Research Corridor Journal of Engineering Science
ISSN Online: 3078-3054, ISSN Print: 3078-3046
Volume No: 02 Issue No: 03 (2025)

International Conference on Innovating for a Sustainable Future: Global Challenges and Solutions
April 24-25, 2025

Building Information Modeling framework for improved Visualization, Management, and Simulation

Hussnain Farzand [a]*, Usman Pervaiz Khan [a]
[a]*Department of Civil Engineering, Faculty of Engineering-FOE, Lahore Leads University-City Campus, 53101, Lahore, Pakistan.*

Absract:
The discipline of civil engineering has witnessed a revolutionary approach in the form of advanced software of BIM due to the expeditious progress observed in construction technologies. This study offers a thorough analysis that examines conventional building techniques with BIM-based techniques, highlighting the efficiency of each approach for project management and execution. An actual building structure is used in the research to demonstrate the practical implementation of BIM tools and it results in efficiency, accuracy, and flexibility. The results show that BIM substantially lowers construction costs and duration while raising overall project quality because of better decision-making offered by BIM during the designing and planning stage.
Furthermore, a thorough Survey is being carried out to determine how engineering experts in Pakistan feel about BIM and its adoption. The results of the survey and practical implementation highlight how revolutionary BIM can be in transforming Pakistan's building sector. In order to promote the wider adoption of BIM, the study calls for the creation of strategic efforts, such as the creation of policies, educational initiatives, and financial incentives. By tackling these issues, Pakistan's construction sector may become more cost-effective, and efficient, and produce high-quality projects that are in line with international best practices.
Keyword: BIM Tools, Conventional Tools, Comparison of methods, Estimation, Management , Visualization, Simulation

1 Introduction

The building sector contributes significantly to Pakistan's economy. The biggest share of employment is generated by it (Maqsoom et al. 2013, Ali et al., 2018, Akram et al., 2019, B. Farooq et al., 2020). Pakistan's engineering sector has a projected annual expansion of 9.05%, according to the country's 2016–2017 economic evaluation (Pakistan Economic Survey 2017, B. Ali et al., 2018) . Similar to poor sovereign states, Pakistan encounter disruptions in its construction industry due to violations of pre-established quality, cost, and schedule limits (Gardezi, 2014, Maqsoom, 2014, Farooq et al., 2020). Moreover, the government is unable to achieve its desired objectives due to miss-management which results in the form of overspending and increased time frame then the allocated (Maqsoom, 2014, B. Ali et al., 2018, Farooq et al., 2020). BIM is one of the most recent developments that may effectively accomplish the intended goals (Farooq et al., 2020).

1.1 Invention of Building Information Modeling (BIM)

In the early 1960s, labor productivity was found very low in the construction industry resulting in cost and time overruns, as well as labor and capital savings were also lacking. The industry was facing pressure about its old and outdated traditional methods used for drawings, splitting roles of stakeholders, ineffective communications, and labor productivity problems (Fatima et al., 2015).

Corresponding Authors: Tell: +92-307-8993993
Email Address: hussnainfarzand4@gmail.com

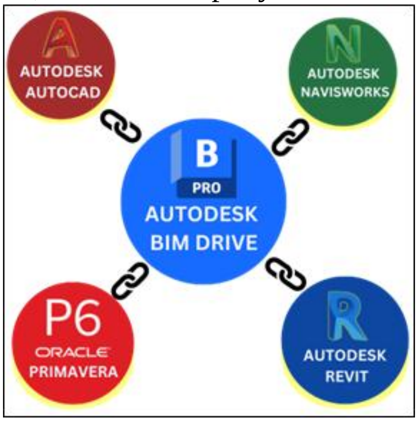
Research Corridor Journal of Engineering Science

ISSN Online: 3078-3054, ISSN Print: 3078-3046

Volume No: 02 Issue No: 03 (2025)

International Conference on Innovating for a Sustainable Future: Global Challenges and Solutions
April 24-25, 2025

In 1982, the first company that introduced the two-dimensional CAD (Computer-aided design was Autodesk (Masood et al., 2014, Farooq et al., 2020). More Effective paperwork, accurate designing, and considerable time savings are all provided by 2D CAD. Practitioners in architecture, engineering, and construction have shifted to using AutoCAD due to its user-friendly features (Yan, 2008, Farooq et al., 2020).



(Bredell, 2019, Farooq et al., 2020) claims that in 1970, Chuck Eastman and Robert were the initial individuals to propose the concept of BIM. This type of structure for displaying was used for twenty years under several names, such as virtual structure, perceptive article, and item model (Ozorhon, 2016). Because of its advantages over traditional CAD 2D models, it can be successfully used for undertaking planning, designing, construction, and operation duties (Azhar, 2011, B. Ali et al., 2018, Farooq et al., 2020). Engineering, design, and construction specialists are drawn to BIM for the board's successful and fruitful development and structure (Charlesra, 2014, Farooq et al., 2020). It is an entire process rather than just a product (Azhar, 2011, Masood et al., 2014, B. Ali et al., 2018, Autodesk, 2024). In the 1990s, the basis of project-oriented building modeling was acknowledged by the AEC industry. In the early start, parametric 3D modeling was adopted by several sectors of the market, prefabricated structural steel was one of them (Eastman, 2008, Masood et al., 2014). The word BIM was first used formally in 1992. In the twenty-first century, "the Revit program Software" was created. A comparable tool was later supplied to Autodesk in 2004, and they made many adjustments to it. That product is currently known as "Autodesk Revit." In the sphere of architectural design, this technology has gradually evolved (Haron, 2009, Farooq et al., 2020).

Once the model is completed in the computer, it contains enough data can support the construction, fabrication, and procurement process through which that facility can be created in reality (AGC 2009, Hussain & Choudhry, 2013). With BIM, the majority of the problems are readily resolved (Farooq et al., 2020). It is the evolution of smart models for computations that enables the incorporation of the stages of planning, designing, executing, and operating in BIM (Hussain & Choudhry, 2013, Masood et al., 2014, B. Ali et al., 2018). Autodesk drive, normally known as BIM Cloud, provides a central cloud room where those working on a certain assignment can access project records. All of the project's key stakeholders communicate using the community-focused (Farooq et al., 2020).

Figure 1: Linking of BIM Supporting tools with Autodesk Cloud.

Corresponding Authors: Tell: +92-307-8993993
Email Address: hussnainfarzand4@gmail.com

Research Corridor Journal of Engineering Science
ISSN Online: 3078-3054, ISSN Print: 3078-3046
Volume No: 02 Issue No: 03 (2025)

International Conference on Innovating for a Sustainable Future: Global Challenges and Solutions
April 24-25, 2025

1.2 Variation between BIM and 2D-CAD

One way that 2D CAD differs from BIM is that it uses separated 2D perspectives, including elevations, plans, and sections, to provide clarity on a structure. In the unlikely event that changes are made in one area, it becomes necessary to adjust from all angles. This is a lengthy procedure that increasingly leads to errors and poorly documented work. Furthermore, the sophisticated foundation of creating information modeling models, which distinguish between design elements and frameworks, such as walls, beams, columns, and slabs, contrasts with 2D drafting, which displays data as a pictorial element, such as curves, circles, and lines (Innovation, 2007, Hussain & Choudhry, 2013, Farooq et al., 2020). The integral parts and characteristics along with the exterior of the building can be visualized through it (Hussain & Choudhry, 2013, Masood et al., 2014). Parametric rules and data attribution are the important parts of the intelligent building components over which the BIM depends (Masood et al., 2014). To manage the entire lifecycle of the project, BIM offers the procedure and application for Virtual Design and Construction (VDC) (Hussain & Choudhry, 2013, Masood et al., 2014, Abbas et al., 2016, B. Ali et al., 2018) that predicts the performance and operation can be significantly enhanced with its adoption (Hussain & Choudhry, 2013). It can take all the stakeholders on board to communicate the knowledge, and information, and provide the necessary data among the key stakeholders of the project (Hussain & Choudhry, 2013, B. Ali et al., 2018) . The confusion caused by the information contained in the traditional drawings can be easily interpreted (Masood et al., 2014) the abilities include, better involvement of stakeholders, improved visualization, take-off quantities directly from the model, better documentation, enhanced accuracy, and effective design, planning, construction, and facility management (B. Ali et al., 2018).

1.3 Worldwide BIM Implementation

Experts worldwide are continuously searching for issues about the application of BIM in the building industry (Bhatti, 2018, Farooq et al., 2020) investigated, the percentage of the Architecture, Engineering, and Construction (AEC) businesses that used BIM globally expanded from 26% in 2007 to 57% in 2016 (B. Ali et al., 2018). The figures nearly quadrupled in just ten years (Chuah, 2014, Farooq et al., 2020). In wealthy nations, policies are put in place to make its implementation mandatory (B. Ali et al., 2018, Farooq et al., 2020). The deployment is limited in developing nations like Malaysia, South Africa, Pakistan, and India because of a lack of regional BIM policy, opposition, software integration, and reluctance to shift expertise (Zakaria, 2013, B. Ali et al., 2018, Farooq et al., 2020). The role of government is crucial for these advanced tools and techniques to encourage the players in the construction industry through constitutional reforms (B. Ali et al., 2018).

1.4 BIM in Pakistan

In Pakistan, BIM gained considerably high attention and acceptance on the ground for the last 5 years (Hussain & Choudhry, 2013). Pakistan’s infrastructure development ranks lowest because of poor practices in the construction sector (Maqsoom, 2013). The main hazards related to the country's construction industry are poor quality, inaccurate planning, project scope, and design modifications, disagreements and claims, partial design, corruption, and quantity variations (Shabbar, 2017). Insufficient design, scope changes, incomplete drawings, delayed approvals, inaccuracies in estimates, poor planning, insufficient coordination amongst stakeholders, and poor contract administration are some more variables that

Corresponding Authors: Tell: +92-307-8993993
Email Address: hussnainfarzand4@gmail.com

Research Corridor Journal of Engineering Science
ISSN Online: 3078-3054, ISSN Print: 3078-3046
Volume No: 02 Issue No: 03 (2025)

International Conference on Innovating for a Sustainable Future: Global Challenges and Solutions
April 24-25, 2025

contribute to overruns in time and costs (Gardezi, 2014). The percentage of BIM adoption across Pakistan is 11% at level 01, and their use of this technology is confined to creating 3D drawings—just one use for BIM (Bhatti, 2018).

Several firms have implemented BIM on their projects and many are in the process of BIM adoption in Pakistan (Hussain & Choudhry, 2013). One of the big hindrances in adopting the BIM process is the reluctance of other project stakeholders like consultants (MEP, Structural, etc.) (Masood et al., 2014).

1.5 Problems in Conventional Methods

A barrier to enhancing the effectiveness of the construction project's lifecycle is the lack of adoption of Information systems (IT) which has been a very significant concern (Jung, 1999). For developing nations, a critical part of the true utilization of information techniques is the use of distinct engineering and management software (Memon, 2012). In traditional methods, DBB (Design-Bid-Build), with the CAD 2D (two-dimensional) method drawings are cleared, and it splits the role of the project's participants throughout the designing and execution phase. Stated differently, the construction officials and project managers are not engaged in the project's design phase. These traditional methods are completely creating hindrances in a true collaboration environment. Due to the fragmented role of each stakeholder, the Architecture and Engineering departments produce their drawings/documents to present their work to clients and contractors. One of the big reasons for the clash of information is these drawings that are not linked with each other which may affect the productivity rate of labor on site. Based on these drawings prepared in the 2D CAD approach the estimators calculate their take-off quantities for the consultants. Linking of drawings with schedule and cost cannot be performed in the conventional 2D CAD approach. The building firms are considered small specialized and zonal companies because of the unforeseeable demand and unrepeatable site conditions.

Currently, different types of BIM tools are easily available for the AEC industry (Eastman, 2008). The real benefits of Building Information Modeling have been acknowledged by the AEC industry at the stage where the labor effectiveness gap can be minimized to a higher extent.

1.6 Current State of BIM

Some studies have shown their concerns that the adoption of BIM is still lacking and some argued that the potential change in the BIM industry is very reluctant to adopt and deploy. With an understanding of the roles and opportunities in the BIM industry, the stakeholders and disciplines can easily eliminate these hindrances. There are compelling signs that it possesses the capacity to totally change the building industry since it combines multi-faceted abilities and enables significant enhancements during the planning and building phases (Masood et al., 2014).

1.7 BIM Education

Despite practical advancement, it is a matter of concern that construction education must be up-to-date like other technical education. It is the need of time that the universities must update their curriculum and offer BIM as a course because it is a new development in the construction industry (Ahbab, 2013). Many universities around the world have incorporated it in their curriculum programs of architecture, engineering, and construction-AEC to satisfy the needs of Engineers in BIM skills. AEC specialists expect its implementation in academics

Corresponding Authors: Tell: +92-307-8993993
Email Address: hussnainfarzand4@gmail.com

Research Corridor Journal of Engineering Science
ISSN Online: 3078-3054, ISSN Print: 3078-3046
Volume No: 02 Issue No: 03 (2025)

International Conference on Innovating for a Sustainable Future: Global Challenges and Solutions
April 24-25, 2025

as entire courses or programs at different levels like undergraduate, and post-graduate based on growing interest and demand (Pikas, 2013, Abbas et al., 2016).

1.8 Safety in BIM

However, the AECO field's rising occurrences of accidents are hindering future innovation and jeopardizing the industry's reputation (Zou et al., 2017). The socio-economic impact of injury and death rates is still unsettling, unlike the provisions of the Occupational Safety and Health Act (OSHA) in the USA, the National Institute for Occupational Health (NIOH) in India, the Health and Safety Executive (HSE) in the UK, and the Labor Department in Hong Kong. The AECO industry exhibits the highest number of casualties (Li et al., 2015; Tixier et al., 2017) when reviewing workplace records compared to Europe from the years 2008 and 2016 (Eurostat, 2016). Despite a couple of exceptions, the majority of construction accidents aren't documented or disclosed, until they get media or public attention.

By creating a clear link between construction planning and safety considerations, as well as by offering thorough site layouts and safety plans to promote safety communication, BIM ensures the maximum workers safety throughout the construction. It may be observed as a proactive risk management system that provides an acceptable compromise in project risk (Akram et al., 2019).

1.9 Environmental Durability

Considering the crucial role of massive structures in economics, conservation, ecological health, and quality of life, the construction sector has been considered as one of the most crucial aspects of environmental durability. If high-rise structures, address the social, financial, and surrounding impacts they have on the neighbourhood and support the long-term, sustainable growth of society, then they should be considered sustainable. Proactively capable of balancing one's own needs with those of future generations is referred to as social sustainability. Furthermore, there are two primary ways that BIM might improve social sustainability (Manzoor et al., 2021). Firstly, an enhanced socialization facility layout is offered (Akram et al., 2019). By analyzing the three-dimensional (3D) building data model, BIM assists clients in providing information and doing design analysis before building the facility (Masood et al., 2014, Fatima et al., 2015, Farooq et al., 2020, Manzoor et al., 2021). Secondly, BIM improves working relationships between project participants by transforming old practices into a lot closer to a collaborative approach (Hussain & Choudhry, 2013, Masood et al., 2014, Fatima et al., 2015, Abbas et al., 2016, Farooq et al., 2020, Manzoor et al., 2021).

Conventional methods have long been used by the construction industry for project management, design, and execution. Even though they have been tested, these conventional approaches frequently have issues with efficiency, adaptability, and accuracy. More sophisticated and integrated methods are required more and more as building projects get bigger and more complex. In this context, Building Information Modeling (BIM) has become a breakthrough technology, providing comprehensive solutions that improve project management accuracy, flexibility, and efficiency.

In order to better understand how traditional construction methods and BIM-based approaches affect project accuracy, flexibility, time, and cost efficiency, this thesis will evaluate and contrast them. In order to accomplish this, a thorough case study was carried out utilizing BIM tools on an actual building structure, demonstrating the useful advantages and difficulties related to BIM deployment. The study showed that BIM greatly decreased the

Corresponding Authors: Tell: +92-307-8993993
Email Address: hussnainfarzand4@gmail.com

Research Corridor Journal of Engineering Science
ISSN Online: 3078-3054, ISSN Print: 3078-3046
Volume No: 02 Issue No: 03 (2025)

International Conference on Innovating for a Sustainable Future: Global Challenges and Solutions
April 24-25, 2025

time and expenses associated with managing projects while also enhancing accuracy and flexibility.

Furthermore, for BIM to be widely used, it is essential to comprehend how the technical community views it and how prepared they are to adopt it. Consequently, a survey was carried out among Pakistani engineering professionals to ascertain their perspective on the implementation of BIM. The purpose of the poll was to gauge industry awareness, acceptance, and perceived hurdles to BIM adoption.

The thesis aims to offer significant insights into the benefits of BIM over conventional techniques, the useful use of BIM in real-world projects, and the prevalent perspectives of engineering experts in Pakistan on BIM through this comprehensive study. These discoveries will add to the expanding database of information on BIM and guide the development of strategies for its successful application in the building sector.

2 Literature Review

In the construction industry, the most recent and auspicious development is Building Information Modeling (BIM) (Hussain & Choudhry, 2013). The intricate data flow during the project life cycle is because of the lack of information technology applications (Masood et al., 2014). The better collaboration process offered by BIM has rapidly gained attention and all over the world, owners are highly requiring BIM implementation for their projects (Hergunsel, 2011, Fatima et al., 2015). It has the potential to develop the most accurate model that can be very useful all the way through the entire life cycle of the project, from initiation through occupancy and operation (Tulke & Hanff, 2007, Fatima et al., 2015). It uses the virtual n-dimensional (n-D) models e.g. high-quality 3D model, 4D for scheduling, 5D for cost estimation, 6D for energy optimization, 7D for facility management and maintenance throughout the entire lifecycle of the project (Masood et al., 2014, M. Ali & Azam, 2022), which help in identifying the conflicts at the stage of design, construction, or operation of any facility, hence it gained equal attention in the AEC (Architecture, Engineering, and Construction) industry (Azhar et al., 2008, Masood et al., 2014). It is recommended in the building sector to create, coordinate, oversee, and execute construction projects. It offers improved visualization for stakeholders as well as enlarges the capacity of design reviews, constructability analysis, and direct model extracted estimation and sequencing of the construction activities (Azhar et al., 2008, Hussain & Choudhry, 2013, Masood et al., 2014). It helps to curtail the risk of disagreements between the different stakeholders of the project regarding the multiple views of the project like plans, sections, and elevations with the flow of useful and understandable information to the client, consultant, contractor, and other stakeholders of the project (Hussain & Choudhry, 2013, Masood et al., 2014,). Compared to the traditional methods it has the least influence on the saving of money, time, and personnel.

Building Information Modeling (BIM) integrated the fragmented Architecture, Engineering, and Construction industries which completely altered the conception, design, communication, and construction of the projects (Hergunsel, 2011, Masood et al., 2014). For optimizing and managing the projects, time schedules define the sequence of activities and allocate the resources in terms of labor, material, and equipment. The 3D model is used to establish the activities of the time/schedule manually, i.e. every object must be selected by the user and allocate the time/schedule. Because of the restriction to visualization of the construction sequence, 4D simulation adds limited value. One of the major reasons why the 4D simulation has not been accepted by professionals practically is due to the additional effort required for

Corresponding Authors: Tell: +92-307-8993993
Email Address: hussnainfarzand4@gmail.com

creating the 4D simulation and having lesser benefits for visualization of construction sequence only. Data stored in the building model can be used for the 4D simulation which can significantly improve the efficiency of creating the time schedule (Tulke & Hanff, 2007, Hergunsel, 2011).

During the 2016-2017 rapid development in the construction sector of Pakistan about 9.05% was witnessed (Manzoor et al., 2021). Despite that swift progress, the records show project completion rate was very poor within the allocated time, cost, and resources (Farooq et al., 2020, Manzoor et al., 2021). One of the biggest reasons for such bad performance is the use of old and traditional methods which are not yet replaced with advanced technology like BIM. The BIM implementation can revolutionize the productivity rate of the construction industry in Pakistan (B. Ali et al., 2018, Farooq et al., 2020). The study was conducted on the construction project of a hospital to help the client understand that it can save their time and capital (B. Ali et al., 2018). The problems faced by the construction management as well as the hurdles in the adoption and implementation of BIM in the local construction industry were addressed (Fatima et al., 2015, Manzoor et al., 2021).

But in these modern times, it is very unfortunate its adoption in Pakistan is still very slow and it is about 11% (Fatima et al., 2015, Farooq et al., 2020). In Pakistan as well as all over the world economical, timely, and properly managed projects can be obtained by the implementation of BIM (Farooq et al., 2020). Many factors like contractual obligations, legal barriers, traditional tools, management systems, and security are playing their role in opposing the implementation of BIM (Richter et al., 2011, Sardroud et al., 2018). These barriers/hurdles were investigated using Interpretive Structure Modeling (ISM) and Cross-Impact Matrix Multiplication (CIMM). Based on the responses that were received from the professionals of the Architectural, Engineering, and Construction (AEC) industry, it was discovered that around 63% of professionals have an awareness of Building Information Modeling (BIM), and 17% have utilized BIM in their projects so far. That is accepted by the respondents that the implementation of BIM can save cost and time by up to 57% (Farooq et al., 2020).

The high-rise building design to get complete benefits in all stages depends highly on the decision-making process without risking feasibility, and sustainability (Azhar & Brown, 2009, Manzoor et al., 2021). Implementation studies of Building Information Modeling (BIM) on massive structures are still very limited. Building sustainability performance can be enhanced to considerable limits by its implementation. The Exploratory Factor Analysis (EFA) and Structural Equation Modeling (SEM) method is utilized to investigate how the use of BIM in massive structures. The outcome of Exploratory Factor Analysis (EFA) indicated five components namely, efficiency, coordination, sustainability, visibility, and safety improvements have a distinctive impact on the overall life cycle of the massive building. It has been discovered that the education and utilization of advanced tools for massive buildings are still very limited (Manzoor et al., 2021).

One of the major factors that is damaging the esteem of the construction industry is the disreputable safety management practices. Although desired rules and regulations are stated by the constitution clearly, however, the violations of these rules and regulations stated by the government are at their peak. One of the major causes of these violations is the inappropriate data and the absence of integration of essential data in conjunction with further project activities. Building Information Modeling (BIM) provides the ability to remedy inadequate

Corresponding Authors: Tell: +92-307-8993993
Email Address: hussnainfarzand4@gmail.com

Research Corridor Journal of Engineering Science
ISSN Online: 3078-3054, ISSN Print: 3078-3046
Volume No: 02 Issue No: 03 (2025)

International Conference on Innovating for a Sustainable Future: Global Challenges and Solutions
April 24-25, 2025

safety management practices over the course of the project's lifetime. Keeping the safety factors and BIM features in view it is revealed that the visualization feature is the most auspicious aspect of identifying hazards, in a very important construction safety application area (Akram et al., 2019).

With the revolution in information technology (IT), instructive methods are also changing in modern times (Masood et al., 2014, Abbas et al., 2016). Educational institutions need to introduce some new IT tools in construction management (CM) education, and in this regard, BIM is the only tool that can be used to fill that gap (Abbas et al., 2016). There isn't much academic or building industry research on BIM in Pakistan (Hussain & Choudhry, 2013). For now, many universities worldwide offer BIM as a course in their construction management (CM) programs, and many other institutions/universities are still in the process of integrating BIM into their syllabus. Still, many institutions/universities fail to realize the importance of BIM application. With BIM education, the universities will be able to induce graduates with the demanded knowledge and skills of advanced tools like BIM before they enter into their professional careers (Abbas et al., 2016)

Corresponding Authors: Tell: +92-307-8993993
Email Address: hussnainfarzand4@gmail.com

Research Corridor Journal of Engineering Science
ISSN Online: 3078-3054, ISSN Print: 3078-3046
Volume No: 02 Issue No: 03 (2025)

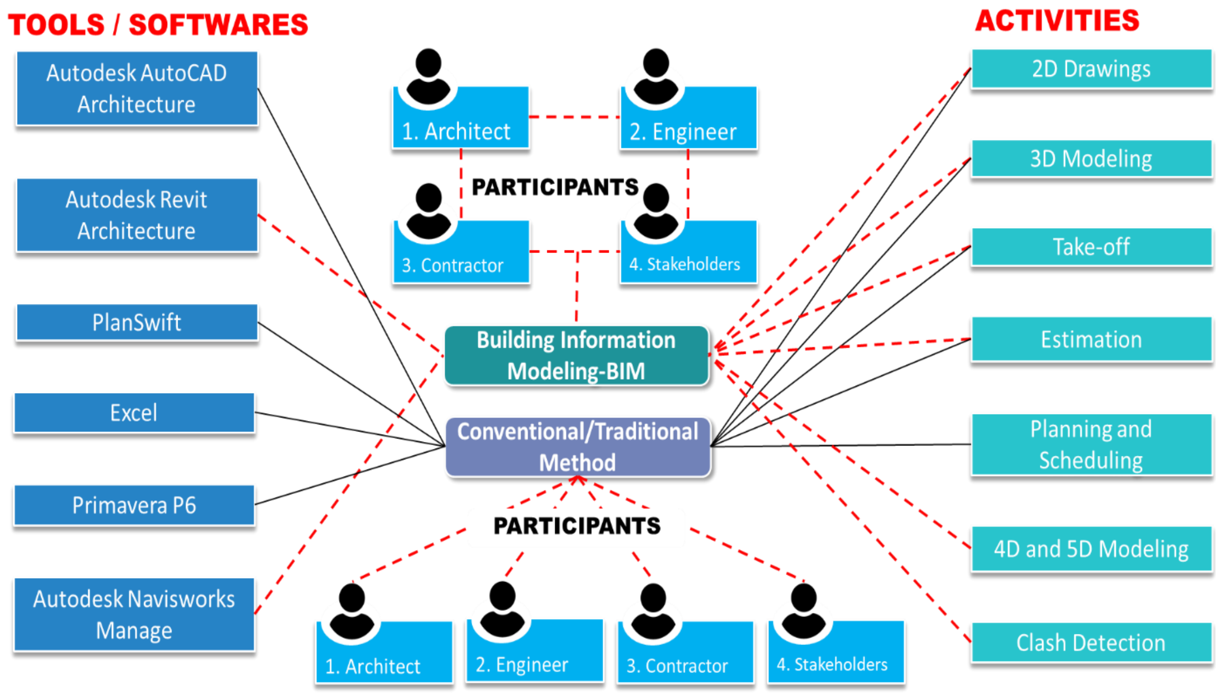
International Conference on Innovating for a Sustainable Future: Global Challenges and Solutions
April 24-25, 2025

3 Methodology

3.1 Aim and Objective

A comparison of traditional methods used for visualization, simulation, and management and BIM is performed. BIM (Building Information Modelling) is comprised of different types of software with different specialties and each software performs its work more efficiently and effectively. Similarly, traditional methods are comprised of AutoCAD, Primavera P6, Plan Swift, and Excel etc, which are in practice in Pakistan. To achieve the desired results of the proposed project, the following main steps were performed:

1) The data in the form of AutoCAD drawings were obtained for the proposed building from the Design Line Association. Further, Planning and estimation for the structure are performed using specialized tools in traditional methods.
2) The same structure was planned, modeled, estimated, and simulated using the n-D model of BIM. The purpose of modeling, management, and simulation using 2 two different methods is to clearly understand how BIM is better than traditional methods.
3) The survey was conducted to understand the professional level of BIM and its adoption. Based on this knowledge the research concluded to check whether the problems faced by these professionals can be solved by using the BIM.



3.2 Research Methodology

The proposed residential building data was obtained from a consultant named Design Line Association. The proposed residential building was situated in the Tipu Block, Bahria Town Lahore. The building consists of a Basement (18,000 Sq. ft), Ground Floor (18,000 sq. ft), and 1st to 10th floor (9,672 Sq. ft) each.

In the first step, the same residential building was planned, modeled, estimated, and simulated by using traditional and BIM advanced tools. The BIM advanced tool (Autodesk

Research Corridor Journal of Engineering Science
ISSN Online: 3078-3054, ISSN Print: 3078-3046
Volume No: 02 Issue No: 03 (2025)

International Conference on Innovating for a Sustainable Future: Global Challenges and Solutions
April 24-25, 2025

Revit) is used to create the 3D model. The 3D model was created by using the Architectural and Structural templates. Similarly, the estimation was performed using Plan Swift and Excel traditionally, and for BIM the estimation was directly extracted from Revit. Correspondingly, the planning and scheduling were performed using Primavera P6. Once all the steps were performed, the 3D BIM model was exported to Autodesk Naviswork Manage to perform the 4D, 5D modeling, and Clash Detection.
In the second step, a survey was conducted among the professionals of the AEC industry to identify the current level of BIM and the problems faced by the professionals.

Figure 2: List of Activities, Tools, and Participants in both methods

For this study, the total listed major project activities were 7 and the total tools were 6 in both the methods to perform that major work of the project. The same work was performed with two different methods and their specialized tools. The relationship of the participants are also different in both methods. In case of traditional method all the stakeholders are directly linked to the project and perform their assigned work. But the scenario in case of BIM is entirely different because the participants of the BIM are linked together from the very beginning of the project and then they are linked to the project. The important thing to be acknowledged is that in case of traditional method there is no specialized tool to detect the clash within between the works as it is purely experienced based activity to detect before actual execution of the project. But in case of BIM the one of the most important feature is Clash Detection and to perform that work a specialized tool Autodesk Naviswork manage is used. It enables the professionals of the AEC (Architectural Engineering and Construction) industry to identify the clashes before the actual execution of the work.

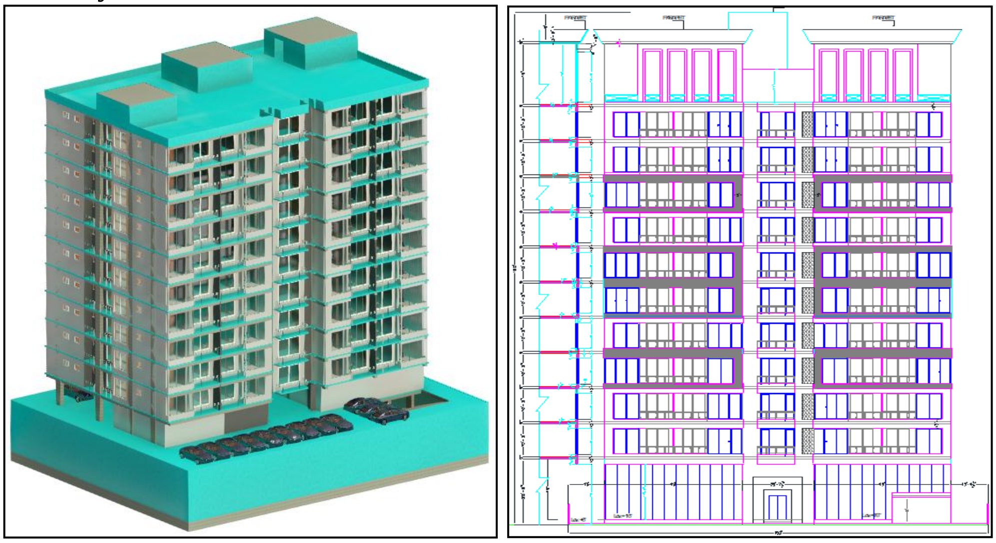


Figure 3: Final model using BIM and Traditional

The final model comparison was generated by two different methods. The BIM model is comprised of two different templates to result in the final model but the CAD-generated model was purely drawn manually by the combination of lines, arcs, and circles.

Table 01: Difference in Estimation of Traditional and BIM Methods

Column Difference=	1.057	%
Beam Differences=	0.478	%
Difference in Slab=	0.612	%
Difference in Footing=	0	%
Total Difference in Volume=	0.538	%
Plastering=	3.004	%
Brickwork=	3.199	%
Average of difference=	**1.270**	**%**

Once the final model is completed the estimation was performed in both the methods and the result is shown in the above table.

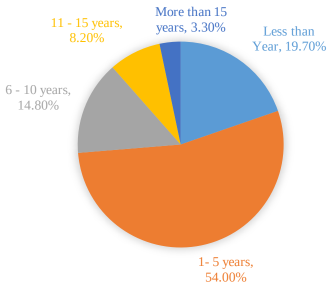


Figure 4: Experience of the Professionals

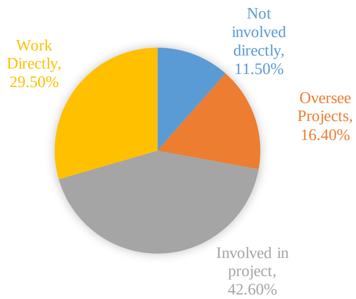


Figure 5:Current Involvement in the Project

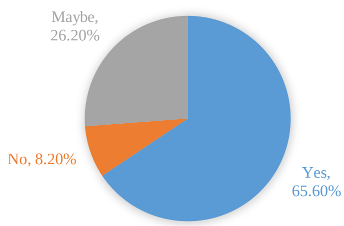


Figure 6: Past project difficulties and inefficiencies

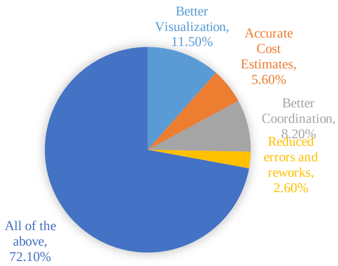


Figure 7: Advantages of BIM over traditional method

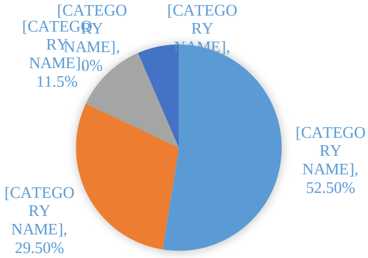


Figure 8: Recommendations of BIM for Future Projects

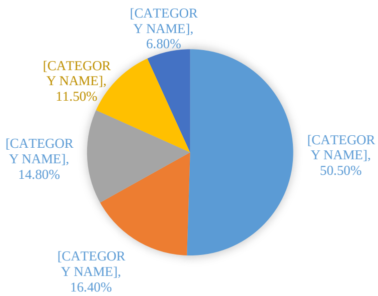
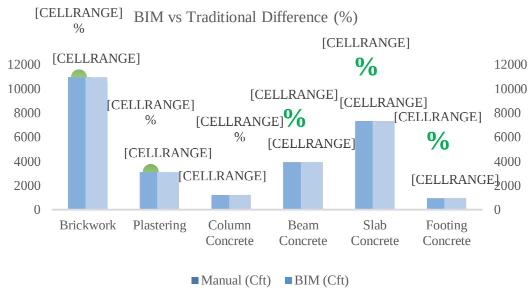


Figure 9: Barriers or Challenges in the adoption of BIM



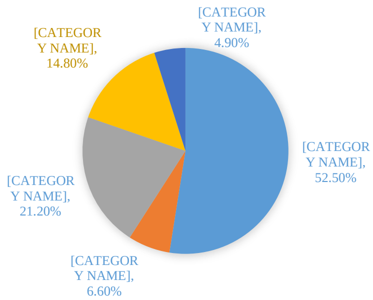


Figure 10: Steps to overcome Barriers in the adoption of BIM

4 Results and Discussion

Table 02: Side-by-side comparison of both methods

Sr No.	Description	BIM Tools	Traditional Tools
1	**Visualization**	1	0
2	**2D and 3D**	1	1
3	**4D, 5D, nD**	1	0
4	**Manual Change**	0	1
5	**Automatic Change**	1	0
6	**Analogous Processing**	0	1
7	**Digital Processing**	1	0
8	**Slow Work**	0	1
9	**Fast Work**	1	0

10	**Necessity of Printing**	0	1
11	**Electronic Communication**	1	0
12	**Fully integrated**	1	0

The comparison of conventional method vs advanced BIM tools showed that visualization in the BIM is far better than the conventional tools. The time required for the preparation of project documentation e.g., plans, sections, elevation, and 3D model is less as compared to the traditional methods. Similarly, changes and modifications can be performed very smoothly and easily if required in BIM. For planning and monitoring, BIM can link the 3D model with the cost (4D) and schedule (5D) while for the other method, this option is not available. It helps to track the project in real time on a single station. The comparison of both methods clearly shows that decision-making is very clear and easy in BIM which reduces the cost of reworks and conflicts among the key stakeholders and facilitates the successful completion of the project.

Figure 11: Difference in take-off Quantities between BIM and Traditional Methods

A brief comparison based on take-off quantities was conducted. The difference in take-off quantities between the conventional and BIM method was found 1.10% for columns, 0.5% for beams, 0.60% for slab, and footing which was 0%. Similarly, for plastering that difference was noted for about 3.004%, and 3.1999% for brickwork. Both methods give nearly the same results but that little difference is because of the human errors or digit round-offs in manual calculation.

The results of this study show that CAD (Computer-Aided Design) which is applied for the drafting of 2D drawings, now supports 3D as well. CAD can be applied smoothly in the initial phases of a project to perform the documentation but it does not provide support in other phases of the project. In traditional methods for other phases of the project, some different tools are used that include specialized skills. On the other hand, BIM provides support throughout the lifecycle of the project because it contains detailed information about the element, facility management, and data management across different disciplines.

In the design phase, the complete focus of the traditional method is on design accuracy where collaboration is very low. BIM ensures the collaboration of projects from design to operation and maintenance phase. The data-centric approach of BIM is very high because it contains all the information including specifications, properties, and characteristics for each element. In traditional methods, it becomes very hard to manage this information for each element. The collaboration among Architects, Engineers, and Construction professionals is very high because BIM links these professional bodies together to ensure each of them receives the right information at the right time. But in the traditional method, they are performing splitting roles and sometimes do not receive the required information at the right time which causes conflicts and hinders the project's progress.

During this study, it has been found that many professionals pointed out limitations and challenges in the traditional methods. About 50% of professionals said this “Lack of coordination between different project phases” is the biggest challenge in conventional methods. “Poor communication among project stakeholders” was a challenge for 36.5% of the professionals. As well as “Inaccurate cost estimation” was a challenge for 15.4% of the respondents. Around 48.1% of the professionals responded that “Time delays during project execution” are one of the biggest limitations of the traditional method. “Quality control issues” was a limitation in the conventional method for 38.5% of the respondents.

It has been found that 63.5% of the respondents are facing difficulties and limitations in the traditional method while 9.6% of the respondents were quite happy with the existing method as well as 26.9% of professionals were found neutral in this regard. The results show that around 69.2% of professionals have complete knowledge of advanced tools and techniques that are available in the market. While 53.8% recommended these advanced tools and techniques for future projects.

As compared to previous studies these numbers are quite exciting but 51.9% of professionals believe that "Lack of awareness or understanding of BIM" is one of the biggest barriers to the wide adoption of BIM. Similarly, 17.3% said that "High initial cost" plays its role in restricting the adoption of BIM, and 48.1% believe that these barriers can be removed with the help of "Training and education programs".

5 CONCLUSION

- It has been concluded that the application of BIM can significantly improve the productivity, quality, and efficiency of the project due to the accurate schedule of material and cost estimates that are directly extracted from the BIM model.
- Detailed and realistic visualization as well as clash detection are very helpful to identify the problems before the actual execution of the project and it can save the time and money required for rework. As well as better visualization plays a crucial role in decision-making.
- The preparation of the project's initial documentation becomes very easy and fast. Change orders/change requests can be managed very swiftly and smoothly without wasting enough time.
- The linking of different project files and key stakeholders together in one place may help to improve transparency and reduce conflicts.
- For cost analysis, the most accurate take-off quantities can be directly extracted from the model within a short time and it can give a clear idea to the client that it should be executed or not.
- The take-off quantities comparison makes it clear that both methods have a small difference in results. The BIM results are considered accurate because it calculate the quantities based on your modeling and extract them directly from the model, while on the other hand in the conventional method, human error and digit round-off can create a little inaccuracy in the results.
- From the results, it has been found that "Lack of coordination between different project phases" is an issue of great concern that can be addressed with the advanced technologies that are available in the market. The communication channel between key stakeholders is better than the conventional methods, and it ensures all the participants are getting the right details at the right movement of time and reduces misunderstandings additionally conflicts. It basically performs the 4R communication, the right information, to the right people, at the right time to have the right impact.
- The above digits show that a large portion of professionals are facing limitations and difficulties in the existing methods. The nature of these difficulties is not recorded but with the advanced features of BIM, a major portion of their difficulties and limitations can be addressed.
- Intra-departmental training and seminars should be conducted for the professionals to avoid the expensive starting price, lack of awareness, understanding of BIM, and educational expenditures.

6 Recommendations

- In Pakistan, the importance of the construction industry cannot be ignored and academia should introduce BIM-related courses at every level from diploma to post-graduate programs.
- About 51.9% of professionals believe that "Lack of awareness or understanding of BIM" is the restriction in the adoption of BIM, and 48.1% of professionals responded that these

barriers can be removed with "Training and education programs". Keeping these figures in view regulatory authorities like the PEC-Pakistan Engineering Council should conduct seminars on the advanced tools of BIM and encourage the high number of participants to provide them with CPD points in this regard.

- Integrate BIM in the contract and design process, similarly establishing a framework for the PDS-Project Delivery System that will improve the productivity of the construction industry.
- The clients should demand BIM on their future projects.
- It is important to check the effect on transparency after the integration of BIM.
- During this study it has been found that a large portion of professionals are facing limitations and difficulties in the existing conventional methods. Research should be conducted to record the nature of their difficulties and compare these limitations with the BIM features to find out how much their problems can be addressed with the BIM implementation.
- Proper legislation should be implemented to speed up the implementation of BIM and significantly improve the construction sector's productivity and efficiency.
- With the implementation of BIM, perform a complete impact assessment on all the other sectors that are directly or indirectly related to the construction industry in Pakistan.
- This study is performed by academia and it is advised to apply it in practical projects and analyze its benefits, and as well as it is also recommended for the industry-academia to check the benefits of the live projects.

References

[1] Abbas, A., Din, Z. U., & Farooqui, R. (2016). Integration of BIM in Construction Management Education: An Overview of Pakistani Engineering Universities. *Procedia Engineering*, *145*, 151–157. https://doi.org/10.1016/j.proeng.2016.04.034.

[2] Ahbab, C., A. Rezaei, and N.S. Sistani. Integration of building information modeling into the undergraduate curriculum: case of Eastern Mediterranean University. in 2nd International Balkans Conference on Challenges of Civil Engineering. 2013.

[3] Pikas, E., R. Sacks, and O. Hazzan, Building information modeling education for construction engineering and management. II: Procedures and implementation case study. Journal of Construction Engineering and Management, 2013. 139(11).

[4] Akram, R., Thaheem, M. J., Nasir, A. R., Ali, T. H., & Khan, S. (2019). Exploring the role of building information modeling in construction safety through science mapping. *Safety Science*, *120*(December 2018), 456–470. https://doi.org/10.1016/j.ssci.2019.07.036.

[5] Zou, Y., Kiviniemi, A., Jones, S.W., 2017. A review of risk management through BIM and BIM-related technologies. Safety Sci. 97, 88–98. https://doi.org/10.1016/j.ssci.2015. 12.027.

[6] Li, H., Lu, M., Hsu, S.-C., Gray, M., Huang, T., 2015. Proactive behavior-based safety management for construction safety improvement. Safety Sci. 75, 107–117. https:// doi.org/10.1016/j.ssci.2015.01.013.

[7] Tixier, A.J.P., Hallowell, M.R., Rajagopalan, B., Bowman, D., 2017. Construction safety clash detection: identifying safety incompatibilities among fundamental attributes using data mining. Autom. Constr. 74, 39–54. https://doi.org/10.1016/j.autcon. 2016.11.001.

[8] Eurostat, 2016. European statistics. Retrieved from http://ec.europa.eu/eurostat/web/main.

[10] Ali, B., Zahoor, H., Mazher, K. M., & Maqsoom, A. (2018). BIM Implementation in Public Sector of Pakistan Construction Industry. *ICCREM 2018: Innovative Technology and Intelligent Construction - Proceedings of the International*

Conference on Construction and Real Estate Management 2018, *1*, 42–51. https://doi.org/10.1061/9780784481721.005.
[11] Maqsoom, A., Charoenngam, C. and Awais, M. (2013). "Internationalization process of Pakistani contractors: an exploratory study" In Proceedings of ICCREM 2013: Construction and Operation in the Context of Sustainability, Karlsruhe, Germany, 59-72.
[12] Pakistan Economic Survey. (2017). <https://goo.gl/FN6Gbo>
[13] Ali, M., & Azam, H. (2022). a Comparative Analysis of Building Information Modelling. November, 0–7.
[14] Azhar, S., & Brown, J. (2009). Bim for sustainability analyses. *International Journal of Construction Education and Research*, *5*(4), 276–292. https://doi.org/10.1080/15578770903355657
[15] Azhar, S., Nadeem, A., Mok, J. Y. N., & Leung, B. H. Y. (2008). Building Information Modeling (BIM): A New Paradigm for Visual Interactive Modeling and Simulation for Construction Projects. *First International Conference on Construction in Developing Countries (ICCIDC-I)*, *1*, 435–446.
[16] Farooq, U., Ur Rehman, S. K., Javed, M. F., Jameel, M., Aslam, F., & Alyousef, R. (2020). Investigating bim implementation barriers and issues in Pakistan using ism approach. *Applied Sciences (Switzerland)*, *10*(20), 1–21. https://doi.org/10.3390/app10207250.
[17] Gardezi, S.S.S.; Manarvi, I.A.; Gardezi, S.J.S. Time extension factors in construction industry of Pakistan. Procedia Eng. 2014, 77, 196–204.
[18] Maqsoom, A.; Charoenngam, C. Motives and competitive assets of Pakistani international construction contracting firms: Impact of size and international experience. J. Financ. Manag. Prop. Constr. 2014, 19, 138–151.
[19] Yan, H.; Demian, P. Benefits and barriers of building information modelling. In Proceedings of the 12th International Conference on Computing in Civil and Building Engineering (ICCCBE XII) & 2008 International Conference on Information Technology in Construction (INCITE 2008), Beijing, China, 16–18 October 2008.
[20] Bredella, N. Simulation and architecture: Mapping building information modeling. NTM Z. Gesch. Wiss. Tech. Med. 2019, 27, 419–441.
[21] Ozorhon, B.; Karahan, U. Critical success factors of building information modeling implementation. J. Manag. Eng. 2016, 33, 04016054.
[22] Azhar, S. Building information modeling (BIM): Trends, benefits, risks, and challenges for the AEC industry. Leadersh. Manag. Eng. 2011, 11, 241–252.
[23] Charlesraj, V.P.C. Knowledge-based building information modeling (K-BIM) for facilities management. In Proceedings of the International Symposium on Automation and Robotics in Construction, ISARC, Sydney, Australia, 9–11 July 2014.
[24] Autodesk. (2024, 07 01). Autodesk BIM 360. Retrieved from Autodesk: https://www.autodesk.com/bim-360/.
[25] C. T. Eastman, P.; Sacks, R; and Liston, K., BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors, New York: John Wiley and Sons, 2008.
[26] Haron, A.T.; Marshall-Ponting, A.J.; Aouad, G. Building information modelling in integrated practice. In Proceedings of the 2nd Construction Industry Research Achievement International Conference (CIRIAC 2009), Kuala Lumpur, Malaysia, 3–5 November 2009.
[27] Innovation, C.C. Adopting BIM for Facilities Management: Solutions for Managing the Sydney Opera House; Cooperative Research Center for Construction Innovation: Brisbane, Australia, 2007.

[28] Bhatti, I.A.; Abdullah, A.H.; Nagapan, S.; Bhatti, N.B.; Sohu, S.; Jhastial, A.A. Implementation of building information modeling (BIM) in Pakistan construction industry. Eng. Technol. Appl. Sci. Res. 2018, 8, 3199–3202.
[29] Chuah, S.; Pan, Z.; Sanjayan, J.G.; Wang, C.M.; Duan, W.H. Nano reinforced cement and concrete composites and new perspective from graphene oxide. Constr. Build. Mater. 2014, 73, 113–124.
[30] Bin Zakaria, Z.; Muhamed Ali, N.; Tarmizi Haron, A.; Marshall-ponting, A.J.; Abd Hamid, Z. Exploring the adoption of Building Information Modelling (BIM) in the Malaysian construction industry: A qualitative approach. Int. J. Res. Eng. Technol. 2013, 2, 384–395.
[31] Ullah, K.; Lill, I.; Witt, E. An overview of BIM adoption in the construction industry: Benefits and barriers. In Proceedings of the 10th Nordic Conference on Construction Economics and Organization, Tallinn, Estonia, 7–8 May 2019; Emerald Publishing Limited: Bingley, UK, 2019.
[32] Fatima, A., Saleem, M., & Alamgir, S. (2015). Adoption and Scope of Building Information Modelling (BIM) in Construction Industry of Pakistan. *6th International Conference on Structural Engineering and Construction Management 2015*, *December*, 90–99.
[33] Hergunsel, M. F. (2011). Benefits of Building Information Modeling. *Benefits of Building Information Modeling*, *May*, 1136–1145. http://www.wpi.edu/Pubs/ETD/Available/etd-042011-135239/unrestricted/MHergunsel_Thesis_BIM.pdf.
[34] Hussain, K., & Choudhry, R. (2013). Building Information Modeling (BIM) Uses Applications in Pakistan Construction Industry. *Proceedings of the 13th International Conference on Construction Applications of Virtual Reality*, *October*, 30–31.
[35] AGC (2009). The Contractor's Guide to BIM. Las Vegas, Associated General Contractors of America (AGC) Research Foundation.
[36] Maqsoom, A.; Charoenngam, C.; Awais, M. Internationalization process of Pakistani contractors: An exploratory study. In Proceedings of the ICCREM 2013: Construction and Operation in the Context of Sustainability, Karlsruhe, Germany, 10–11 October 2013; pp. 59–72.
[37] Shabbar, H.; Ullah, F.; Ayub, B.; Thaheem, M.J.; Gabriel, H.F. Empirical evidence of extension of time in construction projects. J. Leg. A. Disput. Resolut. Eng. Constr. 2017, 9, 04517008.
[38] S. Azhar, "Building Information Modeling (BIM): A New Paradigm for Visual Interactive Modeling and Simulation for Construction Projects," Advancing and Integrating Construction Education, Research & Practice, 2010.
[39] W. Y. Norbert, Stephen, A.J., Gudgel, J.E., "The business value of BIM," New York: SmartMarket, 2009.
[40] L. F. Foster, "Legal issues and risks associated with building information modeling technology," Engineering and the Graduate Faculty, University of Kansas. , 2008.
[41] J. Tulke, and J. Hanff, "4D construction sequence planning–new process and data model." pp. 79-84, 2007.
[42] J. M. Wilson, Jr., and Koehn, E. E. , "Safety management: Problem encountered and recommended solutions.," Journal of Construction Engineering and Management, vol. 126, no. 1, pp. 77–79, 2000.
[43] M. F. Hergunsel, "Benefits of building information modeling for construction managers and BIM based scheduling.," Engineering Department, Worcester Polytechnic Institute., 2011.

[44] L. Sabol, “Challenges in cost estimating with Building Information Modeling,” IFMA World Workplace, 2008.

[45] A. Winberg, and Dahlqvist, E., “ BIM - the Next Step in the Construction of Civil Structures,” Department of Civil and Architectural Engineering Royal Institute of Technology, Sweden, 2010.

[46] S. K. Parag. "Integration of BIM with Structural Analysis Software: Some Cautionary Notes," 2013.

[47] J. Messner. "BIM Execution Planning: Lighting Analysis,"; http://bim.psu.edu/Uses/Lighting_Analysis.aspx.

[48] S. Azhar, and Brown. J, “BIM for sustainability analysis,” Journal of Construction Education and Research, vol. 5, no. 1, pp. 276-292, 2009.

[49] Z. Liu, “Feasibility Analysis of BIM Based Information System for Facility Management at WPI,” Worcester Polytechnic Institute, 2010.

[50] P. Meadati, Irizarry, J. and Akhnoukh, A.K., “BIM and RFID Integration: A Pilot study,” in Second International Conference on Construction in Developing Countries, Cairo, Egypt, 2010.

[51] E. a. D. Elbeltagi, M., "Automated BIM and GIS-Based nD Visualization System for Controlling Repetitve Construction Projects.", 2013.

[52] I.Kamardeen, "8D BIM modelling tool for accident prevention through design." pp. 281-9, 2014.

[53] Manzoor, B., Othman, I., Kang, J. M., & Geem, Z. W. (2021). Influence of building information modeling (Bim) implementation in high-rise buildings towards sustainability. *Applied Sciences (Switzerland)*, *11*(16). https://doi.org/10.3390/app11167626.

[54] Masood, R., Kharal, M. K. N., & Nasir, A. R. (2014). Is BIM adoption advantageous for construction industry of Pakistan? *Procedia Engineering*, *77*, 229–238. https://doi.org/10.1016/j.proeng.2014.07.021.

[55] Y. Jung, and G. E. Gibson, “Planning for computer integrated construction,” Journal of computing in civil engineering, vol. 13, no. 4, pp. 217-225, 1999.

[56] Z. A. Memon, Memon, N.A., Chohan, A.H., “The Use of Inforamtion Technology Techniques in the Construction Industry of Pakistan,” Mehran University Research Journal of Engineering & Technoogy vol. 31, no. 02, 2012.

[57] C. T. Eastman, P.; Sacks, R; and Liston, K., BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors, New York: John Wiley and Sons, 2008.

[58] Sardroud, J. M., Mehdizadehtavasani, M., Khorramabadi, A., & Ranjbardar, A. (2018). Barriers analysis to effective implementation of BIM in the construction industry. *ISARC 2018 - 35th International Symposium on Automation and Robotics in Construction and International AEC/FM Hackathon: The Future of Building Things, Isarc*. https://doi.org/10.22260/isarc2018/0009.

[59] Tulke, J., & Hanff, J. (2007). 4D Construction Sequence Planning – New Process and Data Model. *Proceedings of CIB-W78 24th International Conference on Information Technology in Construction*, 79–84. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.116.4602&rep=rep1&type=pdf.