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Realising the Information Requirements of Building Information Modelling for Facilities Management (BIM-FM)

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Abstract

This study presents a systematic review to identify the essential information requirements for implementing Facilities Management (FM)-enabled Building Information Modelling (BIM). Despite growing interest in BIM for FM applications, limited research has clearly defined the data needed to support operational activities. Guided by the PRISMA methodology, 27 studies from Scopus and Web of Science were analysed, resulting in the categorisation of information needs into geometrical and non-geometrical domains. Geometrical requirements focused on Level of Development (LOD) below 500, tailored according to task and asset type. Non-geometrical information was classified into four key themes; managerial, legal, technical, and commercial, comprising 15 detailed sub-themes. The findings offer a foundational framework for stakeholders to structure BIM data for FM integration, supporting more efficient facility operations and decision-making. The study concludes with recommendations for future research on practical implementation, qualitative insights, and standardised review approaches.

1. Introduction

In recent years, the proliferation of digital technologies has significantly transformed building operations and maintenance, particularly during the Facilities Management (FM) phase of the building life cycle. This rapid advancement has heightened the demand for accurate and comprehensive FM-related data to enable the effective and efficient implementation of these digital tools. A systematic approach to data organisation plays a crucial role in aligning people, processes, and technology toward shared FM objectives [1]. Furthermore, well-structured and accessible data storage is essential for supporting data-intensive FM tasks, resulting in more streamlined and effective operational processes [2].

Building Information Modelling (BIM) presents considerable potential for FM by enabling integrated information management from the early project stages. However, current industry practices continue to face a major challenge: a persistent disconnect between the information needed for FM and the data typically handed over at project completion [3]. The transition from design and construction to FM is often marked by data gaps or loss, leaving BIM models deficient in essential facility-related information [4]. Consequently, these models may generate data that is irrelevant or unusable for FM teams [5], thus diminishing BIM's effectiveness in supporting daily FM operations [6]. In order to determine the crucial FM information needs of important stakeholders in the construction and FM sectors, this study conducts a thorough review of the body of existing literature, paying special attention to BIM integration. The study intends to create a structured dataset that supports FM service delivery at different competency levels and is in line with larger organizational goals, guided by the British Standard (BS), European Standard (EN), and International Organization for Standardization (ISO) 19650-3.

The structure of this paper reflects these goals. The next section introduces the central research questions. This is followed by a description of the methodology used for the systematic literature review. The results section presents findings in two parts: one addressing the Level of Development (LOD) necessary for geometric data in BIM, and the other exploring the requirements for non-geometric information. The final section synthesises these insights into a practical framework for information management and highlights key directions for future research. Ultimately, this study targets the diverse stakeholders involved in the BIM-FM offering insights to support the development and implementation of an effective BIM-FM framework.

1.1 BIM Application at the Facilities Management Stage

The current landscape of BIM-FM digital integration reflects a significant shift toward the digitalisation of building lifecycle processes, including planning, design, construction, and operation [7]. As such, BIM is increasingly viewed as a critical tool for optimising building performance, bridging information gaps, and elevating the overall quality of FM processes lifecycle of a facility [8]. During the operational phase in particular, BIM has demonstrated strong potential in supporting Facilities Management (FM) by delivering coordinated, computable, and continually updated building information [8]. For this research, the lifecycle stages examined are those most relevant to BIM's contribution to operational information management.

At its core, BIM-FM integration relies on using BIM technologies to enhance the management and operation of buildings and infrastructure across their lifecycle [9]. Information generated during the pre-construction and construction phases plays a critical role, as it forms the basis of the BIM model and must be accurately identified and captured [10]. Ensuring a smooth and uninterrupted flow of information is especially important during the handover stage, where information losses commonly occur and can hinder FM activities [7]. Consequently, BIM's essential function in information management is to support the integration of diverse data sources and enable seamless exchange with FM systems [11].

Recent advancements in digital technologies have further strengthened the potential of BIM-FM. Increased emphasis on digital transitions in FM has opened opportunities to improve information management in existing buildings through data analytics, machine learning, simulation tools, and interoperable BIM platforms [12]. Technologies such as BIM, Computer-Aided Facilities Management (CAFM), and Building Information Systems (BISs) are increasingly used to address challenges related to real-time information collection, processing, and utilisation [13]. BIM, in particular, is transforming the built environment sector by providing a comprehensive, data-rich digital database of building systems and spaces. This enhances automation and integration of FM processes while promoting collaboration among stakeholders over the building's lifecycle [14].

Through its ability to integrate Architecture, Engineering, and Construction (AEC) data, BIM strengthens FM operations and improves services delivered to end-users [8]. Overall, the evident trend in BIM-FM digital integration is a growing recognition of the value that digital technologies bring to FM. These include improved data management, better identification of issues and defects, enhanced decision-making, and more efficient operational workflows [15]. As such, BIM is increasingly viewed as a critical tool for optimising building performance, bridging information gaps, and elevating the overall quality of FM processes [15].

1.2 Structure of BIM-FM Information

The structure of BIM-FM centres on creating a computable digital representation of a facility that includes its physical and functional characteristics, along with comprehensive project and lifecycle information. As an intelligent, model-based process, BIM offers tools and insights that support the planning, design, construction, and management of buildings and infrastructure [7]. Ensuring an appropriate model structure is essential; effective modelling practices must allow the correct computation of FM-related information and enable seamless information exchange between the BIM model and the owner's FM applications [16].

Within this context, the information required for BIM in FM spans a broad range of data essential for efficient facility operations and maintenance. BIM can function as a knowledge repository that documents evolving facility information, thereby supporting informed decision-making throughout the operational life of a building [14]. To manage this information effectively, it is crucial to track FM data, outline stakeholder responsibilities for data provision, export equipment information in the COBie format, and import COBie datasets into FM systems [17]. These information exchange processes position BIM as an information backbone for FM systems, capable of providing 3D, objective-based parametric data for complex information flow management [7].

With its rich geometric and semantic information, BIM supports a wide range of FM activities. It enhances practices such as commissioning, quality control, maintenance, energy management, and space management across the facility lifecycle [8]. Facilities managers' involvement in capturing accurate and complete building data is essential to ensure that BIM can fully support lifecycle management [9]. Capabilities such as 3D visualisation and comprehensive information databases further strengthen FM functions, aiding tasks like maintenance planning, emergency response, and energy optimization [12]. Integrated BIM-FM systems also provide benefits such as improved spatial visualisation for maintenance operations within virtual environments [12]. Similarly, leveraging IFC-based semantic information enables applications such as defect mapping and improved monitoring [18]. By providing accurate and up-to-date building information, BIM can significantly enhance the efficiency and effectiveness of FM practices 20].

Optimising BIM for FM use requires the development of specific parameters that map semantic information to various FM tasks. Systems for arranging and presenting BIM data help facilitate data import, processing, visualisation, and collaboration within FM workflows [14]. Establishing baseline datasets during the design phase can also assist FM professionals and software providers in utilising BIM more effectively during the operational phase [9].

The structure of BIM-FM information involves creating a comprehensive digital representation of a facility that captures both physical characteristics and lifecycle data. Achieving this requires robust model structuring, reliable information exchange mechanisms, and effective use of BIM's geometric and semantic capabilities. When these elements are aligned, BIM becomes a powerful platform for supporting a wide range of FM activities throughout the building's lifecycle.

2. Methodology

This systematic review was conducted using a structured and rigorous search strategy, encompassing the stages of scoping, planning, identification, screening, and eligibility assessment, as outlined by Siddaway, Wood, and Hedges [20]. During the initial phase, existing systematic reviews with similar objectives were identified. However, upon closer examination, these studies addressed different research questions, pursued distinct aims, and employed varied methodological approaches.

The subsequent subsections detail the comprehensive search strategy employed to retrieve literature specifically addressing the core research question: the information requirements and implementation strategies necessary for FM-enabled BIM frameworks. Drawing on insights from both the current study and related literature, the FM information requirements for integration into BIM models are categorised into two main groups: (a) Level of Development (LOD) requirements pertaining to geometrical information, and (b) non-geometrical information requirements.

2.1 PRISMA and Resources

This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure a transparent and methodical literature search process. A structured search strategy was employed, with all relevant records systematically tracked throughout the review process. The review was conducted in three distinct stages prior to full-text analysis.

In the initial stage, a total of 785 records were retrieved from the primary databases using a predefined query string (Table 1). During the identification process, 65 duplicate records were removed. To manage the large volume of initial results, a two-tiered screening process was implemented, in line with PRISMA recommendations. In the first tier, records were filtered based on the database's built-in inclusion criteria. This step excluded 498 items, including conference proceedings, book series, trade publications, and non-English sources published prior to 2016.

The second stage of screening involved a detailed review of the titles and abstracts of the remaining records. As a result, 179 articles were excluded from further analysis. The primary reasons for exclusion included a lack of focus on BIM applications for facilities management, absence of relevant information pertaining to building operation activities, and the exclusion of empirical research. Following this stage, 43 articles were deemed potentially eligible and subjected to full-text review (Fig. 1).

During the eligibility assessment, each full-text article was evaluated based on the methodology and results sections to determine its relevance and rigour. Ultimately, 15 articles met all inclusion criteria and were selected for qualitative synthesis (Table 2).

Table 1 *Search strings used*

Databases	Keywords
Scopus	TITLE-ABS-KEY ((info* OR data* OR knowledge* OR deliver* OR requirements*OR specifications* OR guidance* OR document* OR report*) AND (“BIM” OR "building information model*" OR "building information management" OR "digital model*" OR "3D model*" OR "collaborative 3D model*" OR "collaborative digital model*") AND ("facilities management" OR "facility management" OR "facilities maintenance" OR "facility maintenance" OR "infrastructure management" OR "infrastructure maintenance" OR "asset management" OR "asset maintenance" OR "construction maintenance" OR "building maintenance" OR "operations management" OR "building operations"))
Web of Science	TS=((info* OR data* OR knowledge* OR deliver* OR require* OR specifications* OR guidance* OR document* OR report*) AND (BIM OR "building information model*" OR "building information modelling*" OR "digital model*" OR "3D model*" OR "digital twin" OR "collaborative digital model*" OR "collaborative 3D model*") AND ("facilities management" OR "facility management" OR "facility maintenance" OR "facilities maintenance" OR "infrastructure management" OR "infrastructure maintenance" OR "asset management" OR "asset maintenance" OR "construction maintenance" OR "building maintenance" OR "building operation*" OR "operations management"))

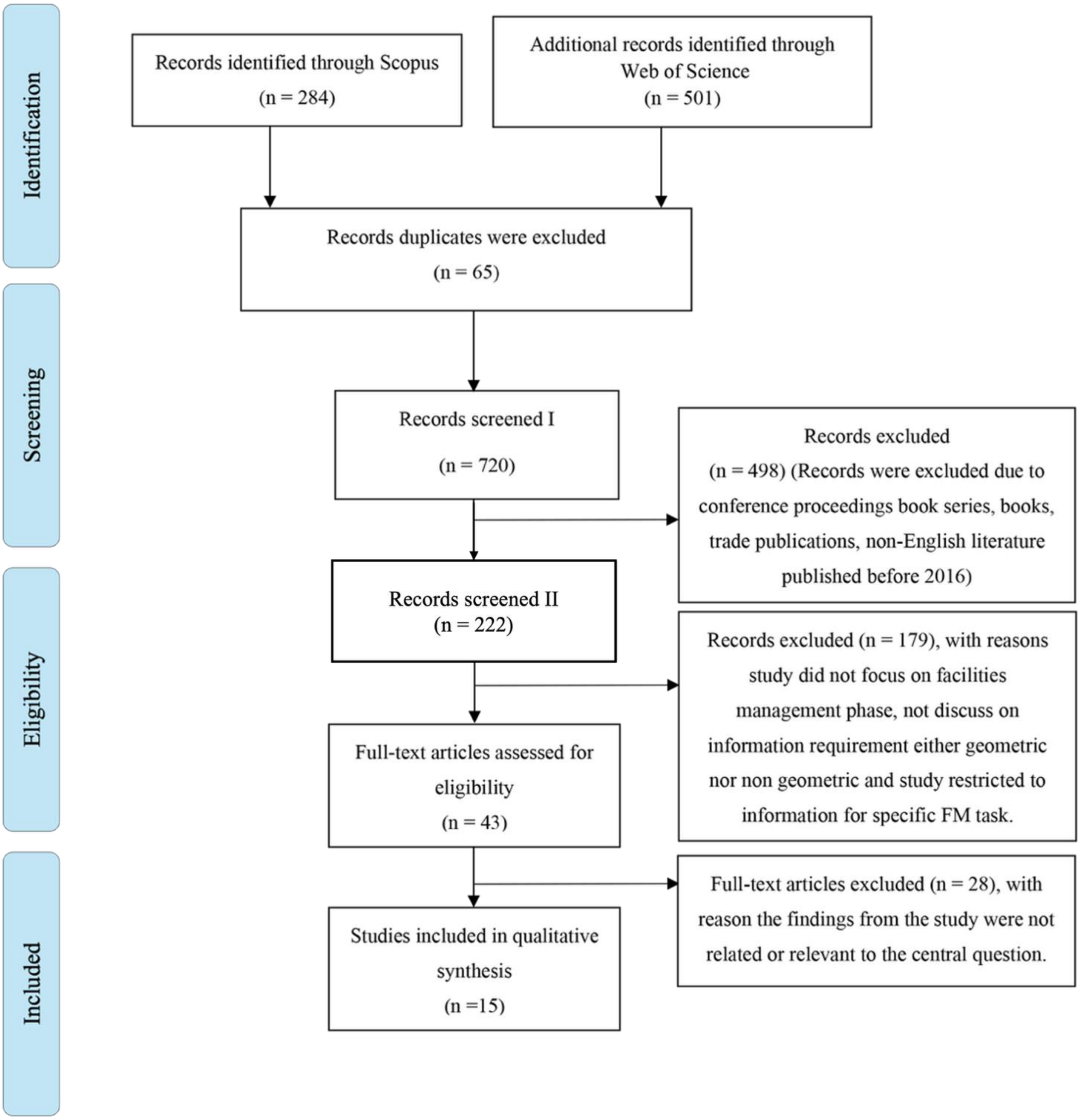

Fig. 1 *Record appraisal process according to PRISMA guideline*

2.2 Eligibility and Criteria

The initial phase of the search strategy involved the systematic planning of search terms and selection criteria. Relevant keywords were identified through an exploration of related terminology in encyclopedias, dictionaries, thesauruses, and key academic sources. These keywords informed the construction of search strings used across the selected databases. To ensure a focused and replicable search process, specific inclusion and exclusion criteria were established. These criteria were defined based on source type, language, and publication timeframe. Only peer-reviewed journal articles were considered, while literature reviews, book chapters, and conference proceedings were excluded. Furthermore, the search was restricted to articles published in English and Malay between 2016 and 2020, a period deemed sufficient to capture both the depth and relevance of recent developments in the field.

2.3 Data Abstraction and Analysis

This study aimed to conduct a rigorous analysis of preferred datasets to support building operation activities through the use of BIM, drawing upon a range of relevant literature to critically evaluate their characteristics. The review specifically focused on studies that addressed the defined research questions and demonstrated methodological reliability.

In the preliminary stage, the articles were initially screened and assessed based on their abstracts and conclusions. This was followed by an in-depth review of the full texts to identify relevant themes and sub-themes. A qualitative content analysis approach was adopted to extract and synthesise recurring themes related to FM information requirements in the context of BIM. For non-geometrical data, the identification and categorisation of themes were guided by the framework provided in BS EN ISO 19650-3. Sub-themes were subsequently organised under these broader categories.

Although the selected studies employed diverse research methodologies and produced a range of findings, they were underpinned by core principles that collectively contributed to a deeper and more comprehensive understanding of the central research problem [21].

2.4 Second Round of Systematic Literature Review

Another round of systematic literature review was conducted to update records within the latest 5 years. The same methodology from first round was applied to this round, except for years of records. Literature within 2021 to 2024 were identified through Scopus and Web of Science by using the same keywords. These records were filtered thoroughly before several of them were assessed for review. Records from this round of review were synthesised into several themes and adapted into relevant themes from the previous round. The final 12 records were included for final review (Fig. 2).

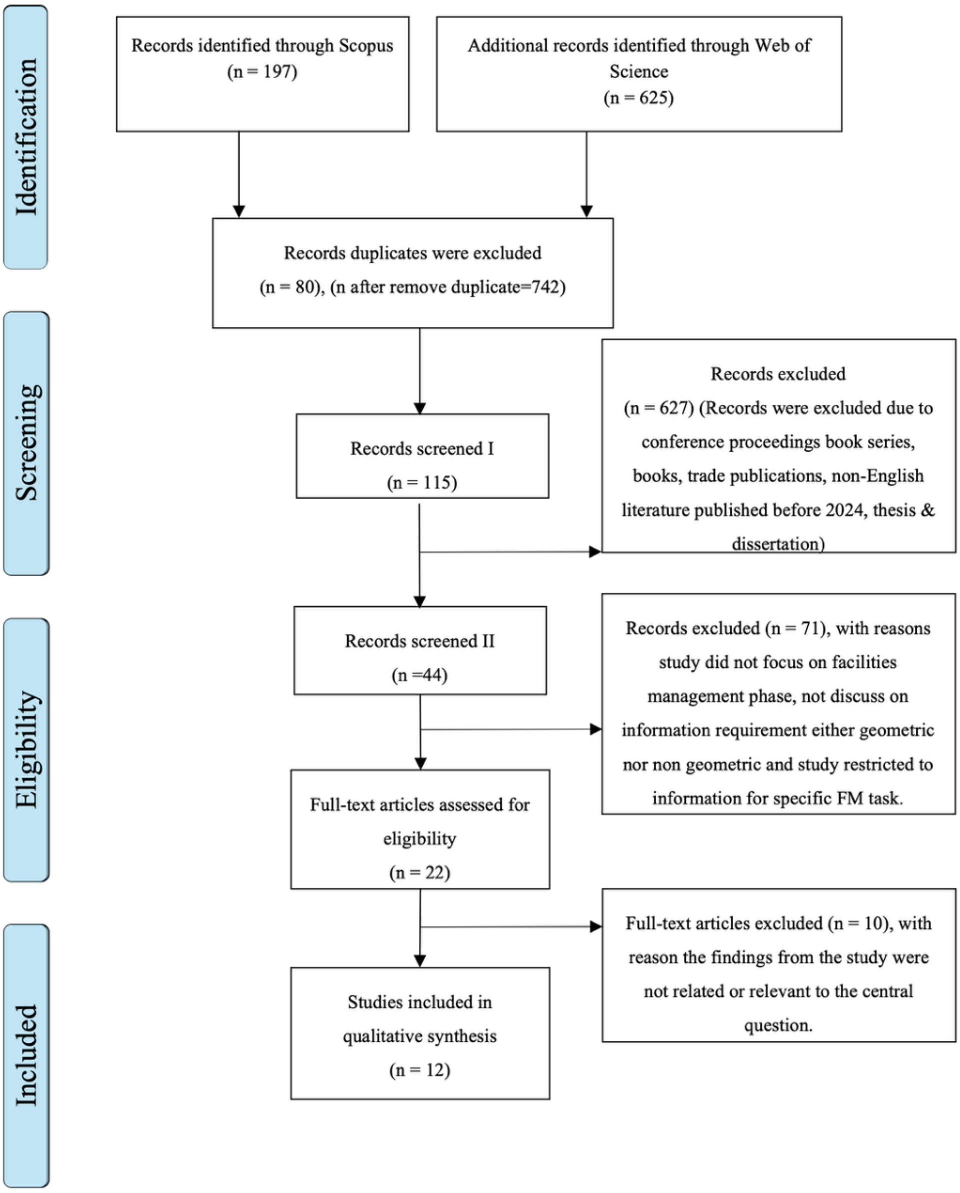

Fig. 2 *Record appraisal from second round of systematic literature review*

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3. Findings

3.1 Result from the First Round of Systematic Literature Review (2016-2020)

The central focus of this study is to identify information needs to enable BIM at the FM phase. The results of this study are presented in two sections. At the first layer, it presented the geometrical data requirements analysed from a total of 8 studies, comprising 15 records. The second section presented findings from 15 studies on non-geometrical data requirements, identifying four main themes and 15 sub-themes. (Table 2).

Table 2 *A total of 15 record identified for data abstraction (2016-2020)*

Studies	Country	Context of Study	Study Design*	LOD Requirement	Non-Geometrical Requirement
Mayo & Issa [5]	US	Educational institutional	QL		√
Lin et al. [22]	Taiwan	General	QL	√	√
Liu & Issa [23]	US	Facilities management activities in general	QN	√	√
Thabet & Lucas [24]	US	Large educational institutional	QL	√	√
Cavka et al. [25]	Canada	Educational institutional and public services infrastructure	MM	√	√
Nguyen et al. [26]	Vietnam	High-rise infrastructure in general	MM		√
Lu et al. [27]	China	General	MM	√	√
Farghaly et al. [28]	UK	Educational institutional for case study	QL		√
Pishdad-Bozorgi et al. [10]	US	Educational institutional for pilot study	MM	√	√
Bortoluzzi et al. [29]	Canada	Existing educational institutional and healthcare	QL	√	√
S. Matarneh et al. [11]	UK	General	MM		√
Sadeghi et al. [30]	US	Educational institutional	QL	√	√
Abdirad & Dossick [31]	US	Existing educational institutional and public transit infrastructure	QL	√	√
Dias & Ergan [32]	Canada	General	QL	√	√
Yin et al. [33]	China	Utility tunnel	QL		√

*Note:
MM - Mixed Method
QL - Qualitative
QN - Quantitative

3.2 Result from the Second Round of Systematic Literature Review (2021-2024)

The results from data extraction and analysis of records from 2021 to 2024 are shown as in Table 3. An additional round of systematic literature review (SLR) was conducted to update the dataset with publications from the most recent five-year period (2021-2024) relative to the current year of article writing. Analysis of these recent studies revealed a consistent pattern in the facilities management requirements for non-geometrical data. Notably, an increasing number of recent works incorporate cost-related information and asset lifespan data, in addition to the previously established non-geometrical parameters. Conversely, there has been a noticeable decline in the emphasis on LOD (Level of Development) requirements in these newer studies.

Table 3 *A total of 12 record identified for data abstraction (2021-2024)*

Studies	Context of study	Study Design*	LOD Requirement	Non-Geometrical Requirement
Alhassan et al. [34]	Student Residential Hall	QL		√
Altwassi et al. [19]	Clinic Building	MM		√
Asare et al. [35]	Central Energy and Refrigeration Plant (CERP)	MM		√
Carneiro et al. [36]	Single-Family Building	QL		√
Carvalho et al. [37]	Family BIM Element	QL		√
Charlemagne et al. [38]	Tunnel	QL	√	√
Demirdogen et al. [39]	Healthcare Facility	QL		√
di Filippo et al. [40]	Multidisciplinary Cultural Centre	QL	√	√
Ensafi et al. [41]	Science Campus Department	QL		√
Halmetoja and Lepkova [42]	Variety: Office, Education & Special Premises Building	MM		√
Sadeghi et al. [43]	Higher education institutions	MM		√
Tsay et al. [16]	Healthcare & Residential	MM		√

*Note:
MM - Mixed Method
QL - Qualitative
QN - Quantitative

3.3 LOD Requirements

The review identifies that LOD requirements for facilities management commonly range below LOD 500, with LOD 300-350 frequently preferred to balance information sufficiency and model manageability. Lower LODs reduce file size and remodelling time [22][30], while some cases include LOD 500 elements for FM personnel input [10]. LOD requirements were often derived from detailed FM information needs, including asset specifications, MEP distribution, and logical object structuring [23][27]. Studies also highlighted that LOD should be task-specific, varying by FM activities such as preventive maintenance, space management, or asset tracking [25][32]. Moreover, LOD specificity by asset type was necessary for components with nested relationships (e.g., air handling units), where individual asset functionality dictated unique development levels [2].

3.4 Non-geometrical Requirements

This section focused on result for non-geometrical information needs. The analysis culminated in four main themes and a total of 15 sub-themes related to specific facilities information for building operation. The four main themes are managerial, legal, technical, and commercial. Managerial information consists of seven sub-themes which are i) identification of assets, ii) location of the assets, iii) spatial data related to assets, iv) warranties and guarantee document, v) historical maintenance record, vi) schedule of maintenance and inspection tasks, and vii) operational related plan, processes, and procedures. Legal information consists of two sub-themes which are i) safety and disaster planning, and ii) emergency planning. There are also two sub-themes in technical information namely i) engineering specification and design parameters, and ii) commissioning data. Meanwhile, commercial information consists of four sub-themes which are i) specifications of assets, ii) assets systems and classification, iii) manufacturer and vendor data, and iv) spare parts information.

4. Discussion

This study presents a systematic review of existing literature to analyse the information requirements necessary for implementing BIM-FM (Table 4). In the FM industry, identifying the specific data needed to support BIM has long been a challenge, often leading to resource inefficiencies. Consequently, there is a pressing need to establish baseline guidelines outlining key information requirements for best practices.

Through a comprehensive search across two major databases, Scopus and Web of Science, 5 relevant studies on BIM applications in FM were identified globally. The analysis revealed that information requirements vary significantly depending on the organisational context. From the data appraisal, the study identified four overarching themes, managerial, legal, technical, and commercial information, comprising fifteen sub-themes that are essential for effective facilities management and maintenance. Managerial information underpins decision-making, coordination, control, analysis, and visualisation, ensuring operational efficiency and effective resource allocation. Legal information focuses on adherence to statutory requirements, regulations, and contractual obligations, supporting compliance and reducing organisational risk. Technical information covers engineering, operational, and maintenance data, including system specifications, equipment performance, and infrastructure needs that sustain asset functionality and extend its lifespan. Commercial information incorporates financial data, procurement details, and asset-related records, all of which facilitate accurate product specification, lifecycle cost analysis, contract management, and investment planning to optimise cost-effectiveness

By integrating these information domains, facilities management can adopt a structured, comprehensive approach that promotes efficiency, compliance, and sustainability throughout a building's lifecycle. Regarding the Level of Development (LOD) in BIM, FM applications demand a composite BIM model, unlike conventional homogeneous models that apply a uniform LOD across the entire BIM model. In a composite BIM model, varying LODs are implemented depending on the functional requirements of each building component.

Attributes such as asset locations and identifiers are crucial for distinguishing assets [31]. Accurate location data enhances the planning of repair schedules and the formulation of emergency response plans, as personnel can quickly pinpoint equipment or structures within the BIM model [33]. Although asset locations are often captured during the design phase [28], these must be verified periodically, as design-phase data may become outdated or inaccurate [2].

Moreover, compared to manual methods, BIM significantly streamlines FM processes. Practices such as embedding URLs within Revit parameters or linking room schedules to PDF warranties improve information accessibility for clients during requests for information (RFIs) on building elements that may have been omitted during project closeout [30]. Traditional handover processes often suffer from data integration gaps, particularly concerning warranty information, which FM teams frequently find difficult to trace [23]. Hence, incorporating essential data, like warranty expiration dates, into the BIM model is vital to ensure timely updates and effective information management.

The review also highlighted that each project carries unique requirements aligned with specific organisational objectives, often resulting in differing terminologies and data preferences. Even with a standardized information baseline, variations remain inevitable. For instance, Mayo & Issa [5] noted that FM personnel preferred receiving manuals in a portfolio format, while Dias & Ergan [32] and Lu et al. [23] reported that asset location data is often favoured as geometrical information rather than non-geometrical.

Such divergences underscore the importance of collaborative discussions among project stakeholders to align information management practices with the distinct needs of each organisation.

Table 4 *Findings on non-geometrical requirements for BIM-FM (2016-2020)*

Studies	Managerial Information							Legal Information		Technical Information		Commercial Information			
	Identification of assets	Location of assets	Spatial data related to assets	Warranties and guarantee document	Historical maintenance record	Future Schedule of maintenance and inspection tasks	Asset related standards, processes, and procedures	Safety and disaster planning	Emergency planning	Engineering specification and design parameters	Commissioning data	Asset description, type and group	Assets systems	Manufacturer and vendor data	Spare parts information
Altwassi et al. [19]	√	√	√	√		√	√	√	√	√	√			√	√
Mayo & Issa [5]	√	√		√	√		√		√	√	√		√	√	
Lin et al. [22]				√	√		√	√		√					√
Liu & Issa [23]		√		√			√								
Thabet & Lucas [24]	√	√		√	√	√	√				√		√	√	√
Cavka et al. [25]				√			√								
Nguyen et al. [26]	√	√	√	√	√	√	√	√	√	√	√			√	
Lu et al. [27]	√	√	√	√	√		√					√		√	
Farghaly et al. [28]	√	√		√								√		√	
Pishdad-Bozorgi et al. [10]		√	√		√	√	√								
Bortoluzzi et al. [29]	√	√	√	√		√	√					√	√	√	√
Matarneh et al. [11]		√		√			√			√					
Sadeghi et al. [43]	√	√	√	√					√	√		√	√	√	√
Abdirad & Dossick [31]	√	√	√	√							√			√	
Dias & Ergan [32]		√						√						√	
Yin et al. [33]	√	√	√	√		√	√	√	√	√	√			√	√
Total	9	13	7	13	6	5	11	4	4	6	5	4	4	10	5

5. Conclusion

This study presents a systematic review of existing literature to analyse the information requirements necessary for implementing This systematic review focused on identifying the critical information required to support Facilities Management (FM) through Building Information Modelling (BIM). While current research trends demonstrate significant interest in the application of BIM across the entire building life cycle, there remains a notable gap in studies that explicitly define the information requirements necessary to facilitate effective FM within BIM environments. To address this, the review analysed existing literature to construct thematic classifications of FM information needs for BIM-enabled practices.

In the initial stage of the analysis, three primary themes emerged concerning geometrical information requirements: (i) LOD requirements typically fall below LOD 500; (ii) LOD is often derived from detailed information needs assessments; and (iii) LOD may be specified according to particular FM functions or tasks. In the second stage, the review identified four key classifications of non-geometrical information: managerial, legal, technical, and commercial, which were further refined into 15 sub-themes.

The study examined how BIM is applied during the FM phase across different sectors, aiming to map the nature and organisation of required information to support building operation and maintenance. Due to the lack of a standardised framework for defining these requirements, this review offers valuable insights for asset owners and facility managers seeking to establish information standards aligned with industry best practices. The analysis concentrated on two major categories, geometrical and non-geometrical information, with further classifications beyond these two not addressed in this study.

Based on the findings, several recommendations are proposed for future research. First, there is a need for more in-depth qualitative studies involving a broader range of organisational profiles, to capture nuanced and context-specific information requirements. Second, further investigation is needed into the practical implementation of FM data in BIM environments, with the goal of proposing applicable strategies for industry adoption. Lastly, the development of a standardised and rigorous systematic review methodology tailored to the context of FM-related BIM research is essential to ensure consistency and reliability in future evidence synthesis.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Syahrul Nizam Kamaruzzaman;* ***data collection:*** *Wan Siti Hajar Wan Nasharuddin;* ***analysis and interpretation of results:*** *Syahrul Nizam Kamaruzzaman, Wan Siti Hajar Wan Nasharuddin, Nurshuhada Zainon;* ***draft manuscript preparation:*** *Wan Siti Hajar Wan Nasharuddin, Nurshuhada Zainon. All authors reviewed the results and approved the final version of the manuscript.*

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