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A Review of Obstacles to the Construction Industry's Use of Building Information Modeling (BIM)

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Research Article

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Abstract: In 2017, one of the biggest economic sectors in the globe was the construction industry. Additionally, the construction sector has been strengthened by Building Information Modeling (BIM), a potent combination of technologies for design, construction, and management. Even after a project has completed its lifespan, BIM offers substantial advantages, but the project is unable to reap these advantages due to the construction industry's inability to successfully adopt BIM technology. This study's primary goals are to determine the most important obstacle to BIM deployment and to rank them according to their relative influence on this problem. A thorough literature research was used to perform the study and gather the essential data. The literature analysis produced a list of 37 barriers that prevent the construction industry from using BIM technology. For every barrier found in the literature review, a relative rank was determined based on its frequency and relative effect. B17 (Social and habitual reluctance to change), B19 (Traditional ways of contracting), B3 (Training expenditures and the learning curve are too costly), B20 (High cost of software acquisition), and B33 (Lack of knowledge about BIM) are the five most important obstacles to the adoption of BIM. B19 (Traditional contracting techniques), B17 (Social and habitual opposition to change), B33 (Lack of BIM awareness), B2 (Inadequate BIM training), and B28 (Lack of BIM expertise) are the five most significant barriers. The government and other project stakeholders must work together to remove the barrier based on priority in order to reap the enormous advantages of BIM technology.

Key Words: BIM; Barrier; Literature Review; Relative Impact; Construction Industry

1. Introduction

"BIM (Building Information Modeling) is an intelligent 3D model-based process that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure," according to Autodesk, the company that creates a variety of BIM tools [1]. "A digital representation of physical and functional characteristics of a facility" is another definition. As a result, it functions as a common knowledge base for details about a facility, providing a trustworthy foundation for choices made throughout its life cycle from the beginning [2]. For sketching, modeling, simulation, management, and control, BIM is a major technical development for the construction sector. It has grown to be the most crucial component of the global architecture, engineering, and construction (AEC) sectors. In the 1960s, the idea of BIM was developed for basic computer applications, and in the 1970s, it was refined for solid modeling programs [3]. According to a source, the creation of ArchiCAD software is regarded as the actual assessment of BIM, and the use of Revit software is the successful application of contemporary advanced BIM [4]. The main concept of BIM is to complete a project visually before actual construction begins in order to identify any risks, issues, and disputes. Additionally, it examined building methods and procedures as well as the feasibility of socioeconomic considerations in the project's early design stage. Instead of using CAD and 3D modeling, BIM refers to the effective and efficient organizing systems of cooperation of suitable persons and information that are prepared for various predetermined processes and technologies. BIM is an intelligent, data-driven, object-oriented, virtual facility display that aids in decision-making and enhances the construction and delivery process [5]. Personnel, process, information, and technology are the main components of BIM [6].

In the context of building construction, a Building Information Modeling (BIM) is a 3D model that addresses design, planning, construction, and operation [7]. Rich structural, technological, and managerial data are included in the 3D model. is used to analyze scheduling, cost, sustainability, and building performance [8]. Building information modeling (BIM) was first used to plan and analyze various stages of building construction, but it is now employed in the industrial and services sectors as well as to monitor, regulate, and manage building performance and operation. BIM is a sophisticated and suitable collection of methods and procedures used across the whole project lifecycle [9].

The architectural, engineering, and construction (AEC) sector was completely transformed by Building Information Modeling (BIM) in the latter half of the 20th century. The idea of 3D project modeling gave rise to the modern concept of BIM, which later expanded to include 4D modeling related to construction processing and scheduling, 5D modeling with project cost estimation, 6D modeling with project sustainability, 7D modeling with facilities management and application, and even nD modeling [10]. It is widely accepted that BIM may be used to integrate the different stages of a manufacturing project across its whole lifespan [11]. BIM was oddly introduced at the AEC sector in the early 1990s to address the poor productivity of building projects as well as other risks and obstacles that hinder the progress of the construction industry [12]. The design and construction process is made more straightforward and transparent in many ways by BIM technology, which also offers a number of direct and indirect advantages [13]. With the use of BIM technology, there is a 40% reduction in unbudgeted costs, a 7% reduction in the time it takes to deliver a project to the customer without significant disagreement, and an 80% reduction in the time it takes to produce cost estimates with a better rate of accuracy of roughly 3% [5]. With the U.S. construction industry projected at US$1.288 trillion for 2008, the Construction Industry Institute estimated in 2004 that 57% of money spent on construction is non-value added, or waste. At 57% waste, more than $600 billion is squandered year [14]. The Digital Built Britain strategy for construction and procurement, which is entirely BIM-driven in the UK, was made possible by BIM, which helped the UK government save almost $1.7 billion in construction costs in 2013–2014 [15]. Design, construction, maintenance, and control may all be integrated using BIM technology. It is a comprehensive model that helps all stakeholders increase performance efficiency and has enough data throughout the lifespan. By lowering expenses, risk, and waste in addition to carbon emissions and environmental pollutants, BIM is the greatest technology for sustainable design and development. Additionally, BIM technology strengthens more collaborative working habits, enhances communication between project stakeholders, and improves the hard work marketplace [16].
Through a thorough analysis of the literature, the research aims to determine the primary obstacle to the use of BIM technology in the construction sector. Additionally, determine the proportionate effects on the industry of each implementation hurdle.

2. Methodology

The critical factors that affect the implementation of BIM and the benefits of implementation of BIM are questionnaire design for the study by conducting a comprehensive literature review. The questionnaire design finalized from an intensive review of journal paper, research paper, technical and review paper, books, articles and websites and blogs. Then a relative ranking and impact is found among the barrier to implementation of BIM technology to the construction industry based on the frequency on literatures. Then the relative impact of each barrier calculate from the equation (1);

$$\text{Relative Impact, RI} = \frac{F}{H \; X \; A \; X \; P} \quad (1)$$

In equation (1), F is the frequency of the barrier, P is the highest rank found from literature review of the barrier, A is the lowest rank found from literature review of the barrier and H is the highest frequency among all barrier (H=28 for this study).

3. Result and Discussions

The report pinpoints the primary obstacle preventing the construction sector from using Building Information Modeling (BIM). Based on the current frequency of examining literature resources, Table 1 displays the relative rank among the essential elements that determine the effective application of BIM technology in the building sector. Additionally, Figure 1 visually depicts frequency versus the obstacles. Social and habitual reluctance to change (F=28) is one of the top twelve variables influencing the adoption of BIM technology in the construction industry. (2) Conventional contracting procedures (F=28), (3) Exorbitant training costs and learning curve (F=27), (4) Exorbitant software purchase costs (F=26), (5) Ignorance of BIM (F=26), (6) Expensive BIM tools and hardware (F=25), (7) BIM setup is challenging at first (F=24), (8) Insufficient BIM specialists (F=24), (9) Exorbitant maintenance expenses (F=24), (10) Inadequate BIM training (F=23), (11) BIM complexity (F=23), and (12) BIM licensing issues (F=23). Additionally, the following issues have the least influence on BIM implementation: (1) Lack of BIM risk insurance (F=5), (2) inadequate internet connectivity (F=6), and (3) frequent power outages (F=6). (4) The construction market is not yet ready or appropriate (F=7).

Table 1: Rank of barriers to the implementation of BIM

ID	Barrier	Frequency F	Rank	Relative Impact
B1	Construction market is not suitable and ready yet	7	34	0.0317
B2	Unavailability of proper training on BIM	23	9	0.0730
B3	Training expenses and the learning curve are too expensive	27	2	0.0667
B4	Higher authority and decision maker don't provide full support	16	21	0.0635
B5	Unavailability of BIM risk insurances	5	37	0.0159
B6	The system of single-discipline design but not integrated design	12	28	0.0476
B7	Benefits are not tangible enough to warrant its use	21	15	0.0567
B8	Contractor don't usually prove empirically the benefits of BIM to clients	22	13	0.0492
B9	Difficult to having everyone on project to make BIM effort worthwhile	15	25	0.0317
B10	Too many legal barriers exit	17	19	0.0397
B11	The legal barriers overcome cost	9	32	0.0317
B12	Lack of global use in local construction industry	18	17	0.0643
B13	Not sufficient demand from clients and/or other organizations on projects	20	16	0.0714
B14	lack of guidelines and standards of the way BIM have to be implemented for construction industry	16	21	0.0794
B15	Uncertainty of the benefits of BIM implementation	10	31	0.0556
B16	Current technology in construction is enough	9	32	0.0635
B17	Social and habitual resistance to change	28	1	0.0833
B18	Complexity of BIM	23	9	0.0563
B19	Traditional methods of contracting	28	1	0.0817
B20	High cost of software purchasing	26	4	0.0643
B21	High cost of BIM hardware and tools	25	5	0.0587
B22	BIM licensing problems	23	9	0.0317
B23	High Maintenance costs	24	7	0.0508

B24	Low computer skills among a lot of participants in the construction industry	22	13	0.0492
B25	Requirement of advanced electronics equipment	13	26	0.0476
B26	The shortage of sufficient time to evaluate BIM and its training	16	21	0.0159
B27	Absence or incomplete national standard for BIM	18	17	0.0556
B28	Lack of BIM experts	24	7	0.0722
B29	Lack of information sharing in BIM	12	28	0.0794
B30	Firms are not familiar enough with BIM use	16	21	0.0556
B32	Initial set up of BIM is difficult	24	7	0.0579
B33	Lack of awareness about BIM	26	4	0.0802
B34	People comparing BIM to CAD	13	26	0.0397
B35	Poor internet connectivity	6	36	0.0238
B36	Frequent power failure	6	35	0.0159
B37	Product liability risks	17	19	0.0079
B31	It does not help if your counter-parties are not using the BIM	11	30	0.0397

Source: [1-39]

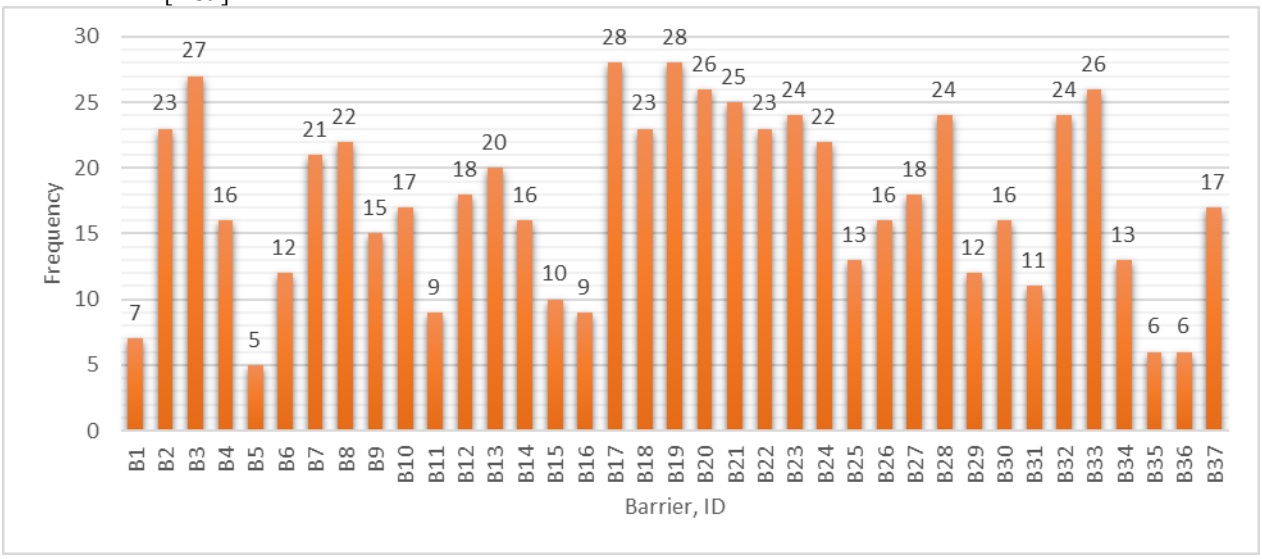


Figure 1: Frequency against the each barrier to implementation of BIM

Every living thing naturally resists change due to social and habitual factors. Everyone tries to stay the same despite the uncertainty of change, even the stakeholders in a building project. The typical contractual procedure is the second most important aspect. The persons involved have been using the conventional way for a long time, and they are proficient and fast at it. Therefore, replacing existing methods is difficult for stakeholders and not universally accepted. Some individuals lack confidence, particularly when it comes to using new technologies due to ignorance [40]. The cost of training and the learning curve are prohibitive for the construction sector to successfully use BIM technology. Because of this, local construction companies are reluctant to use BIM technology due to the significant financial outlay. Another major obstacle to BIM application is the high cost of software value for BIM beginning. The system of BIM technology implementation failure in the construction sector is reinforced by a lack of knowledge about BIM. Each party involved in the building project is hesitant to use BIM if they lack substantial expertise and understanding about it.

However, the less significant aspects that influence the building industry's effective adoption of BIM technology are not as accountable as the most important ones. The most significant yet less significant issue influencing BIM deployment is the lack of BIM risk insurance. Insufficient insurance coverage for BIM technology due to the insurance company's ignorance of BIM. Frequent power outages and an adequate internet connection might further hinder the adoption of BIM. Since the majority of BIM tools rely on constant electricity and the internet, BIM

technology cannot be implemented and operated in advanced ways without these resources. Prioritizing the barrier based on its effect value is crucial to removing the obstacle to the construction industry's adoption of BIM technology. The influence of each barrier is accurately shown in Figure 2 together with its frequency. The obstacles that have a bigger influence on the use of BIM technology should be addressed first. The high-ranked, highly impactful obstacles to BIM adoption in this research include B19 (old contracting techniques), B17 (social and habitual reluctance to change), B33 (Lack of knowledge about BIM), B2 (unavailability of suitable training on BIM), and B28 (lack of BIM specialists). The most important obstacle to overcome in order to address this problem is these highly rated, highly significant obstacles. In order to overcome the BIM implementation issue in the construction sector, the low-ranked, low-impact hurdles are addressed last. Product liability concerns (B37), the lack of BIM risk insurance (B5), frequent power outages (B36), and inadequate internet connection (B35) are some of the low-ranked, low-impact obstacles found in this research.

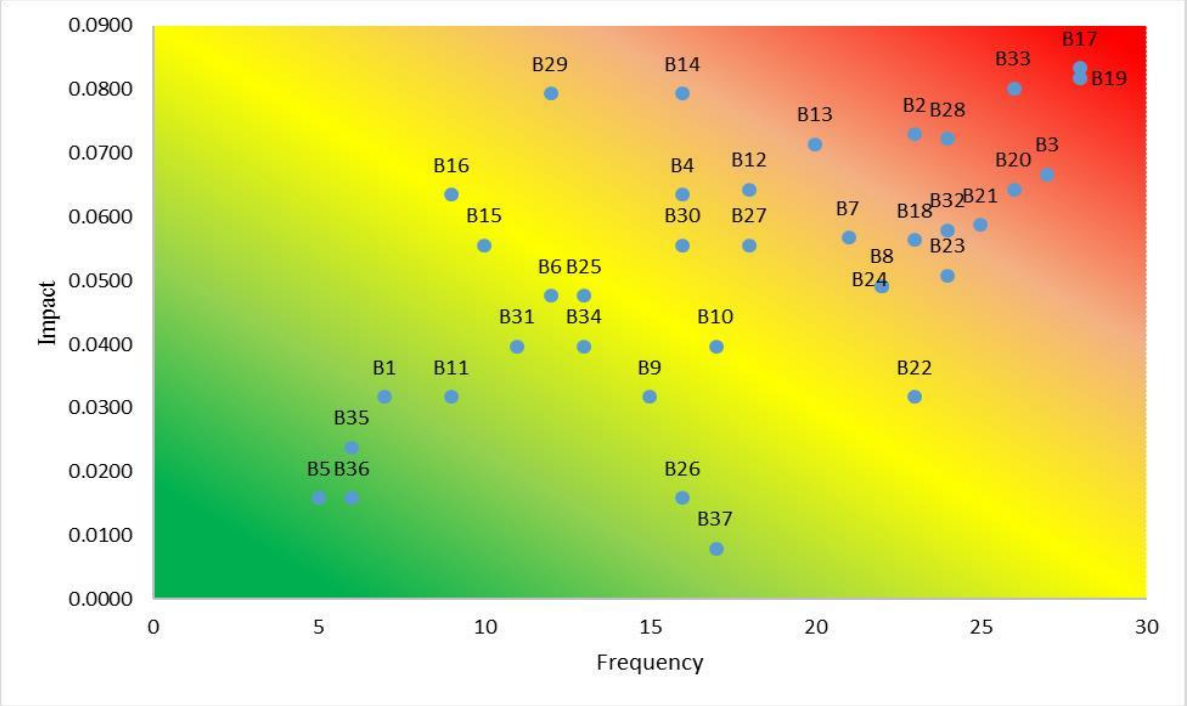


Figure 2: Impact matrix of barrier of implementation of BIM

4. Conclusion

Building information modeling (BIM) has been shown to improve construction performance, but the industry's adoption of BIM has been moving slowly. This research identifies a variety of contributing elements, including (1) social and habitual reluctance to change, (2) Conventional contracting procedures; (3) Exorbitant training costs and learning curves; (4) Expensive software purchases; and (5) BIM ignorance. Therefore, if the government wants the building sector to be able to compete on a worldwide scale, these issues must be resolved. In addition, government assistance is a major factor in accelerating the use of BIM in the building industry. The governments of nations like Singapore, Hong Kong, Australia, and the United Kingdom (UK) have incorporated BIM into their building industries [39]. For example, the government of the United Kingdom is requiring BIM; Australia is supporting BIM; Singapore requires the use of BIM as part of their policy and contract conditions; and Hong Kong is promoting BIM [41–43]. Construction stakeholders, including owners, consultants, and contractors, should play their own part by shifting the paradigm from using the traditional method to a more innovative one. This is because having strong government support alone is ineffective. It may be inferred that the growing involvement of government authorities and other construction players has helped the building sector overcome the obstacle to using BIM.

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