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Building information modelling (BIM) and knowledge management in implementation for construction projects

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A B S T R A C T

The widespread use of knowledge management in a wide range of applications aids in professionally and wisely streamlining the procedure to produce improved outcomes and deliverables. Knowledge management is essential in the construction sector due to the considerable investment, extended deadlines and the need for higher performance efficiency and quality. The usage of BIM in construction projects has simplified the procedures required in building construction. The fundamental motivation behind the creation of BIM was the need to apply knowledge management approaches to make projects more sustainable and compliant with green building requirements. There are various limitations and risks associated with using BIM in construction projects, such as issues with file sharing and data security. This research examines numerous BIM benefits and drawbacks from a variety of angles, providing information and various measures for building the program. BIM adoption in construction projects includes a wide range of benefits as well as drawbacks. The relationship between the variety of information and outcomes was explored using different findings from numerous scientific studies that looked at the use of BIM in the construction sector. Due to the wide range of data that is available in the BIM sector, numerous areas were also found in this study. A thorough analysis was undertaken to present a variety of author viewpoints from various articles. This report's strengths and weaknesses have been noted. It has been demonstrated that BIM has additional benefits, including meeting client expectations, reducing design errors, and achieving project sustainability. However, there are also drawbacks to BIM, including user skill gaps, ambiguous standards and protocols, and transfer data problems. A few studies have addressed some of the research gaps and limitations in some of the domains. Additionally, these regions were thoroughly addressed from many authors' points of view.

1. Introduction

Because the construction industry is so large, numerous systems are needed to streamline the planning, budgeting, and results so that consultants, contractors, and clients may achieve their goals and expectations. The early 2000s saw the introduction of building information modelling (BIM), which permits project members to enhance methods and technology at different points. Examples include digital development, management and reduction of C&D waste, design review, 3D coordination, and planning and design. These activities must be finished before building can start on these difficult infrastructure projects, which are required in many countries. It is important and advantageous to use knowledge management in a variety of sectors. The

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use of software to ascertain needs, objectives, goals, customer satisfaction, high revenue, profit, and sustainability has increased across a variety of industries in recent years. In the construction industries, one of the keys to meeting project deliverables and objectives has been effective software use. Building information modelling (BIM), which models and simulates various aspects of building design, is one of the frequently used pieces of software. BIM software aids in cost reduction during design, the mitigation of construction hazards, and the achievement of project sustainability, quality, and performance. Data loss may occur as a result of some BIM software usage challenges, like communicating data with other users. Although BIM deployment has encountered issues because of a lack of expertise and training, this software is still in common use. This study's goal is to identify and look at some potential BIM software deployment areas in the building and construction sectors. As part of a thorough examination based on the literature, the numerous advantages and disadvantages of BIM will also be examined. In order to obtain comprehensive remarks from many points of view, this study tries to pinpoint the advantages and disadvantages of various authors' viewpoints. Additionally, BIM software includes a lot of benefits as well as challenges and threats.

According to Anton and Diaz (2015), BIM offers the entire toolkit needed to finish a construction-building project more effectively and with higher quality. Although 94% of UK businesses now utilize BIM extensively, there have historically been implementation problems (Tran, 2012). According to Gulghane and Khandve (2015), Civil engineering constructions can now be made using a wide variety of building materials. The overall cost of the materials may represent 60% or more of the total cost, depending on the type of project. Effective construction material management is essential to the success of any project. Construction garbage is a serious problem in the construction industry. Construction waste is created throughout the entire construction process and comes in a range of shapes, sizes, and qualities. In India, the largest economic sector is the construction industry. After agriculture, it is the second-largest economic activity, according to the eleventh five-year plan. Project management includes the key component of materials management. The success of a building project depends on an efficient process for managing the resources. It has altered and evolved throughout the years in response to the projects' increasing complexity. Understanding the history of materials management practices and how they differ from those used in other industries is crucial.

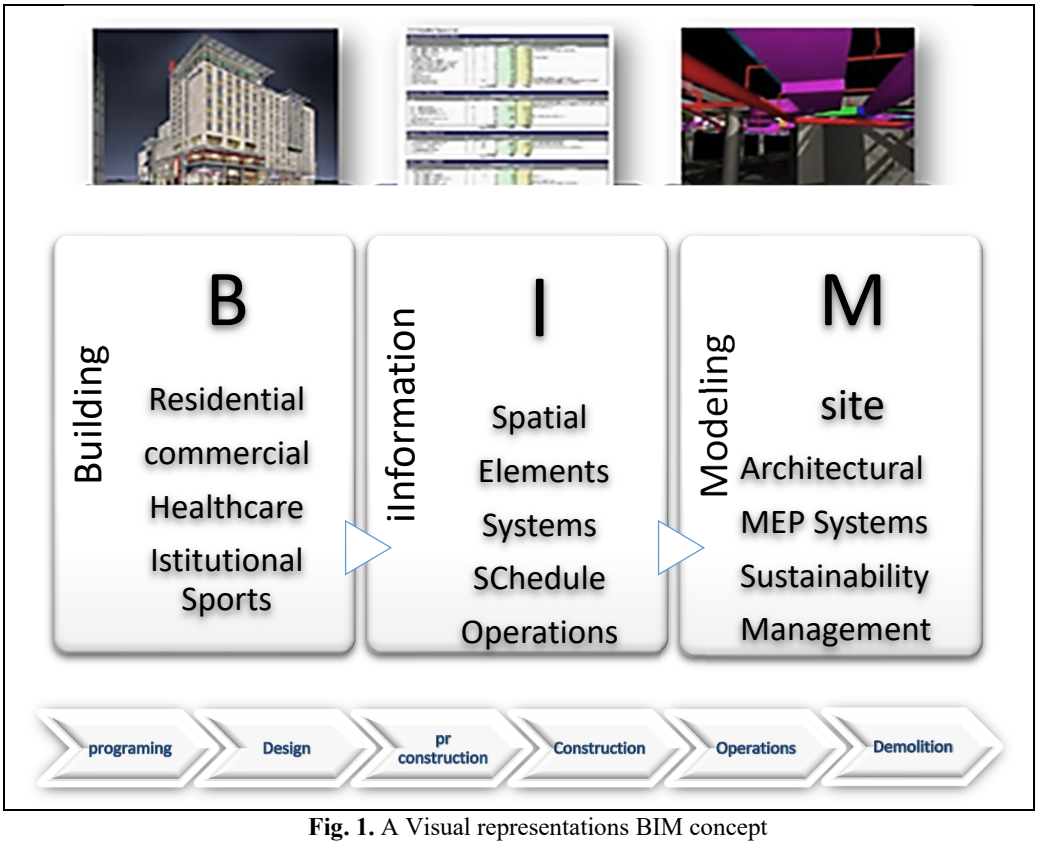

Fig. 1. A Visual representations BIM concept

2. Literature Review

Globally, the development of the construction, engineering, and architectural sectors has quickened. The building techniques have been designed, developed, and improved using a variety of methodologies, approaches, and technology (Bryde, 2013). Following the Research Council's Building Research Board's recommendation that combining databases would be the most

practical way to manage facilities, In the middle of the 1980s, the National Academy of Science approved building information modeling (BIM) (Scarponcini, 1996). BIM software lowers expenses and design errors while increasing reliability and quality through activity coordination (Silva FAC, 2015). According to Anton and Diaz (2014), building information modeling software provides a wide-ranging active capacity to improve project performance and quality. 39% of UK residents use BIM, and 94% are aware of it, according to Tran et al. (2012). BIM can be used to develop projects from the construction stage through deconstruction. (Gholami et al., 2015). Building performance modeling and simulating BIM systems can contain measures for the efficiency of a building. J. S. Haberl, S. Kota, W. Yan, and M. J. Clayton. The technology that BIM produces is visual prototyping (Salman Azhar, 2012). BIM is a method and a piece of software that supports adapting project delivery and workflow processes. BIM can be used to manage a facility's complete life cycle, from the stages of planning and design through those of operation and maintenance (Hardin, 2009).

Abanda et al. (2017) contend that off-site manufacturing is superior to conventional production techniques for BIM. The UK Construction Leadership Council suggested accepting off-site production using BIM to enhance the performance of the construction industry (Farmer, 2016; Goulding et al., 2012). Off-site manufacturing productivity has been the subject of a lot of discussion. Alaghbari (2007) asserts that manufacturing off-site could speed up the completion of construction projects. BIM will produce better off-site production than conventional building, according to Babic (Babic, 2010). The data can be stored in the BIM object library and used for upcoming projects, according to Abanda et al. (2017a, 2017b).

BIM's benefits include securing project requirements through early design, assessing building performance through operations simulation, saving money by counting the number of order changes, 3D animation that aids in effective project marketing, and comprehensive knowledge of the building and its systems. According to Ku and Taiebat (2011), the US Army Corps of Engineers aggressively encourages designers and contractors to use BIM on all projects. BIM makes it possible to undertake sustainability analysis continuously, which saves time and money (Azhar, 2011). BIM was inspired by the Leadership in Energy and Environmental Design (LEED) green building rating system used in the United States. The use of BIM by contractors can lead to a leaner working process because it can be used to estimate quantity used and costs, identify design flaws, plan and analyze projects, verify on-site labor and track construction activities, prefabricate components off-site and model safety plans, and improve communication between engineers, designers, and subcontractors. These benefits will lead to high profitability, safety plan management, improved work production quality, cost and schedule evaluation, and customer happiness (Azhar, 2008).

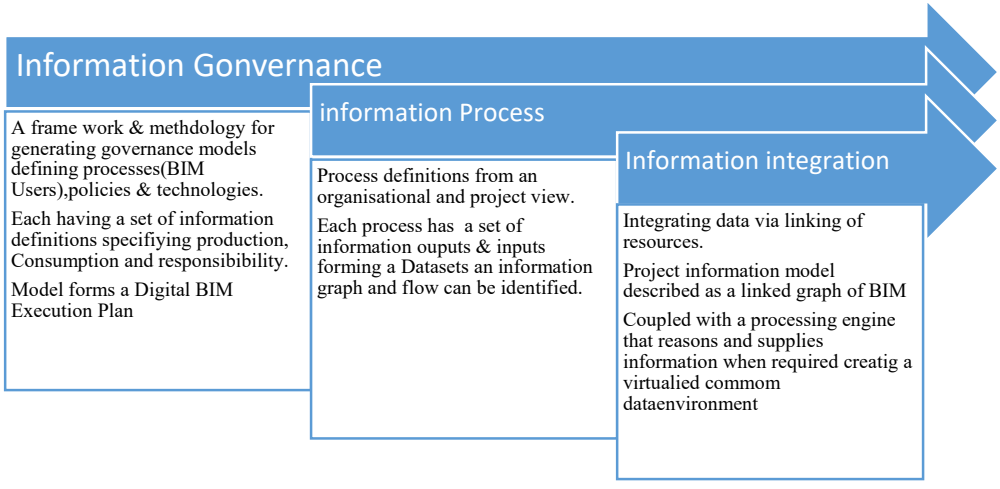

Fig. 2. Roadmap for infrastructure & con structure BIM development

Based on the benefits of BIM, there are also dangers and challenges associated with adopting this software, which can be classified into two groups: risks connected to technology and risks related to processes. One of the risks associated with technology is the absence of BIM standards for managing and integrating interdisciplinary teams, which requires significant access to the software model. This needed implementing protocols to ensure information and context consistency. Since each company has its own standards, there are currently no standards protocols established for BIM software, which can lead to inconsistencies and faulty results in the model itself (Azhar, 2012). To prevent problems, the project team must perform a routine audit (Weygant, 2011). Data transmission across apps enables automation and re-entry of data. Industry Foundation Classes (IFC) and XML can be used to tackle interoperability problems (Smith & Tardif, 2009). When a member of the project

team, an architect, or an engineer supplies data to BIM, questions over license may arise (Thompson & Miner, 2007). Process-related risks include those relating to the organization, contracts, and legislation. BIM data for ownership must be protected in accordance with copyright regulations (Azhar, 2012; Thompson, 2001). The UK BIM industry standards include eight publications that cover the BIM protocol, digital plans for construction, and the unless categorization system. The BIM standard BS1192, which provides a series of procedures for gathering and transmitting data over the length of a created asset's existence, specifies that five of the eight papers are necessary (Salameh et al., 2022). Data exchange and publication via file systems, including network access, SharePoint document management systems, storage, and cloud technologies are all covered by the most recent standard, BS1192:2007. Information can be distributed based on earlier iterations, but it is subject to change before being delivered as intended. Project information includes data on clients, stakeholders, and the project itself. To enable operational BIM practice, information is necessary to be more specific with the delineation of stakeholder tasks and personalities. All standards place a strong emphasis on clearly defining the data that must be included in the project information model. The best and safest ways to link with BIM to guarantee data integrity are consumption and segregation. Bradley et al. (2016) contend that the description of how the data is shared among the participants is the most important component of the standards. Normative modeling and the BIM deliverables are related to this idea. Examples of merging different databases and data types are abundant in information integration. In order to incorporate sustainable practices in the design process, BIM enables the data to be covered on a single model (Autodesk, Autodesk Ecotect Analysis. Sustainable Building Design Software, 2012). This makes it possible for engineers and architects to exchange information about sustainability evaluations pertaining to the design process. Kato et al. (2014) assert that enhancing building performance is a benefit of employing data sets to simulate building design early on. Dependence on BIM software could provide issues for external databases used in appropriateness analysis. The external database's limited data input and default limits are the cause, which results in calculations with low dependability and nonconformities (Autodesk, Autodesk building performance analysis assistance, 2015). To enhance data exchange among BIM users, a new structure was created in compliance with BIM open standards files. Industry Foundation Classes (IFS) created tools and concepts to enable the foundation of mapping and integration interchange with other applications. One-to-many mapping in GIS operations has three different security tiers (Sanguinetti et al., 2012).

BIM data is communicated throughout the design phases, according to Son et al. (2015). It is stored in a database. BIM software users can cooperate thanks to data exchange standards. Industry Foundation Classes (IFC) promoted the development of data sharing standards for construction-related issues (Hietanen J, Final S., 2006). According to Azhar et al. (2011) and Azhar et al. (2012), it's crucial to supply information, software, and security when adopting model access agreements in order to avoid mistakes. The biggest obstacles to the industry's adoption of BIM software are a lack of demand, high costs, and technical challenges. Moreover, there is a lack of interoperability, expertise, and abilities. Many BIM users around the world expressed concern about its use, citing issues including a poor return on investment and poor user experience. For BIM to be successfully implemented, the Architecture, Engineering, and Construction industries must make large investments in software, hardware, and training (Bernstein et al., 2012). However, BIM shines in areas like satisfying client needs and expectations through project prototype visualization. Krygiel et al. (2008) claim that these beneficial elements can help reduce carbon footprint, energy use, and expenses to meet green construction standards.

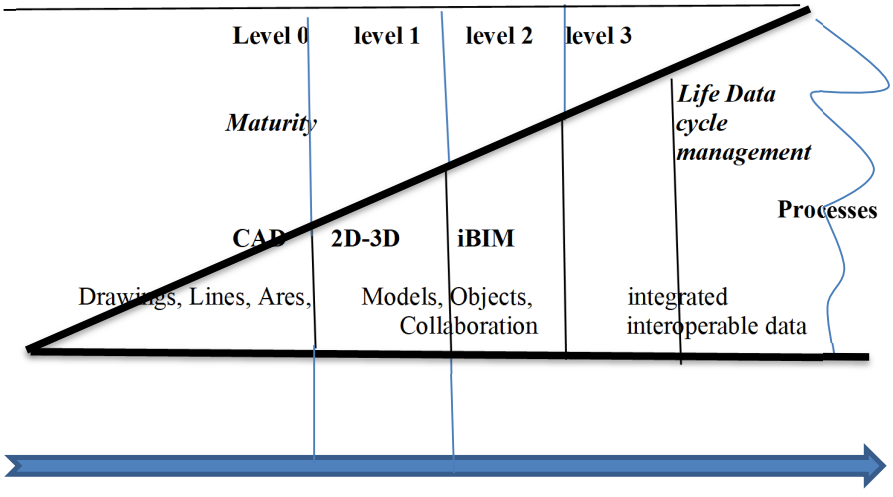

Fig. 3. BIM maturity levels U.K. Adapted from BIS

According to McGraw-Hill (2009), 30% of Canadians and 50% of Americans use BIM software, which has a great return on investment. A contract must be signed by Client or the owner before using more commonly accepted technologies (Moore & Dainty, 2001). To produce high-quality buildings with better outcomes, adoption of BIM necessitated changes to conventional work procedures (Cerovsek, 2011). 90% of BIM users surveyed by National Building Specifications (NBS) in the UK in 2010

said that their industry's practices needed to change. Cost is a frequent justification for not embracing BIM (National BIM Report, 2012). According to a 2012 research from Australia's Cooperative Research Centre (CRS) for Construction Innovations, there are a number of technological barriers to BIM adoption that have an effect on connected organizations and business processes. BIM has a multitude of benefits, yet it isn't more expensive than traditional management methods. According to the executive summary of the 2011–2012 BIM Survey by the Institute for BIM in Canada, The Canadian construction sector uses BIM to the fullest degree and it has extremely high popularity. The vast majority of the industry operates at level 1 progressions, according to the 0–3 grading system developed by the UK Department of Business Innovations and Skills (BIS) (British Standards Institute, B/555 roadmap, 2012). Since BIM deployment in the public sector requires standards and protocols with a common language to keep information available and non-proprietary, there are interoperability concerns (Hewage & Porwal, 2013). Building Information Modeling National BIM Report (2012), B/555 plan of the British Standards Institute. The UK government made the decision to exclude any contractors who were not using BIM since it plans to use BIM software in all upcoming projects. BIM advocated for public education regarding procurement in addition to pushing for specific changes to its procedures (Integrated Project Delivery, 2012). By guaranteeing that software data transmission in BIM continues to grow, data transfer becomes better and more accessible over time. Users of the program must apply and comprehend the BIM-partnering framework (Porwal & Hewage, 2013). According to A. Ghaffarianhoseini, 2017, users need assistance with a variety of issues, including getting started, project user capabilities, stakeholder training and support, the absence of necessary instruments, the dangers, and the disputes that surfaced in working methods during the introduction of BIM.

Table 1
Benefits, dangers, opportunities, drawbacks, and research gaps associated with different types of knowledge management for BIM

Rewards, hazards, rewards, disadvantages, and research gaps of BIM's diverse knowledge management (critique of articles)	
Management of facilities activities 2014 Volk, Stengel, and Schultmann; Akcamete, A., and B. (2010); and Garrett, J.H. Becerik-Gerber, B., Jazizadeh, F., Li, N., and Calis, G.	**Retrofit planning** Mill T, Alt A, Liias R., 2013 Woo J-H, Menassa C., 2014
Maintenance Motawa I, Almarshad A., 2013	**Emergency management** It was written by Tashakkori H., Rajabifard A., Kalantari M., 2015 Li N., Becerik-Gerber B., Krishnamachari B., Soibelman LA., and 2014 Arayici Y.
Communication Numerous studies show that BIM dramatically enhances communication between project participants. K. Liston, P. Teicholz, C. Eastman, and R. Sacks (2008) **monitoring and evaluation** Eastman C, Teicholz P, Sacks R, and Liston (2011) It was published in 2011 by Arayici Y., Becerik-Gerber B., Jazizadeh F., Li N., and Calis G.	**Positive factors that affect C&D waste minimization and management:** • According to J. Won and J.C.P. Cheng (2017), important aspects of construction include design review, 3D coordination, quantity take-off, phases, site usage planning, digital prefabrication, 3D control, planning, and building, as well as ordering materials based on precise measurements.
BIM challenges increase performance and remove obstacles from the construction industry (F.H. Abanda, J.H.M. Tah, and F.K.T. Cheung, 2017)	**Utilizing BIM to control risks** Avoid the dangers brought on by faulty design and subpar construction in the architecture, engineering, and construction (AEC) sectors. (Jones, S. W., Yoou, Kiviniemi, 2016)
Quality control F. Boukamp and B. Akinci, 2007	**Energy management** Marzouk M., Abdelaty, 2008. Cho YK, Alaskar S, Bode TA, 2011.
Advantages • According to Shahryar Habibi, 2017, enhancing a building's energy efficiency and indoor air quality performance. • According to Irizarry J, Karan EP, Jalaei F, 2013, gives precise counts for the parts and building materials that make up a design.	**Advantages** • According to Gu, 2010, Current BIM research includes Virtual Reality (VR) as a key component, and vice versa. • According to E. Gholami, A. Kiviniemi, T. Kocaturk, and S. Sharples, 2015, Create lifecycle stages from conception to destruction and utilize them for facility management, visualization, prototyping, and design comparison.
Disadvantages • The protection of intellectual property and cyber security of BIM tool outputs is one of the major issues facing the development of BIM (Solihin W, Eastman C., 2015). • Because team members can now access project data through information sharing, cyber security is a worry owing to the risk of unauthorized online access and copyright infringement (Chien K-F, Wu Z-H, Huang S-C., 2014). • According to Ali Ghaffarianhoseini, 2017, contractors and designers have not been adequately persuaded of the economic benefits to invest in BIM.	**Disadvantages** • According to Jung Y and Joo (2011), the general effectiveness of BIM utilization has not been sufficiently proved. • Chien K-F, Wu Z-H, and Huang S-C (2014) state that the adoption of BIM is fraught with a variety of dangers, including managerial risks, financial risks, legal risks, environmental risks, and others. • According to Azhar, Khalfan, and Maqsood (2012), The integrated idea of BIM hides the level of accountability across varied project team members.
Research Gaps • The integration of BIM and BIM-related digital technologies with traditional methods, processes, and strategies for risk management has not been extensively addressed in research.BIM can support economic growth and is more time and cost effective when assessing the sustainability of renovation projects. • According to F.H. Abanda and L. Byers (2016), "BIM can be used to facilitate the impact of orientation on energy consumption" in small-scale construction. • BIM Required standards and protocols	**Barriers** Based on a survey of 31 contracting companies in the US, Ku and Taiebat (2011) identified the following challenges to the adoption of BIM: 1. Learning curve and a shortage of qualified staff 3. Resistance from other stakeholders (such as the architect, engineer, and contractor) 2. High implementation costs 4. Lack of modeling standards and collaborative work processes 5. Compatibility 6. A lack of enforceable agreements
Technology-related Risks • According to Weygant, 2011, The inability of multidisciplinary teams to manage and integrate models due to the lack of BIM standards. The project team should do frequent "model audits" to ensure that any difficulties are avoided since merging transdisciplinary information into a single BIM model necessitates multiuser access to the BIM model.	**Process-related Risks** • Rosenberg (2007) points to organizational, legal, and contractual concerns. The first issue is that it is impossible to determine who the owner of the BIM data is; as a result, copyright laws and other legal routes are required to protect it. (2011) Thompson. Include ownership rights and responsibilities in the contract requirements for the most straightforward way to avoid copyright issues.

Table 2
Using BIM to increase the advantages and obstacles of off-site manufacturing from a qualitative standpoint

Parameters	Drivers and advantages of off-site manufacturing	Bathers and constraints	How BIM can enhance the benefits and also improve the barriers
Quality	Product building components) tried and tested in factory. Greater consistency, as same product types are exactly identical; more control quality especially with regards to compliance with standards.	The of offsite manufacturing is colored by the experiences of the past, especially around 1960s where some prefabricated buildings colbmed. Perceived as expensive when can pared to traditional methods. High initial and set-up costs high. Interaty or county transport can be very high and a negate any advantage The need for cranes for transporting building	Quality of data in BIM is improved and highly accurate leading to engraved quality of building component. Building a component can be virtually built and tested in the factory beiare erecting on site. This minimizes errors that could possibly jeopardize quality.
Cost/Value	Lower preliminary costs, Increase certainty-less risk, increased in added value, Lower overheads, less on-site damage and Less waste; Serial productions leads to significant reduction in formwork and hence cost; Offer good economic value.		ashes detected virtually leads to significant cost savings. Collaborative viewing of models leading to improved communications and mist between stakeholders and enabled rapid decision making early in the process leads to cost savings. Pre-design investigation that prevents costly and time-consuming redesign at later stages.
Time	Less time spent on site, Speed of delivery of product, less time spent on commission, Guaranteed delivery- more certainty over the program and reduced management time		BIM provides opportunities to gain time in delivering construction projects. Using coordination resolution in pre-construction requests for information (Ms) and change orders can be reduced to zero. By explains nD models using BIM a lead to the identification and avoidance of errors that should have occurred during the execution of real project
Productivity	las nagging, Les site disruption, reduction in the use of wet trades, removal of difficult operations from ca-site, Work being undertaken at the same time both en-site and offsite.		By modelling virtually and integrating with
People and occupational	Fewer people on-site hence reduced number of online		

3. Future Prospect

A meta-analysis methodology was used to examine several pieces of data that were gathered for this study. The growth of BIM software has shown that it is suitable and useful for usage in the building industries. The knowledge management industry around the world uses BIM as a standard piece of software. The benefits of employing BIM are numerous, including lower project energy costs. However, the safety plan was a crucial component of BIM that helped identify current and potential safety risks before construction. Moreover, employing BIM software greatly improved construction performance. In all construction-related businesses, meeting project deadlines and deliverables is crucial to avoiding any financial problems. The absence of BIM management experience may hinder rather than help a project's progress. The deployment of BIM may raise further complaints and require spending more money on minor areas because clients may not be interested in the program's advantages. According to recent study, integrating BIM might be difficult in some construction projects since it is not necessary. On the other hand, it's critical to establish a time when all clients are informed of the benefits of BIM across the whole building development life cycle, including safety precautions, cost and energy reduction, and adherence to green building standards. The issue with investing in the program in all projects occurred since not all clients in building projects required BIM as software to achieve project sustainability or efficiency. On the other hand, BIM issues can be challenging for many endeavours. The introduction of BIM is being hampered by issues with data interchange and copyright, despite the fact that this research identified these issues.

The magnitude of construction projects and the financial requirements for BIM should be the main topics of future BIM research. To elaborate, project size and design may reveal whether it is crucial to employ BIM software instead of alternative tools. Future studies should investigate how the use of BIM impacts the size of construction projects and the amount of funding required, taking project size into consideration. A better indication of the viability of this system in various building projects might be obtained by researching the relationship between BIM from the financial perspective and project size. However, as many articles have noted, finding answers to the problem of data sharing and file exchange is crucial for future study. This is due to the fact that this issue has hindered the usage of BIM software in construction projects numerous times. Another issue that requires additional study is the connection between BIM software and related protocols and standards. This partnership could contribute to the development of a new standard or the modification of the already-existing BS1192:2007 (Collaborative production of architectural, engineering, and construction information), which called for more detailed information on the establishment of (AEC) information. The claims of BIM's benefits and drawbacks were discovered to be connected. Overall, it was demonstrated that the majority of the benefits were connected to savings in numerous areas, however the amount of savings was not specified. On the other hand, there were numerous objections and knowledge gaps in the off-site manufacturing sector. Off-site manufacturing can be implemented using BIM software, however there are several advantages and

limits that are only applicable to certain projects. Additionally, there are no problems with database storage while sharing and exchanging data, making this the sole instance where BIM software has been confirmed to be fault-free. Additionally, as noted in the literature review, the majority of construction projects have a negative influence on the program since it is unsuitable for file sharing with other users because some information is missing.

The evaluation of the claims in light of the benefits and drawbacks of BIM software as revealed in the literature review. The connections between the statements were in some ways limited to a particular field, such as how BIM improves project performance and results in cost and energy savings as well as project sustainability. While in certain instances, the relationships between the many writers fluctuated, such as when people shared and exchanged data, which caused some information to be lost. The topic of adopting BIM in off-site manufacturing was also determined to have research gaps and restrictions, and there was no concrete data to rely on. Compared to the conventional building process, off-site manufacturing requires more BIM research. The investment and cost-effectiveness should be the main areas of the inquiry.

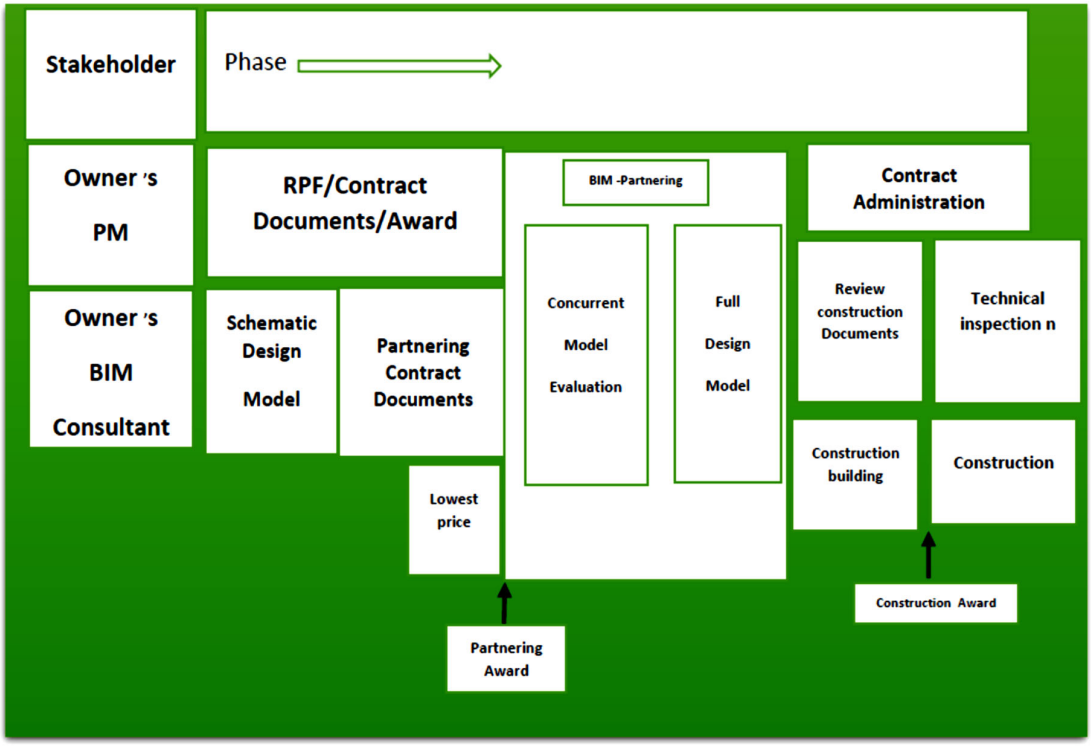

Fig. 4. Early BIM Partnering delivery method

Fig. 4 (BIM maturity level the UK adapted from BIS) illustrates that computer-aided design is at levels 0 to 1, with the ability to produce 2D and 3D designs. Its procedure is also exceedingly slow as compared to IBM. While level three integrated, interoperable data has a lot of data and necessitates lengthy processes. The present degree of maturity is between 1 and 2, and it includes collaboration, objects, and models. BIM can be implemented in construction projects based on client or owner requirements, project size, type of project (whether BIM is mandatory or not), nature of project (whether residential or industrial project), and users' level of competence in implementing and managing BIM to integrate a potent system and avoid risks and obstacles (Zou et al., 2017; Wang et al., 2015).

The stakeholders in relation to various phases are shown in the above graphic. The owner's BIM consultant, which includes a phase of schematic design model and partnering contract paperwork, is the most important component. When compared to the preceding phases, this phase has a larger model. Some claims made in the literature study had contradictory relationships, such as the fact that although BIM is utilized to a greater or lesser extent than 50% of the time in some nations, there are still difficulties setting up the system and getting stakeholders to use it. However, using BIM requires certain abilities, such as experience working on various projects. The literature review makes numerous references to the BIM's difficulties and obstacles. Data transfer problems, the absence of user training requirements, and the necessity for more defined standards and protocols for all users. To combat the integration of BIM in the construction and building industries, the establishment of the new standard was suggested in numerous papers. However, it was determined that this area was crucial for introducing users to BIM software and assisting in removing potential obstacles.

Future research will concentrate on a variety of topics, including standard field, BIM implementation, and the relationship between the design phase and BIM establishment phase. Some sections were not fully developed to reveal all of the explicit knowledge, but there were thorough investigations that discovered were somehow sufficient to obtain data and proof in some areas that called for in-depth investigation. BIM was widely used in many nations, but implementation was very low for a variety of reasons, including user inexperience and software problems, which were extensively covered in numerous declarations. Many nations have low BIM adoption rates, and the absence of BIM-focused articles from other nations like the USA and Asia makes it unnecessary to conduct further research in this field. The only nations represented in the articles used in this report are the UK and Canada. Different countries may have different reasons for not employing BIM software, including cost concerns and inadequate implementation. Future study will be crucial in identifying this area's limitations in order to integrate the various reasons for not using BIM in various regions and perform analysis to determine the major and minor reasons for not using BIM.

4. Discussion and Conclusion

Both benefits and drawbacks of BIM adoption are numerous. By implementing BIM software, building projects can advance more quickly through the construction process, simplifying the process flow in the construction industry. Many of the articles featured in this study concern safety and its uses. The benefits of BIM in safety-related topics may improve working conditions. The use of BIM software on the construction site has significantly improved work organization and cost savings. The integration of BM and the power supply required on the site has sufficient viability to lower the cost of energy and achieve project sustainability by adhering to green building regulations. On the other hand, energy consumption and in building projects is high and expensive. One of the main benefits of integrating BIM applications was the emission, such as carbon footprint. The development of BIM software had some flaws, including problems with data sharing and user-shared BIM files' security, which resulted in computations that weren't accurate. Shared files in BIM software can corrupt data and have a negative impact on the database of the program. To prevent any difficulties with using the program, it is crucial that BIM standards and protocols are available. These protocols protect the copyright and authorization of BIM software. It is advised to perform a routine audit to reduce risks associated with using BIM in various applications.

There were several BIM-related topics that needed more research, such as how BIM and Computer Aided Design (CAD) relate to one another. This portion of the inquiry required finding certain papers in the field of information technology. Because the majority of the cited articles only offer a few facts on each application, the gaps between Computer Aided Design (CAD) and BIM software are not covered in this study. While some research discussed the broad obstacles that CAD and BIM can encounter in the data security domain. This study, which provides general details and relation outcomes, will benefit more from a technical information investigation. Further research is needed to determine the return on investment of BIM. Despite all the benefits of utilizing BIM, many authors criticized the potential expenditure that BIM software could require. The BIM system is widely available throughout the world, but there are numerous concerns that could prevent users from making a profit and an investment at the same time. This subject was left out of the report since the economic benefits of BIM relate more to the financial sector than to technical issues. According to several studies, utilizing BIM as the principal software in the building sector carries financial risks that could result in time wastage and other problems. The usage of BIM, however, has drawbacks and knowledge gaps as a result of numerous disagreements amongst the writers in several fields. Future research in these areas is necessary. The use of BIM in off-site manufacturing was one of the numerous debates. Because there are so many papers on the subject, many of which emphasize the drawbacks of utilizing BIM in off-site manufacturing projects in place of the conventional production method, this topic has drawn a lot of interest. Exploration should be the main goal when comparing conventional building methods and off-site manufacturing to determine the advantages and disadvantages since this can help to close research gaps and constraints.

Finding the cost of developing BIM software needs, such as training, software cost, and return on investment in the comparison of various projects of different sizes and locations, is one of the study limits in adopting BIM in construction projects. This study examines all of the pros and cons in a wide range of domains. To overcome the research limitations in BIM use in the construction industry, more study is needed. By employing BIM, construction project delays can be avoided, and data sharing and an effective BIM database are both guaranteed. The dangers and obstacles associated with employing BIM, which are mentioned under the specific domain of information sharing hazards, represent another study gap. Only the hazards associated with sharing BIM data were discovered, and the number of research was small. To guarantee that any software problems are present, it is necessary to further investigate the risks and barriers associated with adopting BIM. While other studies disagreed, some studies provided a more accurate indication of BIM data exchange. The creation of the new standard is a crucial step that is referenced in numerous study disciplines. To address the current problems and shortcomings in the application of BIM software in the construction and building industries, more research is needed. To pinpoint the serious issues with BIM software, extensive research was required in a number of domains.

Recently, there have been numerous issues with BIM implementation and interaction with other systems, making it impossible for anyone region to resolve BIM integration across all parties. Additionally, several topics covered in this study may just be a minor concern, such as the requirement for training, which is frequently cited as a potential obstacle. On the other hand, some areas, such as the system's challenges with data transmission issues and ambiguous protocols, were discovered to be a significant problem for establishing BIM software. For the hazards in BIM software to be valid, this section needs to be more

in-depth and supported by substantial evidence. While using BIM in various regions, it is necessary to locate and compile a variety of papers from various fields in order to learn about the viability, drawbacks, and benefits of BIM in that particular area.

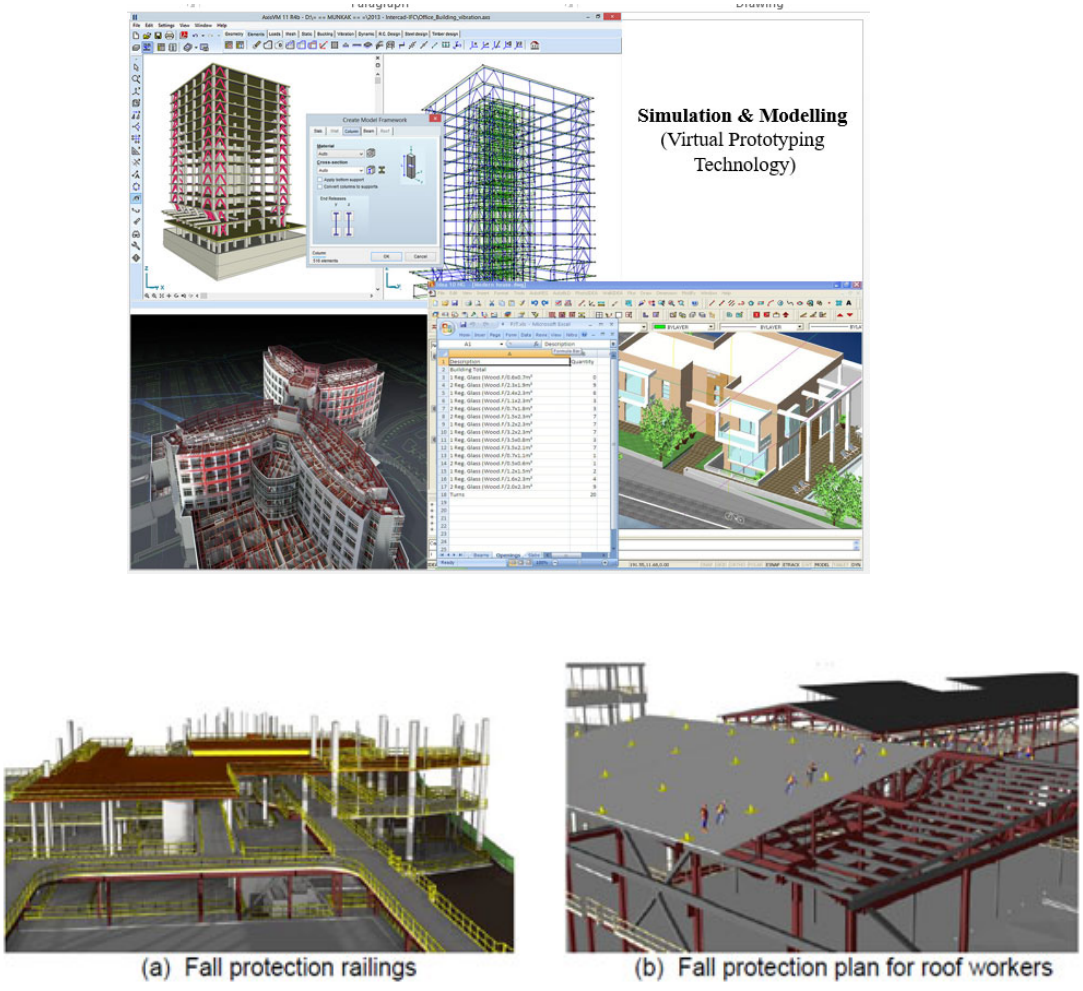

Fig. 5. A BIM-based sit specific safety plan

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