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Facility management adoption in low-resource public hospitals: A systematic review and context-driven model for enhancing operational performance

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ABSTRACT

Public hospitals in low-resource settings face continuous operational challenges that lead to poor-quality service delivery. Facility Management (FM) as a strategic discipline in well-developed countries enhances efficiency, safety, and sustainability. But in many Low- and Middle-Income Countries (LMICs), especially post-conflict countries such as Iraq, FM practices are fragmented, reactive, and no longer supported by an integrated administrative structure. Several pieces of evidence on FM decision-making and planning were examined to better understand the drivers, obstacles, and effects influencing FM operational performance during its adoption in public hospitals. A systematic search was conducted across Scopus, Web of Science, and PubMed from 2018 to 2025, in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines. The inclusion criteria used were considered in including thirty-three studies. The critical appraisal Skills Programme (CASP) and the Mixed Methods Appraisal Tool (MMAT) were used to determine the quality of the methodology, and NVivo was used to assess the thematic synthesis. The findings prove that adoption of FM depends on nine overall practices that are proactive maintenance, digital technologies, sustainability practices, safety management, organizational culture and readiness, government initiatives, data management, digital integration, and outcomes of operational performance. It is on these determinants that the current study has offered a context-based FM model that is particularly tailored to the institutional context of Iraq and other post-conflict environment. This model is a novel and workable mechanism of enabling system-level improvement in poor health FM system.

Keywords: Facility Management, Public Hospitals, Iraqi Healthcare System, Operational Performance, Systematic Review, Post-Conflict Health Systems.

1. Introduction

Healthcare organizations across the globe are facing significant challenges in providing quality, flexible services. Notably, the demand is increasing day by day along with digital development and operational challenges. Effective management of buildings, systems, services, and other assets affects hospitals' overall operational performance, as well as their clinical and medical aspects. Accordingly, Facility Management (FM) refers to the coordinated management of technical and support services within healthcare facilities (such as hospitals and healthcare centers). It can also be described as a key and important element that commonly determines the effectiveness, risk, and sustainability of these healthcare institutions. Moreover, it influences the quality of healthcare provision in all the scenarios [1, 2]. In this regard, the necessity to consider a way

of integrating FM into healthcare systems to provide continuity in services and resilience in the face of crisis was emphasized during the COVID-19 pandemic.

Proper FM of healthcare facilities involves the coordinated maintenance, operation, and performance of the infrastructure of hospitals. In the developed world, this has contributed to the creation of advanced and complex FM models, which are highly dependent on digital technologies [3]. Building Information Modelling (BIM), Computerized Maintenance Management Systems (CMMS), and the Internet of Things (IoT) are some of the tools commonly used to manage and track facilities in real-time, enhancing the accuracy of information and quality of operational decisions [4]. The technologies also enhance predictive maintenance, as well as facilitate more efficient and sustainable operations. Consequently, hospitals will experience less downtime, improved patient safety, higher-quality services, and more cost-effective operations.

FM does not exist in any organized or professional structure in many Low- and Middle-Income Countries (LMICs), especially in post-conflict regions, such as Iraq. Rather, hospitals depend on alternative management and technical units, including the maintenance and the general services department, which seem to be working independently with little interaction or coordination. Besides that, the lack of formal safety regulations and sustainable policies also undermines the performance of operations. Such a disjointed design leads to the common failure of equipment, increased cost of operation, and constant safety issues. The utilization of energy is also quite inefficient and makes the services less reliable, as well as constraining the capacity of the system to obtain the resilience that is often seen in the more reliable healthcare setting [5], [6], [7].

Research studies worldwide have further revealed that facilities management within the public hospitals enhances processes, costs, sustainability, and operational performance. Nevertheless, the studies in LMICs are not much focused on the main issue. The available literature is usually incomplete, covering either one or two of the issues, including proactive maintenance policies, energy management, or cost management [8], [9]. This restricts the knowledge of the larger issues and issues behind facilities management in the hospitals of developing nations. Remarkably, none of the studies has focused on the analysis of the integrated or coherent adoption of facilities management practices in Iraq in particular, which makes a glaring gap in the knowledge on how facilities management practices may be harmonized and efficiently transferred into the post-conflict public hospital system.

Therefore, this paper recommends that context-based theories should be developed to facilitate FM amidst the weak healthcare systems of the developing nations. In order to fill this gap, this review relies on the following theories:

- The Technology, Organization, Environment (TOE) framework explains how technological, organizational, and environmental factors impact FM adoption [10].
- Institutional Theory, which emphasizes regulative and normative pressures shaping healthcare management [11].
- Resource-Based View (RBV), which associates FM-related assets and competencies with long-term operational performance and resilience [12].
- Socio-Technical Systems Theory, which focuses on the interaction between people, technology, and organizational structures to achieve optimal performance.
- Contingency Theory argues that organizational effectiveness depends on alignment between internal capabilities and external conditions.
- High-Reliability Organization (HRO) Theory, which explains how organizations operating in high-risk environments achieve consistently safe and reliable outcomes.
- Safety Culture Theory, which emphasizes the role of shared values, beliefs, and practices in ensuring workplace safety.

Combined, these theories offer an effective map of drivers of FM adoption, organizational barriers, as well as aspects of its functioning in the Iraqi healthcare setting.

Therefore, the following questions are to be answered in terms of this systemic review:

1- Which are the major technology, digital, organizational, institutional, and contextual drivers of adopted and implemented FM practices in public hospitals?

2- What is the most effective way to create a holistic and context-oriented framework of implementing FM to address the issue of infrastructure, resource, and governance challenge in the field of the public healthcare sector in Iraq?

3- How can the suggested FM framework foster the operational performance, resilience of infrastructure, cost-efficiency, and sustainable outcomes in the Iraqi governmental healthcare institutions?

This study gathered data between the years 2018 and 2025 following the PRISMA guidelines [13, 14] to come up with the first theory-based review of adopting FM in Iraqi state-run hospitals and other post-conflict nations. It relies on nine interrelated factors, namely proactive maintenance, adoption of digitalization, sustainability, adherence to safety measures, government initiative, organizational culture and preparedness, data management and digital integration, organizational prepared to digital transformation and operational performance outcomes. It is important to note that all the factors relate to a solid theory and reliable sources. Although they all work together in medical FM systems in developed nations, this paper has incorporated them in one framework, which is a new, context-specific innovation in Iraq and other post-conflict countries. The framework is meant to implement such principles in those environments that were previously missing a coherent FM system, which makes it both viable and innovative in such settings [6, 7]. The method is consistent with the existing global trends of research that aim at the adaptive FM solutions in the resource-constrained environment by adopting sustainable practices and using modern digital applications [15], [16].

2. Methodology and materials

To ensure transparency and scientific integrity, this study followed the PRISMA 2020 ([14]) and guidelines for systematic reviews, both widely used in facilities management and engineering research. These guidelines were used because they provide a suitable approach for facilities management and contribute to a coherent collection of technical, organizational, and empirical evidence. The systematic review in this study aims to collect empirical evidence on the impact of integrated FM practices, such as proactive maintenance, digitalization applications (e.g., CMMS, BIM, IoT), sustainability measures, and organizational integration and sustainability, on the operational performance of public hospitals in developing countries and LMICs. Specifically, the focus is on post-conflict situations, such as Iraq, as a target. Nevertheless, the study draws on data from some developed countries. This enabled comparisons and highlighting contextual differences in FM practice and operational performance between LMICs and high-income and selected developed countries, which serve as benchmarks [5], [6].

In the case of theoretical and analytical conformity, the term “integrated facilities management” used in this paper is described as the aggregate effect of the facilities management applications, in both their organizational, technical, and sustainability matters, which directly influence the performance of operations [7]. In order to be aligned with major and faster changes in the management and technological development, the time of the review (2018-2025) was intended to accommodate all the digital changes and the requirements of operations due to the COVID-19 pandemic, and the use of flexible policies to govern the healthcare infrastructure. In the following sub-sections, the methodological details will be presented, including quality assessment techniques using CASP and MMAT, data extraction, and synthesis procedures. Table 1 summarizes the methodological procedures and protocol for the systematic review, outlining each review stage.

Table 1. Protocol of the systematic review

No.	Review Stage	Data Collection and Actions	Notes/Justifications
1	Protocol Development & Registration	The objectives, research questions, scope, and eligibility criteria were defined in advance and documented in the preregistered OSF protocol.	This ensures transparency, replicability, and alignment with PRISMA 2020 and the OSF registration standards.
2	Search Strategy & Sources	This stage will systematically identify the most relevant studies across the following Databases: Scopus, PubMed, Web of Science, IEEE Xplore, ScienceDirect, Emerald, using predefined Boolean expressions related to FM, operational performance, and healthcare.	This provides comprehensive coverage across the FM sectors in engineering, operation, and healthcare.
3	Eligibility Criteria	A two-stage framework will be applied to organize the selection process: G1 (mandatory criteria for initial screening), G2 (supplementary criteria for full text evaluation). Inclusion focused on empirical studies (2018-2025) in public hospital settings in LMICs.	This ensures that the study is consistent with the research objectives and their relevance in the given context.
4	Deduplication	This stage will use EndNote X9 and Mendeley to remove duplicates.	This ensures the accuracy of group data and prevents duplicate counts.
5	Screening Titles & Abstracts	This stage will examine the titles and abstracts of each study according to Group 1 mandatory criteria, and any exclusion reasons will be recorded.	Ensure transparency and a replicable screening procedure.
6	Full-Text Eligibility Assessment	This stage will examine the full text of each study according to Group 2 supplementary criteria to ensure alignment with FM practices and public hospital settings.	This ensures that studies meet the review objectives.
7	Data Extraction & Thematic Coding	In this stage, FM variables such as dependent variables, independent variables, mediators, moderators, and the theoretical framework will be extracted. NVivo software will then be used for thematic coding and pattern identification.	This ensures the data is organized and optimized in line with theory, ready for qualitative analysis, and FM practices are linked to operational outcomes.
8	Quality Appraisal	This stage will assess each study's quality, reliability, and eligibility for use in this review. Two independent reviewers will assess methodological quality using the CASP and MMAT checklists. Any difference will be solved through conversation.	This will reduce bias and reinforce findings.
9	Interpretation & Synthesis	This phase will entail planning the FM practices to have operational performance, the adoption of the findings with the applied theories and synthesized thematic lines, the development of comparative tables, and the conceptual framework as a foundation for adopting FM in Iraqi public hospitals.	Develop practical insights and empirical evidence to support and enhance the integration of FM within the Iraqi healthcare system.

To achieve transparency, accuracy, and reproducibility, a clear plan and methodology were drawn prior to starting the research. A definition of the research objectives, the necessary criteria, the research methodologies, the research procedures, the plan of data collection, and the analysis of the research were all specified. Additionally, to comply with the principles of open science, the protocol was registered on the

Open Science Framework (OSF) platform, a reputable platform within the spheres of technology, healthcare regulation, and interdisciplinary research. Regularities in registering are as follows:

- Registration Platform: https://osf.io/
- Registration Type: OSF Pre-Registration Form
- Registration Date: November 20, 2025
- Participant: Arslan Mohammed Ali

The OSF platform offers appropriate documentation of multidisciplinary and specialized reviews of the management systems with total transparency and openness of the protocol to the population.

The registration can assist in making the review more credible, minimizing possible sources of bias, and following the best practices in research review [14, 17].

Between January and October 2025, six academic databases included in the search for pertinent literature were Scopus, Emerald, Web of Science, IEEE Xplore, ScienceDirect, and PubMed.

The various sources present a broad base in terms of FM, engineering, management, and health operation disciplines. The chosen databases can be identified as consistent, which is why they are applicable to creating a solid base of cross-disciplinary comparisons [18, 19]. At the same time, Boolean operators and domain-specific keys were used: ("facility management" OR "CMMS" OR "BIM" OR "IoT") AND ("healthcare maintenance" OR "hospital performance" OR "operational efficiency") AND ("public hospitals") AND ("LMICs" OR "developing countries" OR "post-conflict" OR "Iraq"). The first search resulted in 185 records. After the initial screening process, 30 duplicates were eliminated with EndNote X9 and Mendeley Reference Manager, and a total of 155 unique studies were obtained to pass through the next level of screening.

To ensure thematic relevance as well as methodological rigor, the assessment and screening process was done in accordance with PRISMA 2020 guidelines [14, 20]] and adopted a two-level inclusion framework. This framework is consistent with the Systematic Mapping Study (SMS) protocols that were used in the FM literature [13, 14]. The framework classified the criteria into two groups: Group 1 consists of the mandatory criteria that apply during the title and abstract screening stage, while Group 2 contains the supplementary relevance criteria at the full-text screening stage [20].

Group 1: Mandatory criteria (Title and Abstract Screening – All Must Be Already "Yes").

- Is the objective of the study clearly stated?
- Is the research centered on public healthcare FM (e.g., public health infrastructure) or on the broader public sector, with helpful insights that can be translated into healthcare?
- Does the systematic organization of knowledge offer any academic or practical contribution?

Group 2: Supplementary Relevance Criteria (Full-text Assessment, at least one must be "Yes").

- Were any specific FM practices noted in this study (CMMS, BIM, IoT, etc.)?
- Does the study evaluate the frameworks that shape the operation of healthcare systems?
- Does the report of the study address performance metrics or FM strategies?

Inclusion Criteria:

- Studies that other experts have agreed upon.
- Review period: published between 2018 and 2025.
- Hospital in FM: Focuses on FM adoption and operations in public hospitals in LMICs or post-conflict settings and selected developed countries as benchmarks.

- These challenges need to address any issues related to FM in governmental organizations.
- Language: Written in English.

Exclusion Criteria:

- Non-empirical, editorials, and conceptual.
- Studies focused on unrelated variables.
- Duplicate and inaccessible full-text publications.

The Inclusion process involves systematic steps to ensure the included studies are the most relevant and reliable. Therefore, the review followed clear screening stages and specific criteria that helped arrive at the final sample. A brief explanation of each screening stage follows.

In the first phase, the first group of criteria was applied to the abstracts and titles to ensure clarity of objectives, their significance to FM in the public healthcare sector, and their role in improving operational performance [15]; [13]).

As a result, 99 studies were excluded at this stage for the following reasons:

Did not highlight FM specifically in the Health Sector (n = 41).

Related and focused on private hospitals (n = 25).

Not related to FM (n = 21).

Conceptual or non-empirical research (n = 12).

In the second stage, the second set of criteria was applied to the remaining papers through a comprehensive review of the full texts. This review assessed FM practices (such as facility maintenance management systems, BIM systems, and other FM practices), as well as the contexts and frameworks that influence operational processes in public hospitals, and the performance indicators or FM strategies mentioned in the studies [13] [21]. A total of 56 full-text articles were returned, of which 23 were excluded:

Published outside the target period 2018-2025 (n = 15).

Full text unavailable (n = 3).

Non-English language (n = 5).

Thirty-three (33) studies were included in the final qualitative analysis following the two-stage screening and full-text evaluation. Most of these studies focus on FM applications in public health institutions within LMICs, including Iraq. Studies from developed countries were less selected and were used primarily for comparative analysis purposes. The variety of the contexts offered useful data on digital FM applications, including BIM, CMMS, and the IoT applications, and waste and energy management applications, which are useful in evaluating the performance of operational activities in healthcare systems [15] [13].

The screening and selection were done in two stages. In the initial phase, all titles and abstracts of the 155 articles were filtered using predetermined eligibility criteria. During the second step, full-text articles that had passed the initial evaluation were evaluated to ensure their suitability for the aim of the review.

Two independent reviewers were used to conduct the screening process. Cohen's Kappa (κ) was computed to determine the consistency of the reviewers as well as the degree of agreement provided beyond chance [22]. The results of the reviewers led to a conclusion of 145 out of 155 cases with a Kappa value of about 0.82, which means there was strong agreement (Landis et al., 1977). Any differing views were sorted out by discussing. Ultimately, 33 studies were incorporated in the final synthesis, and they all met the criteria. The reviewer's decision matrix for all records is provided in Appendix A, summarizing both individual and consensus decisions. Figure 1 illustrates the PRISMA 2020 flow diagram.

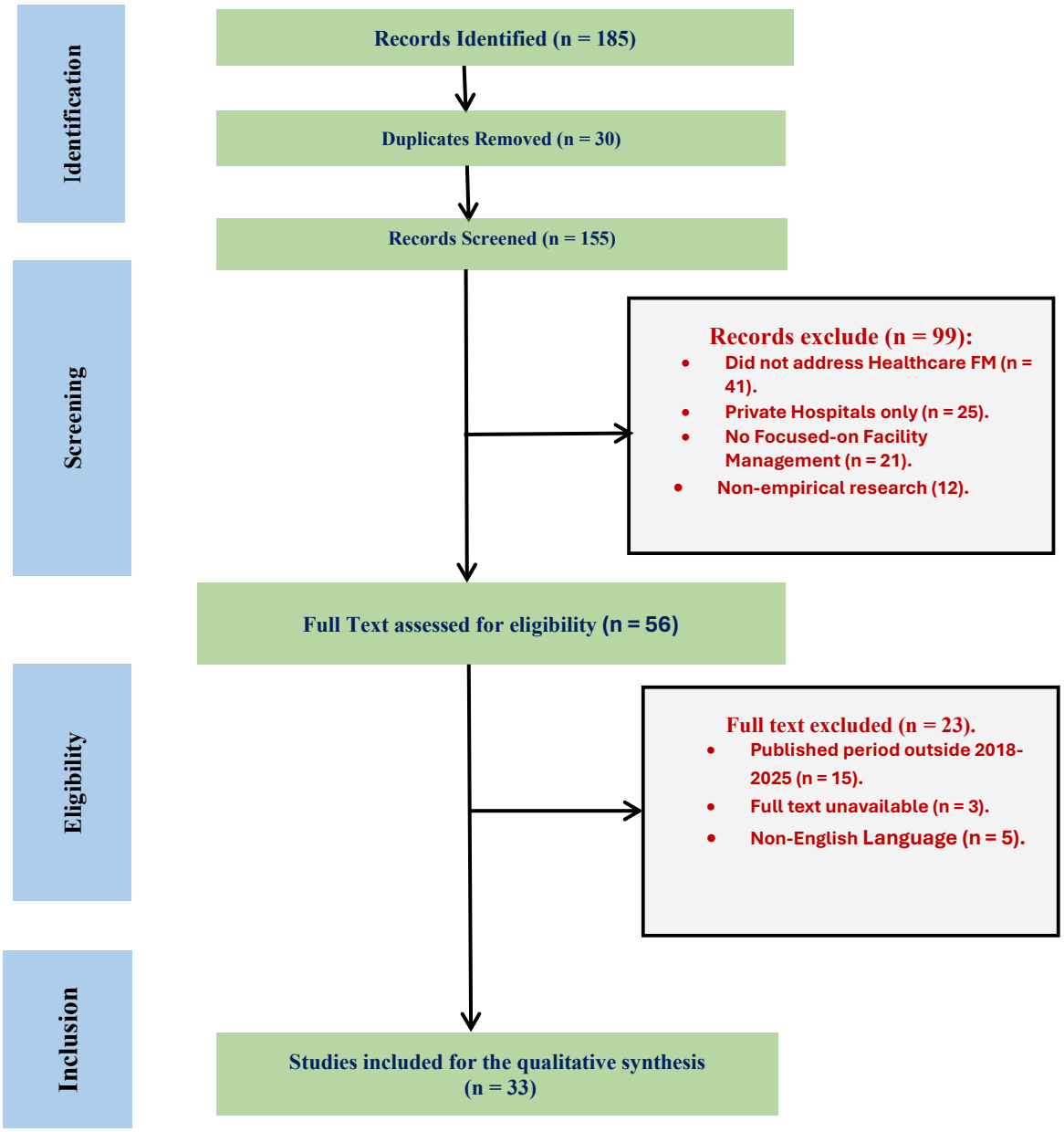

Figure 1. PRISMA 2020 flow diagram [13]

To document and extract data from each study, a structured extraction sheet was designed in Microsoft Excel, following established guidelines for systematic reviews [13, 23].

The extracted information includes the following elements:

- **Author(s), year, and country** of the study.
- **Research Design and Methodological** (quantitative, qualitative, or mixed methods), allowing meaningful comparison across variable forms of empirical studies [24].
- **Type of FM Intervention**: The 33 studies examined nine key variables: preventive maintenance, adoption of digital technologies, sustainability, organizational culture, safety, government initiatives, data management, organizational readiness, and operational performance (such as; cost efficiency, system uptime, energy consumption, and resource utilization) ([15, 25, 26], (consumption, and resource utilization)

- **Theoretical frameworks applied**: TOE framework, RBV, and Socio-Technical Systems Theory [27, 28].
- **Key findings, enabling factors, and recommendations:** providing practice-based advice on how to optimize the work of FM in a healthcare facility [16, 29].

Assessment of the quality of the 33 studies was done based on the methodological design of the individual studies. To evaluate qualitative studies, the Critical Appraisal Skills Programme (CASP) (2018) was used as a suitable and standardized appraisal tool. Meanwhile, the Mixed Methods Appraisal Tool (MMAT) is an evaluation tool in quantitative and mixed-method research [24], and the Cochrane Risk of Bias 2 is an evaluation tool in a randomized controlled study [30].

In the case of qualitative research, the CASP checklist consists of 10 criteria that are used to assess the following factors:

- The research question,
- The appropriateness of the methodology.
- The rigor of data collection.
- Ethical considerations.
- The adequacy of the interpretation of findings.

MMAT checklists, which consist of 5 core criteria, are applied to assess the quantitative and mixed-method research to address the following aspects:

- Sample representativeness.
- Reliability of measurements.
- Completeness of data.
- Consistency of analysis.
- The coherence between qualitative and quantitative components.

The responses for each appraisal tool have been structured using a standardized qualitative scoring format (Yes/No/Can't tell). However, the reviewers maintain a uniform response structure across all items to ensure consistency in the scoring process.

The assessment processes for CASP and MMAT were conducted by two independent reviewers. All disagreements between reviewers were resolved through discussion. However, a third independent party was consulted when necessary to enhance reliability and transparency.

To determine the inter-rater reliability and analyze the degree of agreement and consistency between the reviewers, Cohen's 0.72 was applied, with a coefficient of 0.72 meaning that there is a high degree of consistency. This finding can be taken as a good reason to be accurate and transparent with the process of assessment.

There was no exclusion of any other studies based on quality score. Rather, bad records were simply assigned less interpretative weight in the synthesis, as quality records were assigned less interpretative weight [24]. Such a method establishes the consistency of methods and reduces the probability of bias.

The full systematic appraisal table in Appendix B presents the research identifiers, the checklists used, the ratings at the item level, the justification notes, and the statistics on the agreement. The evaluation process, including how the study is classified, the choice of the tool, and the checklist.

This structure and top-down evaluation procedure will guarantee that the evidence produced has methodological soundness and situational relevance in the facility-management study in the public healthcare setting.

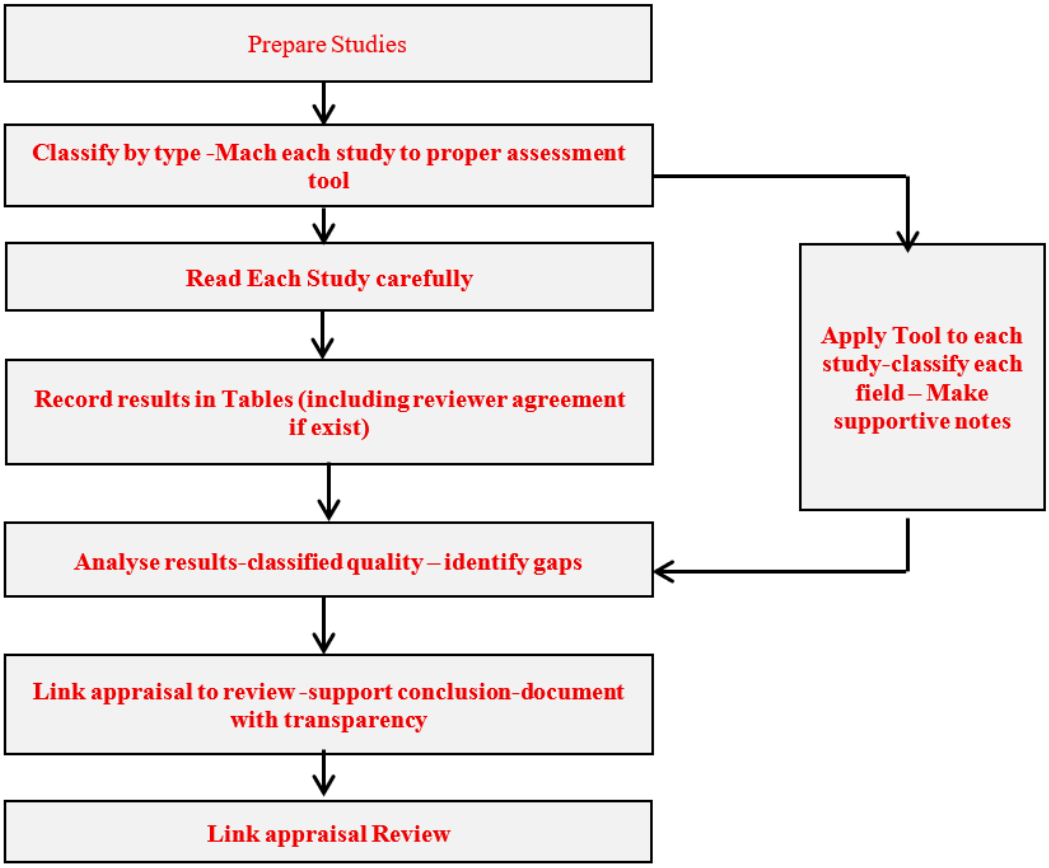

Figure 2. Bias and Quality Assessment flow diagram

In accordance with the eligibility criteria in Section 2.2 and along with the PRISMA 2020 recommendations [14, 20], this section states the methodological peculiarities of the 33 articles included in this review. The inclusion was determined according to Group 1 criteria (all responses must be "yes") and Group 2 criteria (at least one response must be "yes"). Note that all studies met the eligibility criteria detailed in Section 2.2. This section highlights how the selected studies align with the analytical framework of this review and their contribution to developing a facilities management framework for public hospitals, particularly in low- and middle-income as well as post-conflict contexts. Table 7 presents a classification of the included studies according to the Group 1 (G1) and Group 2 (G2) criteria.

Table 2. Eligibility of review articles based on adherence to inclusion criteria.

No.	Authors and Year	G1-1	G1-2	G1-3	G2-1	G2-2	G2-3
1	[5]	Yes	Yes	Yes	Yes	Yes	Yes
2	[6]	Yes	Yes	Yes	Yes	No	Yes
3	[31]	Yes	Yes	Yes	No	Yes	Yes
4	[32]	Yes	Yes	Yes	Partially*	Yes	Yes
5	[33]	Yes	Yes	Yes	Yes	Yes	Yes
6	[8]	Yes	Yes	Yes	Yes	Yes	Partially*
7	[34]	Yes	Yes	Yes	Yes	Yes	Yes

No.	Authors and Year	G1-1	G1-2	G1-3	G2-1	G2-2	G2-3
8	[35]	Yes	Yes	Yes	Partially*	No	Yes
9	[36]	Yes	Yes	Yes	Yes	Yes	Yes
10	[37]	Yes	Yes	Yes	No	Yes	Yes
11	[38]	Yes	Yes	Yes	Yes	Yes	Yes
12	[39]	Yes	Yes	Yes	Partially*	No	Yes
13	[40]	Yes	Yes	Yes	Yes	Partially*	No
14	[41]	Yes	Yes	Yes	Partially*	Yes	Yes
15	[42]	Yes	Yes	Yes	Yes	Yes	Yes
16	[43]	Yes	Yes	Yes	Yes	Partially*	Yes
17	[44]	Yes	Yes	Yes	Yes	Yes	Yes
18	[45]	Yes	Yes	Yes	Yes	No	Yes
19	[46]	Yes	Yes	Yes	Yes	No	Yes
20	[47]	Yes	Yes	Yes	Yes	Yes	Yes
21	[26]	Yes	Yes	Yes	Partially*	No	Yes
22	[48]	Yes	Yes	Yes	Yes	Yes	Yes
23	[49]	Yes	Yes	Yes	Yes	Partially*	Yes
24	[31]	Yes	Yes	Yes	Yes	Yes	Yes
27	[50]	Yes	Yes	Yes	Yes	Yes	Yes
28	[36]	Yes	Yes	Yes	Yes	No	Yes
29	[51]	Yes	Yes	Yes	Yes	No	Yes
30	[52]	Yes	Yes	Yes	Yes	No	Yes
31	[53]	Yes	Yes	Yes	Yes	No	Yes
32	[54]	Yes	Yes	Yes	Yes	Yes	Yes
33	[55]	Yes	Yes	Yes	Yes	No	No

A narrative synthesis approach was adopted for this review, following [21], to account for the methodological and contextual diversity of the 33 selected empirical studies on FM interventions and their operational impacts in public hospitals.

The selected studies address FM interventions and operational aspects in public hospitals across LMICs, as well as in post-conflict settings such as Iraq. Moreover, the review considered studies from some developed countries and identified positive examples that may be relevant for enhancing hospital FM operations in LMICs and post-conflict contexts. The thematic analysis was conducted using NVivo 14 [56]), resulting in the emergence of nine conceptual themes: proactive maintenance, adoption of digital technology, safety management, sustainable FM, organizational culture and readiness, government initiative and policy influence, data management and digital integration, organizational readiness for digital transformation, and operational performance outcome [57]. These themes replicate common patterns in the chosen studies and

are confirmed by both the literature and the theoretical frameworks mentioned in the empirical research of other healthcare settings.

Table 3 presents the independent variables, the mediator, the moderator, and the contextual variables that substantiate the research evidence. This framework reinforces the conceptual and operational parts in accordance with the systematic review standards suggested by [21, 58].

The different traditions and methodologies used in this study have helped us to understand more about it, broaden its use, and enhance its effectiveness in the integration of FM practices, and also enhance its contribution to the improvement of operations in the public health institutions.

There are various constraints that were taken into consideration to come up with the scope of the methodology. The review was limited to English language publications, and thus this could have excluded any other study that might be relevant but published in different languages [59, 60]. The analysis was primarily focused on six large databases to research the sources, which enhanced the research management. Nevertheless, it raises this study to the risk of overlooking significant literature that falls outside these sources [61]. The constraints consisted of the publication date of the studies, which were not older than 2019 and 2025, thus failing to provide more valuable studies that might have been published before this time. Moreover, grey literature, including various governmental reports and theses, was left out, even though it is likely to offer valuable LMIC-specific data, particularly in relation to Iraq [62].

Among the limitations of the methods applied, the risk of publication bias was recognized, as well as other limitations of the research. Other than that, with NVivo software, peer review was applied to perform thematic coding, which can result in subjective interpretive bias, which can affect the reliability and specificity of the results [63].

3. Results

This research identified 33 empirical studies on FM practices and their influence on the performance of operations in government hospitals based on the PRISMA 2020 guidelines. Validated measurement instruments, CASP (CASP, 2018) (qualitative research) and MMAT (2018 version) (quantitative and mixed results research) were used to enhance scientific rigour and minimize bias [24], [64]. All the information in this evaluation is checked in Appendix B.

Moreover, the coding was conducted in NVivo 14 [56]), yielding an analysis of word frequencies, themes, and visualizations. Methodological and geographical trends graphs were prepared using the Microsoft Excel program. The analysis was conducted in accordance with systematic review criteria [13]; [21]), which incorporated the analysis of the research rigor, consistent word patterns, and identification of the main FM determinants. The major findings of this study are addressed in this chapter. The tables and figures in the results sections clearly indicate the distribution of research approaches, geographic coverage, themes, and the rigor of the research since the studies were conducted in a post-conflict country and a developed country as a reference point [33, 43].

This study adopted a systematic coding approach, examining word frequency patterns and developing visual outputs through a structured, reproducible review of 33 selected research papers using NVivo 14 [56]. Microsoft Excel was used to develop integrative and descriptive charts to illustrate methodological distributions and geographical patterns. The descriptive analysis conducted in this study relied on the distribution of research methodologies used in the selected studies and the geographical areas in which the research was conducted [3]. Here, CASP for qualitative studies and MMAT for quantitative and mixed-method studies [24], [64] were applied to assess quality and reduce bias. Table 3 presents the key characteristics of the 33 selected studies and the appraisal tool applied on each study that supports the subsequent systematic, geographical, and thematic analyses discussed in the following sections.

Table 3. Overview of Reviewed Studies (2018–2025)

Ref.	Country	Field of Study	Research Method	Appraisal Tool Applied
[5]	Saudi Arabia	Construction/FM in public hospitals	Mixed methods (survey, interviews, case studies)	MMAT (2018)
[6]	Iraq	Healthcare/FM	Mixed methods (survey with SPSS analysis, RII)	MMAT (2018)
[31]	Ghana	Hospital Waste Management/FM	Exploratory sequential mixed methods (case study interviews + questionnaire survey)	MMAT (2018)
[32]	Finland	Healthcare/FM	Mixed methods (CLD, surveys)	MMAT (2018)
[33]	Malaysia	Construction/FM in public hospitals	Quantitative (survey, SPSS, ANOVA)	MMAT (2018)
[8]	Iraq	Healthcare/FM	Delphi survey + FAHP	MMAT (2018)
[34]	Italy	Healthcare/FM	Quantitative (financial data analysis, ANOVA, Kruskal-Wallis)	MMAT (2018)
[35]	Canada	FM/Hospital maintenance	Multi-agent simulation (AnyLogic, UML, Java)	MMAT (2018)
[36]	South Africa	Public Healthcare/FM	Qualitative (semi-structured interviews, thematic analysis)	CASP (2022)
[37]	Ghana	FM/Public healthcare	Exploratory sequential mixed methods (case studies + questionnaire survey)	MMAT (2018)
[38]	Switzerland	Healthcare/FM/Digital transformation	Sequential exploratory mixed methods (qualitative + quantitative analysis)	MMAT (2018)
[39]	Brazil	Public sector FM/Building maintenance	Mixed-method empirical study (quantitative + qualitative interviews)	MMAT (2018)
[40]	Iraq	Public sector building maintenance	Quantitative (historical data analysis, SPSS, Excel)	MMAT (2018)
[41]	Hong Kong	Hospital FM/Performance evaluation	Mixed methods (ANP within MCDM framework)	MMAT (2018)
[42]	China	Healthcare FM	Mixed methods (Delphi + AHP)	MMAT (2018)

Ref.	Country	Field of Study	Research Method	Appraisal Tool Applied
[43]	Malaysia	Healthcare/FM	Quantitative (5-year data, SPSS)	MMAT (2018)
[44]	Philippines	Public healthcare FM	Quantitative (survey, SPSS descriptive statistics)	MMAT (2018)
[45]	Spain	Hospital maintenance efficiency	Quantitative (maintenance data analysis, SPSS, ANOVA, regression)	MMAT (2018)
[46]	Nigeria	BIM adoption in FM	Quantitative (survey, factor analysis, regression, Kruskal-Wallis)	MMAT (2018)
[47]	Nigeria	Healthcare FM	Qualitative (interviews, thematic analysis)	CASP (2022)
[26]	South Africa	Public building FM	Quantitative survey (descriptive statistics, PCA)	MMAT (2018)
[48]	Jordan	Hospital building maintenance	Quantitative (survey, SPSS, ANOVA)	MMAT (2018)
[49]	Iran	Hospital FM/BIM	Mixed methods (literature review + pilot case study)	MMAT (2018)
[65]	Africa	Public healthcare FM (COVID-19)	Quantitative (survey + interviews, SPSS)	MMAT (2018)
[66]	Malaysia	Public hospital FM	Quantitative (questionnaire survey, SmartPLS, IPMA)	MMAT (2018)
[67]	Ghana	Public healthcare FM	Mixed methods (survey + interviews)	MMAT (2018)
[50]	Malaysia	Hospital FM & building maintenance	Quantitative (questionnaire survey, PLS-SEM)	MMAT (2018)
[36]	South Africa	Public healthcare FM	Qualitative (semi-structured interviews, thematic analysis)	CASP (2022)
[51]	Ghana	Primary healthcare/FM	Quantitative observational study (multi-level modeling, significance testing)	MMAT (2018)
[52]	Sri Lanka	Healthcare FM/Sustainability	Delphi survey (two rounds)	MMAT (2018)
[53]	Jordan	Hospital building maintenance	Quantitative survey (SPSS, descriptive analysis, Mann-Whitney U-test)	MMAT (2018)

Ref.	Country	Field of Study	Research Method	Appraisal Tool Applied
[54]	Nigeria / Developing countries	Digital twin adoption in FM	Quantitative survey (SPSS 29)	MMAT (2018)
[55]	Ghana	Healthcare waste management/FM	Quantitative survey (SPSS, Excel)	MMAT (2018)

The studies published between 2019 and 2025 demonstrated clear methodological diversity, reflecting the varied research methods used to analyze the relationship between FM practices and operational performance in public hospitals. Ultimately, the final review demonstrated that the methodological distributions are as follows: 18 quantitative studies (55%), 12 mixed studies (36%), and three qualitative studies (9%). Such a methodological pluralism is based on the observation that FM research within the context of a public hospital relies on methodological measurement and thorough research to examine the barriers to operations and institutional requirements. Figure 3 illustrates the distribution of study approaches to be carried out between 2018 and 2025.

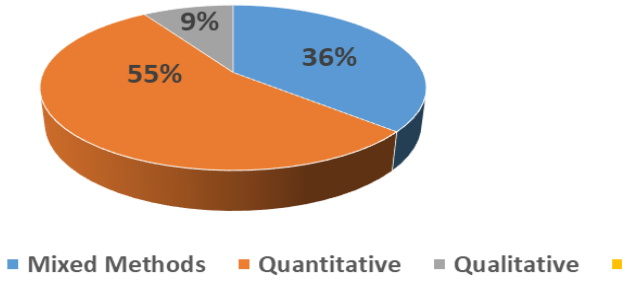

Figure 3. Distribution of Research Methods (2018–2025)

An appraisal process was carried out to determine the quality of all the selected studies by applying the right appraisal instruments. The appraisal tool was applied according to each study's methodological design: the MMAT for quantitative and mixed-methods studies, and the CASP for qualitative studies.

The findings of quality assessment of the 33 studies are summarized in Appendix 3 and Table 3. The findings suggest that the highest proportion of high-quality evidence was quantitative studies, which included 11 high-quality studies, mixed-methods studies comprising 10 high-quality studies, and qualitative studies with two high-quality studies [24, 68].

On the other hand, 24% of all studies (8 studies) were rated as moderate because their methods of sampling were not adequately reported or their instruments were limited. Meanwhile, the amount of research with a low-quality rating was small (3%). Nonetheless, it was not excluded according to [69], since it is not advised to omit low-quality research studies in general.

Table 3. Summary of Study Quality and Appraisal Tool

Study approach	Appraisal Tool	High quality	Moderate	Low quality	Total
Quantitative	MMAT	11	6	1	18
Mixed Methods	MMAT	10	2	0	12
Qualitative	CASP	2	1	0	3
Total	-	24	8	1	33

Combined, the allocation of the approaches to the study and the findings of the quality appraisal demonstrate three valuable facts:

1- Quantitative and qualitative research is a pillar of the facilities management research within the field of the public health sector, as it offers good tools of analysis and interpretation of measurable data and the development of actionable insights.

2- Qualitative studies represent an effective methodology for interpreting operational patterns and institutional procedures within public hospitals.

3- The results of the current study, which demonstrate that a large portion (73%) of the chosen studies had high methodological quality, are helpful in justifying the efforts made by the current study to create a broad framework for implementing FM with the purpose of improving the operational performance of government hospitals in developing nations like Iraq.

The last study sample covered wide geographical areas, representing the interests of the whole world in facilities management and its investigation of the effects on the operational performance of the public health institution. The geographical distribution of studies numerically was as shown below: the highest percentage of 13 studies was covered in the Middle East and Asia, Europe with eight, and Africa with six, and North and South America with three studies each. The geographical distribution of the studies is presented in Table 5. Table 4 provides a summary of the geographical location of the 33 studies.

Table 4. The geographical distribution of the 33 Studies

Region	Number of Studies
Middle East & Asia	13
Africa	6
Europe	8
North America	3
South America	3

Figure 4 was developed to provide a clearer interpretation of research trends and to visualize the general pattern of geographical distribution. This number represents that it is concentrated in some areas, with a significant drop in others.

The analysis indicates that the majority of studies regarding the topic of FM in the case of public hospitals are directly connected to the healthcare systems of the Middle East, Asia, Africa, and Europe, with little research being conducted in Latin America. This makes it necessary to conduct more in-depth and region-specific studies.

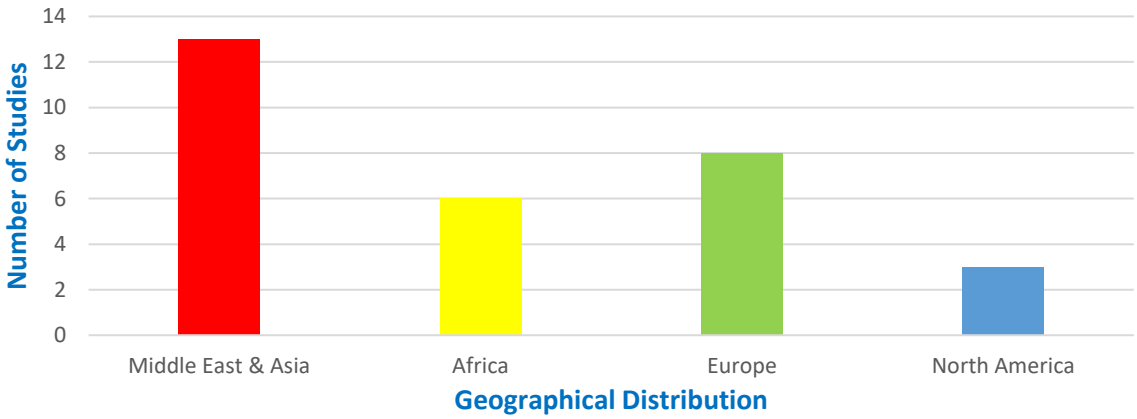

Figure 4. Geographical Distribution of Reviewed Studies (2019–2025)

It should be stressed that the level of research within a particular environment is not enough to discuss the existing issues or fill gaps; what matters is the quality of the conducted research and its ability to diagnose the problem. This highlights the need for qualitative and geographically oriented studies that help fill the gaps

and address concerns, especially in developing countries like Iraq. Such studies would provide more comprehensive contextual insights into opportunities for adopting FM, improving operational efficiency, and promoting sustainability in the public hospital sector [15].

This study conducted a content analysis of 33 studies on FM in health institutions using NVivo version 14 [56]. The papers' full texts were imported into NVivo to extract frequently occurring terms and domains' thematic patterns as outlined by [57].

Table 5. Word Frequency Query Results of 33 studies produced by NVivo (Version 14, QSR International, 2024)

Word	Length	Count	Weighted Percentage (%)
Maintenance	11	3266	1.51
Management	10	2418	1.12
Facilities	10	1436	0.66
Performance	11	1321	0.61
Building	8	1191	0.55
Digitalization	8	1160	0.54
Healthcare	10	978	0.45
Cost	5	925	0.43
Hospitals	9	894	0.41
Operation	6	879	0.41
Sustainable	8	773	0.36
efficiency	8	731	0.34
Safety	6	726	0.34
Culture and Readiness	8	723	0.33
Government	14	223	0.28
Adoption	14	223	0.2

Table 8 presents a direct NVivo output generated from the word-frequency query. Before conducting the analysis, stop words and common terms were removed, and only words with more than three letters were retained. The output was further restricted to terms that appeared more than 100 times [3].

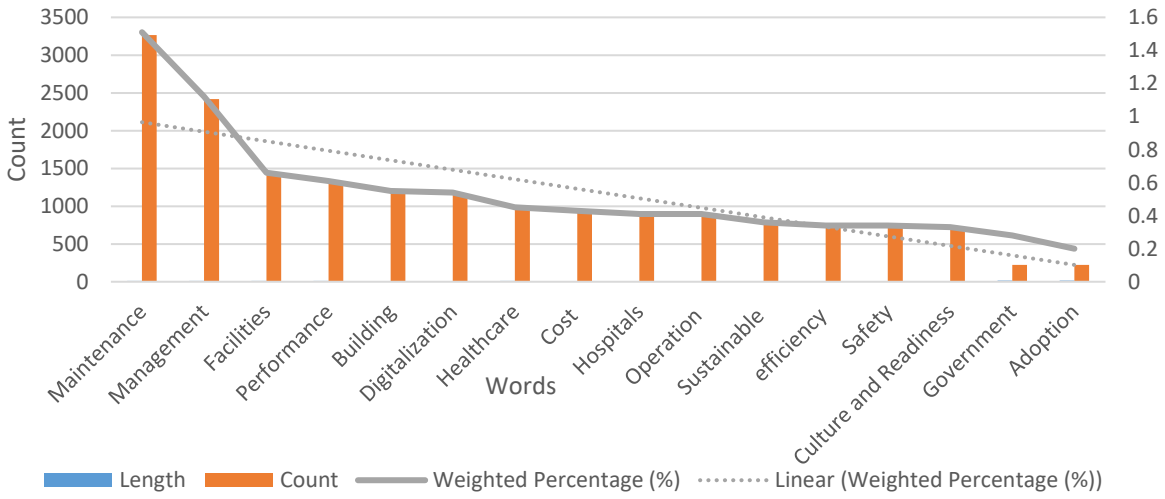

Figure 5. Most frequent words in facility management literature on healthcare (NVivo Analysis of 33 Papers)

The frequency distribution of the domain terms was highlighted by NVivo and is visualized in Figure 5, which was produced using Excel .The graph clearly illustrates that proactive maintenance, digital adoption, and sustainability-related topics, culture, and readiness received strong attention and consistent focus in healthcare FM research. This is noteworthy because these domains align closely with the core variables of this study. The strong convergence across the reviewed studies explains why digital applications, proactive maintenance, and sustainable operations are essential drivers for effective, feasible FM in public hospitals worldwide [70].

Figure 6. Word cloud on the complete texts of 33 studies produced by NVivo

Figure 6 presents the clustered word cloud generated from the full texts of the 33 studies. The most frequently occurring words are maintenance, management, and performance. The world cloud analysis depicts that repetition of terms such as maintenance, management, performance, and healthcare reflects the sector-specific focus on the reviewed literature. In contrast, the recurring use of terms such as cost, safety, efficiency, culture, readiness, governance, and adoption aspects shapes FM research. The results obtained with the use of NVivo give a coherent overview of FM in public healthcare. Repeating such phrases contributes to the findings of this paper by finding that there are general issues, similar solutions, and knowledge weaknesses. The extraction and analysis of these patterns is useful in setting up the analytical grounds of studying the FM context in post-conflict settings, particularly Iraq [71].

This review has established nine major areas forming the FM structure in the public hospitals. The variables were present throughout the thirty-three studies analyzed, which is in accordance with the current practices of the FM analysis [72]. Furthermore, they are areas that concisely summarize the empirical evidence of the most relevant literature and indicate continued common operational priorities in various regions and research methodologies.

The nine areas include:

• **Proactive maintenance:** The majority of studies endorsed proactive maintenance as one of the key elements of the operation requirement. Other than that, the outputs of NVivo foreshadowed the prevalence of terms like maintenance and operation, highlighting the key point of concern of the literature studied ([6]; [40]).

• **Adoption of digital technologies**: A majority of the studies related to it placed the emphasis on digitalization as a central aspect of the operating process. The terms associated with CMMS, BIM, the IoT, and Artificial Intelligence (AI) were found in the output of NVivo with high frequencies and prove the relevance in the literature reviewed [5, 32].

• **Sustainable FM (ISO 41001, Energy efficiency):** The sustainability applications are highly emphasized in the literature reviewed since it has become a global and regional trend. The repetitiveness of such terms as sustainability, energy, and efficiency in the NVivo outputs suggests that sustainability is a popular topic across the whole world, on different applications of sustainability in FM in the public health institutions [33, 55].

• **Organizational culture and readiness:** The studies reviewed highlight the critical importance of the organizational structure and preparation as the necessary requirements to establish the implemented integrated FM in healthcare facilities. The high frequency of the keywords, including management, leadership, readiness, and capabilities, also indicated the importance of organizational preparedness in the previous studies through NVivo analysis [5, 38].

• **Safety management practices:** The studies reviewed were on the safety protocols and how they are implemented in various work setups. The keywords safety, hazard, and risk were used directly in the NVivo analysis results, which indicated the growing interest in safety applications in the FM of public hospitals [41].

• Government initiatives and policy impact: The studies included in this paper were evidently interested in government initiatives and how funding organizations contributed to the implementation of integrated FM frameworks. The prevalence of terms such as regulations, governance, and institutional requirements demonstrates that the role of governmental support in the development of FM practice in different settings, including Iraq, is important [8].

• **Data management and digital integration**: Past research was very keen on digital systems and data integration in facilitating the FM processes. The high frequency of terms such as information, data, integration, and workflow evidences the high importance of this variable in implementing the FM framework in the healthcare institutions of the population [5], [32].

• **Organizational readiness for digital transformation:** Among the most significant aspects that past research has identified, institutional preparedness is a leading condition that should be fulfilled to transform facilities management to digital space successfully. The terms digital maturity, technology, digitalization, and adoption are frequently used, which represents that this variable is the mediating one between the facilities management practices and the operational performance in the public hospitals [6, 8].

• **Operational performance outcomes:** It has been established by most studies that performance optimization is the anticipated result of FM practices. The terms performance, cost, efficiency, and responsiveness are performance-related terminologies, which are significant, and their relevance is direct to the aims of the present research [40].

These variables form the empirical core of this review and directly entail the patterns that were observed upon the analysis of the full texts of the chosen studies. These nine variables used collectively give the methodological basis to the association of the results with the background related to the adoption of FM in the Iraqi healthcare organizations. Both variables have strong theoretical bases and are backed by a great amount of empirical literature. The association between them is brought together in Table 6, which summarizes the variables, their theoretical framework, and the main sources underpinning them.

Table 6. Linking thematic domains to supporting references: Evidence from 33 empirical studies

Variable Type	Variable/Component	Supporting Theory	Supporting References	Logical & Academic Justification
IV	Proactive Maintenance Activities (planned preventive & condition-based maintenance)	Resource-Based View (RBV)	[36]	RBV theory explains that good asset management enhances organizational efficiency and operational performance.
IV	Adoption of Digital Technologies (CMMS, BIM, IoT, AI)	Technology-Organization-	[32, 46]	It is described by the TOE and IDT models as the adoption of technology relying on the technical capabilities and organizational preparedness as the natural conditions in facilities management in

Variable Type	Variable/Component	Supporting Theory	Supporting References	Logical & Academic Justification
		Environment (TOE) Innovation Diffusion Theory (IDT)		public institutions, with healthcare being no exception.
IV	Sustainable Facility Management (ISO 41001, energy efficiency, green infrastructure)	Socio-Technical; Institutional Theory	[33, 52]	These two theories emphasize that interactions among environmental, technological, and organizational systems improve organizational performance.
IV	Organizational Culture & Readiness (leadership, institutional environment, internal capabilities)	Contingency Theory; Institutional Theory	[5, 38]	These two theories explain the importance of leadership, internal capabilities, and alignment among administrative structures within institutions for the success of administrative processes, including facilities management in public hospitals.
IV	Safety Management Practices (hazard prevention, emergency preparedness, safety communication)	High-Reliability Organization (HRO) Theory; Safety Culture Theory	[55]	They explain that human resources and a safety culture maintain safe operations through risk control systems and awareness.
IV	Government Initiatives & Policy Influence (strategies, regulations, training)	Institutional Theory	[8]	Highlight the impact of institutional pressures and governance standards on the adoption of organizational and administrative structures, such as facilities management, through government policies, regulations, and strategies.
MV	Data Management & Digital Integration	Socio-Technical; Institutional	[32, 35]	The theory states that structured data, interoperability, coordination, and digital integration improve decision quality and operational workflow.
MoV	Organizational Readiness for Digital Transformation (IT maturity, digital literacy, resource availability)	Socio-Technical; Institutional	[5]	The theory explains that accumulated expertise in information technology and digital management, along with the availability of resources, contribute to the successful implementation of digital enterprise management systems, including FM systems in government hospitals.
DV	Operational Performance Outcomes (cost reduction, operational time, response time, space utilization)	Resource-Based View (RBV)	[33]	The theory explains how the management of technical sections, such as the FM system, contributes to cost reduction.

Nine interrelated components were identified in this systematic review as the main elements for establishing an integrated FM system in LMICs. Although these components are effectively operational in the developed

countries' healthcare facilities, no structured approach has been adopted to implement the entire ensemble of these elements as a single system within Iraq and similar post-conflict environments. There is currently no comprehensive FM department or hierarchical structure under the FM title. While the principles of this framework are universally recognized, the presented conceptual model is novel and context-specific to Iraq and other post-conflict countries. This study developed an innovative, theoretical FM framework for implementing the nine practices in contexts where an integrated FM system did not exist. The proposed practices were selected because of their effectiveness, strong theoretical rationale, and alignment with the institutional, technical, and governance arrangements typical of Iraq and similar settings, as evidenced by the empirical literature reviewed.

To develop the conceptual framework shown in Figure 7, this study synthesizes the RBV, TOE, Institutional Theory, Socio-Technical Systems, Contingency Theory, HRO Theory, and Safety Culture Theory, based on evidence from 33 empirical records. In summary, RBV focuses on the importance of well-managed assets. TOE and Innovation Diffusion Theory (IDT) explain technology adoption in terms of organizational readiness and capabilities to adopt it. Institutional and Socio-technical theories emphasize alignment among an organization's technical, organizational, and environmental systems. Contingency Theory emphasizes the importance of leadership and internal capabilities, while HRO/Safety Culture theories stress human resources and safety performance [5, 16]. Therefore, this conceptual framework explains how digital systems interact with institutional readiness, proactive maintenance, and organizational policies to improve operational efficiency, streamline repair processes, and support the long-term functioning of both Iraqi hospitals and other post-conflict countries.

To move forward, the proposed framework requires empirical testing to fully validate its effectiveness. This review recommends applying a mixed-methods approach and Structural Equation Modelling (SEM) to obtain more accurate results by examining causal relationships and evaluating the model's suitability within Iraqi public hospitals and other post-conflict countries. Note that empirical validation of the framework will provide a stronger foundation for developing and promoting the adoption of FM as a formal and functional unit within Iraqi public health institutions [73,74].

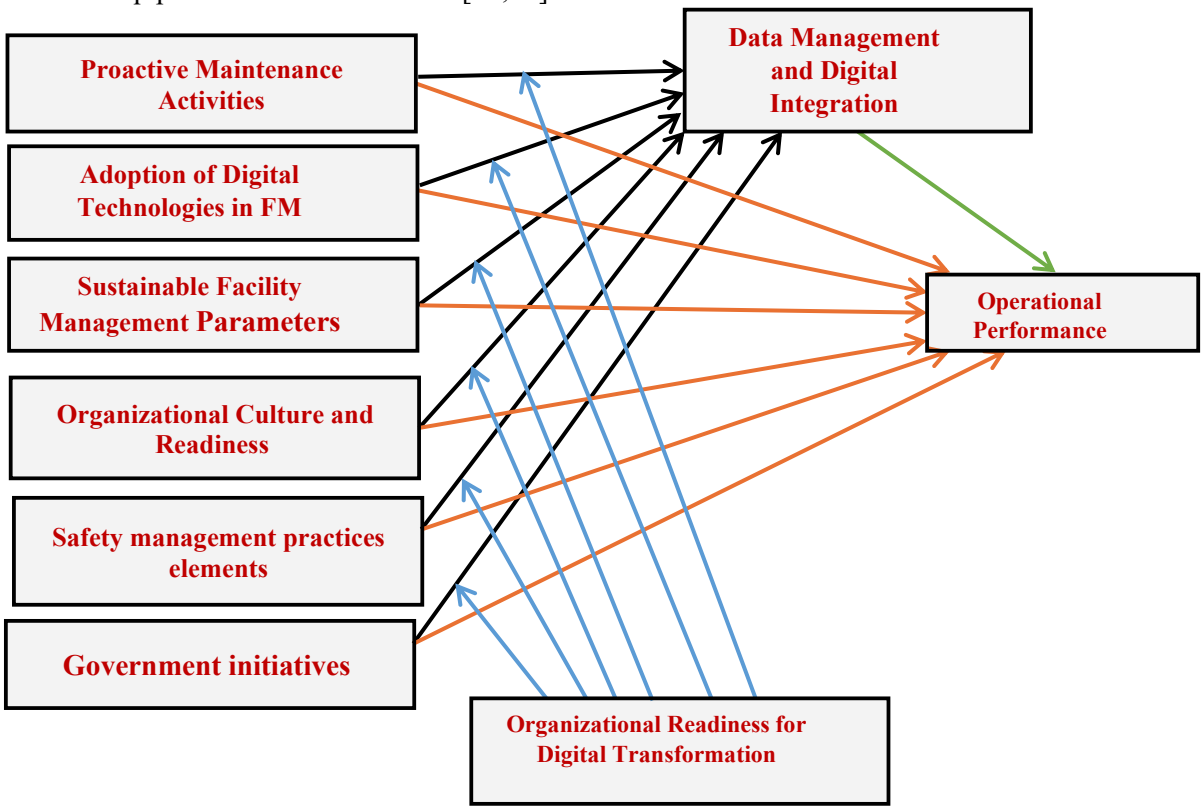

Figure 7. Proposed conceptual framework

8. Conclusion

International research has shown that good FM practices are beneficial in the operations of hospitals. This observation, however, cannot be presupposed in those countries where FM is not an institutional role. In most post-conflict environments, especially those found in the Iraqi healthcare institutions, there is no independent administrative body called Facilities Management. Rather, hospital structures are handled and run by disintegrated administrative and technical departments, including maintenance and services, with little coordination, inadequate documentation, and largely reactive processes. This disintegration leads to high operational failures, high operating costs, high workplace incidences, and poor energy consumption, which fail to allow hospitals to enjoy the advantages of the ordered FM ways of operation, as in the more stable systems.

This is a review of the Iraqi context as an example of post-conflict environments. Based on the findings of 33 empirical studies, it is found that there are nine components that are important in being the bridge between gaps in practice and research, where a complete facilities management system does not exist in the context of the public healthcare institution. The results of the research provide a basis for creating an integrated facilities management framework that is realistically optimized for the conditions of operation in Iraq and similar post-conflict environments.

It is an efficient and realistic model, but to achieve success in the implementation process, it needs a sound empirical research framework and operational plans so that it can be efficiently implemented. These parts are proactive maintenance, digital technologies, sustainability, organizational readiness, safety practices, government policy, data integration, digital readiness, and operational performance. When these elements are brought to a unified framework, it will result in a consistent framework, a framework that is not present in the current facilities management practice in Iraqi public hospitals, as well as in most other post-conflict nations. In this way, the role of the specified review is not only to prove the fact that facilities management enhances performance; it also allows achieving the comprehension of what a facilities management system should be like in the context where such systems are simply absent at all in the first place.

The structure proposed is an efficient sample and a model that can be referred to outline a facilities management unit in the Iraqi public hospitals and other related environments. In addition, it can provide a rational framework in connection with the reality of Iraq and other post-conflict scenarios and enable smooth transition between unstructured, reactive practices and a holistic system of operations premised on proactive maintenance applications, digital tools, safety management, sustainability, and facilitative governance. This analytical research paper is a direction of empirical research that leads to institutionalization of facilities management as a formal and functional dimension of post-conflict public healthcare.

Declaration of competing interest

The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.

Authors' contributions

Arsalan Mohammed Ali: He conceived the research design, came up with the methodological framework, assisted in data analysis and the interpretation process, and was involved in writing and revising the manuscript. Sivadass A/L Thiruchelvam: He helped with the literature review, helped develop the survey instrument, and was involved in data collection. he also provided a valid critique to fine-tune the manuscript. Omar Munaf Tawfeeq: He employed statistical analysis, results interpretation, and contributed to the discussion section of the manuscript, as well as assisting in the overall structure refinement of the paper. Mohd Hafiz Zawawi: He coordinated communication with the participating schools, ensured the logistics of data collection, and provided information on the practical implications of the results, further contributing to the manuscript's clarity and

coherence. The final manuscript has been read and accepted by all authors, and they are satisfied with the authorship order.

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