4th International Conference on Advances in Civil Engineering 2018 (ICACE 2018)
19 –21 December 2018
CUET, Chittagong, Bangladesh
www.cuet.ac.bd

FACTORS AFFECTING THE BIM ADOPTION IN THE CONSTRUCTION INDUSTRY OF BANGLADESH

M. F. H. Rakib*, S. Howlader& M. Rahman
Department of Building Engineering and Construction Management, Khulna University of Engineering & Technology, Khulna-9203, Bangladesh.

E-mail: mfhrakib78@gmail.com;sujanhowlader96@gmail.com;mizanbecm@gmail.com*

**Corresponding author*

ABSTRACT
Building Information Modeling (BIM) empowers organizations in architecture, engineering and construction (ace) industries to change a chain of technological improvements to improve the chain of construction. Considerable effects through BIM execution might be accomplished all through all phases of the development procedure. This exploration shows by means of 40 responses from an example of BIM users that coordinated effort perspectives create the most elevated positive effect. The paper quantifies BIM use throughout the project lifecycle, assuring BIM is largely used in the design phases. BIM requires investment in software and training however, smaller practices can manage the cost of it. Stakeholder's contribution for BIM adoption is ranked concluding that project managers contribute most to adopt BIM. The main reasons currently used for the BIM have been identified and the results indicate a lack of training for existing non-BIM personal and efficiency of BIM software. It will help Government agencies of Bangladesh government to properly plan to take BIM in the life cycle of construction projects and support implementation.

Keywords: Building Information Modelling; BIM adoption; Key factors; Project Management; Project life cycle.

INTRODUCTION
BIM (Building Information Modeling) is an intelligent 3D model-based process that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure. To simulate the planning, design, construction and maintenance phases of a project it requires the development and use of a computer-generated model(Azhar, 2011). UK Government thinks that its use brings many advantages in the project(Eadie, Browne, Odeyinka, McKeown, & McNiff, 2013). BIM is much more than three-dimensional (3D) perception or exchanging the electronic renditions of paper records. Through BIM execution, risks are decreased, plan expectation is kept up, the construction is streamlined(Azhar, 2011; Goedert & Meadati, 2008; Nath, Attarzadeh, Tiong, Chidambaram, & Yu, 2015; Qian, 2012; Tse, Wong, & Wong, 2005).BIM is an up and coming innovative apparatus through which digitized data can be utilized keeping in mind the end goal to help enhancements in profitability and accomplish successful and efficient administration for the duration of the existence cycle of a facility. With the help of BIM, clients may assess possible conflicts ahead of time so as to accomplish best construction (Azhar, 2011; Chien, Wu, & Huang, 2014; Nath et al., 2015; Qian, 2012). It is accounted for that the wreath of BIM adoption in Singapore in years 2009, 2012, 2014 was 20%, 32%and 65%, respectively (Qian, 2012). In a review directed in 2007, the use of BIM and IFC consistent BIM applications in Finland was assessed to be 33% (Kiviniemi, Sulankivi, & Mäkelä, 2007). In a similar overview, it was watched that in Finland, 93% of the designer firms were utilizing BIM for a few

sections in their tasks though the architect's use was almost 60%. The usage of BIM in Denmark is increasing. According to the survey which was done in 2006 (Kiviniemi, 2009), the most commonly used BIM application among architects was Architectural Desktop with approximately 35% of the firms using it. It also expressed that about 50% of the architects, 29% of clients and 40% of engineers in Denmark were using BIM for several portions of their projects in 2006. In this research, Key Factors will be the essential factors that significantly affect BIM adoption in Bangladesh's AEC industry. In this investigation, the information were gathered through a survey-based overview directed for construction firms in Bangladesh.

LITERATURE ANTICIPATING TO BIM

A. BIM application across the project lifecycle

This study explored the use of BIM at the different steps in the construction lifecycle and analyzing the significance of the impacts in the application of BIM. For the objectives of this exploration, the undertaking lifecycle is characterized as incorporating feasibility, design, construction, operation and maintenance. Key literature characterizes the different steps utilizing BIM as feasibility (Azhar & Brown, 2009; Cheung, Rihan, Tah, Duce, & Kurul, 2012), design (Azhar & Brown, 2009; Azhar, Carlton, Olsen, & Ahmad, 2011), preconstruction (detail design and tender) (Azhar, 2011; Azhar et al., 2011; Ibrahim, Krawczyk, & Schipporeit, 2004), construction (Azhar et al., 2011) and operation and management (Ibrahim et al., 2004). BIM is referred to as being valuable and giving advantages at these stages be that as it may, precluded from the literature is the recurrence of utilization by associations at each phase of the project lifecycle.

B. Stakeholders contribution on BIM adoption

The viewpoint of the stakeholders with respect to BIM in the AEC area is essential since they achieve direct benefits from its adoption. The BIM approach can exceptionally enhance the coordinated effort among them conveying an additional incentive to their business. For sure, as per (Arayici et al., 2011) the joint effort among stakeholders can increment authoritative limits which improve the execution of the task administration amid the design and construction process. In any case, each stakeholder of AEC division has their individual work process and demands, so their BIM offer is extraordinary. As a rule, it changes in view of specialization of a stakeholder or phase of the building process (design, building supply, construction, etc.). Different stakeholders concur on the basic issue of interoperability between software that can upset the capacity to encounter an incentive from BIM. Architects are the significant clients of BIM(Travaglini, Radujković, & Mancini, 2014)and they encounter an abnormal state of significant worth additionally as far as Return-of-Investment (ROI). Engineers like architects encounter high an incentive from BIM and in addition saw Return-of-Investment (ROI).

C. Barriers for not using BIM

The barriers for not using BIM on some projects were observed. The following important barriers were selected from study outlined below:

- Lack of expertise within the project team (Ku & Taiebat, 2011; Mayo, Giel, & Issa, 2012)
- Lack of client demand (Birkeland, 2009)
- Investment cost (Giel, Issa, & Olbina, 2009)
- Lack of additional project finance to support BIM (Bazjanac, 2006)
- Training in BIM software for using BIM (Christensen, McNamara, & O'Shea, 2007)

D. Key factors for BIM adoption

Key factors are the influence factors that are most imperative to the conduct of the framework and most impact the prosperity of the procedure in the industry. Key factors are the influence factors that successfully affect on decision making (Ogilvy & Schwartz, 1995). The following important key factors were identified from literature outlined below:

- BIM Training for Existing Non-BIM Personal
- Efficiency of BIM Software

- Initial Investment Cost
- Potential Benefits of BIM
- Organizations Financial Resources
- Facility Management
- Government Support
- Site Layout Planning and Site Safety
- Software and Hardware Upgrading and Maintenance Cost
- Prequalification of Team Member

METHODOLOGY

The questionnaire was planned from literature review and stakeholder's interviews. An online/email-based survey was used to collect data from respondents. The survey was conducted among the construction stakeholders in Bangladesh, such as architects, engineers, main contractors as well as the facility managers. The participants included have past involvement with CAD and are additionally during the time spent relocating towards a BIM-based approach and using BIM instruments.

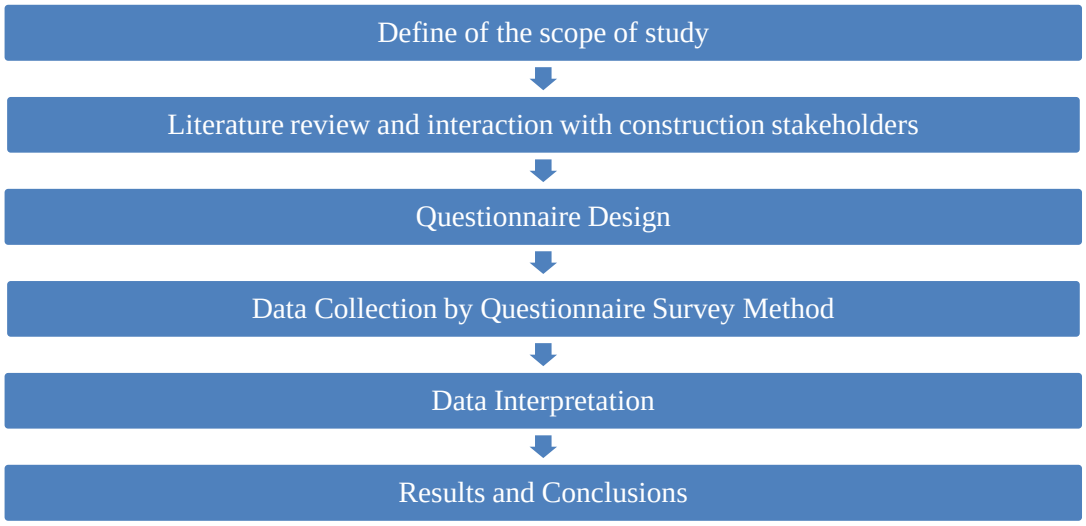

Fig.1: Methodology of the study

DATA ANALYSIS

Relative Importance Index (RII) was used for analysis of data. It helps to rank the factors from collecting data.

RII is defined by the following formulae:

Relative Importance Index (RII) = $\frac{\Sigma W}{AxN}$ $(0 \leq \text{index} \leq 1)$ (1)

Where, W is the weight given to each factor by the respondents and ranges from 1 to 5.

W ranges

1 = Least important
2 = Somewhat important
3 = Moderate
4 = Important
5=Very Important

A is the highest weight = 5.

N is the total number of respondents.

RESULTS AND DISCUSSION

BIM application across the project lifecycle

Table 1: BIM use during the construction stages

Use during the construction project stages	Rank 5	Weight 5	Rank 4	Weight 4	Rank 3	Weight 3	Rank 2	Weight 2	Rank 1	Weight 1	Total	∑W	RII	Rank
Design	18	90	13	52	3	9	3	6	3	3	40	160	0.8	1
Construction	9	45	20	80	5	15	3	6	3	3	40	149	0.745	2
Operation & Maintenance	3	15	20	80	8	24	3	6	6	6	40	131	0.655	3
Preconstruction	6	30	17	68	3	9	4	8	10	10	40	135	0.625	4
Feasibility	0	0	22	88	1	3	6	12	11	11	40	114	0.57	5

The results in Table-1 indicates that BIM is most used in the design stage (RII 0.8), rank 1. The second-place ranking of application across the project lifecycle of BIM is construction stage (RII 0.745). BIM is least used in the operation and maintenance stage as RII 0.655, rank 3. The preconstruction stage is ranked 4 (RII 0.625). Feasibility stage is a potential area for future research to adapt BIM software (RII 0.57), rank 5.

Barriers for not using BIM

Table-2: Ranking of barriers for not using BIM.

Reasons for not using BIM	Rank 5	Weight 5	Rank 4	Weight 4	Rank 3	Weight 3	Rank 2	Weight 2	Rank 1	Weight 1	Total	∑W	RII	Rank
Training in BIM software	17	85	15	60	8	24	0	0	0	0	40	169	0.845	1
Expertise with the project team	6	30	31	124	3	9	0	0	0	0	40	163	0.815	2
Investment cost	3	15	15	60	16	48	3	6	3	3	40	132	0.66	3
Client demand	3	15	12	48	21	63	0	0	4	4	40	130	0.65	4
Additional project finance	0	0	21	84	7	21	3	6	9	9	40	140	0.60	5

Table-2 indicates that the top two barriers for not using BIM are “Training in BIM software” (RII, 0.845) and “Lack of expertise within the project team” (RII, 0.815). BIM has some lack of adoption and it can be filled by potential education and essential training. Investment cost as a reason for not using BIM was ranked third (RII, 0.66). Client demand was less important in the construction and ranked fourth (RII, 0.65). The RII value given to “additional project finance” (0.60) indicates that finance is less needed for BIM adoption on the project.

Stakeholder’s contribution in BIM

Table-3: Ranking of Stakeholder’s contribution in BIM

Stakeholder’s	Rank 5	Weight 5	Rank 4	Weight 4	Rank 3	Weight 3	Rank 2	Weight 2	Rank 1	Weight 1	Total	∑W	RII	Rank
Project Managers	9	45	25	100	6	18	0	0	0	0	40	163	0.815	1
Consultants	8	40	17	68	9	27	3	6	3	3	40	144	0.72	2
Main Contractors	11	55	12	48	11	33	0	0	6	6	40	142	0.71	3
Clients	3	15	17	68	11	33	6	12	3	3	40	131	0.655	4
Sub-Contractors	6	30	10	40	17	51	0	0	7	7	40	128	0.64	5
Suppliers	6	30	3	12	17	51	8	16	6	6	40	115	0.575	6

Table-3 indicates that the top two stakeholder’s contributions in BIM on projects are “Project Managers” (RII, 0.815) and “Consultants” (RII, 0.72). Project managers contribute most to adopt BIM on projects. Client’s contributions to adopt BIM on projects are less important (RII, 0.655). The RII value given to “Suppliers” (0.575) indicates that suppliers are not important for BIM adoption on projects.

Identify key factors for BIM adoption

Table-4: Key Factors for BIM adoption:

Key factors	Rank 5	Weight 5	Rank 4	Weight 4	Rank 3	Weight 3	Rank 2	Weight 2	Rank 1	Weight 1	Total	∑W	RII	Rank
BIM Training for Existing Non-BIM Personal	9	45	13	52	18	54	0	0	0	0	40	151	0.755	1
Efficiency of BIM Software	4	20	25	100	8	24	3	6	0	0	40	150	0.75	2
Initial Investment Cost	3	15	21	84	16	48	0	0	0	0	40	147	0.735	3
Potential Benefits of BIM	0	0	26	104	14	42	0	0	0	0	40	146	0.73	4
Organizations Financial Resources	3	15	24	96	5	15	8	16	0	0	40	142	0.71	5
Facility Management	0	0	24	96	13	39	0	0	3	3	40	138	0.69	6
Government Support	12	60	9	36	6	18	10	20	3	3	40	137	0.685	7
Site Layout Planning and Site Safety	6	30	9	36	19	57	1	2	5	5	40	130	0.65	8
Software and Hardware Upgrading and Maintenance Cost	0	0	21	84	13	39	0	0	6	6	40	129	0.645	9
Prequalification of Team Member	0	0	18	72	14	42	5	10	3	3	40	127	0.635	10

The results in Table-4 shows that the top three key factors for BIM adoption are “BIM Training for Existing Non-BIM Personal” (RII, 0,755), “Efficiency of BIM Software” (RII, 0.750) and “Initial Investment Cost” (RII, 0.735). Organizations financial resources (RII, 0.71) are less important as a key factor for BIM adoption. The RII value given to “Prequalification of Team Member” (0.60) indicates that prequalification is less needed for BIM adoption on the project.

CONCLUSSION

The output of this research revealed that BIM has been widely used in the design and construction stages while rarely used in the operation and management stage, which is stood ranked third. BIM is little used in the pre-construction phases (ranked fourth). Moreover, the study has been incorporated the level of stakeholder’s contribution in projects. From the survey results, it has been found that top two stakeholder’s contributions in BIM adoption on current projects are “Project Managers” and “Consultants” which is stood rank respectively. On the other hand, Client’s contributions to adopt BIM on projects are less important in the construction industry in Bangladesh.

From the survey results it also been identified some influencing factors that affecting BIM adoption and execution in Bangladesh’s AEC industry and the most influencing factors for all phases are identified as follows: BIM training for existing non-BIM personal, efficiency of BIM software and initial investment cost.

Finally, it can be recommended that new course modules associated with Building Information Modeling (BIM) could be incorporated in undergraduate and postgraduate students that will assist to create more BIM expert in the future. Bangladesh Government as well as private firms should take some necessary steps such as increase awareness, training and education to BIM to improve the BIM adoption in the construction industry.

ACKNOWLEDGEMENTS

We would like to thank who participated in questionnaire survey.

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