking countries (Israel, USA, United Kingdom, Australia, and Germany). In the analysis of the set of documents, it is contemplated that the publications are widely distributed among many countries, however, it is identified that the UK and the USA are the leaders in publications on FM in health.

Although the research centers and authors from the UK and USA correspond to just over 20% of the total number of selected documents, their importance is evident due to their Anglo-Germanic origin. However, other emerging countries appear with a transitory production in the FM discipline, such as Nigeria, Malaysia, Italy, and Spain; according to the transience indicators (Vallejo-Ruiz, 2005).

On the one hand, the authors carried out a quantitative analysis of the research that has caused the most impact in the scientific community of this selection of the 243 documents of FM in the health sector, considering the number of citations up to the date of the search. In this analysis, the 25 documents with the most citations published in indexed journals and/or congress articles were identified. A qualitative analysis was carried out on the summaries of these documents, in which it was noted that they have focused on the following 8 topics:

- Cost/Design, through the evaluation of the design of the infrastructure, the life cycle, and the simulation of its use to reduce operating costs.

- Decision-making for management, based on computerization, information, and communication technologies (ICTs) and systems for sustainable decision-making by facilities managers (FMer).

- Logistics, optimization, and monitoring of biomedical equipment, as well as users during their stay in the hospital institution.

- Integrated maintenance, with the study of the benefits of integrated systems and the simulation of hospital operations, for the rational allocation of resources.

- Emergencies/Catastrophes, through the preparation and management of risks linked to events that may arise with greater or lesser probability in hospitals.

- Healthcare-associated infections (HAI), with the impact of contamination for the control and spread of infections to improve medical care.

- Service Level Agreements (SLA) with stakeholders, which generate an added-value (AV) for the FM through agreements and contractual systems with the stakeholders of the health services.

- Management model/Key Performance Indicators (KPI), with the modeling of an integrated FM that manages the information for the development of strategic KPI and models to aid decision-making for efficient hospital operations.

Table 2. Authors, research centers and countries most important of the review

Authors	No.	Research Centers	No.	Country	No.
Shohet I.M. (IS)	8	Virginia Polytech Institute (USA)	7	USA	37
Lavy, S. (IS-USA)	7	University of New South Wales (AUS)	7	UK	28
Bulbul, T. (USA)	7	Texas A&M University (USA)	7	Israel	9
Loosemore, M. (AUS)	7	Clemson University (USA)	6	Australia	8
Liyanage, C. (UK)	6	Ben-Gurion University of Negev (IS)	6	Canada	8
Lucas, J. (USA)	6	Sheffield Hallam University (UK)	5	Germany	8
Lennerts, K. (DE)	5	Karlsruhe Institute of Technology (DE)	5	Nigeria	6
Egbu, C. (UK)	5	University of Uyo (NG)	4	Malaysia	5
Abel, J. (DE)	4	Pennsylvania State University (USA)	4	Italia	5
Thabet, W. (USA)	3	New Caledonian University (UK)	4	Spain	4

On the other hand, in the group of 243 initial documents, research on literature reviews on FM in health was identified, of which 20 documents published in journals, congresses and books. In the analysis of the 20 documents of the literature reviews, it was possible to identify that 70% were published in high-impact journals (Q1 and Q2) and the rest were published in abstracts of international congresses and in a book. This exposes that most of the reviews on FM are investigations that are of interest to high-impact journals, these documents have undergone an analysis of the conclusions to identify the research topics. In this analysis, various research focuses on FM in the health sector were found, instead of research topics, since each of the documents has a different focus on:

- The roles and responsibilities of the FM

- The scope of financial management within the FM

- HAI control

- Legionella control and risk management in IPS

- Performance measurement in FM and maintenance

- Sustainability in FM and maintenance

- Subcontracting in FM and supply services

- Patient safety between FM and medical care

- Other minorities

In this section, it was also identified that the authors, the research centers, and the Anglo-Germanic speaking countries that continue that set the research trends in FM in the health sector in recent decades. Considering the lines of research identified in the documents with the most citations, it is understood that aspects such as the design of buildings are important for the life cycle cost of hospital physical assets. In the operation of support activities, important aspects are related to the logistics of physical assets and the personnel in charge of said activities, as well as the preparation of the infrastructure for emergencies or catastrophes and the control of HAIs through FM.

From the coincidences in the conclusions of these documents, the authors of this work deduce that the development of management models and the development of KPIs for performance management are essential elements that help to obtain an integrated maintenance of the assets and to improve the agreements with stakeholders of the system. Above all, since the development of management models and performance indicators help senior management make decisions based on data and justify them to shareholders.

Once the main references for investigative impact were identified with the previous reviews of the discipline, the information of the group of the 243 documents obtained in the initial search was crossed and the 22 most influential records (most cited) within the group and the 19 most influenced records (with most citations) of the group of initial documents. In this analysis, the 25 records with the most citations in both databases were considered, in addition to 20 reviews of the literature on FM linked to health services.

All these records add up to 86 documents, some of which were merged, and others were deleted because they were duplicate, making a total of 57 publications. The study of research trends on FM in health has some limitations, it should be noted that a low percentage of the selected documents could not be found, but that percentage should not significantly affect the identification of existing thematic trends in this review of the literature.

This selected group of 57 documents identified as the most important (Table 3) was qualitatively analyzed to obtain the trends of the research topics related to the FM discipline in the health sector from 1981 to 2019. Table 3 shows the documents listed with the corresponding title, the year of publication and the main research topic, which is linked to the FM discipline in the health sector. A qualitative analysis of the

information was applied to this set of 57 selected publications by reading the summary and/or document to identify the theme, objective, methodology and conclusions.

Table 3. Set of 57 documents analyzed by research topics

No.	Authors	Theme
1	Kuzdrall, Kwak & Schmitz (1981)	Optimization of processes
2	Smith (1995)	Functions and competences of FMers in health
3	Simon, McLario, Daily, Lanese, Castillo & Wright (1996)	Optimization of processes
4	Akhlaghi (1997)	Benchmarking in FM processes in the health sector
5	Rees (1997)	Functions and competences of FMers in the health sector
6	Rees (1998)	Introduction of the FM within the executive boards of hospitals
7	Payne & Rees (1999)	Functions and competences of FMers in the health sector
8	Featherstone & Baldry (2000)	Strategic role of the healthcare FM
9	Okoroh, Gombera, John & Wagstaff (2001)	Healthcare FM in service level agreements with added value
10	Amaratunga, Haigh, Sarshar & Baldry (2002)	Processes optimization of the strategic objectives of the FM
11	Kirkham, Boussabaine & Awwad (2002)	Life cycle cost analysis
12	Schultz, Mothershead & Field (2002)	Preparing hospitals for bioterrorism
13	Lennerts, Abel, Pfründer & Sharma (2003)	Improvement of FM processes to save operating costs
14	Shohet, Lavy-Leibovich, & Bar-On (2003)	KPI for FM to control the maintenance of hospital buildings
15	Shohet & Lavy (2004a)	FM integrated model

No.	References	Theme
30	Lo, Guo & Chen (2011)	Maintenance costs
31	May & Pitt (2012)	FM cleaning plans in the health sector
32	Mohammadpour, Anumba, Bulbul & Messner (2012)	Improvement of health processes through FM
33	Chakkalakal, Cherlin, Thompson, Lindfield, Lawson & Bradley (2013)	The FM in the Ministry of Health for the design of clinical guidelines
34	Lucas, Bulbul & Thabet (2013)	Information management model for FM
35	Talib, Yang & Rajagopalan (2013)	FM strategic healthcare building performance
36	Irizarry, Gheisari, Williams & Roper (2014)	BIM and mobile augmented reality (MAR) for decision making
37	Ruiz-Ruiz, Blunck, Prentow, Stisen & Kjærgaard (2014)	Hospital logistics optimization
38	Windlinger, Hofer, Coenen, Honegger, von Felten, Kofler & Wehrmüller (2014)	Review of the FM for health in Switzerland
39	Ganisen, Nesan, Mohammad, Mohammed & Kanniyapan (2015)	The FM in the design of sustainable buildings
40	Beggs, Knibbs, Johnson & Morawska (2015)	Spread of Healthcare-associated Infections (HAI)
41	Hicks, McGovern, Prior & Smith (2015)	Participatory of healthcare facilities design
42	Lucas & Bulbul (2015)	Processes operation model
43	Baaki, Baharum, & Ali (2016)	Financial management for sustainable FM
44	Hashim, Sapri & Low (2016)	Challenges of the public private partnership (PPP) framework

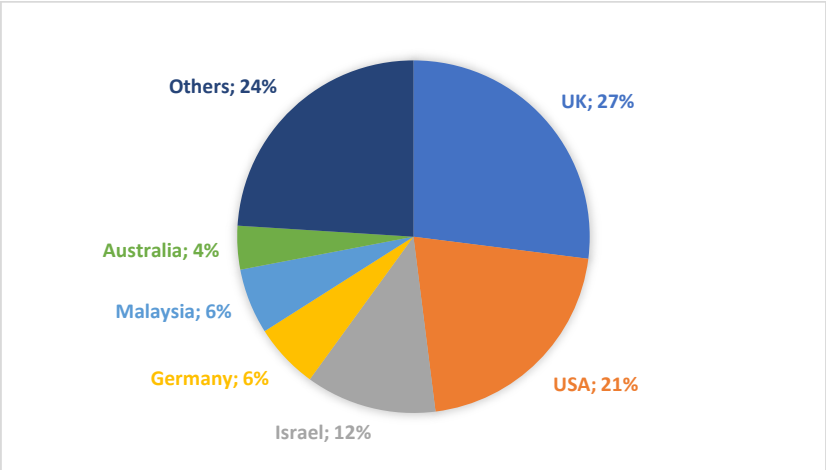
16	Shohet & Lavy (2004b)	Review of core issues for FM models	45	Leiblein, Tucker, Ashall, Lee, Gollnisch, & Hofer (2016)	Roles and responsibilities of the FM
17	Chaudhury, Mahmood & Valente (2005)	Private rooms with FM, operating costs and healthcare associated infections (HAI)	46	Madroñal, Galeano & Escobar (2016)	Identification of KPI for healthcare FM
18	Heng, McGeorge & Loosemore (2005)	Strategic functions of the FM	47	Mohammadpour, Anumba, Bulbul, Messner, Singh & Singh (2016)	Failure impact analysis
19	Lennerts, Abel, Pfründer & Sharma (2005)	FM processes analysis	48	Pheng & Rui (2016)	FM evaluation and patient satisfaction
20	Liyanage & Egbu (2005)	FM in control of healthcare associated infections (HAI)	49	Shohet & Nobili (2016)	FM model based on KPI and life cycle cost (LCC)
21	Beatty, Phelps, Rohner & Weisfuse (2006)	Improvements in business continuity plan (BCP) or emergencies for health services	50	Boge & Aliaj (2017)	Benchmarking studies of facilities services (FS) in hospitals
22	Shohet (2006)	KPIs in FM for financial management	51	García-Sanz-Calcedo & Gómez-Chaparro (2017)	Review of the FM and the standardization of its professional practices
23	Lavy & Shohet (2007a)	FM integrated quantitative model	52	Roper (2017)	Review of the FM and the standardization of its professional practices
24	Lavy & Shohet (2007b)	FM integrated quantitative model	53	Shohet & Lavy (2017)	FM performance in clinics and hospitals
25	Lavy & Shohet (2007c)	Annual maiwntenance expense indicator (AME)	54	Yousefli, Nasiri & Moselhi (2017)	Health maintenance management gaps
26	Ciarapica. Giacchetta & Paciarotti (2008)	FM service contracts and service level agreements	55	Chew, Conejos & Asmone (2017)	Sustainable FM linked to life cycle cost
27	Liyanage & Egbu (2008)	FM service performance management	56	Njuangang, Liyanage & Akintoye (2018)	FM services for healthcare associated infections (HAI)
28	Lavy & Shohet (2009)	Financial strategic decisions in the FM	57	Voordt & Jensen (2018)	Added value model of FM performance
29	Njuangang & Liyanage (2010)	Cleaning contracts and infections linked to the FM			

Source: Authors

In the set of 57 selected documents, 74% of the publications belong to journals with an impact index Q1-Q2, and the rest of the publications belong to sources of lesser impact such as conference summaries and/or peer-reviewed books. In the group of 57 documents are the same Anglo-Germanic speaking countries that set trends in research on FM in the health sector (Table 2). In this group of documents, it has been possible to identify the contribution of each country with the following percentages in Figure 3, in which almost 70% of the documents have been prepared by authors and/or institutions from the Anglo-Germanic sphere: USA, UK, Australia, Canada, Germany,

the Netherlands, Switzerland, Denmark and Norway. The other 30% of the documents belong to countries such as Israel, Malaysia, Spain, Italy, Singapore, India, China, and Colombia.

Figure 3. Countries and their contribution to this review of hospital FM



Source: Authors

Discussion

In the analysis of all the summaries of the 57 documents, it was possible to detect that these investigations could be classified into different themes. The 11 research trends identified in this review are as follows:

- Process management of the organization linked with FM

- Functions, competencies, roles, and responsibilities of FM

- The strategic positioning of FM in the organization

- The collaboration agreements with the facilities services (FS) companies and added-value (AV) of the FM

- Financial management, maintenance costs and life cycle costs through the FM

- FM models based on key performance indicators (KPIs)

- The performance of FM services through KPIs and customer satisfaction

- Management and control of HAI

- Emergency management and business continuity plan (BCP)

- Management of sustainability in the FM

- Other minorities

Likewise, it was verified that several of these research trends were developed for different research groups, being of interest, in several decades. Also, it was possible to relate other points of interest, such as the periods or countries involved in the following issues:

- The optimization of processes based on benchmarking to obtain improvements in FM models by reducing the impact of failures and, therefore, the reduction of forced stoppages of those critical activities in health institutions. This theme was practically developed by research centers in the USA from the 1980s to 2016, in which other countries such as Spain, Denmark and Germany have also ventured to a lesser extent.

- From the 1990s to 2017, the identification of the FMer was carried out, particularly in the UK; and the need to include this figure in top management to coordinate the functions, competencies, roles and responsibilities in health institutions. This has led to research on the standardization of professional practices to improve discipline through the learning of good practices guides.

- Research on FM in the strategic level is represented by research from the UK and to a lesser extent Australia, USA, and Israel in the last three decades (1990-2018). These were focused on positioning the strategic role of this discipline in decision-making and improving the performance of FM services for creating AV health services.

- An important aspect has been the generation of added-value (AV) in FM through collaboration agreements between organizations and stakeholders, through service contracts with FS companies and Public Private Participation (PPP). This has been dealt with by different countries such as the UK, Italy, Malaysia, and Norway that have promoted the development of an AV model of FM performance. Specially, the Netherlands and Denmark studied about the objectives, functions, and responsibilities of the AV of FM in health research institutions.

- In recent decades, the management and control of HAI has been linked to FM, because it is considered an important factor in controlling the spread of nosocomial infections within health institutions. These studies have considered from the architectural design of the type of room, both for individual use and those shared. Further, the impact of HAI on the operating cost, to the management and control of FM service contracts, especially from cleaning companies.

- The KPI for infrastructure management are essential for evaluating the performance of support activities in health institutions. These studies in the last two decades have focused on factors such as financial, environmental, technical, functional, managerial management, job security, and user satisfaction with health services. The studies

started in Israel, by Shohet & Lavy in the 2000s, have been continued mainly in Colombia, UK, Singapore, and USA in the next decade (2010-2018).

- In turn, a set of investigations in the last two decades related to the LCC in the management of physical assets linked to hospital FM, distributed in the countries of the UK, Germany, China, and Malaysia, were identified. In this topic, research has been carried out encompassed in financial management for a sustainable FM that relates: the analysis of LCC, the optimization of FM processes to reduce operating expenses, and the control of hospital physical asset maintenance costs.

- The BCP is a topic linked to the preparation of hospitals for bioterrorism, improvements in emergencies for health services and factors in the design strategy of clinical guidelines for low-income countries. These publications come from Germany, UK, and USA centers in the last two decades. This theme may be recurring for years to come, even more so in view of the global COVID-19 pandemic.

- Sustainability in FM has been an underdeveloped topic in the health sector, even though it is current, were carried out in Spain, Malaysia, Indonesia, the Netherlands, and Singapore. The first important publications, in the last decade, are related to energy consumption in FM activities and hospital maintenance. The impact of FM on sustainable building design, as well as FM sustainable practices linked to LCC are focused on reducing environmental impact.

- As in KPI, most of the research on FM models has been developed in Israel, and later in the USA, by Shohet & Lavy since 2003. These publications, developed in the last two decades, have focused on the development of models through information management and by establishing quantitative KPI. As well as on improving the performance of the health institutions through the optimization of the LCC and, therefore, linked to financial management.

- Other minority studies have focused on the BIM methodology (Building Information Modelling) and Mobile Augmented Reality (MAR) for decision making, so that through FM development studies they can be used as a useful guide for FM practitioners and academics. in hospital buildings. Likewise, in the last decade a study has been carried out to identify gaps in research on maintenance management in health institutions.

Conclusions

This review of FM trends in the health sector, in this study between 1981 and 2018, allowed the authors to confirm the increase in publications on hospital FM. In one hand, the authors have deduced from this work that the transmission of knowledge of FM among Anglo-Germanic speaking countries has led to the generation of a greater

number of publications than Latin, Arab, or Asian countries. On the other hand, the transience indices of the authors and research institutions of this selection of publications show that they are widely distributed worldwide. In any case, the leaders of publications about authors and institutions on hospital FM continue to be Anglo-Germanic speaking countries, mainly USA, UK, and Israel.

In the analysis of the select group of the 57 most important publications, it was possible to identify predominantly 11 research themes. In the results, it has been exposed these themes have usually been developed by several countries, except for the roles and responsibilities of the FMer published by UK institutions. Also, in many cases, the authors have identified the development of these themes in various periods, both in the most cited documents and in the literature reviews of the healthcare FM. Then, it can be verified that the topics identified in the analysis of the documents (most cited and the literature review) are among the 11 topics resulting in this study. This makes it possible to establish a starting point for some of the most significant topics on FM in the health sector such as: process management of the organization linked with the FM; the functions, competencies, roles, and responsibilities of the FM; the strategic positioning of FM in the organization. Even so, the authors consider that the themes published in recent decades still do not cover the current demands of hospital institutions such as: e-health and ICT; use of data for machine learning; energy and sustainability; among others. Therefore, all that content that is not found in the 11 themes found in this work can be the subject of new lines of research unpublished in healthcare FM.

Moreover, this work can be a starting point to deepen other aspects dealt with in the documents analyzed, as the case of the management of organizational processes through FM. This theme is suitable for health institutions to learn which processes can be improved from case studies, even if it will be useful to other researchers to determine new approaches in future projects. Beyond, it would be advisable in future studies to analyze whether research on sustainability in healthcare FM linked to the increase in energy from international military conflicts or the optimization of congestion in hospital institutions caused by COVID-19 has proliferated.

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