Major Project

EVALUATING THE ACCEPTANCE OF ARTIFICIAL INTELLIGENCE ENABLED BUILDING INFORMATION & MODELLING THROUGH TECHNOLOGY ACCEPTANCE MODEL FOR CONSTRUCTION INDUSTRY

Submitted by

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CERTIFICATE

This is to certify that Kshitij Pandey Roll No. 2K21/EMBA/23 has submitted the Major Project Report titled **EVALUATING THE ACCEPTANCE OF ARTIFICIAL INTELLIGENCE ENABLED BUILDING INFORMATION & MODELLING THROUGH TECHNOLOGY ACCEPTANCE MODEL FOR CONSTRUCTION INDUSTRY** in partial fulfilment of the requirements for the award of the degree of Master of Business Administration (MBA) from Delhi School of Management, Delhi Technological University, New Delhi during the academic year 2022-23.

DECLARATION

I hereby declare that Project work entitled "**EVALUATING THE ACCEPTANCE OF ARTIFICIAL INTELLIGENCE ENABLED BUILDING INFORMATION & MODELLING THROUGH TECHNOLOGY ACCEPTANCE MODEL FOR CONSTRUCTION INDUSTRY**" submitted to DTU, Delhi is a record of an original work done by me under the guidance of Dr. Abhinav Chaudhary and this project work is submitted in the partial fulfillment of the requirements for the award of the degree of EMBA. The results embodied in this study have not been submitted by any other University or Institute for the award of any degree or diploma.

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EXECUTIVE SUMMARY

The architecture, engineering, and construction (AEC) sector and industry in India is currently undergoing a period of transition due to the constant and rapid advancements in technology. One of the latest technological developments in the AEC industry is “Building Information & Modelling (BIM)”. While many architects have incorporated this high-tech tool into their offices, only a small number of architectural firms in India have implemented BIM on their projects, and even then, not in its entirety. As a result of low adoption rates among architects and designers, BIM is still considered to be in its early stages of implementation in India.

The construction industry in India accounts for at least 5% of the nation's GDP and contributes 78% to the gross capital formation related with the sector of built environment. “Building Information & Modelling (BIM)” has immense potential and capabilities to improve and enhance society in terms of building construction and design. BIM helps achieve these goals by reducing costs, diminishing human errors, aggregating productivity, and decreasing time taken for the successful project delivery to ensure that the intended quality output across all associated spheres in the AEC sector and industry is of the highest quality at both the micro and macro level.

The digitalization of the construction industry has the ability to vastly improve industry practices. Despite this, traditional construction methods remain the norm in current construction project management practices. The application and use of fully automated AI enabled technological techniques in the construction industry is not yet widespread, which may explain the slow adoption of digital growth, especially and more specifically in most of the developing countries. This study is aimed towards assessing and investigating the level of acceptance for the incorporation of “Building Information & Modeling (BIM)” and “Artificial Intelligence (AI)” in the construction sector and industry.

The objective of this study is to determine how well “Building Information & Modelling (BIM)” and “Artificial Intelligence (AI)” are received in the construction sector. The “Technology Acceptance Model (TAM)” was used in the study to accomplish this goal. According to TAM, the user's acceptance of an information system can be assessed using elements like perceived

usefulness (PU), perceived ease of use (PEOU), attitudes towards using (ATU), and behavioral intents to use (BUI). A survey was done among professionals in the construction business using a questionnaire that was created based on the TAM constructs.

According to the study, professionals' attitudes towards utilizing Building Information Modelling (BIM) and their perceptions of its value both affected their behavioral intention to use BIM. Overall, the study showed that respondents accepted BIM to a high degree. The results provide us a deeper knowledge of BIM user adoption in the building sector. It is advised to employ workshops and seminars to educate experts in the building sector about the value and application of BIM. Additionally, educational institutions that offer programs connected to building should think about incorporating BIM into their courses. Additionally, clients should be urged to insist on the usage of BIM in their projects.

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1. INTRODUCTION

In recent years, the construction industry has been undergoing significant changes in the use of technology. “Building Information & Modelling (BIM)” and “Artificial Intelligence (AI)” have emerged as the latest developments in the construction sector and industry, and they are transforming the way professionals in the industry design, construct, and manage buildings. The difference between BIM and AI is that the former is a digital interpretation and representation of a building's structural and operational elements, while the latter is a computer system's simulation of human cognitive processes. The application of BIM and AI in the construction sector and industry has the potential to transform the way professionals in the industry design, construct, and manage buildings. The amalgamation of BIM and AI has the necessary potential and the capability to bring drastic improvements in construction quality, reduction in costs, and increase efficiency. This paper explores the concepts of BIM and AI, their application, and their impact and adoption readiness in the construction industry.

1.1. BUILDING INFORMATION & MODELLING (BIM)

A digital model of a building is created using 3D computer-aided design (CAD) software as part of BIM, an enhanced approach to building design, construction, and management. It is a collaborative tool that brings together architects, engineers, and contractors to work on a single platform. BIM is used to develop a comprehensive virtual model which comprehensively includes all the physical, operational and functional properties and characteristics of a building, from its structural components to the building systems, and finishes. BIM allows stakeholders to visualize and simulate the building's design, construction, and operation before it is built. This approach helps to reduce and minimize any errors and omissions, improve construction quality, and increase the efficiency of the construction process.

BIM's use in the construction sector has increased dramatically over the past few years, and this trend is anticipated to continue. BIM has been adopted by many countries, including the UK, the US, and Australia, as a standard approach to building design, construction, and management.

Commercial, residential, and infrastructural projects, among many others, have all shown the value of BIM.

BIM comes and brings with itself a wide range and array of uses in the ("Architecture, Engineering, and Construction") sector and industry, some of which are as follows:

1. Design: BIM provides a platform for architects and designers to create and visualize building designs in 3D, which enables them to test and evaluate different design options and make informed decisions. BIM models can also incorporate information on materials and equipment, allowing designers to choose the most appropriate options for a building's requirements.
2. Coordination: BIM enables the coordination of all project disciplines, including architecture, engineering, and construction. The technology allows different project stakeholders to work together in real-time and resolve conflicts before construction begins, reducing project delays and costs.
3. Visualization: BIM allows stakeholders to visualize building designs in 3D, which provides a more accurate visualization and digital representation of the finished project. This helps clients, contractors, and other stakeholders to better understand the design intent and make informed decisions.
4. Cost Estimation: BIM models can incorporate quantities and properties of building components, which allows contractors to create more accurate and detailed cost estimates. This can help in better cost management and reducing the chances of cost overruns.
5. Construction: BIM can be used during construction to optimize schedules, reduce waste, and improve safety. BIM models can also be used to create detailed construction plans and ensure that all stakeholders are working from the same set of information.
6. Facility Management: BIM models can be used to manage and maintain buildings after construction. By including information on building components and equipment, facility managers can easily access information on maintenance schedules and equipment warranties and make informed decisions on maintenance and replacement.

1.2.ARTIFICIAL INTELLIGENCE (AI)

The imitation of our own human brain intelligence by any computer systems, including learning, reasoning, and self-correction, is known as artificial intelligence (AI). AI is based on the idea that a machine can be made to be designed and then trained with the help of the already existing data to think and learn like a human being. In the construction industry, AI is used to automate repetitive tasks, analyze data, and make predictions. AI is used to support decision-making, improve project management, and enhance building performance.

The application of AI in the construction industry is in its very nascent and early stages, but it is expected to grow rapidly in the coming years. AI is being used in the construction sector and industry to improve project management, reduce costs, and increase efficiency. AI is also being used to analyze data to predict potential problems and identify opportunities for improvement.

1. Design: AI can be used to generate and optimize building designs based on project requirements and constraints. AI can analyze data and generate design options, saving time and reducing the risk of human error.
2. Project Management: AI can be used to optimize project schedules, predict and manage risks, and improve project performance. By analyzing data, AI can identify patterns and trends, and provide insights to help project managers make informed decisions.
3. Quality Control: AI can be used to analyze and identify defects in building materials and components, reducing the risk of safety hazards and costly rework.
4. Energy Efficiency: AI can be used to optimize energy consumption in buildings by analyzing data on usage patterns and environmental conditions. This can help reduce energy costs and improve sustainability.
5. Safety: AI can be used to keep an eye on construction sites and spot any potential dangers. AI can also be used to improve safety in building operations by monitoring equipment and identifying potential failures before they occur.
6. Asset Management: AI can be used to manage building assets by tracking and analyzing data on equipment performance and maintenance requirements. This can help reduce downtime and improve overall efficiency.

1.3.BIM & AI INTEGRATION

The amalgamation and of BIM and AI has the potential to transform the construction sector and industry efficiency significantly. The combination of BIM and AI allows for the automation of repetitive tasks, such as generating construction schedules and estimating costs. BIM and AI also allow for the analysis of data to make predictions about the performance of buildings and identify opportunities for improvement.

The integration of BIM and AI has the potential to improve construction quality, reduce costs, and increase efficiency. BIM and AI can be used to improve the design process by allowing stakeholders to visualize and simulate the building's design before it is built. BIM and AI can also be used to optimize building performance by analyzing data from building sensors and making predictions about potential problems and opportunities for improvement.

AI is an area that involves using algorithms to generate outputs, such as images, videos, or designs. In the context of BIM, generative AI can be used to generate building designs, optimize building layouts, or predict building performance. Here are some applications of generative AI in BIM:

1. Automated design optimization: Generative AI can be used to generate and optimize building designs based on project requirements and constraints. By integrating generative AI with BIM, the software can analyze data and generate design options, saving time and reducing the risk of human error.
2. Optimal building layout: Generative AI can be used to optimize building layouts based on a set of parameters. By integrating generative AI with BIM, the software can generate optimal building layouts that meet the desired parameters, such as energy efficiency, cost-effectiveness, or occupant comfort.
3. Performance prediction: Generative AI can be used to predict building performance based on design parameters. By integrating generative AI with BIM, the software can generate simulations of building performance under different scenarios, such as changing weather conditions or occupancy levels.

4. Material and resource optimization: Generative AI can be used to optimize material and resource use in construction projects. By integrating generative AI with BIM, the software can provide insights on material and resource use, enabling more efficient use and reducing waste.

5. Predictive maintenance: Generative AI can be used to predict maintenance needs for building systems and components based on data from sensors and other sources. By integrating generative AI with BIM, the software can provide insights on maintenance needs and schedule maintenance activities, reducing downtime and improving asset performance.

2. LITERATURE REVIEW

“Building information & modelling (BIM)” is a digital and virtual interpretation and depiction of any assets or building’s structural and functional elements. The integration of BIM with Artificial Intelligence technology has revolutionized the AEC industry, making it more efficient and cost-effective. The “Technology Acceptance Model (TAM)” is a widely used framework that helps researchers understand how and why people adopt new technologies. This literature review provides a detailed, comprehensive and in-depth analysis of studies that have used the “TAM” framework to examine the adoption of BIM in the AEC industry.

“Building Information Modelling (BIM)” adoption in the Architecture, Engineering, and Construction (AEC) business has been studied extensively in the literature using the “Technology Acceptance Model (TAM)”. The widely used TAM model contends that the degree of an information system's success can be assessed by the degree of user acceptance, which is gauged by variables like “perceived utility (PU)”, “perceived ease of use (PEOU)”, “Attitudes towards using (ATU)”, and “Behavioral intentions to use (BI)”.

In order to describe how users adopt information technology, Fred Davis originally presented the “Technology Acceptance Model (TAM)” in 1989. The model makes the assumption that perceived usefulness (PU) and perceived ease of use (PEOU), two important criteria, have an impact on people's attitudes and behaviour towards new technologies. The degree to which a technology is thought to have cause the increase in the productivity, efficiency, and effectiveness is regarded and referred to as perceived usefulness. The degree to which any new technology or any emerging technology is seen to be easy, understandable, and simple to use is referred to as perceived ease of use.

TAM has been mostly and widely used to examine the adoption of new technologies in various industries, including healthcare, education, and manufacturing. In recent years, TAM has gained significant attention in the AEC industry to understand the adoption of BIM.

2.1.TECHNOLOGY ADOPTION MODEL

TAM, which is also known as “Technology Acceptance Model”, is a framework used to understand how users react to new technology. This model assists in predicting user acceptance and guiding improvements to the system. Lee and all (2013) explain that “TAM” seeks to clarify the aspects that induce the acceptance of computer amongst the users, which can be applied to a wide array of end-user computing technologies and user populations across geographies. The original model, developed by Davis in 1989, proposes that “TAM” is useful and helpful in measuring, predicting, and explaining the technology currently in use.

The author claims that user acceptance, which may be quantified using elements like “Perceived usefulness (PU)”, “Perceived ease of use (PEOU)”, “Attitudes towards using (ATU)”, and “Behavioral intents to use (BIU)” the system, can be used to assess an information system's success. A system is more likely to be seen as useful when it is simple to use. "The capacity of an information system to be beneficially utilized" is the definition of usefulness. According to Davis and all. (1989), a user's Behavioral intention to use (or not use) a system is influenced by their impression of the system's utility and simplicity.

According to Davis (1989), “Perceived usefulness (PU)” is "the extent to which an individual believes that using a particular information system will enhance job performance." Attitude towards using a technology refers to a user's evaluation of the desirability of utilizing a specific information system. It acts as a partial mediator between the effect of perceived ease of use and perceived usefulness of the technology on the user's behavioral intention to use the system (Davis, 1989; Suki and Ramayah, 2010).

Perceived ease of use (PEOU) is defined as the user's perception of the level of effort required to utilize an information system. Behavioral intention to use (BIU) is the degree to which an individual is willing to accept and use the technology (Davis, 1989).

Behavioral intention to use (BIU) is a crucial factor that determines technology acceptance and actual usage of an information system. BIU measures the likelihood that an individual will use the technology. According to Davis and all. (1989), the usage of a technology is primarily influenced by the user's behavioral intention to use it. In turn, BIU is determined by the user's perceived usefulness of the technology and their attitude towards using it.

Figure 1 illustrates the TAM, which proposes that the user's attitude towards using (ATU) and perceived usefulness (PU) jointly impact their behavioral intention to use (BIU). PEOU also indirectly influences BIU. Both the "Perceived Usefulness PU" and "Perceived ease of use PEOU" directly impact the "Attitude towards Usage ATU", while "Perceived Usefulness PU" is directly influenced by "Perceived ease of use PEOU". TAM also suggests that external variables affect "Perceived Usefulness PU" and "Perceived ease of use PEOU". Therefore, "Perceived Usefulness PU" and "Perceived ease of use PEOU" facilitate the effect of any external variables on the user's attitude (ATU) and behavioral intention to use, ultimately determining the actual system use.

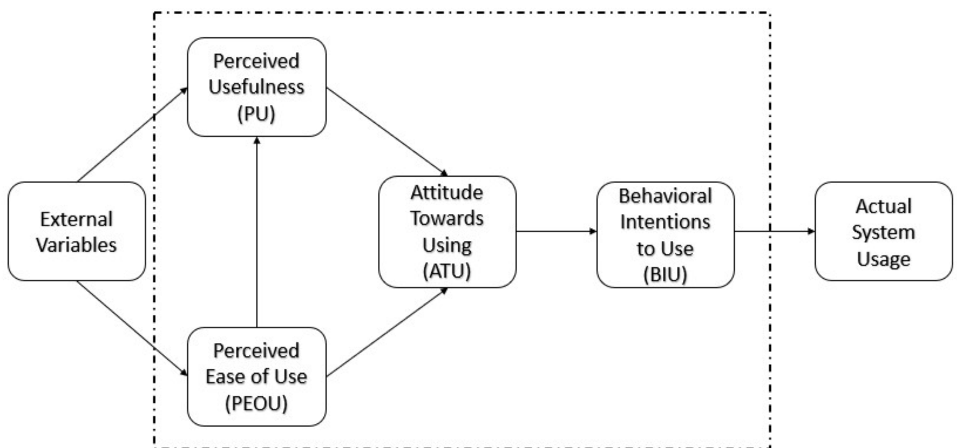

Figure 1: Technology Acceptance Model (Davis and all, 1989)

a. STUDIES ON TAM FOR BIM IN AEC INDUSTRY

Studies on Technology Acceptance Model for BIM Adoption in AEC Industry:

Several studies have used "Technology Adoption/ Acceptance Model TAM" to understand the adoption of "Building Information & Modelling BIM" in the AEC sector and industry. The following is a detailed literature review of some of these studies:

1. Khoiry and Arayici (2016) conducted a survey among architects, engineers, and construction professionals in the UK to examine their intention to adopt BIM. The study

used the TAM framework to inspect any of the factors that influence the implementation of BIM. The results showed that perceived usefulness, perceived ease of use, and attitude towards using BIM significantly influenced the intention to adopt BIM.

2. Guo and Li (2017) conducted a survey among construction professionals in China to investigate the factors that influence the adoption of BIM. The study used the TAM framework and extended it by adding two additional factors: organizational support and government support. The results showed that all five factors (perceived usefulness, perceived ease of use, attitude towards using, organizational support, and government support) significantly influenced the adoption of BIM.
3. Zahoor and all. (2018) conducted a survey among construction professionals in Pakistan to examine the factors that influence the adoption of BIM. The study used the TAM framework and extended it by adding three additional factors: social influence, trust, and perceived risk. The results showed that all six factors (perceived usefulness, perceived ease of use, attitude towards using, social influence, trust, and perceived risk) significantly influenced the adoption of BIM.
4. In a study by (Khalili and all., 2019), they used TAM to investigate the factors that influence the adoption of BIM in the Iranian construction industry. Their study found that the perceived usefulness (PU) of BIM had a significant impact on the behavioural intentions to use (BI) BIM, while the perceived ease of use (PEOU) had a limited effect. In addition, their study found that attitudes towards using (ATU) BIM had a positive effect on BI, indicating that attitudes towards BIM were an important factor in the adoption of BIM.
5. Abbas and all. (2019) conducted a survey among construction professionals in Saudi Arabia to investigate the factors that influence the adoption of BIM. The study used the TAM framework and extended it by adding three additional factors: compatibility, complexity, and self-efficacy. The results showed that all five factors (perceived usefulness, perceived ease of use, attitude towards using, compatibility, and self-efficacy) significantly influenced the adoption of BIM.
2. Another study by (Chau and all., 2020) used TAM to investigate the factors that influence the adoption of BIM and AR in Hong Kong's construction industry. Their study found that the perceived usefulness (PU) and perceived ease of use (PEOU) of BIM were the most In

significant factors in determining the behavioural intentions to use (BI) BIM. In addition, they found that the attitudes towards using (ATU) BIM had a significant impact on the perceived usefulness (PU) of BIM.

3. In a similar study, (Zain and all., 2021) investigated and also examined all the factors that influence the adoption of BIM and VR in the Malaysian construction industry using TAM. Their study found that the perceived usefulness (PU) of BIM had a significant impact on the attitudes towards using (ATU) BIM, while the perceived ease of use (PEOU) had a limited effect. Furthermore, their study found that behavioural intentions to use (BI) BIM were strongly influenced by the attitudes towards using (ATU) BIM.
4. Alshawi and all. (2021) conducted a survey among construction professionals in the UK to investigate the factors that influence the adoption of BIM. The study used the TAM framework and extended it by adding two additional factors: information quality and technical support. The results showed that all seven factors (perceived usefulness, perceived ease of use, attitude towards using, information quality, technical support, social influence, and facilitating conditions) significantly influenced the adoption of BIM in AEC Industry.
5. In a more recent study, (Kuchta and all., 2021) used TAM to investigate the factors that influence the adoption of BIM in the Czech Republic's construction industry. Their study found that the perceived usefulness (PU) of BIM had a significant impact on the attitudes towards using (ATU) BIM, while the perceived ease of use (PEOU) had a limited effect. In addition, their study found that the behavioural intentions to use (BI) BIM were strongly influenced by the perceived usefulness (PU) of BIM.
6.

3. HYPOTHESES

Based on earlier investigations, the following link between the TAM components was proposed:

1. Attitude towards utilising and perceived usefulness have a positive influence on behavioural intention to use (Davis, 1989; Wong and Teo, 2009; umak and all., 2011).
2. Perceived usability and convenience of use have a positive impact on attitudes towards usage (Davis, 1989; Wong and Teo, 2009; umak and all., 2011).
3. Perceived usefulness is positively affected by perceived ease of use (Davis, 1989; Wong and Teo, 2009; Šumak and all., 2011).

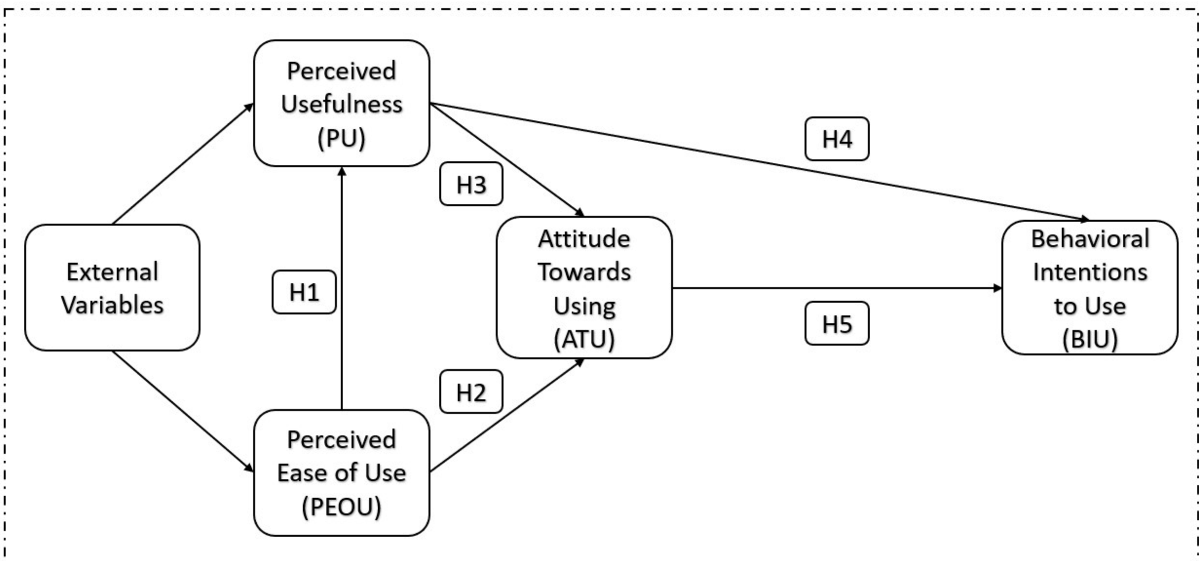

Figure 2: Hypotheses (Davis, 1989)

3.1.PERCEIVED EASE OF USE OF BIM (PEOU)

Perceived Ease of Use (PEOU) refers to the belief of stakeholders and professionals in the construction industry that using BIM is less stressful compared to other systems or traditional methods. User acceptance of an information system is more likely when it is perceived as easier to use than other options. If users believe that a system is easy to use and can help them work efficiently, they are likely to develop a wish to use the system (Marwan and all., 2014, pp. 23). Based on this, the following hypotheses were proposed:

1. H1) User's "PEOU Perceived ease of use" of AI in BIM has a positive effect on the user's "Perceived Usefulness PU" of BIM.
2. H2) User's "PEOU Perceived ease of use" of AI in BIM has a positive effect on user's "Attitudes towards using ATU" BIM.

3.2. PERCEIVED USEFULNESS OF BIM (PU)

The degree and extent to which stakeholders believe that adopting BIM will improve their activities is known as perceived usefulness (PU). (Davis and Venkatesh, 2004; Teo and Noyes, 2011; Sentosa and Mat, 2012) demonstrated that PU is a reliable predictor of behavioural intention to use (BIU) an information technology system. As a result, the following theories were put forth:

1. H3) User's Perceived usefulness of AI in BIM has a positive effect on user's attitudes towards using BIM.
2. H4) User's Perceived usefulness of AI in BIM has a positive effect on user's behavioral intention to use BIM.

3.3. ATTITUDE TOWARDS USE (ATU)

The attitude towards adopting it is thought to affect behavioral intention to use (BIU) AI in BIM. The degree and extent to which a person is inclined favorably or adversely towards the use of BIM is indicated by this. Consequently, the following theory was put forth:

H5) User’s Attitude towards using AI in BIM has a positive effect on Behavioral Intention to Use BIM.

Hypotheses Summary	
H1	User’s Perceived ease of use of AI in BIM has a positive effect on the user’s perceived usefulness of BIM.
H2	User’s Perceived ease of use of AI in BIM has a positive effect on user’s attitudes towards using BIM.
H3	User’s Perceived usefulness of AI in BIM has a positive effect on user’s attitudes towards using BIM.
H4	User’s Perceived usefulness of AI in BIM has a positive effect on the user’s behavioral intention to use BIM.
H5	User’s Attitude towards using AI in BIM has a positive effect on user’s Behavioral Intention to Use BIM.

Table:1 Hypotheses Summary

4. METHODOLOGY

Architects, Engineers, Landscape professionals, Project managers, and quantity surveyors, and engineers working in construction and consulting organizations were chosen for this study using a purposive sampling technique. These people were selected because they are likely to have rich experience with Building Information Modeling (BIM) technologies. The questionnaire asked for background information on the respondents, and 23 items were used to collect data on the various constructs of Technology Acceptance Model (TAM).

Ten questions focused on how BIM augments, improves and enhances the efficiency and effectiveness of creating and producing engineering models on the job, and increases profitability. The questions were made in response to the perceived usefulness scales that were previously developed by Davis and all. (1989), Ajzen, and Fishbein (1975). Six survey questions centered on the ease and simplicity of learning to operate BIM, skillfulness, mistakes in using, perplexity, and annoyance and were modified from the perceived ease of use ratings developed by Davis (1989), Davis and all. (1989), Ajzen, and Fishbein (1975). The attitude towards usage questionnaires created by Davis (1989), Davis and all. (1989), Ajzen, and Fishbein (1975) formed the basis for three of the items. The behavioural intentions to use questions developed by Davis (1989), Davis and all., were modified into four questions.

4.1. SURVEY QUESTIONNAIRE

We hope this message finds you well. We are conducting a survey as part of an academic project, and we would be grateful for your participation.

Our project aims to Study if professionals in Architecture, Engineering and Construction would like to use more Artificial Intelligence enabled generative design features in Traditional AEC Software, and your participation in this survey will help us gather valuable data to support our research.

Your replies will be kept entirely confidential and should only take you around 5 minutes to complete. Please be mindful that taking part in the survey is completely optional, and you are free to skip any questions you don't feel comfortable answering.

Simply click the link below and adhere to the instructions that appear on the screen to take part. Please get in touch with us if you have any queries or worries regarding the survey.

We greatly appreciate your time and effort in completing this survey, and we value your feedback. Thank you for your support and contribution to our academic project.

Please tick the box next to the statements below that best represent your opinion on a scale from 1 to 5, based on your experience.						
		1	2	3	4	5
		I strongly Agree	I agree	Neutral	I disagree	I strongly Disagree
Items	**Questions**	**Scale**				
Perceived Usefulness (PU)		1	2	3	4	5
PU1	I believe that utilizing BIM's AI-enabled Generative Design enhances the quality of project delivery.					
PU2	I believe that employing BIM's AI-enabled generative design improves work effectiveness and productivity.					
PU3	I think using AI enabled Generative Design in BIM boosts efficiency and effectiveness on the job.					
PU4	I believe that adopting BIM's AI-enabled generative design improves productivity and effectiveness at work.					
PU5	I believe that employing BIM's AI-enabled Generative Design has more benefits than drawbacks.					
PU6	I believe that using BIM's AI-enabled generative design will improve our ability to make decisions.					
PU7	I can complete jobs more rapidly thanks to the BIM system's AI-enabled generative design.					
PU8	Making my job easier is using BIM's AI-enabled Generative Design.					
PU9	BIM's AI-enabled Generative Design provides me more authority over my work.					
PU10	BIM with AI powered generative design is generally useful for my job.					
Perceived Ease of Use (PEOU)		1	2	3	4	5
PEOU1	I believe it will be simple for me to learn how to use BIM's AI aided generative design.					
PEOU2	To complete activities on site, AI powered BIM is simple to utilise.					
PEOU3	I rarely make mistakes when using BIM with AI enabled.					
PEOU4	When utilising AI-enabled BIM, I seldom ever get lost or upset.					
PEOU5	BIM with AI is simple to use and comprehend.					
PEOU6	Overall, I found using BIM with AI to be simple.					

Attitude Towards Use (ATU)		1	2	3	4	5
ATU1	I believe it is a fantastic idea to use BIM's AI-enabled generative design.					
ATU2	I believe it is beneficial to employ BIM's AI-enabled Generative Design.					
ATU3	In general, I appreciate the concept of using BIM's AI-enabled generative design.					
Behavioral Intention to Use		1	2	3	4	5
BIU1	I'm likely to start utilising or keep using BIM's AI-enabled generative design.					
BIU2	I want to start utilising BIM's AI-enabled generative design.					
BIU3	In the future, I'll use BIM's AI-enabled generative design frequently.					
BIU4	I will advise others to make use of BIM's AI-enabled generative design.					

Table:2 Survey Questionnaire

5. DATA ANALYSIS

5.1. VALIDITY AND RELIABILITY

The reliability, validity, and consistency of the constructs used in the study were tested using Cronbach's alpha. The results showed a high degree and level of reliability, with values ranging from 0.749 to 0.822, and an agreeable value of 0.749 for Perceived ease of use. As Nunnally (1967) suggests, a Cronbach's alpha value of above 0.70 is considered highly reliable, and all values in this survey exceeded that threshold.

Concepts	N	Cronbach's Alpha
"Perceived Usefulness (PU)"	10	0.822
"Perceived Ease of Use (PEOU)"	6	0.749
"Attitude Towards Use (ATU)"	3	0.814
"Behavioral Intention to Use (BIU)"	4	0.817

Table:3 Validity and Reliability of Variables

5.2. DESCRIPTIVE STATISTICS

According to the results as tabulated and presented in Table 4, the survey respondents had a favorable attitude towards BIM across all of the four variables: perceived usefulness of BIM (Mean= 1.96, Standard Deviation= 0.51), perceived ease of use of BIM (Mean=2.34, Standard Deviation = 0.59), attitude towards using BIM (Mean = 1.74, Standard Deviation = 0.59), and behavioral intention to use BIM (Mean = 1.87, Standard Deviation = 0.72).

Concepts	N	Mean	Standard Deviation
"Perceived Usefulness (PU)"	10	1.96	0.51
"Perceived Ease of Use (PEOU)"	6	2.34	0.59
"Attitude Towards Use (ATU)"	3	1.74	0.59
"Behavioral Intention to Use (BIU)"	4	1.87	0.72

Table:4 Descriptive Statistics of Constructs

5.3. CORRELATION ANALYSIS

Wong and Hiew (2005) stated that an r-value between 0.10 and 0.29 is considered weak, between 0.30 and 0.49 is moderate, and between 0.50 and 1.0 is strong. Field (2005) further advised that the coefficient of correlation should not exceed 0.8 to prevent multicollinearity. Based on the results presented in Table 5, the largest correlation coefficient value (r-value) is 0.574, which is lower and less than 0.8. Therefore, there is no evidence of multicollinearity in this study.

Constructs		PU	PEOU	ATU	BIU
"Perceived Usefulness (PU)"	r-value	1			
	p-value				
	N	150			
"Perceived Ease of Use (PEOU)"	r-value	0.334**	1		
	p-value	0.0001			
	N	150	150		
"Attitude Towards Use (ATU)"	r-value	0.497**	0.314**	1	
	p-value	0.0001	0.0001		
	N	150	150	150	1
"Behavioural Intention to Use BIU"	r-value	0.443**	0.215*	0.574**	
	p-value	0.0001	0.015	0.0001	
	N	150	150	150	150

**. Correlation is significant at the 0.01 level

*. Correlation is significant at the 0.05 level

Table:5 Correlation Matrix

5.4.HYPOTHESES TESTING

All five hypotheses' correlation analysis findings, including the p-values and r-values, are shown. Strong evidence opposing the null hypothesis exists if the p-value is less than 0.05; otherwise, there is just weak evidence, and the null hypothesis will generally be accepted (Greenland and all., 2016). The correlation coefficient (also known as the r-value) has a range of -1.0 to +1.0. The link between the two variables is stronger the closer the r-value is to +1 or -1. An r-value that is nearer to zero (0) signifies that there is little to no correlation between the variables. A high correlation coefficient means that both variables increase while one rises, and vice versa. On the other hand, a negative correlation coefficient shows that when one variable rises.

5.4.1 Hypotheses 1-Perceived ease of use of AI in BIM positively affects perceived usefulness of BIM.

With an r-value of 0.334 and a p-value of 0.0001, the findings in Table 6 show a highly significant and positive connection between the factor of perceived usefulness of BIM and perceived ease of use of BIM. H1 is therefore supported.

Concepts		**"Perceived usefulness (PU)"**
"Perceived Ease of Use (PEOU)"	r-value	0.334**
	p-value	0.0001
	N	150
**. Correlation is fairly significant at the 0.01 level	*. Correlation is fairly significant at the 0.05 level	

Table:6 Correlation of Hypotheses 1

5.4.2 Hypotheses 2 -Perceived ease of use of AI in BIM positively affects attitudes towards using BIM.

With a supported H2 based on the findings, the data analysis in Table 7 demonstrates a highly significant and positive connection between the factor of perceived ease of use of BIM and attitude towards adoption of BIM.

Concepts		"Attitude towards usage (ATU)"
"Perceived Ease of Use (PEOU)"	r-value	0.314**
	p-value	0.0001
	N	150
**.Correlation is fairly significant at the 0.01 level	*.Correlation is fairly significant at the 0.05 level	

Table:7 Correlation of Hypotheses 2

5.4.3 Hypotheses 3 -Perceived usefulness positively affects the user attitudes towards using AI in BIM.

Based on the findings in Table 8, there is an extremely substantial positive correlation between attitudes towards using BIM and user perceived usefulness of BIM. Furthermore, it is discovered that the relationship between attitudes towards using BIM and user perceived usefulness of BIM is stronger than the relationship between attitudes towards using BIM and perceived ease of use of BIM. These results back up H3.

Concepts		"Attitude towards usage (ATU)"
"Perceived Usefulness (PU)"	r-value	0.497**
	p-value	0.0001
	N	150
**.Correlation is fairly significant at the 0.01 level	*.Correlation is fairly significant at the 0.05 level	

Table:8 Correlation of Hypotheses 3

5.4.4 Hypotheses 4 -Perceived usefulness positively affects intention to use AI in BIM.

There is a positive link between behavioral intention to use BIM and perceived utility of BIM, according to the data analysis displayed in Table 9 (p-value (0.00) is very significant). H4 is therefore supported.

Concepts		"Behavioral Intention to Use (BIU)"
"Perceived Usefulness (PU)"	r-value	0.443**
	p-value	0.0001
	N	150
**.Correlation is fairly significant at the 0.01 level		*.Correlation is fairly significant at the 0.05 level

Table:9 Correlation Hypotheses 4

5.4.5 Hypotheses 5 -Attitude towards using AI in BIM positively affects behavioral intention to use BIM.

There is a positive association between the user's behavioural intention to use BIM and Attitude towards utilising BIM, according to the data analysis in Table 10 with a p-value (0.00) that is very significant. H4 is therefore supported.

Concepts		"Behavioral Intention to Use (BIU)"
"Attitude Towards Use (ATU)"	r-value	0.574**
	p-value	0.0001
	N	150
**.Correlation is fairly significant at the 0.01 level		*.Correlation is fairly significant at the 0.05 level

Table:10 Correlation of Hypotheses 5

Hypotheses	Statement	Result
H1	Perceived ease of use of AI in BIM has a positive effect on the user perceived usefulness of BIM.	Supported
H2	Perceived ease of use of AI in BIM has a positive effect on user's attitudes towards using BIM.	Supported
H3	Perceived usefulness of AI in BIM has a positive effect on user's attitudes towards using BIM.	Supported
H4	Perceived usefulness of AI in BIM has a positive effect on the user's behavioral intention to use BIM.	Supported
H5	Attitude towards using AI in BIM has a positive effect on user's Behavioral Intention to Use BIM.	Supported

Table:11 Analysis Summary

6. CONCLUSION AND RECOMMENDATION

According to Davis and all. (1989), Gefen and Straub (2000), Legis and all. (2003), and other relevant research, the constructs employed in the evaluation of "TAM" in the adoption of AI in BIM were determined to be valid and consistent with the original "TAM" model. All of the assumptions were proven correct, proving that respondents had a favourable attitude towards and an intention to apply AI in BIM. The simplicity of use of AI in BIM boosted the experts' perception of its utility, and they adopted a favourable attitude towards its application as a result. Additionally, their behavioural intention to employ AI in BIM dramatically rose as both their attitude and perceived utility increased.

The relationship between perceived usability, attitude of the users towards usage, and the behavioural intention of the BIM professionals to use AI in BIM in the construction business has been examined in this study. If the observed criteria are taken into account, the study's findings can significantly increase user acceptability of AI in BIM and ultimately contribute to the adoption of BIM in the construction sector. Construction sector professionals need to be taught on applying AI in BIM. Future studies could expand TAM to incorporate additional belief components in order to investigate the adoption of BIM from a broader standpoint.

1. REFERENCES

1. Abubakar, M., Ibrahim, Y.M., Kado, D. and Bala, K. (2014). Contractors' Perception of the Factors Affecting Building Information Modelling (BIM) Adoption in the Nigerian Construction Industry, Computing in Civil and Building Engineering, Orlando, Florida, United States.
2. Ajzen, I., Fishbein, M. (1975). Belief, Attitude, Intention and Behavior: An Introduction to theory and research, Addison-Wesley Publication, MA.
3. Averweg, U.R. (2005). Applicability of the technology acceptance model in three developing countries: Saudi Arabia, Malaysia and South Africa. Alternation, 12(1a), pp.331-343.
4. Ayirebi-Dansoh, Ayarkwa, J. and Amoah, P. (2010). Barriers to implementation of EMS in construction industry in Ghana.
5. Azhar, S., Nadeem, A., Mok, J. Y., & Leung, B. H. (2008, August). Building Information Modelling (BIM): A new paradigm for visual interactive modelling and simulation for construction projects, In Proc., First International Conference on Construction in Developing Countries, pp. 435-446.
6. Batarseh, S., & Kamardeen, I. (2017). The Impact of Individual Beliefs and Expectations on BIM Adoption in the AEC Industry, 1, 466–475.
7. Blackwell, B. (2015). Industrial strategy: government and industry in partnership. Building Information Modelling.
8. Botchway, E.A. (2016). Software Application Employed in Architectural Design Education: The Case of KNUST, Review of European Studies, 8(2), 30.
9. Bradley, J. (2008). The technology acceptance model and other user acceptance theories, Sport Coach, 44(1), 277-294.
10. SMART, B. (2010). Constructing the Business Case: Building Information Modelling. British Standards Institute Chen, M., Chen, S., Yeh, H. and Tsaur, W. (2016) The Key Factors Influencing Internet Finances Services Satisfaction: An Empirical Study in Taiwan. American Journal of Industrial and Business Management, 6, 748-762. doi: 10.4236/ajibm.2016.66069.

11. Chung, Y. and Chin, S. (2015). Factors Affecting the BIM Acceptance of Construction Managers. Korean Journal of Construction Engineering and Management, 16(3), pp.11-23.
12. Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology, MIS Quarterly, 13(3), 319-340.
13. Davis, F. D., & Venkatesh, V. (2004). Toward preprototype user acceptance testing of new information systems: implications for software project management, Engineering Management, IEEE Transactions on, 51(1), pp.31–46. http://dx.doi.org/10.1109/TEM.2003.822468.
14. Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models, Management Science, 35(8), 982–1003.
15. Diatmika, I.W.B., Irianto, G. and Baridwan, Z. (2016). Determinants of Behavior Intention of Accounting Information Systems Based Information Technology Acceptance. Imperial Journal of Interdisciplinary Research, 2(8).
16. Eastman, C. M., Eastman, C., Teicholz, P., & Sacks, R. (2011). BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors. John Wiley & Sons.
17. Enegbuma, W.I., Dodo, Y.A. and Ali, K.N. (2014). Building Information Modelling Penetration Factors in Malaysia, International Journal of Advances in Applied Sciences, 3(1), 47-56.
18. Field, A. (2005). Discovering statistics using SPSS, Beverly Hills: Sage Publications. Forgues, D., Iordanova, I., Valdivesio, F., & Staub-French, S. (2012). Rethinking the cost estimating process through 5D BIM: A case study. In Construction Research Congress 2012: Construction Challenges in a
19. Flat World (pp. 778-786). Gefen, D., & Straub, D. W. (2000). The relative importance of perceived ease of use in IS adoption: a study of e-commerce adoption, Journal of the Association for Information Systems, 1(1), 1–27.
20. Greenland, S., Senn, S.J., Rothman, K.J., Carlin, J.B., Poole, C., Goodman, S.N. and Altman, D.G. (2016).
21. Statistical tests, P. European journal of epidemiology, 31(4), pp.337-350.

22. Hergunsel, M. F. (2011). Benefits of building information modelling for construction managers and BIM based scheduling (Doctoral dissertation, Worcester Polytechnic Institute).
23. Hore, A. V., & West, R. (2004). Enabling the re-engineering of material purchasing in the construction industry by the effective use of information technology.
24. InfoComm, B.I.M. (2009). Taskforce. Building Information Modelling.
25. Jung, W. and Lee, G. (2015). The status of BIM adoption on six continents, International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering, 9(5), 444-448.
26. Kreider, R. G., & Messner, J. I. (2013). The Uses of BIM: Classifying and Selecting BIM Uses, State College, Pennsylvania.
27. Lai, P.C., 2017. The Literature Review of Technology Adoption Models and Theories for the Novelty Technology. JISTEM-Journal of Information Systems and Technology Management, 14(1), pp.21-38.