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Building Information Modelling (BIM): A Narrative Literature Review on Theory, Benefits, and Barriers

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ABSTRACT
Building Information Modelling (BIM) has emerged as a transformative methodology within the Architecture, Engineering, and Construction (AEC) sector, significantly changing the approach to project planning, execution, and management. This study presents a narrative literature review (NLR) of BIM, focusing on its theoretical foundations, implementation benefits, and the key barriers to its adoption. The objective is to identify and synthesize the core concepts that define BIM's maturity levels, level of development (LOD), and the use of a common data environment (CDE) within the construction industry. The literature search was conducted using Google Scholar, with keywords such as "Building Information Modelling," "BIM benefits," "BIM barriers," and "BIM theory." The findings indicate that BIM offers significant advantages in enhancing design quality, facilitating collaboration, improving cost estimation, promoting sustainability, and optimizing lifecycle management. However, its implementation faces challenges, including high initial investment, lack of skilled professionals, interoperability issues, and organizational resistance. A case study on a residential building project was also included to illustrate the practical application of 3D, 4D, and 5D BIM. This review concludes with recommendations to enhance BIM adoption through standardization, training, supportive policies, and promoting its role in sustainable construction.

Keywords: *Narrative Literature Review (NRL); BIM maturity; Level of Development (LOD); Common Data Environment (CDE); BIM barriers.*

1. Introduction

Building Information Modelling (BIM) can have different meanings for professionals in the construction industry. Some consider BIM design software, while others consider it a process for documenting building information. BIM refers to a collection of technologies, processes, and policies that enable various related parties in the construction industry to design, build, and operate facilities collaboratively [1]. Some consider BIM a holistic approach that includes the building's design, construction, and maintenance as a whole [2]. These different perspectives demonstrate that BIM is not just a technology but also a new paradigm in the construction industry, changing how projects are planned and managed. With its numerous advantages, BIM has become the standard in many modern construction projects, enabling the optimization of efficiency and reduction of project risks. The implementation of BIM significantly contributes to planning, design, and operational execution, making it one of the most impactful advancements in construction-related technology today.

The architecture, engineering, and construction (AEC) industry has consistently pursued ways to reduce project costs, enhance productivity and quality, and accelerate delivery timelines. BIM has emerged as a transformative approach with the potential to achieve these objectives [3]. From traditional 2D CAD tools (BIM Level 0) to more collaborative and data-driven workflows (BIM

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Levels 1–3), BIM supports a comprehensive digital representation of a construction project's physical and functional aspects. This shift enables better visualization and documentation, promoting full integration throughout the entire project lifecycle, from early design phases to construction and facility management. BIM continues to develop as a methodology, with software solutions adapting to users' needs and becoming increasingly tailored to support multidisciplinary collaboration and operational efficiency [3].

BIM has significantly reshaped how projects are executed in the AEC sector, offering a collaborative environment for stakeholders to work more efficiently and transparently [4]. Its ability to facilitate integrated project delivery (IPD) aligns well with current trends in project management, particularly in large-scale and complex developments [5]—organizations adopting BIM benefit from improved coordination, reduced errors, and better cost control. According to [6], BIM enhances design accuracy, streamlines team communication, and optimizes resource allocation, resulting in fewer delays and increased project efficiency. Thus, BIM is not just a modeling tool but a strategic resource that revolutionizes information management across the construction lifecycle, delivering long-term value to contractors and investors. Given the transformative impact and increasing adoption of BIM, it is important to critically assess how theoretical frameworks align with practical implementation in real-world projects.

2. Material and Method

This study aims to review and classify the literature on Building Information Modelling (BIM) by focusing on its theoretical foundations, recognized benefits, and commonly reported barriers. The primary objective of this narrative literature review (NLR) is to identify how BIM is discussed across academic sources, particularly its application in the construction and infrastructure sectors. By synthesizing existing literature, this study aims to outline the primary dimensions of BIM theory, highlight its practical advantages, and summarize the key challenges that have arisen during its implementation.

The literature review process was conducted through a scientific reference search using Google Scholar. This academic search engine provides access to a diverse range of scientific publications across multiple disciplines. Several limitations in using Google Scholar exclusively are acknowledged. First, not all retrieved articles originate from reputable journals indexed in recognized databases such as Scopus or Web of Science. Second, limited open access to some articles may hinder a comprehensive evaluation of the content. Third, the algorithm's preference for popularity and citation counts over methodological rigor may bias the results. Fourth, the lack of keyword variation or synonym usage may affect the comprehensiveness of the search.

Nevertheless, Google Scholar remains a valuable tool for this study, offering access to global literature, including regional journals and local conference proceedings relevant to BIM adoption. It also offers features such as citation tracking, researcher profiles, and access to multiple versions of articles through institutional repositories. The keywords used in the search included "Building Information Modelling," "BIM benefits," "BIM barriers," and "BIM theory."

3. Result and Discussion

3.1. Theoretical Foundations of BIM

3.1.1. BIM Maturity

BIM maturity represents the extent to which an organization or project can successfully implement Building Information Modelling (BIM) to enhance value creation [7]. It is a reference for assessing an organization's capability, understanding its readiness for BIM adoption, and setting future development goals [8]. Nevertheless, a high maturity level does not automatically imply that BIM is fully applied. An organization might have the resources and skills to utilize BIM for system design and review but could still refrain from doing so due to limitations such as inadequate budgets, frequent project changes, or time constraints [9]. Therefore, BIM maturity should be interpreted as an indicator of potential and strategic alignment with BIM practices rather than directly reflecting operational implementation.

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BIM maturity also reflects the efficiency with which digital technologies and collaborative methods are integrated throughout a project's lifecycle [10]. Transitioning from traditional modeling approaches to an open BIM environment should occur progressively, following a step-by-step process rather than a sudden shift [11]. To represent this progression, BIM maturity is often depicted through a "wedge" diagram; in specific adaptations, subdivisions have been made at Level 0 and Level 3, and a new Level 4 has been introduced [11]. Indicators have been developed to assess four key dimensions—content, digitization, interoperability, and collaboration—across both project execution phases and asset management [11]. Evaluating BIM maturity across these aspects allows a more accurate understanding of a project's developmental stage, acknowledging that different areas may evolve at varying rates.

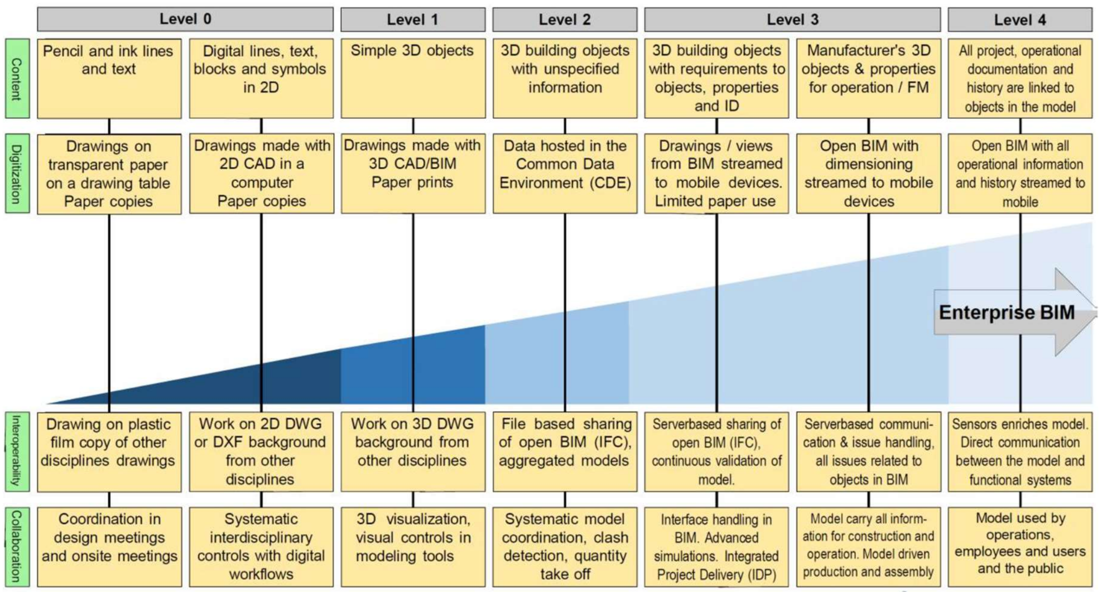

Figure 1. BIM Maturity Levels [11]

Based on **Figure 1**, BIM Maturity Levels are categorized into several progressive stages, each illustrating the degree of digitalization and collaboration in project delivery processes. These levels illustrate the industry's transition from traditional 2D drafting methods to fully integrated, collaborative environments. Each level indicates specific technological capabilities, information management practices, and degrees of interoperability among project participants. Understanding the characteristics of each BIM maturity level is crucial for evaluating a project's digital maturity and planning future development strategies.

At Level 0, project information is primarily produced through unmanaged 2D CAD drawings, which are exchanged either as paper documents or basic digital files. This method has been standard practice for years, focusing mainly on drafting and isolated product information, with minimal collaboration among project stakeholders. As a result, the likelihood of errors is significantly higher than in workflows supported by modern digital technologies [12]. Furthermore, cost estimations, material quantities, and project standards are typically disconnected from the graphical data since 2D drawings remain the primary documentation source [2].

Progressing to Level 1, the workflow incorporates both 2D and 3D information. While 2D drawings continue to serve drafting and documentation purposes, 3D models are primarily used for visualization and design purposes. At this stage, information is organized into structured data formats that comply with standard protocols, enabling seamless transfer across various CAD applications. This level is often utilized to engage investors and perform initial evaluations during the early concept stages of a construction project [12].

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At Level 2, a more advanced, managed BIM environment is established, characterized by intelligent collaboration among disciplines. Information from different teams is shared and coordinated through a Common Data Environment (CDE), and design models are integrated using either proprietary or recommended middleware platforms. Importantly, any software employed at this level must be capable of exporting models into standardized formats such as Industry Foundation Classes (IFC) or Construction Operations Building Information Exchange (COBie) to ensure interoperability [12].

Level 3 is often referred to as full-integrated BIM (iBIM) or openBIM [12]. All project stakeholders can access and work within a shared central model in this environment. Multiple users can simultaneously update the model, and changes made by one discipline are instantly reflected across all other components. This real-time synchronization enhances coordination efficiency and minimizes discrepancies throughout the project lifecycle [13].

Finally, at Level 4, BIM maturity reaches its highest stage, often referred to as Enterprise BIM. In this phase, all project-related data, including operational documents, historical records, and user and system information, is continuously streamed in real-time to mobile devices. BIM evolves beyond its traditional role, becoming a central platform that integrates information from building sensors and operational management systems with the needs of users and maintenance teams. Thus, the BIM model serves as a tool for design and construction, as well as a dynamic operational information hub that supports strategic decision-making and long-term asset management.

3.1.2. Level of Development (LOD)

The Level of Development (LOD) is a critical protocol in Building Information Modeling (BIM), specifying the content and reliability of information contained in model elements at various stages of a construction project [14]. It has been widely adopted and refined by institutions such as the American Institute of Architects (AIA), which describes LOD as encompassing the dimensional, spatial, quantitative, qualitative, and other data required to define a model element [15]. While the term is often used interchangeably with Level of Detail (LoD), there is a fundamental distinction: LoD refers to the amount of detail included in a model element regardless of its accuracy. At the same time, LOD represents the reliable and confirmed information agreed upon by project stakeholders [16].

Since 2013, the term LOD has officially taken on the meaning of Level of Development [17] in the United States. LOD is designed to overcome problems related to inadequate information in project delivery by establishing clearly defined levels of information completeness [14]. It is vital in execution planning, contracting, facilities management, and decision-making phases [18]. Establishing and maintaining consistent LOD definitions across all model elements improves project coordination, especially when aligned with a BIM Execution Plan [7].

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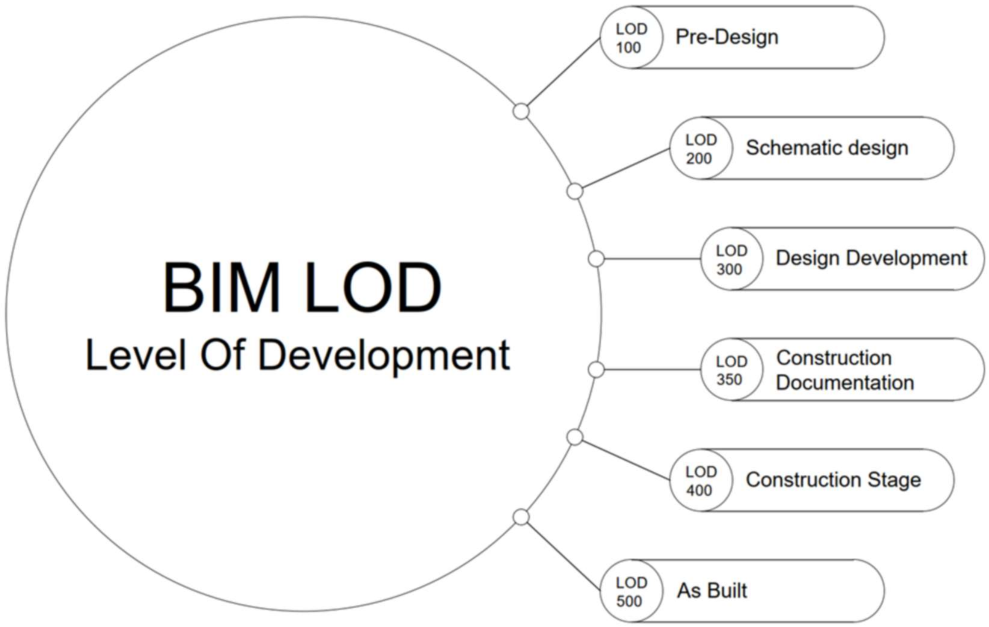

Figure 2. Level of Detail—LOD models (LOI + LOG) [6]

According to BIMForum and other scholars, LODs are divided into six progressive levels: LOD 100, 200, 300, 350, 400, and 500 [17, 19]. These levels range from conceptual representations to fully detailed as-built models, as illustrated in **Figure 2**.

a. LOD 100 involves generic placeholders with no detailed shape or geometry [16, 19]. It is used for conceptual modeling where elements are represented with symbols, such as rectangles for walls or circles for columns [6].
b. LOD 200 includes generic elements used as stand-ins, containing rough geometric shapes and basic semantic data [16, 19]. At this stage, elements are still represented generically but are more informative, enabling spatial analysis, such as room area calculations [6].
c. LOD 300 introduces precise geometry, where all elements are modeled with specific shapes, sizes, orientations, and locations [16]. This supports detailed architectural plans such as elevations and sections [6].
d. LOD 350 adds system-level details and inter-component interfaces, enabling clash detection and coordination across disciplines such as electrical and mechanical systems [6].
e. LOD 400 presents fabrication-ready models, including detailed installation information, specifications, and assembly requirements [19].
f. LOD 500 is a field-verified as-built model [16, 19] containing exact data about the final built condition, including component condition and maintenance information [6].

This development progression is visually illustrated in **Figure 3**, which presents a comparative example of how an elevator component evolves across LOD stages from LOD 100 to LOD 400 [16]. **Figure 3** effectively demonstrates the increasing detail and complexity level in geometry and information. At LOD 100, the elevator shaft is depicted only as a basic volumetric placeholder with no detailed elements. Moving to LOD 200, more recognizable shapes, such as the rough outlines of the elevator car and basic panel locations, begin to form. LOD 300 introduces defined geometric representations, including doors, platforms, and guiding structures. At LOD 350, additional components, such as mechanical shafts and rails, are integrated, showing inter-system coordination. Finally, LOD 400 incorporates fabrication-ready elements, such as pulleys and connection details, enabling complete preparation for installation.

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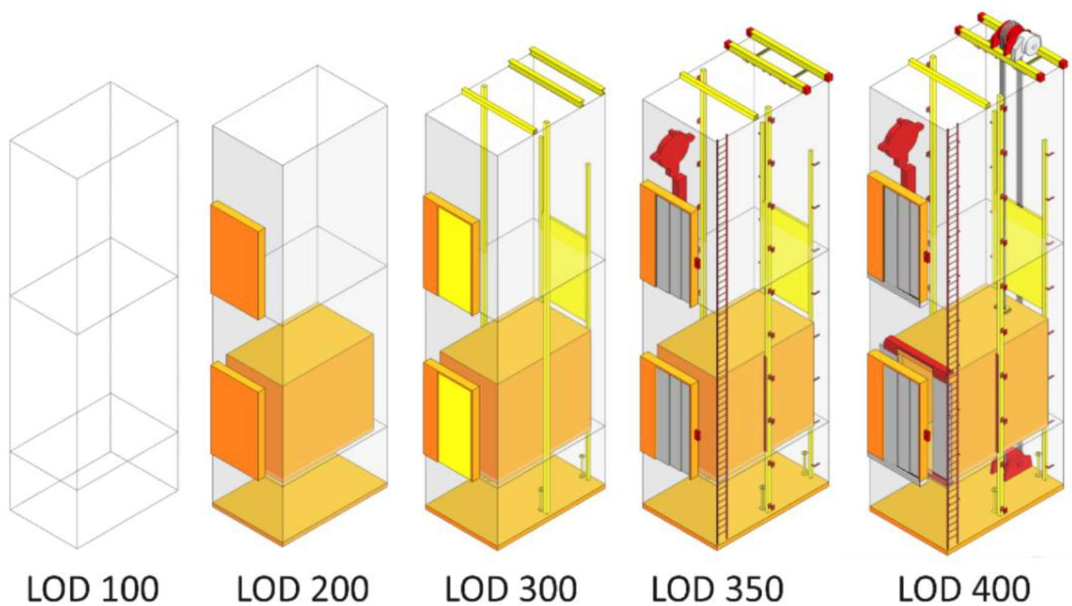

Figure 3. Progression of Design Across LODs (Elevator Example) [16]

The visual progression reinforces how LOD scales support clarity and reliability in design development, helping project teams manage expectations and responsibilities effectively. Based on **Figure 3**, the application of LOD should be purpose-driven, depending on project-specific needs rather than rigidly following every level. Despite its hierarchical nature, research has shown that project owners do not necessarily need to increase the LOD of a BIM model unless it directly supports management and analytical needs [9]. Undefined or mismatched LODs at different design stages can impact the granularity and utility of model data, particularly during transition phases from LOD 100 to LOD 500 [20]. Ultimately, LOD plays a crucial role in Building BIM, as it defines the extent to which building components are accurately and comprehensively represented within the model [6]. LOD allows users to depict BIM elements with varying degrees of detail, ranging from broad approximations to highly detailed and precise representations [21].

3.1.3. Common Data Environment (CDE)

A Common Data Environment (CDE) is a centralized digital platform designed to store, manage, and share information throughout the lifecycle of a construction project. ISO 19650-1:2018 defines it as "an agreed source of information for a project or designated asset, used to collect, manage, and disseminate each container of information through a managed process" [22]. In practice, a CDE serves as a reliable single source of truth where all authorized stakeholders can access, upload, and update project-related data, including models, drawings, and documents [23-24]. It ensures consistency, enhances data accuracy, and streamlines communication across disciplines [25].

The role of a CDE in BIM is especially critical during the early stages of the project lifecycle, where coordination and collaboration are paramount [26]. Its function is not limited to simple data storage; instead, it promotes real-time information exchange, version control, document traceability, and secure access—all of which contribute to improved project efficiency [27]. In particular, cloud-based CDE platforms, such as Autodesk BIM 360 or Trimble Connect, have emerged as robust solutions that integrate IoT sensors to offer live status updates of building components [28]. These systems also support clash detection and reduce design silos from the earliest stages [29].

By embedding BIM within a CDE, the design and delivery process becomes more collaborative, enabling multiple disciplines to work collectively through a unified platform [30]. This shift toward greater transparency and data sharing lays the foundation for a more integrated construction

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environment, encouraging interoperability and minimizing rework [31, 32]. In doing so, CDE fosters a culture of accountability where all project participants can access the same, up-to-date information. This reduces miscommunication and improves decision-making throughout the project lifecycle. Over time, such integration enhances project efficiency and supports long-term asset management through a structured digital record.

To assess the maturity of CDE implementation in practice, [22] propose a classification framework comprising four levels (Level 0 to Level 3), each reflecting a distinct degree of digital integration and collaborative capacity. This maturity matrix is illustrated in **Figure 4**, which presents the progressive structure of CDE development across four orientation axes: document management, coordination, communication, and BIM production. Each level represents a significant advancement in digital integration and collaborative functionality:

a. Level 0 represents a pre-CDE environment where data management is manual. Most documents are stored in physical format or shared ad hoc via email or cloud storage, and there is no structured policy governing the exchange of information.
b. Level 1, defined as EDM-oriented collaboration, aligns with PAS 1192 and ISO 19650 standards. It includes basic document management functions—acquisition, classification, storage, and distribution—secured through access rights and user identification. However, communication is external to the platform.
c. Level 2 introduces model coordination features. It allows automated updates across linked models and documents, ensuring consistency. This level also includes electronic version tracking with digital signatures for quality assurance.
d. Level 3 reflects full BIM integration, where a central model encompasses all disciplinary models (architecture, structure, HVAC, etc.). Synchronous collaboration allows multiple users to work concurrently on shared files. Enhanced communication tools, such as instant messaging, VOIP, and video conferencing, are integrated, and document editing is fully embedded within the platform.

Ultimately, implementing a robust CDE is essential for organizing the complex information flows inherent in modern construction projects. It fosters collaboration, reduces fragmentation, and enhances project delivery outcomes through structured, accessible, and secure information management [22].

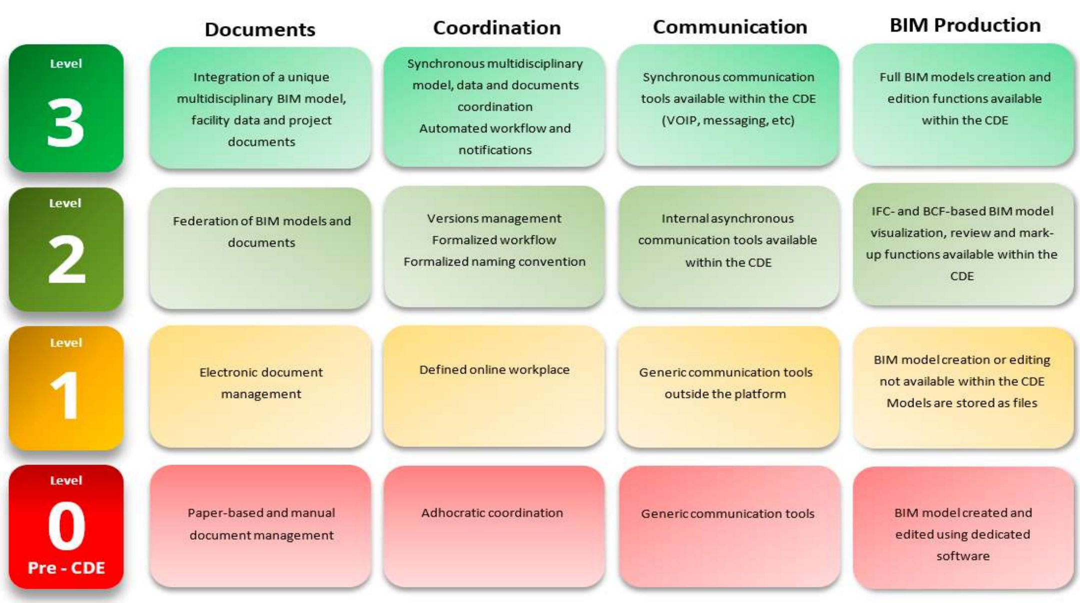

Figure 4. Matrix of 3 levels of CDE [22]

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3.2. Bim Outcomes and Benefits

Over the past few decades, numerous studies have analyzed the advantages and measurable value of BIM implementation in the construction industry. These studies are essential for academic inquiry and supporting industry practitioners in navigating BIM-related decision-making, especially amidst widely discussed implementation challenges [33]. However, most existing evaluations focus heavily on financial benefits while overlooking other crucial dimensions, such as environmental sustainability and social impact [33]. [34] emphasized that one of the most impactful uses of BIM is enabling the exchange of design-related decisions between project team members and clients. They also pointed out that BIM contributes significantly to constructability by simulating construction processes early in the project. Importantly, the benefits of BIM are not isolated; they are interrelated and often influence each other directly or indirectly. Their literature review identified the specific advantages of BIM during the design, pre-construction, construction, and post-construction phases, with detailed findings presented in **Table 1**.

Further reinforcing these insights, [35] highlighted how BIM contributes positively to the building industry's sustainability goals. Their study demonstrated that BIM provides clear advantages across three dimensions—environmental, financial, and social—which are detailed in **Table 2**. In a broader international context, [36] surveyed participants from 54 countries to determine the primary benefits they experienced when using BIM tools to capture and reconstruct built environments. The results of their study are presented in **Figure 5**, illustrating how BIM is globally perceived as a valuable tool for enhancing project outcomes and digital integration in the construction sector.

Table 1. Extract BIM Benefit Codes [34]

Design	Pre-Construction	Construction	Post-Construction
– Enhancing design quality and promoting sustainable design development – Better visualization of plans – Reducing the designer's need for modifications – Minimizing errors in public design documents – Identifying design mistakes and obstacles – Energy consumption analysis and sustainability assessment – Reviewing and improving design plans – Reducing analysis time and estimating related factors (e.g.,	– The presence of all stakeholders and enhanced relationships among them – Earlier and improved project visualization – Clarifying project concepts for the employer and increasing satisfaction – Utilizing modern construction technologies and methods as competitive advantages – Enhanced information management and documentation – Strengthening team-building capabilities – Better understanding of	– Improving coordination and integration across design, construction, and logistics – Applying and developing prefabrication methods – Enhancing safety through improved access to project details and risk identification – Increasing overall project quality – Responding to requests for information (RFI) more efficiently – Empowering contractors with greater decision-making authority – Reducing construction time	– Facilities management enhancement – Reduction in maintenance costs – Improved decision-making and support throughout the project lifecycle – Better strategies for building maintenance – Enhanced project performance – Creation of added value and increased profit margins

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Design	Pre-Construction	Construction	Post-Construction
structure, materials, orientation, energy) – Evaluating multiple design alternatives – Increasing communication, coordination, and integration – Improving early problem detection before construction – More accurate time and cost estimation – Gaining earlier access to accurate project information – Enhancing decision-making capabilities – Strengthening MEP design and coordination with other systems – Improving constructability – Enhancing feedback mechanisms – Detecting clashes in design analysis – Analyzing project site conditions and equipment positioning	construction components – Understanding the sequence of activities during the construction phase	and associated costs – Boosting productivity – Minimizing errors, duplication, waste, and delays – Strengthening communication among all project stakeholders – Accelerating responses to design changes – Reducing conflicts – Improvement in risk management – Better resource management – Timely project delivery	

Table 2. Benefits of using BIM methods in the building industry's sustainability initiatives [35]

Conservational advantages	Financial advantages	Communal advantages
– Enables energy and building code assessments, including predictive performance evaluations – Supports tracking of energy output, regulation of energy consumption, and efforts to reduce carbon emissions	– Enhances design effectiveness and project accuracy – Reduces costs associated with as-built drawings – Decreases overall project expenditure – Boosts building efficiency and productivity	– Encourages collaboration and teamwork to accelerate project progress – Improves workplace safety and health performance – Extends the usable life of built structures – Facilitates the smooth transfer of knowledge

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Conservational advantages	Financial advantages	Communal advantages
– Enhances ventilation system efficiency – Assists in evaluating the potential for water collection and reuse – Offers alternative solutions for sustainable architectural design – Increases efficiency in resource management – Facilitates complete life cycle analysis of thermal performance in buildings – Enables life cycle evaluation of lighting systems within structures – Helps in thoroughly assessing design alternatives and viable options – Promotes the use of energy-efficient and environmentally friendly technologies – Contributes to a significant reduction in material waste generation – Promotes green building practices in design, construction, and operations – Raises awareness among stakeholders regarding the benefits of sustainable development – Encourages the adoption of sustainability principles across the construction industry – Provides insights for proactive energy planning and environmental performance forecasting	– Raises overall project output – Optimizes management throughout the building life cycle—covering design, construction, operations, and maintenance – Strengthens financial oversight and control mechanisms – Minimizes the time and resources required to complete specific tasks – Facilitates preplanning for financial, equipment, and material requirements – Improves data flow efficiency related to operational processes – Enables exploration of renewable and energy-efficient solutions – Identifies the most cost-effective and energy-saving approaches – Promotes the use of budget-friendly, sustainable design practices – Helps predict and manage future energy consumption – Provides access to reliable financial forecasting and investment planning tools – Supports pricing and quantity estimation for accurate budgeting – Enhances quality assurance and project delivery standards	from design to execution and maintenance phases – Inspires stakeholders to support sustainability-focused initiatives – Enhances the efficiency of data entry, sharing, and transformation within projects – Contributes to raising living standards through thoughtful design – Promotes the adoption of sustainable systems and practices – Improves the accuracy of construction quality monitoring – Ensures that project challenges and obstacles are properly tracked – Provides a centralized database for managing project information throughout its lifecycle – Strengthens understanding among stakeholders regarding sustainability goals and practical solutions – Aids in informed and collaborative decision-making – Streamlines planning and renovation processes – Boosts the reputation of the construction industry through innovative and green initiatives – Reduces health and safety risks during construction activities

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Figure 5 presents the key benefits of BIM in the geometric reconstruction process using point cloud data based on participant feedback [36]. The most frequently cited advantage is the ability to work with a complete 3D model of the building, as mentioned by 60.1% of respondents. This is followed by modeling accuracy (48.9%) and faster acquisition of building sections and elevations (38.2%), highlighting BIM's contribution to precision and efficiency in design workflows. Other notable benefits include improved speed in modeling (33.7%) and faster detection of errors and deviations (33.1%), both of which are essential for reducing rework and ensuring quality control.

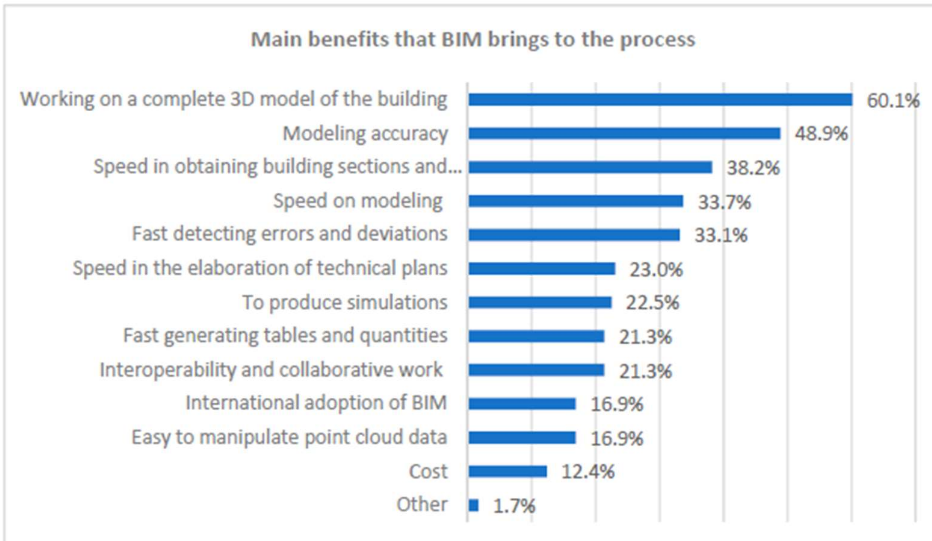

Figure 5. The main benefits that BIM brings to the geometric reconstruction process from point clouds [36]

Additionally, 23.0% of participants acknowledged the advantage of using BIM to accelerate the elaboration of technical plans. In comparison, a smaller but still significant portion recognized its usefulness for simulations (22.5%), generating quantities (21.3%), and promoting interoperability and collaborative work (21.3%). Aspects such as international adoption (16.9%) and ease of manipulating point cloud data (16.9%) were also noted. While cost savings were cited by only 12.4% of respondents, this suggests that the perceived value of BIM lies more in its operational and technical benefits than direct financial returns. Overall, the data in **Figure 5** reinforces the essential role of BIM in improving workflow efficiency, accuracy, and collaboration in point cloud-based modeling processes.

3.3. Common Barriers to BIM Adoption

Barriers to BIM adoption are often rooted in challenges widely acknowledged across the construction industry. These include high implementation costs, a shortage of skilled professionals, and general resistance to change [37]. Among the various categories of barriers, cost-related issues are frequently highlighted as the most critical. This encompasses the initial investment in BIM and the ongoing costs of training and acquiring necessary software [38]. In addition to financial constraints, other significant obstacles include managerial limitations, technological inadequacies, cultural resistance, and weak client demand. A comprehensive summary of these findings, as identified in the studies by [37] and [38], is illustrated in **Table 3**.

Both [38] and [37] highlight a wide range of barriers hindering the widespread adoption of BIM in the construction industry. Although their perspectives stem from different contexts and publication periods, their findings significantly overlap in identifying technical and organizational challenges.

– A significant theme in both studies is the issue of technological limitations. [38] The key barriers are poor internet connectivity, power instability, and software system incompatibility. These are

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echoed in [37], which similarly notes gaps in system integration, a lack of technological support, and limitations in software coding. Both studies also acknowledge that the expense of software and the complexity of tools can discourage adoption, especially in small to medium-sized firms.

- Both sources agree that insufficient BIM-related skills, technical knowledge, and experience pose substantial obstacles. [38] points out the lack of training and skilled personnel, while [37] adds that academic institutions are not yet fully equipped to support BIM education. This deficiency in human resources directly contributes to organizations' reluctance to embrace change.
- High initial costs—encompassing training, licensing, and software—are a shared concern in both sources. Notably, [38] mentions the financial burden of upskilling, while [37] reinforces this by discussing extended setup time and capital investment as deterrents to BIM adoption. These financial factors often accompany clients' reluctance to demand or pay for BIM-driven solutions.
- Resistance to change is another commonality that is often powerful. Both studies observed that personal perceptions, traditional work practices, and unfamiliarity with BIM processes lead to inertia among employees and decision-makers. [37] Many practitioners are satisfied with existing methods, while [38] discusses the influence of subjective opinions and limited awareness, even among senior management.
- Legal uncertainties and a lack of clear policy direction emerge as shared concerns. [38] details the absence of enabling policies and legal complexities, while [37] mentions liability risks and inadequate legal frameworks. These regulatory gaps undermine confidence in BIM deployment across project phases.
- Lastly, communication breakdowns and poor collaboration are cited as critical issues. [37] explicitly refers to an unwillingness to share data and collaborate, which aligns with the findings of [38] on a lack of ecosystem support and pushback from employees. These barriers hinder the integrated workflows that BIM fundamentally relies upon.

Table 3. Common Barriers to BIM Adoption

Hyarat, Hyarat and Kuisi (2022) [37]	**Alshibani *et al.* (2024) [38]**
– Lack of strong support from top-level management – Limited awareness and inadequate technical expertise in BIM – Inaccessibility to suitable technologies and structured frameworks – Personal biases or subjective opinions toward BIM adoption – Absence of clear and comprehensive BIM guidelines – No supportive environment or ecosystem for BIM integration – High initial investment required for BIM implementation – Unclear vision regarding potential profitability – High cost associated with training and upskilling – Expensive software tools needed for BIM operations – Resistance due to the extensive cultural shifts BIM demands	– Issues related to compatibility and lack of interoperability among BIM tools – High initial setup costs, including expenses for training, software licenses, and hardware – Shortage of personnel with the necessary skills and experience in BIM – Absence of standardized procedures, methodologies, and implementation frameworks – Inadequate BIM education within academic institutions – Organizational resistance to adopting change; Limited technological support or infrastructure to back BIM use – Lack of awareness due to limited access to training, seminars, or educational programs – Legal uncertainties and liability risks in using BIM – The unique nature and complexity of construction projects make BIM integration difficult – Preference for traditional methods by some construction practitioners

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Hyarat, Hyarat and Kuisi (2022) [37]	Alshibani *et al.* (2024) [38]
– Competition with other ongoing initiatives within organizations – Lack of willingness or pushback from employees – Complexities in legal compliance and contract requirements – Poor internet connectivity is affecting digital workflows – Interruptions due to inconsistent power supply – Low demand or interest from clients to adopt BIM – Software incompatibility and limited system interoperability – Absence of backing or regulation from the government or policymakers – The belief that existing conventional technology is already sufficient.	– Technical limitations in coding, interface standards, and modelling – Gaps in technological development and inadequate system integration – Low market or client demand for BIM solutions – Poor communication or reluctance to share data and collaborate – Extended setup duration compared to conventional methods.

Both studies offer a comprehensive overview of BIM adoption barriers, categorized into five major areas: technological, financial, human resources, cultural, and regulatory. The convergence of their findings underscores the need for a comprehensive strategy that integrates technical tools and training with organizational culture, legal clarity, and stakeholder engagement. Addressing these shared challenges will be crucial for achieving successful and sustainable BIM integration in the global construction industry.

3.4. BIM Implementation in the Project – Case Study

The case study presented in the dissertation by [39] revolves around modeling a four-story residential building that incorporates both architectural and structural elements. Autodesk Revit 2022 was chosen as the primary tool for developing the 3D model due to its strong capabilities in collaborative modeling and data sharing. The building model encompassed foundational slabs, columns, staircases, and roof structures. The objective of the study was to develop a comprehensive BIM workflow that extends beyond 3D modeling to incorporate 4D (time) and 5D (cost) aspects, aiming to enhance efficiency, facilitate precise quantity takeoffs, and enable visual simulations for improved project understanding.

Several BIM tools were utilized throughout the project. Autodesk Revit served as the core platform for developing both architectural and structural models, and it also enabled the creation of federated models that integrate multiple disciplines. Autodesk Navisworks played a crucial role in clash detection, allowing the integration of various models through the ".NWC" and ".IFC" formats for coordinated project reviews. STR Vision CPM was used to connect the model to scheduling and cost-related data, thus supporting both 4D and 5D functionalities. It allowed real-time updates and could integrate with Revit as well as other platforms such as Tekla and ArchiCAD.

However, several challenges were encountered during the implementation of BIM in this project. Among the most prominent issues was the lack of standardized BIM protocols and legal clarity regarding data ownership and responsibilities. Incompatibility between different software platforms hindered seamless data exchange, and the high costs and complexity of implementing 5D BIM further complicated adoption. Additionally, Autodesk Revit was found to have limitations in its default family libraries, requiring manual parameter inputs to generate accurate quantity take-offs. Integrating Revit with STR Vision also proved to be imperfect, revealing interoperability issues across platforms.

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Despite these challenges, the impact of BIM on project outcomes was notably positive. Real-time cost estimation and forecasting through STR Vision led to improved financial planning. Time savings were achieved through early clash detection using Navisworks, which helped to avoid costly rework and construction delays. The use of shared coordinates in Revit facilitated better collaboration among project teams by allowing multi-disciplinary model integration. Finally, the incorporation of 4D BIM enabled the simulation of construction sequences, improving scheduling accuracy and providing visual feedback through Gantt charts and dynamic model updates.

4. Conclusion

This narrative literature review has examined the theoretical foundations, practical benefits, and common barriers associated with Building Information Modelling (BIM) in the construction industry. The review highlights that BIM is not merely a technological tool but a comprehensive approach that enhances collaboration, coordination, and efficiency across project stages. Key theoretical concepts such as BIM Maturity Levels, Level of Development (LOD), and the Common Data Environment (CDE) provide a structured framework for understanding how BIM is implemented and scaled. In terms of benefits, BIM significantly contributes to improving project quality, reducing construction errors, enhancing sustainability efforts, and optimizing resource management. However, several barriers hinder its broader adoption, including high implementation costs, lack of skilled personnel, technological limitations, and institutional resistance to change. The inclusion of a practical case study further validates the theoretical discussion and demonstrates real-world challenges and successes in BIM integration.

To support the effective and widespread adoption of BIM, several actions are recommended. First, training and educational programs focusing on BIM technologies and collaborative workflows should be expanded to bridge the skill gap between professionals and students. Second, government bodies and project owners are encouraged to establish supportive policies, financial incentives, and legal frameworks to promote BIM adoption, especially in public infrastructure projects. Third, the development and enforcement of standardized BIM protocols—such as clear definitions of Level of Development (LOD) and structured Common Data Environment (CDE) practices—are essential for ensuring interoperability and consistency across stakeholders. Moreover, fostering a collaborative culture across multidisciplinary teams will enhance information flow and project coordination. Ultimately, greater emphasis should be placed on promoting BIM as a driver of sustainability, encouraging its application in environmentally responsible design, construction, and operational strategies to achieve long-term value creation.

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