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Exploring the Obstacles to Building Information Modeling (BIM) Implementation in Bangladeshi Higher Education

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ABSTRACT

In today's world, construction education's pedagogic approaches are evolving. Building Information Modeling (BIM) is one example of how information technologies impact architectural education. In the last several years, the use of Building Information Modeling (BIM) has risen dramatically across the developing world. However, various limitations have been identified limiting the technology's full potential. The lack of BIM courses in higher education has been cited as an impediment. Several institutions throughout the globe already offer BIM courses, and many more are in the process of incorporating BIM into their curriculum. The majority of institutions are unaware of the significance of BIM applications, BIM teaching strategies, and plans to overcome BIM integration challenges. Similarly, Bangladesh has a growing need for BIM to be integrated into the higher education system to provide students with the necessary knowledge and abilities to operate in a BIM environment. This study will use a mixed-method research approach to explore the condition of BIM in Bangladeshi higher education, identify significant hurdles to its acceptance, and highlight specific recommendations that will improve BIM implementation in the higher education system.

1. Introduction

Maintaining current knowledge is critical for architecture education and other technical education. Universities must incorporate cutting-edge technologies into their architecture education curricula. Building Information Modeling (BIM) is a relatively new technology and tool in the building industry (Ahbab, C and Sistani, NS, 2013). Recently, BIM has garnered considerable interest from educational institutions.

Indeed, some schools have begun to include BIM into their academic curricula to fulfill the industry's demand for qualified personnel (A. Shibani, K. and F. Sidqui, 2019). Numerous technological, procedural, and regulatory issues are addressed through BIM education, described as acquiring theoretical and applied knowledge about BIM technologies, processes, and protocols (Succar et al., 2012). On the other hand, Barison, M. B., & Santos, E. T. (2010, June) noted that educational institutions must employ specialized strategies to produce skilled students capable of adapting to the current construction industry shift. BIM incorporation into educational curricula is still in its infancy. Numerous studies have proven that academic institutions' pedagogical approaches to BIM are still problematic, despite broad recognition of the benefits of BIM and its potential to transform the whole architectural industry's approach (Johnson and Gunderson, 2009). K. Panuwatwanich et al. (2013) performed research with most participants originating in the United States, the United Kingdom, and Australia. "The biggest challenges to integrating BIM into higher education, according to respondents, are a lack of time and money to establish a new curriculum, a lack of window within the current curriculum for specific classes, and a lack of sufficient resources for BIM-related training" (Abbas, A., Din, Z.U., and Farooqui, R., 2016).

Additionally, there is limited study on BIM use in academia and the construction sector in Bangladesh. BIM education lacks formal and informal settings (Al Amin, 2019). There is a noteworthy lack of focus in Bangladeshi universities on construction engineering and management skills and education. BIM integration in higher education

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is in its infancy compared to other affluent nations like the United States and the United Kingdom. As a consequence, the purpose of this article is to investigate the state of BIM in Bangladeshi higher education and to identify essential obstacles to its implementation.

2. BIM in Academia

The role of BIM in education as a technology and a process is not fully understood at the moment (Clevenger et al., 2010). Different schools progressively implement BIM into their curricula, generate course materials, and explore BIM pedagogical methodologies via dedicated BIM courses and BIM-integrated conventional programs (Wu, W et al., 2013).

According to McGough (2013), the UK government has mandated BIM in all infrastructure projects beginning in 2016. In response to the government's efforts to expedite BIM adoption in the construction industry in the United Kingdom, several British colleges have included it into their curricula. Numerous schools in the United Kingdom offer a variety of BIM-related coursework as part of their AEC programs (ZA Adamu and T. Thorpe, 2015).

Numerous university courses assisting the AEC business are available at various levels in the United States, including Civil Engineering, Architecture, Architectural Engineering, Construction Engineering, and Construction Management. However, a survey found that few schools have integrated BIM subjects into their curricula (R. Sacks & E. Pikas, 2013).

3. BIM in Bangladeshi Architectural Educational System

In design and construction schools, BIM is frequently utilized (Azhar, S., 2011). Universities all across the globe are adapting their educational courses to reflect this shift. Ibrahim and Okeil (Ibrahim and Okeil, 2011). Academics have previously focused on transitioning 2D CAD to BIM (Berwald, S., 2008). Recent research, on the other hand, has focused on how BIM is used in design and construction classes (Abdel Hameed, W., 2018)

Unfortunately, owing to the absence of a mandated adoption requirement, universities in Bangladesh are still in the early stages of BIM implementation, and the industry is still unfamiliar with the technology (Al Amin, 2018). However, given the rapid growth of BIM use globally, it looks that Bangladeshi educational institutions will need to make a concerted effort to include this technology into their curricula. As a result of this inclusion, new graduates will be prepared with the skills and competence necessary to meet market needs and work in a BIM context.

Despite a plethora of studies and information on how to use BIM in higher education, there seems to be no straightforward approach for doing so (Woo, 2006). Specific suggestions about how BIM might be successfully incorporated into the higher education sector will be made from this study.

4. Research Methodology

To carry out this study, mixed methods approaches had been used, specifying the mixture of quantitative and qualitative components and the timing of their integration (Creswell and Clark, 2011; Doyle et al., 2009). According to scholars, creating a mixed-methods design can assist and guide researchers with little competence in expressing methodological rigor Bryman, (2006 et al.). This study aimed to ascertain the impediments to BIM implementation in Bangladeshi higher education. The three fundamental types of mixed methods research designs are convergent, explanatory, and exploratory Creswell and Clark, (2011). This study used a convergent design technique.

Findings from a quantitative and qualitative strand are compared in a convergent design to understand phenomena better. Quantitative and qualitative data gathering and analysis are commonly done simultaneously using this method. The integration of data sources happens at the outcomes or interpretation stage after collecting and analyzing complementary data for the quantitative and qualitative strands (Creswell and Clark 2011; Fetters et al. 2013).

4.1 Review Of Literature

Academic organizations encounter several challenges. To find the best techniques for training practitioners and the future generation of professionals about BIM, the author conducts a detailed and critical review of the literature on BIM definition and education at architectural schools.

4.2 Questionnaire Survey

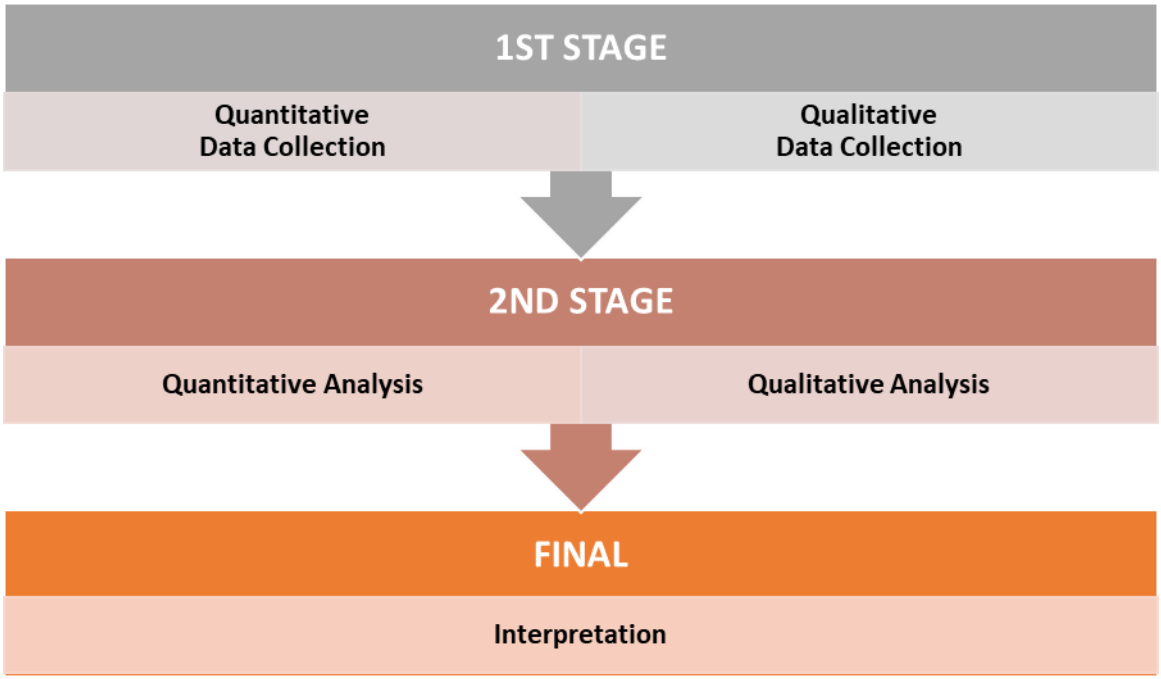
The preceding study identified impediments to BIM implementation in higher education (Literature Review). Then, a questionnaire survey of affiliated academics and undergraduate students was conducted to elicit further information about these concerns. The data is divided into three sections: the first section contains personal information about respondents, such as their status and whether they work in a public or private university; the second section contains information about respondents' perceptions, awareness, and consciousness about BIM; and the third section contains information about respondents' perceptions, awareness, and consciousness about BIM. Finally, the final segment offers data on respondents' opinions of impediments to BIM use in higher education in Bangladesh.

The questionnaire was then circulated to collect the respondents' feedback. The questionnaire was delivered and gathered via internet-based tools such as Google Forms and staff-directed distribution and retrieval. 150 Questionnaires were delivered in total.

Finally, semi-structured interviews were performed with academics (faculty members) to elicit data. The interviews were divided into three sections. The initial

section of the interview contained some basic questions about the respondent. The second segment consisted of detailed questions concerning the research subject. The final segment contained a summary question that included all of the critical points raised during the interview. Due to the participants' limited time, the interviews were conducted through the Internet and lasted around 30 minutes apiece.

The technique adopted for this study was to identify and quantify hurdles to BIM adoption in Bangladeshi higher education and solicit ideas and academic perspectives on how Bangladeshi institutions may adopt BIM.



4.3 Semi-Structured Interviews

The interviews were held in a semi-structured approach to allow two-way, focused conversation (Yin, 1984). In contrast to questionnaires, which include pre-planned questions, semi-structured interviews continue with more general or open-ended topics (Wengraf, 2001). A minimum sample size of 5 to 25 participants is required for semi-structured/in-depth interviews (Kuzel, 1992). This reference was used to interview five academics from three distinct organizations. The data is organized and collected using the Creswell data collecting tool.

5. Collecting Data

The data were analyzed using a variety of techniques. The purpose of utilizing many analytic techniques is to provide a definite conclusion. The SPSS 24 software was used to examine the data. The first section of the questionnaire was examined using tables. Calculations are simplified by the fact that the percentages and frequencies of each bar item are basic. The second component of the questionnaire was examined using descriptive statistics (mean score and standard deviation) and reliability tests.

5.1 Collecting Data From The Literature Review

While there is a growing need to research alternate approaches for teaching BIM to practitioners and the next generation of professionals, academic institutions face several challenges. According to Kymmell (2008), conceptual (lack of process knowledge), technical (difficulties using the requisite tools), and environmental barriers to BIM learning exist (circumstances of the learning environment). Sabongi (2009) also notes the challenges of incorporating BIM into an already overburdened curriculum, a lack of resources and time to integrate BIM into new curricula, and a shortage of BIM materials suited for active education.

The majority of existing information is derived from published research papers or vendor-sponsored material pushing proprietary BIM systems (Arayici and Coates, 2013). A significant roadblock is the necessity of developing instructional materials for BIM education from scratch. Educational institutions are seeing significant opposition to BIM education, and in the worst-case scenario, teachers are actively rejecting adopting BIM into their present courses (Kiviniemi, 2013). In comparison, universities in Bangladesh are still in the early phases of BIM implementation because most institutions encounter the issues mentioned above as part of their growth process.

5.2 Collecting Data Questionnaire Responses

150 questionnaires were circulated, 48 responded, and the results were analyzed statistically using SPSS version 24. Although the sample size was not vast, it was adequate

for any virtual poll (Groat, L. N., & Wang, D., 2013).

The majority of the research questions were graded on a 1–5 scale (Likert scale), with 1 indicating "strongly disagree" and 5 indicating "Strongly Agree," and some on a "categorical scale." On a scale of one to 10, the responses were evaluated H. M. Blalock Jr (1960). The questionnaire was distributed and collected online using Google Forms, Gmail, and staff distribution and retrieval.

6. Analysis And Discussion

6.1 Questionnaire Survey 1st Section

This study aimed to establish the factors that operate as obstacles to BIM adoption in a Bangladeshi architecture firm. Around 150 questionnaires were issued to various institutions, students, and academics, and 49 responded. The 48 respondents' data were gathered and analyzed using SPSS 24. The Questionnaires (included in the attachment) were designed to respond to only those with the most significant degree of unfamiliarity with the BIM concept.

As indicated in Table 01, the overwhelming majority (90.5 percent) of respondents were undergraduate students, followed by postgraduate students (6.2 percent) and faculty members (2.3 percent) (Table 01). Almost every respondent (42 of them) was familiar with the concept of BIM. (Fig. 01 of the Pie diagram).

Table 1- Respondent's Grouping (undergraduate students, postgraduate students, and faculty members).

Status	Frequency	Percent	Cumulative Percent
Undergraduate student	40	90.5	90.8
Postgraduate student	6	6.2	97
Faculty	2	2.3	100

6.2 Questionnaire Survey 2nd Section

Participants were asked in question three if their institution was familiar with the notion of Building Information Modeling (BIM). According to the statistics, 89.6 percent of respondents answered affirmatively, while 10.4 percent responded negatively. This demonstrates that most respondents' colleges were familiar with BIM.

When asked if their university teaches or at the very least discusses BIM, 33.3 percent of respondents replied no, while 66.7 percent said yes. As a result, most respondents said that they did not teach or discuss BIM at their university. Those who said no were then asked if they would accept this new procedure. Because 91.7 percent of respondents said yes, the bulk of them were willing to try to adopt this new BIM method.

When asked whether they have attempted to organize a BIM workshop at their university, 52.1 percent responded negatively, while 47.9 percent responded positively. This reveals that most respondents sought to organize BIM workshops at their institutions.

When asked if their university has a competent faculty to teach BIM, 27.1 percent said no, and 72.9 percent said yes. This demonstrates that most respondents' universities have qualified personnel to teach BIM. Following that, respondents were asked if they had received mail/resource/person asking about BIM, to which 56.3 percent said yes, and 43.8 percent responded no. Consequently, it was apparent that the majority of respondents encountered queries and apprehension about BIM from students. Following that, respondents were asked whether they believed Bangladesh was prepared to execute this method at educational institutions. 85.4 percent of those surveyed said yes, while 14.6% chose no. Consequently, nearly half of respondents believed Bangladesh was prepared to institute this approach in educational institutions.

When asked about the significance of BIM implementation in Bangladeshi education, 81.3 percent indicated that it was highly significant, 14.6 percent indicated that it was substantial, and 4.2 percent indicated that it was not significant. According to most respondents, BIM implementation in education is either critical or extremely critical in Bangladesh.

6.3 Questionnaire Survey 3rd Section

The final section discusses the problems that have hampered Bangladesh's adoption of BIM. Respondents assigned a score to the majority of the study questions on a scale of 1 to 5 (Likert scale), with 1 representing "Strongly disagree" and 5 representing "Strongly Agree." Interval scales were used to quantify (H. M. Blalock Jr., 1960).

Barriers of BIM implementation

It was clear from question 11 (Qus 11: "Lack of student demand is a hurdle to implementing building information modeling in Bangladesh's higher education system") that 43.8 percent of those polled chose Strongly agree, 22.9 percent agree, 12.5 percent neither agree nor disagree, 14.6 percent disagree while 6.3 percent chose Strongly disagree. As a result, almost half of the respondents' lack of student demand is a hurdle to implementing building information modeling in Bangladesh's higher education system.

Following that, respondents were asked (Qus 12: "Lack of building information modeling materials is a hurdle to implementing building information modeling in Bangladesh's higher education system ") lack of building information modeling materials is a hurdle to implementing building information modeling in Bangladesh's higher education system, to which 39.6 percent said Strongly agree, 27.1 percent agree, 27.1 percent agree, 20.8 percent neither agree nor disagree,

10.1 percent disagree and 2.1 percent said Strongly disagree. As a result, it was clear that most respondents agreed that the lack of building information modeling materials was a hurdle.

Following that question 13, (Qus 13. "Shortage in faculty's time and resources to develop a new course is a hurdle to implementing building information modeling in Bangladesh's higher education system ") respondents indicated that a lack of faculty time and resources to design a new course is a barrier to applying building information modeling in Bangladesh's higher education system, with 52% saying strongly agree, 25% agreeing, and 2.1% strongly disagree. Consequently, most respondents felt that the faculty's lack of time and resources to design a new course is a barrier to using building information modeling.

Regarding that, respondents were asked (Qus 14: "Lack of skilled professional to teach building information modeling is a hurdle to implementing building information modeling in Bangladesh's higher education system ") if a shortage of trained professionals to teach building information modeling is a barrier to implementing building information modeling in Bangladesh's higher education system, to which 50% responded Strongly agree, 22.9 percent agreed, and 0% said strongly disagree.

From question 15, (Qus 15: "Lack of knowledge of the process is a hurdle to implementing building information modeling in Bangladesh's higher education system ") it was evident that 50 percent of those surveyed preferred Strongly agree: 25% of respondents agree, 25 percent agree, 18.8 percent neither agree nor disagree, while 6.3 percent disagree and 0 percent strongly disagree. As a result, over half of the lack of understanding of the process prevents Bangladesh's higher education system from using building information modeling.

Concerning it, Question 16 (Qus 16: Ambiguity about building information modeling is a hurdle to implementing building information modeling in Bangladesh's higher education system ") questioned respondents if ambiguity about building information modeling is a barrier to building information modeling implementation in Bangladesh's higher education system, and 41.7 percent said yes. Strongly agree (25 percent), agree (27 percent), neutral (27 percent), and strongly disagree (4.2 percent).

Following issue 17 (Qus 17: "Hesitation to change current courses is a hurdle to implementing building information modeling in Bangladesh's higher education system. ") respondents stated that a barrier to integrating building information modeling in Bangladesh's higher education system is a reluctance to modify present courses, with 39.6% strongly agreeing, 25% agree, 22.9% indifferent, and 10% disagreeing. As a result, most respondents believe that the fear of changing present paths is a barrier to using building information modeling.

Regarding that question 18, (Qus 18. "need for industry involvement may increase the implementation building information modeling in Bangladesh's higher education system.") respondents said that industry engagement might help Bangladesh's higher education system implement building information modeling, with 56 percent strongly agreeing, 22.9 percent agreeing, 10.4 percent neutral, and 4.2 percent strongly disagreeing. As a result, most respondents believe that a lack of time and resources for faculty to develop a new course is a barrier to utilizing BIM.

6.4. Data Analysis

The data were analyzed using the Relative Importance Index (RII). It aids in the ranking of factors gleaned from data collection. The following formulas define RII:

Relative Importance Index (RII) = $\Sigma W/(A \times N)$ $(0 \leq \text{index} \leq 1)$

W is the weight ascribed to each factor by respondents, ranging from 1 to 5. W values range from 1 (least important) to 5 (very important).

A is the heaviest weight, equal to 5. The total number of respondents is denoted by the letter N.

According to Table 2, the five barriers to BIM adoption include "lack of industry participation" (RII, 0.862) and "lack of process expertise" (RII, 0.858). BIM does have particular adoption challenges. However, they may be overcome with minimal knowledge and necessary training. Thirdly, faculty lack the time and resources necessary to develop a new course, which was a barrier to employing building information modeling (RII, 0.82). Uncertainty in BIM was ranked fourth (RII, 0.816). The RII grade of 0.80 for "reluctance to adapt existing courses" indicates that implementing BIM in Bangladesh's higher education system is problematic.

The previous explanation indicates a lack of awareness of building information modeling, which results in a substantially lower degree of industry engagement. Pearson Correlations provide statistical support for this (Table 03). The Relativity Impact Index's five components are closely interrelated. Inadequate expertise, particularly in constructing information modeling, and a shortage of qualified individuals in the business are substantially connected with $r(48)= 0.735^{**}$ (question 18 and 15) and $r(48)= 0.649^{**}$ (question 18 and 13), respectively, at the 99 percent confidence level; p0.01.

As seen above, a lack of skill in developing information models is a substantial educational hurdle. Simultaneously, industry cooperation is urgently needed to expedite the process.

Table 2- Ranking of barriers for not using BIM

Qus	Rank 5	Weight 5	Rank 4	Weight 4	Rank 3	Weight 3	Rank 2	Weight 2	Rank 1	Weight 1	Total	ΣW	RII	Rank
Qus 11	21	105	11	44	6	18	6	12	3	3	48	182	0.758	**6**
Qus 12	17	85	13	52	10	30	5	10	1	1	48	178	0.741	**7**
Qus 13	24	120	12	48	8	24	2	4	1	1	48	197	0.820	***3***
Qus 14	20	100	11	44	7	21	6	12	0	0	48	177	0.737	**8**
Qus 15	25	125	12	48	9	27	3	6	0	0	48	206	0.858	***2***
Qus 16	21	105	12	48	13	39	1	2	2	2	48	196	0.816	**4**
Qus 17	20	100	12	48	11	33	5	10	1	1	48	192	0.8	***5***
Qus 18	28	140	11	44	5	15	3	6	2	2	48	207	0.862	**1**

Table 3- Pearson Correlations

		15. "lack of knowledge of the process"	18. "need for industry involvement may	16. "ambiguity about building information modeling "	13. "shortage in faculty's time and resources"	11. "Lack of student demand"	12. "lack of building information modeling materials."	14. "lack of skilled professional"	17. "hesitation to change current"
15. "lack of knowledge of the process"	Pearson Correlation	1	.735**	.631**	.649**	.137	.628**	.630**	.589**
	N	50	50	50	50	50	50	50	50

***. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).*

However, statistical analysis (Table 4) between questions 8 and 13 demonstrates that those with a sufficient understanding of building information modeling and those without sufficient knowledge agree on the need for a good teacher and training materials. As a result, this is one of the primary impediments to its implementation in education.

6.5 Reliability Test

Cronbach's alpha is a tool for assessing the reliability of survey data. In BIM adoption, the aggregate alpha value for each variable is determined. Cronbach's alpha coefficient for respondent data is 0.752, within the acceptable range of 0.3 to 0.8 Ferketich (1991).

Table 4- Crosstab Analysis

		13. "Shortage in faculty's time and resources to develop a new course is a hurdle to implementing building information modeling in Bangladesh's higher education system."					Total
		Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	
8. Do you have any academic members	No	1	0	3	5	12	21

working on building information modeling research?	Yes	0	2	5	7	15	29
Total		1	2	8	12	27	50

6.6 Interviews And Discussion

Three interviews were conducted to complete the qualitative research, and each interview was attended by three academic members ranging in rank from professors to lecturers. A semi-structured interview was used to extract information on building information modeling and its application in education and the challenges and possibilities. Seven to eight questions were asked, and each interview lasted around 30 minutes.

The qualitative study collected participants' thoughts and practical experience with information modeling related to its distribution and impediments in education, then statistically examined to triangulate and confirm the quantitative findings. To begin, we used open coding to guarantee that significant chunks of the qualitative data were included (transcribed interviews and responses). Then, a topic was determined using a thematic analysis approach.

The three respondents were asked if they had ever been confronted with questions concerning building information modeling or had previously responded to questions from building information modeling surveys. The first interviewer (lecturer) said that he is often required to respond to survey questions on building information modeling. On the other hand, the other two teachers, associate professors, and professors stated that they were recently required to respond 'Frequently' to questions or surveys about building information modeling. In contrast, they were not asked any survey questions about building information modeling five years ago. This demonstrates that there has been a significant increase in interest in developing expertise about information modeling in Bangladeshi institutions.

The three respondents were asked whether they had ever attended class lectures, workshops, or seminars on modeling constructing formations. Two out of three respondents said that they had participated in building information modeling seminars or workshops at various points in their careers, while one stated that he was aware of the concept but had never attended a workshop or lecture. However, the three stated that students are highly interested in and aware of building information modeling today.

When respondents were asked how frequently they were questioned about BIM, they replied frequently questioned. The first interviewee stated "almost usually," whereas the second and third respondents stated "frequently." This reveals that instructors at Bangladeshi universities were frequently quizzed on BIM. One thing is evident from this: architecture in Bangladesh can play a significant role in the building information model of higher education provided it receives adequate incentives and acceptability.

They had been questioned regularly about whether the existing model of higher education in Bangladesh is the right moment to use this technology. In response to this query, they stated that while demand for model courses is rising, there are not enough competent individuals or teaching resources available to teach this topic. Additionally, they stated that most colleges could not carry it because of the high installation costs, which are viewed as a significant barrier to deployment in education.

The interviewers were then asked whether there have been any external requests for BIM's course. According to three of them, industry and architectural companies had lately requested three academics to teach courses on building information modeling. This scenario indicated that the need for and acceptance of building information modeling in the field of architecture in Bangladesh is increasing. Additionally, respondents were asked which technique is most appropriate and straightforward for applying to BIM courses in Bangladeshi higher education. They suggested developing a new BIM course, delivering it as a stand-alone course, or adding BIM content into an existing AEC course. The integrated response indicates that lecturers' reluctance to switch from traditional to new work, the high cost of software, the length of time required to learn, and a lack of suitable people and learning materials are significant impediments to implementing building information modeling in higher education in Bangladesh.

Finally, respondents were asked how impediments to BIM implementation in Bangladeshi higher education may be solved to assure its success. The following measures can be taken to effectively implement BIM in Bangladeshi higher education, according to the content analysis of their responses: a policy shift, recognition of the value of facilitating construction, widespread awareness/acquisition of software, technological advancements, lecturer training on new software, and overcoming resistance to change.

7. Conclusion And Recommendations

The purpose of this study was to ascertain the current state of BIM in Bangladesh's higher education system. According to study findings, the condition of BIM in Bangladeshi institutions is in its infancy. However, the need for BIM in Bangladesh's building sector continues to rise. Even if every government or non-government entity continues to function according to established standards, the number of people who appreciate the multifaceted nature and relevance of BIM continues to expand. As a result, teacher and student demand for knowledge about developing information models are expanding. Other drawbacks discovered during data collecting were a

shortage of BIM materials, a lack of knowledge among instructors, and a high cost of BIM training.

On the other hand, participants generated several suggestions for overcoming these obstacles and implementing BIM into Bangladeshi universities. One suggestion was to make BIM mandatory, as it is in the United Kingdom, encouraging businesses and institutions to use the technology. Additionally, they recommend that teachers receive education on new software and technology, despite the expensive expense, because the availability of a BIM course will attract a more significant number of students, leading to a greater return on investment. Finally, the speakers underscored the critical role of government in boosting business and institutional awareness of BIM.

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