Bim in Bangladesh's Education System and Construction Industry: Adaptability And Benefits in A Developing Country Context

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Abstract. Since Building information modeling (BIM) was introduced in the global Architecture, Engineering, Construction and Operation (AECO) industry, especially in a large number of developed countries it has transformed their construction sector by offering cost-effectiveness, increased project productivity, improved collaboration, and sustainability. Last few years, Bangladesh's AECO industry has seen rapid growth due to increased construction projects, development activities, mega-projects, and higher government and non-government investment. Yet, BIM has not been adopted in our AECO industry to taste its benefits. Integrating BIM into the construction industry and education system of a developing country like Bangladesh renders some formidable challenges. Here, we aim to compare anticipated and actual BIM benefits and challenges and also explore reasons why BIM has not yet been adopted on a large scale in the Bangladeshi AECO sector. A portion of this study is conducted by the Technology Acceptance Model (TAM) to assess the perceptions and attitudes toward BIM by surveying and through a few questionnaires to the key stakeholders, educators, students, and industry professionals. A multimethodology is applied in the survey among university teachers and students, and expert professionals within the AECO industry of Bangladesh. It systematically evaluated the effect of the introduction and integration of BIM into the undergraduate syllabi of construction-related subjects considering student attitudes and assessed its efficacy to meet the demands of the upcoming Industrial Revolution 4.0 (IR-4.0) era. A significant portion of the respondents expressed varying levels of familiarity with BIM concepts. Notably, 74.2% knew what BIM is, but due to a lack of facility and proper education, they fell behind in learning it. Respondents highlighted factors influencing BIM acceptance, challenges, benefits, and adoption rates, offering valuable insights into the dynamics of BIM implementation in Bangladesh. The research provides an analysis of factors affecting BIM adoption, including client preferences, government support, training opportunities, and industry collaborations. "University collaborations for BIM programs" emerged as the top-ranked factor, suggesting the importance integration of BIM into the undergraduate syllabi of

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construction-related subjects in the academic institutions to alleviate BIM education. Also finds the necessity of arranging workshops, seminars, and relevant events for students and AECO professionals to promote BIM and increase its awareness. It is also found that if clients provide the initial investment in the planning and recommend making BIM a requirement for their projects to reduce cost and time will play a significant role. Findings will be further strengthened, if the decision-makers take swift action to align educational and learning techniques to meet the AECO industry's needs and enable individuals to withstand in today's technologically advanced world.

***Keywords*:** Adaptability, AECO industry, BIM, IR-4.0, TAM.

1 Introduction

Building information modeling (BIM) is a process involving the generation and management of digital representations of the physical and functional characteristics of places. BIM is supported by various tools, technologies and contracts. The BIM process creates a Building Information Model (BIM), which includes building geometry, spatial data, geography, and building component details [1]. The construction industry, by its very nature often fails to deliver a good value for money to its customers. This is primarily because each building project is unique by its type. The collaborative use of BIM reduces design mistakes and increases the productivity of the construction industry. BIM, therefore, provides an emerging new paradigm for construction management [2]. The idea of BIM has been around for a long time around the late 1970s and early 1980s. Charles (1974) has also published a research report regarding such an idea. The report investigated the redundancy of having a 2D drawing representing a 3D model [3]. Although such a proposition was available, the idea was not readily adopted since technology during that time was not that advanced making the hardware for such an idea very expensive and bulky. As the technology gets better and hardware gets cheaper, BIM technology will be an integrated part of the construction industry.

Efforts can be seen as each of the country's governments works towards implementing BIM usage in the construction industry [4]. The USA, China, and the UK have been pioneers in adopting BIM. Several European countries, including Austria, Norway, the Nordic nations, the UK, France, and Russia, have implemented BIM mandates, with varying levels of requirements. Italy has a mandate for large public projects, while Germany, Spain, and the Czech Republic are actively pursuing BIM programs, anticipating mandates in the coming years. The EU BIM Task Group, funded by the European Commission, aims to enhance BIM adoption in the public sector across Europe, providing insights and support through their Handbook for the Introduction of Building Information Modelling by the European Public Sector, which gathers perspectives from over twenty European countries [5].

Bangladesh's adoption has been comparatively slower, with the first research publications emerging in 2011. Almost no research on BIM in developing countries existed before 2013 [6]. There is still a lack of established quantitative robustness in understanding how BIM technologies can enhance the overall outcome of a construction project, despite the reality that many research findings have examined issues like the way BIM methods can be applied to simplify architecture, engineering, and construction practices. Owner support and appreciation are the most notable obstacles to BIM execution and acceptance in the AEC sector. Building Information Modelling (BIM) enables the Civil engineering professional to accomplish the digital requirements and also integrate and collaborate on the elaboration of projects and maintenance of buildings [7].

In response to this trend, the industry and academia realized that BIM education in university curricula is an important requirement for satisfying the educational demands of the industry, and a notable body of research has reported strategies AEC programs implemented to incorporate BIM in their curriculum [8]. The results from integrating BIM in an introduction engineering course at HiOA in Norway show that the students are happy with the course and respond with positive feedback, despite certain complaints. The students' efforts have been much higher than one might expect, considering that the project has only an indirect transference to the final written individual exam, and the project itself is not graded [9]. 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 [10]. According to the findings of a study, the utilization of Building Information Modeling (BIM) in Bangladeshi institutions is still in its early stages. However, the demand for BIM within Bangladesh's construction sector is steadily increasing. Despite government and non-government entities adhering to established standards, there is a growing awareness of the multifaceted nature and significance of BIM among individuals. Consequently, there is a rising demand among teachers and students for knowledge related to the development of information models. This trend reflects the evolving landscape of BIM adoption within the country [11]. To incorporate BIM in the Department of Architecture and Civil Engineering undergraduate level it is necessary to redesign the handout of some courses from different years which may help students start their learning of building information modeling. It may take some time to learn this system but for the benefit of future architects and architects, it is necessary to incorporate BIM in every department of architecture school in Bangladesh [11].

Bangladesh's Government as well as private firms should take some necessary steps such as increasing awareness, training and education on BIM to improve BIM adoption in the construction industry [12]. The transition from traditional paper-based design to digital methods stemmed from the need to overcome inherent limitations. Initially, Computer Aided Design (CAD) software, a pioneering digital tool, introduced a more efficient way to represent designs. The evolution from paper-based design to digital methods like BIM and CAD signifies a significant shift in the industry, with BIM offering enhanced collaboration opportunities and improved project delivery methods.

The purpose of this study is to investigate as well as identify methods, benefits, and challenges for BIM implementation and adoption in Bangladesh's education system and the AECO industry. Also, explore the possibilities of integrating BIM into construction-related subjects curriculum.

2 Methodology

This study's main goal was to investigate and identify Building Information Modeling's (BIM) applicability, benefits, and implementation in Bangladesh's educational system and industry sector. The study approaches to conduct questionnaire surveys of university teachers and students, government and non-govt. employee, AECO professionals are gathering their knowledge, taking suggestions and also considering how they see the implementation of the BIM education system and construction industry.

2.1 Parameters of Study

Research strategy. The research strategy that was chosen for this study is the quantitative method due to its compatibility with the situation and characteristics of the conducted study. Quantitative research aims to provide a proposed explanation for the relationship among the variables being tested while qualitative research is used to serve as a lens for the inquiry generated during the study. Here, we aim to compare anticipated and actual BIM benefits and challenges and also explore reasons why BIM has not yet been adopted on a large scale in the Bangladeshi AECO sector. The research questions serve as the guiding framework for this study, shaping all aspects of data collection and creation. Direct observations and literature reviews are the base to set the questions to align with the study's objectives, and the data collection methodology is meticulously designed to match the study's aims.

Survey platform. In this study, an online survey data collection system is applied. Traditionally, questionnaires were administered through postal mail or telephone interviews. However, with the advancement of technology and the widespread availability of the Internet, surveys can now be efficiently conducted online. Given the convenience and accessibility of web-based surveys, this method will be adopted for this study. Additionally, various online tools are available to facilitate surveys including Google Forms, SurveyMonkey, JotForm, and others. Given prior experience with Google Forms and its user-friendly nature, it will be the primary platform chosen for conducting the survey, as there are no restrictions on its use.

Questionnaire type. There are two ways to set the question when conducting a survey using a questionnaire: an open-ended question or a question with a predefined answer. Pros and cons for the analysis can be found in both methods. Open-ended questions allow rich qualitative insights but are challenging to analyze due to diverse responses. In contrast, closed-ended questions, chosen for this research given its large sample size, offer easier analysis and align with a predefined list of factors. Using the Technology Acceptance Model (TAM) in question design assesses stakeholders' perceptions. TAM, proposed by Davis (1989), aids in understanding user's acceptance of new technologies and predicting their knowledge [13]. Also, multimethodology is applied in the design of surveys among university teachers and students, and expert professionals within the AECO industry of Bangladesh.

2.2 Data Collection

The data collection started with the distribution of the questionnaire survey link in Google Forms. To reach the teacher a list of 864 e-mails is prepared by accessing the websites of the different institutions. Similarly, a list of 3174 industry professionals' e-mails list is prepared by accessing different websites of different government, and non-government organizations, LinkedIn and Facebook profiles by considering their profession relevant to the Architecture, Engineering, Construction and Operation (AECO) industry. After preparing a list of 4038 e-mails, invitation mail is sent to them with respective descriptions. To reach the students of different institutions a campus representative is reached then the survey link is shared with their students. The targeted students were fresh graduates, 5th, 4th and 3rd-year undergraduate students. In the findings of the teachers and students disciplines of study that were filtered out are Civil Engineering (CE), Architecture, Building Engineering and Construction Management (BECM), and Urban and Regional Planning (URP).

Number of institution considered to reach the students and the teacher was 29, namely Bangladesh University of Engineering and Technology, Dhaka University of Engineering and Technology, Khulna University of Engineering and Technology, Rajshahi University of Engineering and Technology, Chittagong University of Engineering and Technology, Islamic University of Technology, Shahjalal University of Science and Technology, Bangabandhu Sheikh Mujibur Rahman Science and Technology University, Mvmensingh Engineering College, Sylhet Engineering College, Faridpur Engineering College, Pabna University of Science and Technology, Hajee Mohammad Danesh Science and Technology University, Khulna University, Military Institute of Science and Technology, Bangladesh Army University of Engineering and Technology, BRAC University, North south university, University of Asia Pacific, Ahsanullah University of Science and Technology, IUBAT, Stamford University, European university of Bangladesh, Sonargoan University, The Institution of Engineers, Bangladesh-IEB (AMIE), Presidency University, Bangladesh University of Business and Technology, Rajshahi Science and Technology University.

2.3 Data Handling

The Google form is linked with a spreadsheet for convenience of analysis and data collection. Since the survey data from the quantitative research cannot be easily distinguished between the cause and effect, the number produced would then need to be interpreted before a conclusion may be drawn. For the convenience of understanding, we considered eight different sections towards the design of the questionnaire and the sections are designed to fulfil divided parts of the targeted objectives.

Below are the divided parts of the questionnaire:

A) Capturing participant background and skill set (Sections 1 to 3).

B) Assessing participant responses on acceptance, challenges, benefits, adaptation, and driving factors for BIM implementation in Bangladesh's education and construction industry (Sections 4 to 7).
C) Evaluating responses on methods, opinions and necessity of learning BIM concepts (Section 8).

Table 1. Likert-scale

Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

2.4 Data Analysis

The data obtained from the questionnaire shall then need to be analyzed statically to be made sense of. After the initial drafting of the questionnaire, it is usually tested for content and construct validity. Next is the test for internal consistency of the questionnaire. Therefore, a reliability test shall be carried out to estimate the level of error associated with the data obtained. The overall internal consistency of the questionnaire can be measured by Cronbach's alpha [14]. With that, the data shall then be analyzed hypothetically and the literature review shall be revisited and analyzed. Lastly, a conclusion shall then be drawn by calculating the Relative Importance Index (RII) on the objectives that have been set out regarding the outcome of the investigation [15]. The results obtained will be arranged according to the level of importance.

The formula for calculation of Cronbach's alpha, $\alpha = (\frac{k}{k-1}) \times (1 - \frac{\sum \sigma_i{}^2}{\sum \sigma_t{}^2})$ (1)

Where, k = number of items (question/statement) in the questionnaire

$\sum \sigma_i{}^2$= The variance of i^{th} item

$\sum \sigma_t{}^2$= The variance of the total score

In Table 2, the values of Cronbach's alpha limits and reliability relationships

are presented.

Table 2. Cronbach's alpha reliability limit.

Reliability	Cronbach's α
Excellent	≥ 0.9
Good	0.8-0.89
Acceptable	0.70-0.79
Questionable	0.60-0.69
Poor	0.50-0.59
Unacceptable	< 0.5

The formula for calculation of Relative Importance Index, RII=$\frac{\sum W}{A \times N}$ (2)

$\sum W$=$(1 \times Number\ of\ strongly\ Disagree)$+$(2 \times Number\ of\ Disagree)$+$(3 \times Number\ of\ Neutral)$+$(4\ Number\ of\ Agree)$+ $(5\ Number\ of\ Strongly\ agree)$

Where, W = Weightage that is assigned to each variable by the respondent,
A = Highest score obtainable (5) and
N = total number of respondents.,

The RII value ranges from 0 to 1 (0 not inclusive). It shows that the higher the value of RII, the more important was the sustainable criteria and vice versa. The comparison of RII with the corresponding importance level is measured from the transformation matrix as proposed by Chen et al. (2010).

Table 3. Relative Importance Index, RII.

RII	Top
High (H)	0.8 < RII < 1.0
High-Medium (H-M)	0.6 < RII < 0.8
Medium (M)	0.4 < RII < 0.6
Medium-Low (M-L)	0.2 < RII < 0.4
Low (L)	0.0 < RII < 0.2

Table 3 shows the Relative Importance Index (RII) of the sustainable criteria along with the corresponding ranking and their importance level. Rating opinions on a 5-point Likert Scale on the following criteria in terms of the importance of BIM in the Bangladeshi Education system and construction industry.

3 Research Findings and Results

This section is organized based on the outcomes derived from the data collection methods. We targeted approximately 6018 potential respondents within the education sector and the AECO field.

3.1 A Subsection Sample

The total number of respondents was 209, with backgrounds (Table 4) including teachers (21), students (125), government employees (18), non-government employees (21), self-employed (8), and entrepreneurs (16). Regarding their educational levels, respondents included undergraduates (151), graduates (54), and PhD holders (4). Current roles varied, with individuals teaching (21), graduated (62), graduate students (4), 5th-year undergraduates (7), 4th-year undergraduates (51), 3rd-year undergraduates (33), 2nd-year undergraduates (22), and 1st-year undergraduates (9).

They were mainly from the departments of Civil Engineering (185), Architecture (14), BECM (6), and URP (4).

Table 4. Details about survey participants. *(Survey period: 9/29/2023 to 11/12/2023)*

Backgrounds	Educational level	Department	Current educational Status
Teacher- 10%	Undergraduate-72.25%	Civil Engineering-88.52%	Teaching-10.05%
Student- 60%	Graduate-25.84%	Architecture-6.70%	Graduated-29.67%
Govt. Employee-9%	PhD- 1.91%	BECM- 2.87%	Graduate student-1.91%
Non-Government Employee- 10%		URP-1.91%	5th-year undergraduate student-3.35%
Self employed-4%			4th-year undergraduate student-24.40%
Entrepreneur- 8%			3rd-year undergraduate student-15.79%
Teacher- 10%			2nd-year undergraduate student-10.53%
			1st-year undergraduate student-4.31%

In the industry professional group (64 respondents), their current designations (Table 5) at the workplace included CEO (3), Chief Engineer (10), Additional Chief Engineer (1), Project Director (6), Addition-al Project Director (1), Executive Engineer (4), Project Manager (6), Sub- Divisional Engineer (1), Assistant Engineer (16), Design Engineer (10), Junior Engineer (3), Project Engineer (1), Associate Architect (1), and Sub-Assistant Engineer (1). Among the 21 teachers, their positions included Professor (2), Associate Professor (1), Assistant Professor (6), Lecturer (11), and Assistant Teacher (1). Table 5 shows insight into the designation of the faculty and the industry professionals.

Table 5. Designation of respondents (Faculty and professionals only).

Teacher Designation	Industry Professionals Designation
Professor-9.52%	CEO-4.69%
Associate Professor-4.76%	Chief Engineer-15.63%
Assistant Professor-28.57%	Additional Chief Engineer-1.56%
Lecturer-4.76%	Project Director-9.38%
	Additional Project Director-1.56%
	Superintending Engineer-0.00%

	Executive Engineer-6.25%
	Project Manager-9.38%
	Sub-Divisional Engineer-1.56%
	Assistant Engineer-25.00%
	Design Eningeer-15.63%
	Junior Engineer-4.69%
Teacher Designation	Industry Professionals Designation
	Project Engineer-1.56%
	Associate Architect-1.56%
	Sub-Assistant Engineer-1.56%

3.2 BIM Experience

Survey findings indicate that within the education sector and AEC industry, 74.2% of respondents are aware of BIM, while 25.8% are not (Figure 1), in number 155 respondents reported having heard about BIM, while 54 respondents indicated not being familiar with it. In assessing familiarity with Building Information Modeling (BIM) concepts, 76 respondents reported being very familiar, 72 respondents reported being somewhat familiar, and 61 respondents reported not being familiar at all, their familiarity with Building Information Modeling (BIM) presented in Figure 2.

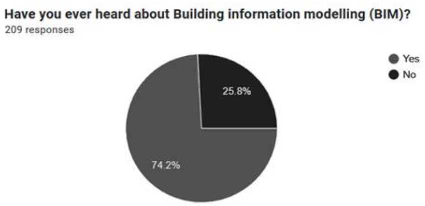


Fig. 1. Respondents who know about BIM

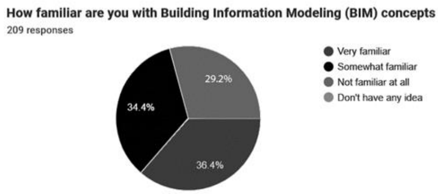


Fig. 2. Respondents familiarity with BIM

Information includes that CAD applications are mostly used by respondents or their organizations, with 164 using 2D and 114 using 3D which is 78.5% and 54.4% respectively. Regarding the duration of BIM or BIM-related software usage in their institutions, 156 respondents marked as never used, 36 reported less than 3 years, 12 reported less than 5 years, and 5 reported more than 5 years. The name of the CAD software used by the respondent or their institution is collected (Figure 3). We found that AutoCAD is mostly used which is 177 (84.7%) and in the second position E-tabs in number 90 (43.1%). In most universities, these two software are included in the undergraduate curriculum, and the result is in front of us. If we integrate BIM software like Revit, Navisworks, and ArchiCAD into our undergraduate syllabus we can then expect our graduates to implement their knowledge in real life.

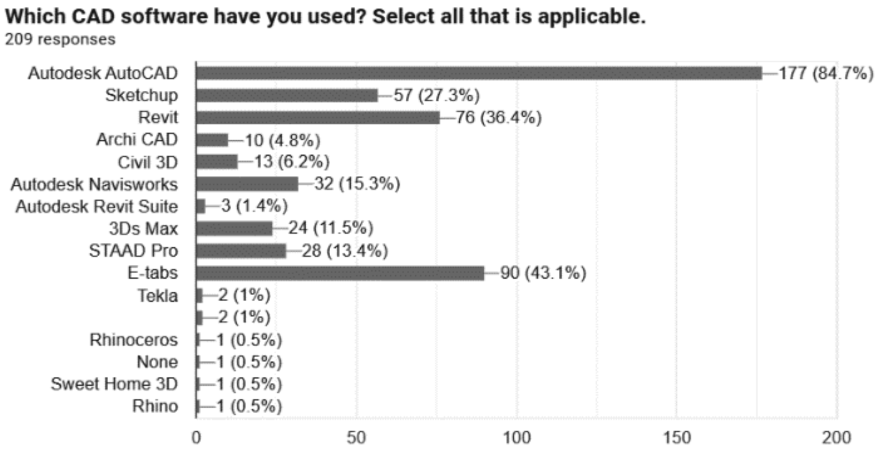
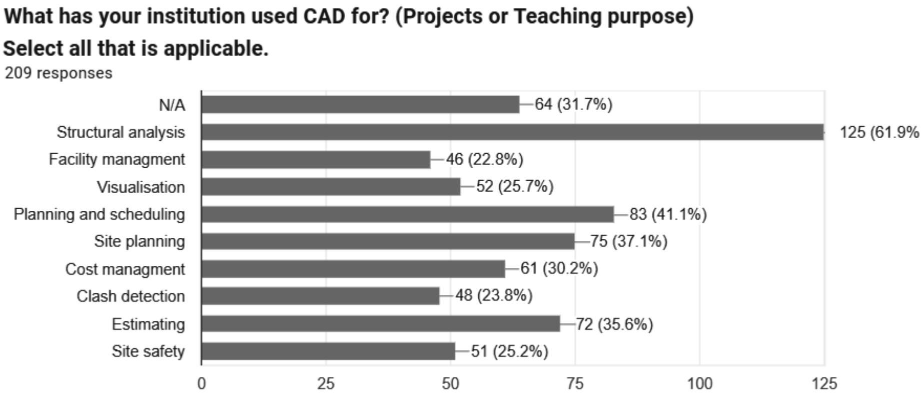


Fig. 3. Name of CAD software used

Results showed varied applications of software within institutions (Figure 4), whether for projects or educational purposes. Approximately 31.70% of respondents indicated "N/A," while the majority engaged in diverse uses such as Structural Analysis (61.90%), Planning and Scheduling (41.10%), Estimating (35.60%), and Visualization (25.70%). Other applications encompass Facility Management, Site Planning, Cost Management, Clash Detection, and Site Safety, showcasing the multifaceted



utility of CAD and BIM across different domains within these institutions.

Fig. 4. On which purposes user or their institution uses CAD software

According to the respondents, the readiness of undergraduate students to learn and apply BIM concepts and tools is very prepared by 81 respondents (38.76%), somewhat prepared by 79 respondents (37.80%), and not prepared by 49 respondents

(23.44%). In response to the respondents ever receiving any training or professional development related to teaching BIM, they responded: Yes: 30% (63 respondents), No: 70% (146 respondents). Respondents believe that BIM would be implemented by their institution:

- If required by the client or project: 101 responses (48.33%).

- If training and support are offered by BIM vendors or the government: 84 responses (40.19%).

- If better productivity is achieved when switching towards BIM: 57 responses (27.27%).

They think BIM will be implemented by their institution or organisation in:

-Next year: 87 respondents (41.63%)

-Next 3 years: 58 respondents (27.75%)

-Next 5 years: 59 respondents (28.23%)

When considering the optimal approach for BIM training, a significant 67.90% favoured Seminars or Workshops highlighting the value of interactive learning. Additionally, 58.90% advocated for Self-learning, emphasizing the importance of individual initiative. In-house training was preferred by 30.10% of respondents, while 5.30% indicated alternative methods beyond the provided options. A significant 94.74% of respondents believe that BIM knowledge is essential for Architecture, Engineering, and Construction (AEC) professionals in Bangladesh to thrive in the era of Industrial Revolution 4.0, while only 5.26% think otherwise.

3.3 Accessing the Acceptance, Challenges, Benefits and Adoption Rate of BIM

Based on the questionnaire results from respondents, the data were analysed the reliability was checked (Table 6) then the value of the Relative Importance Index (RII) was used for ranking all factors that affect the implementation of BIM in Bangladesh's education system and construction industry. The reliability of each section is excellent, so the data are okay to be analysed for RII.

Table 6. Cronbach's alpha reliability limit for each section.

Section Description	K	$\sum \sigma_i^2$	$\sum \sigma_t^2$	α	Opinion
Acceptance of BIM	8	10.68	74.11	0.98	Excellent

Challenges of implementation	8	10.66	61.38	0.94	Excellent
Benefits of BIM	9	11.17	66.63	0.93	Excellent
Adoption rate of BIM	8	9.84	63.88	0.96	Excellent

Acceptance Related. The Relative Important Index (RII) and ranks of eight (8) factors related to acceptance of BIM in the construction industry and education system in Bangladesh are shown in Table 7. The factor of "BIM speeds up my tasks in the job" was ranked first with a value of RII 0.748. The factors BIM improves their job performance and increases productivity are ranked second and third respectively.

Table 7. Factors affecting the acceptance of BIM in the construction industry and education system of Bangladesh.

Sl.	Factor group: Acceptance of BIM	Respondent scores					RII	Rank
		Disagree: 1	Strongly disagree: 2	Neutral: 3	Agree: 4	Strongly Agree: 5		
1	BIM speeds up my tasks in my job.	20	4	43	65	73	0.748	1
2	BIM improves my job performance.	20	4	32	94	54	0.737	2
3	The use of BIM in job increases productivity.	22	5	35	81	61	0.733	3
4	BIM enhances my effectiveness.	18	6	40	91	49	0.726	4
5	BIM simplifies my job.	21	6	41	79	56	0.720	5
6	Learning to operate BIM software was easy.	15	21	57	74	38	0.683	8
7	Interaction with BIM has been clear and understandable.	13	17	56	73	45	0.700	6
8	Easy to become BIM-skilled.	13	19	53	79	41	0.700	7

Challenges Related. The Relative Important Index (RII) and ranks of eight (8) factors related to the challenges of BIM in the construction industry and education system in Bangladesh are shown in Table 8. The factor of "Lack of BIM knowledge" was ranked first with a value of RII 0.753.

Table 8. Factors affecting the challenges of BIM in the construction industry and education system of Bangladesh.

Sl.	Factor group: Challenges of BIM	Respondent scores					RII	Rank
		Disagree: 1	Strongly disagree: 2	Neutral: 3	Agree: 4	Strongly Agree: 5		
1	Lack of BIM knowledge	17	11	36	75	68	0.753	1
2	Lack of training in BIM software usage	18	6	34	96	52	0.743	2
3	BIM software is too expensive	14	24	57	70	41	0.687	4
4	Existing CAD software meets current needs	20	21	54	73	39	0.680	5
5	BIM software isn't needed by the project or team	14	30	63	69	31	0.664	7
6	Against traditional construction trend	17	30	50	69	40	0.673	6
7	No Return On Investment data for BIM	19	25	63	65	35	0.663	8
8	Lack of working procedure and standard	17	18	60	69	42	0.688	3

Benefits Related. The Relative Important Index (RII) and ranks of eight (9) factors related to the benefit of BIM in the construction industry and education system in Bangladesh are shown in Table 9. The factor of "Reduced project risk" was ranked first with a value of RII 0.751.

Table 9. Factors affecting the benefits of BIM in the construction industry and education system of Bangladesh.

Sl.	Factor group: Benefits of BIM	Respondent scores					RII	Rank
		Disagree: 1	Strongly disagree: 2	Neutral: 3	Agree: 4	Strongly Agree: 5		
1	Reduced conflicts during construction	19	7	45	77	59	0.738	7
2	Higher-performing structures	15	8	40	98	46	0.740	5
3	Faster review and approval process	15	6	46	80	59	0.746	3
4	Advanced prefabrication options	14	5	53	85	50	0.740	5
5	Reduced project risk	16	4	47	80	60	0.751	1
6	Enhanced project quality	15	9	43	80	59	0.744	4
7	Cost-saving through waste reduction	13	9	49	81	54	0.739	6
8	Better visualization and design control	16	9	42	77	63	0.749	2
9	Could-based capability	18	6	52	78	52	0.725	8

Adoption Related. The Relative Important Index (RII) and ranks of eight (8) factors related to the adoption rate of BIM in the construction industry and education system in Bangladesh are shown in Table 10. The factor of "University collaborations for BIM programs" was ranked first with a value of RII 0.757.

Table 10. Factors affecting the adoption rate of BIM in the construction industry and education system of Bangladesh.

Sl.	Factor group: Adoption of BIM	Respondent scores					RII	Rank
		Disagree: 1	Strongly disagree: 2	Neutral: 3	Agree: 4	Strongly Agree: 5		
1	Government Support and enforcement for BIM	18	8	40	72	69	0.753	3
2	Clients willing to invest in BIM	12	20	52	88	35	0.703	8
3	Client demand for BIM	17	8	56	76	50	0.722	7
4	Standardize work procedure for BIM	14	9	47	92	44	0.728	6
5	BIM training courses establish	16	6	40	78	66	0.756	2
6	Promotion and seminar on BIM awareness	13	7	44	89	53	0.746	4
7	Readily available BIM expert for hire	13	9	51	79	55	0.742	5
8	University collaborations for BIM programs	15	8	40	75	68	0.757	1

Top factors. Top 10 important factors affecting the implementation of BIM in Bangladesh's education system and construction industry among the 25 factors considered throughout the study are presented in Table 11.

Table 11. Top factors affecting implementation of BIM in the construction industry and education system of Bangladesh.

Sl.	Factor group: Top factors	Respondent scores					RII	Rank
		Disagree: 1	Strongly disagree: 2	Neutral: 3	Agree: 4	Strongly Agree: 5		
1	University collaborations for BIM programs	15	8	40	75	68	0.757	1
2	BIM training courses establish	16	6	40	78	66	0.756	2
3	Lack of BIM knowledge	17	11	36	75	68	0.753	3
4	Government Support and enforcement for BIM	18	8	40	72	69	0.753	3
5	Reduced project risk	16	4	47	80	60	0.751	4
6	Better visualization and design control	16	9	42	77	63	0.749	5
7	BIM speeds up my tasks in my job.	20	4	43	65	73	0.748	6
8	Faster review and approval process	15	6	46	80	59	0.746	7
9	Promotion and seminar on BIM awareness	13	7	44	89	53	0.746	7
10	Enhanced project quality	15	9	43	80	59	0.744	8

4 Conclusions

This study sheds light on the current state of Building Information Modeling (BIM) adoption in Bangladesh's AECO industry. Despite the transformative impact of BIM observed globally, its integration in the Bangladeshi AECO sector faces challenges. The research employed a quantitative methodology, utilizing online surveys distributed to university teachers, students, and AECO professionals. Through a comprehensive analysis utilizing TAM and a multimethodological approach, the research identifies key factors influencing BIM acceptance, challenges, benefits, and adoption rates. The research methodology employed a reliable quantitative approach, with Cronbach's alpha indicating excellent reliability for each section of the survey. The Relative Importance Index (RII) was used to rank factors, providing a clear hierarchy of their significance. Among the important findings, the study identified the top factors influencing BIM implementation in Bangladesh, with "University collaborations for BIM programs" ranking highest in importance. Other significant factors included the establishment of BIM training courses, government support for BIM, reduced project risk, better visualization and design control, speed up user tasks, and faster review and approval. Based on findings it is clear that integrating BIM software into the undergraduate curriculum, alongside established tools like AutoCAD and E-tabs, can broaden graduate’s skill sets and readiness for diverse challenges in the professional realm. The study's comprehensive approach, involving teachers, students, and industry professionals, contributed to a holistic understanding of BIM implementation in the Bangladeshi context. The findings underscore the crucial need for targeted interventions, such as workshops and seminars, to enhance BIM awareness and application proficiency among students and AECO professionals. Swift action in aligning educational approaches with industry needs is recommended for ensuring a successful transition to BIM, thereby fostering cost-effectiveness, improved collaboration, and sustainability in Bangladesh's rapidly growing construction landscape. The overwhelming consensus among respondents underscores the perceived indispensability of BIM knowledge for AECO professionals, positioning it as a crucial asset in withstanding the challenges of Industrial Revolution 4.0. The study's findings underscore the importance of collaborative efforts, training initiatives, and government support to foster a conducive environment for BIM adoption in both educational settings and the professional realm.

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