BIM implementation in the middle east construction: evaluating the prospects and challenges

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Abstract. This research explores the potential benefits and challenges associated with the implementation of Building Information Modelling (BIM), a rapidly evolving global trend, within the construction industry of the Middle East. The study is underpinned by a comprehensive literature review on the global and Middle Eastern usage of BIM. A methodical empirical survey was employed to collect quantitative data, comparing the perspectives of Clients, Contractors, and Consultants. Key impediments to BIM adoption in the Middle East were identified as a scarcity of BIM-skilled subcontractors, the lack of industry standards, substantial initial costs, and organizational structures that do not support BIM. On the other hand, the advantages of BIM include improved construction planning, enhanced project quality, an elevated organizational image, and streamlined communication. The study provides crucial recommendations for local governments, policymakers, construction companies, and stakeholders to encourage comprehensive BIM adoption and its utilization in construction projects, while also discussing the practical implications of the findings.

1 Introduction

Using Building Information Modelling (BIM) a technique, architects may develop buildings digitally. "Building Information Modelling (BIM) is a procedure that helps with design by using technology to store and evaluate various building-related data. building's construction and life cycle management, including renovation and/or demolition" [1]. This helps engineers, architects, and clients to specify and comprehend the building before it is constructed. Additionally, as BIM allows for the integration of multidisciplinary information into a single model, it presents an opportunity for sustainability measures to be included during the design phase of a building's lifecycle. This modeling facilitates the study and tracking of various design choices for sustainability [2]. Particularly, the three primary fields of sustainable design that are directly related to BIM are as follows [3]: (a) selection and administration of material sites; (b) selection and use; and (c) systems analysis. Despite the fact that BIM, or

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building information modeling, is frequently recommended as a fix. But making improvements comes with a lot of work, especially when it comes to energy efficiency. At the moment, using BIM alone is frequently insufficient to solve these problems [4]. This is particularly true in the Gulf countries, where the absence of sustainable design has not been greatly addressed by the adoption of BIM [4]. BIM adoption and use in the built environment are steadily increasing [5]. Adoption of BIM is largely driven by maintaining a healthy balance among the project management triangle of scope (features & quality), money, and time [6]. This is due to the fact that it resolves a pressing issue that clients in the architecture, engineering, and construction (AEC) industry have. Meanwhile, Wong et al. [7] believed that using BIM in a building project might help stakeholders maximize benefits relating to time, money, and quality. Because of this, cutting-edge technology is hot right now, and with the way the construction business has developed recently, Building Information Modelling (BIM) has become the talk of the town [8]. BIM has revolutionized the structure and procedures of the construction sector, according to Abanda et al. [9], who called it a "global digital technology, among other things, BIM's innovative and user-friendly characteristics can be used to enhance the construction project phases. The construction sector has experienced a major paradigm change due to the dynamic nature of BIM innovation [10]. According to [11], BIM is an enhanced process and tool that houses a variety of virtual facilities elements, concepts, and systems within a single environment. It entails using and maintaining an integrated digital representation of various data throughout a construction project's phases (design to handover) [12]. According to [13], building information modelling (BIM) is the process of using a database infrastructure to compile built facilities from the perspectives of various stakeholders, allowing those stakeholders to query, simulate, and estimate operations and keep an eye on the building process as a whole. Constructability and analysis, scheduling, cost estimation, and sequencing can all be supported by a variety of BIM tools ([14]. The new paradigm of BIM has enormous potential for integration into the construction project life cycle, and it is an essential tool in the project procurement process [15]. Despite the potential benefits of BIM, its adoption comes with challenges, especially when it comes to energy efficiency (Abu-Gaueh, 1995). This is particularly true in the Gulf countries, where the absence of sustainable design has not been greatly addressed by the adoption of BIM. However, BIM adoption and use in the built environment are steadily increasing (Salleh and Phui Fung, 2014), driven by the need to balance scope, cost, and time in project management (Olawumi and Chan, 2018). This research aims to investigate the advantages and obstacles of implementing BIM in the construction sector of the Middle East region.

1.1 Global and Middle Eastern Adoption and Implementation of BIM

Recent studies suggest that Building Information Modelling (BIM) can be employed in various tendering processes to enhance the overall procedure [16], [15]. Numerous governments, including the UK [15], the USA [7], and Australia [17], have devised strategies for BIM implementation in building projects. For instance, between 2007 and 2012, North American contractors saw a significant increase in BIM usage [18]. In a progressive step, the UK government mandated the use of fully collaborative BIM for government projects with a minimum capital cost of $5 million by 2016 to reduce delays and cost overruns [19]. This mandate has led to widespread BIM adoption, particularly in the Middle East region, where British architects, project managers, engineers, and contractors have a strong presence [20]. The Middle East region, comprising the Gulf Cooperation Council (GCC), North Africa, and a few Asian nations, is experiencing rapid development due to its growing population and increased demand for infrastructure-related projects. As per [15], there are currently 117 major projects underway in the region, expected to be completed by 2030 at a total cost of $1 trillion USD. The Architectural, Engineering, and Construction (AEC) industry witnessed

a procedural and technological shift with the introduction of Building Information Modelling (BIM) by Eastman (1975) under the title "The use of computers instead of drawings in building design." [21]. According to [22], the Dubai Municipality was the first public authority in the Middle East region to mandate the use of BIM for most large-scale projects within the Emirate. Reports from Kuwait indicate that BIM usage has improved communication, reduced project risks through collaboration, and enabled stakeholders to openly track their projects' progress across all project phases [23]. The Middle East region as a whole has adopted BIM, according to [15]. The study concluded that BIM utilization is not mandatory in the Middle East region. The study examined BIM application in Jordan and the Gulf Cooperation Council (GCC), offering suggestions for future growth in this area. In Jordan, the construction industry is a significant contributor to manufacturing activity and a key driver of economic growth [24]. It was reported that BIM usage has enhanced productivity, reduced design errors, and increased quality control, even though the survey revealed only 25% of respondents utilize it. Furthermore, the study noted that since 64% of those who received training are self-taught, there is a concern regarding the shortage of BIM specialists. Although consultants and contractors constitute the majority of BIM users, 40% of respondents stated they have used BIM on more than five projects. However, many organizations have only used BIM on a single project. According to 62% of respondents, "the client has not asked for the use of BIM" is the primary reason why BIM has not been adopted. 19% of respondents stated that BIM is too expensive to be adopted, followed by 43% who did not know how to use it and 41% who were interested in adopting it but did not know where to start. Furthermore, according to [25], the public sector in the Middle East region is not implementing BIM, contributing to the region's lowest adoption rate. Professionals in the Middle East region often perceive Building Information Modelling (BIM) as merely a tool for creating a 3D representation of a building [25]. A study spanning six continents revealed that BIM services in the Middle East region are primarily used for clash detection, design authoring, and 3D coordination [26]. Recent research identified the main barriers to BIM adoption in the United Arab Emirates as the absence of standards, high implementation costs, and uncertain return on investment [27]. As per the 2021 IWA Country Classification, countries like Algeria, Egypt, Jordan, and Syria are classified as low-income nations, while Kuwait, Qatar, Saudi Arabia, and the United Arab Emirates are considered high-income nations [28]. Lastly, the construction processes in the Middle East region, for the most part, follow the same standards and norms, predominantly American or British. This necessitates a thorough analysis of modern BIM methodologies across various nations in the Middle East region (Gerges et al., 2016).

This study aims to establish a more solid footing for Building Information Modelling (BIM) in the Middle East, promoting its wider adoption and application. The research begins with a historical review of design tool literature. Following this, data specifically related to BIM is collected through questionnaires. These questionnaires, containing a series of questions, are distributed to relevant professionals in the building industry within the Middle East region. The objective of these questionnaires is to evaluate the current status of BIM and to shed light on the reasons why some businesses choose to adopt this technology while others do not. The study further explores the primary advantages of adopting BIM compared to other methods and offers predictions about its future use.

2 Research methodology

The team started by conducting a thorough literature review on the use of BIM in the Middle East and around the world in order to accomplish this goal. After that, an exploratory study is carried out using a structured online survey that was created based on the literature analysis to ascertain the present state of BIM expertise and describe the perceived worth, advantages,

and difficulties related to BIM adoption. The purpose of the questionnaire is to gather information about the present status of BIM implementation and use in the Middle East in a clear, straightforward, and accurate manner.

Eighty-five questionnaires are completed and returned after being distributed online to Middle Eastern construction industry professionals. Respondents must be employed by government agencies and regulatory authorities, as well as clients, engineers, top-tier contractors, and construction managers from the construction industry. This study uses a variety of commonly used statistical analysis techniques to compare the opinions of different respondent groups and analyze the data collected from the questionnaire survey. These techniques are used to compare the opinions of different respondent groups, analyze the data collected from the questionnaire survey, and draw conclusions about the level of BIM knowledge, BIM's role, and its benefits and drawbacks in the construction industry.

Cronbach's alpha analysis is used in SPSS to assess the reliability of the answers to each questionnaire component. The results show that Cronbach's alpha has a minimal value of 0.937. This demonstrates the reliability and suitability of the research apparatus as a measurement tool. The survey results also demonstrate the extremely high levels of internal consistency. Descriptive statistics are used in accordance with the study's objectives to determine the perceived benefits of BIM and the barriers to its adoption in the Middle Eastern construction industry.

This research evaluated the perspectives of major participants in the AEC industry in the Middle East region on the primary challenges to BIM deployment and its key benefits. A methodical empirical questionnaire survey was employed as a tool for quantitative research to collect viewpoints from prominent individuals in the Middle East region's construction industry. The study was conducted within the framework of a post-positivist research paradigm, with a deductive approach being used for the majority of the study and a combination of deductive and inductive reasoning to arrive at the questionnaire items (benefits and barriers). The study used a purposive sampling strategy [29] to choose the intended survey participants.

This study aims to gather insights from clients, contractors, and consultants in the Middle East region who have direct experience with BIM in their construction projects. Their perceptions are assessed through a questionnaire survey. To measure their level of consensus, they were asked to rate the pros and cons of adopting BIM in the Middle East region on a scale of one to five, known as the Likert scale.

Furthermore, the survey questionnaire inquired about the respondents' years of professional experience in the construction industry and the number of BIM projects they had participated in. The majority of the survey participants were seasoned experts with the requisite BIM knowledge in the construction field, hence their opinions were considered to be precise and representative of the actual perspectives on BIM practices in the industry. Additional information included their role within the organization and the type of organization they are affiliated with. Employing a purposive sampling method, 86 completed questionnaire surveys were collected from the target respondents who had experience working on BIM projects. The sample size of this study (86 responses) was deemed satisfactory and adequate for various types of statistical analysis conducted. As a result, it was determined that the selected sample was trustworthy and broadly representative of the survey population. The first objective is to determine the level of BIM awareness among AEC companies in Middle East countries. The second objective of the survey is to ascertain the number of AEC firms in Middle East countries that are implementing BIM. The third objective is to identify the benefits that businesses gain from using this design technology. Additionally, the fourth objective is to use a questionnaire to evaluate the challenges that hinder businesses from adopting BIM technology.

A well-organized questionnaire was designed with four sections. The first section collected basic socio-demographic data about the respondent, including their location, years of experience in the construction industry, and the type of organization they belong to. In the second section, participants were asked to evaluate their knowledge of BIM and whether they have read any previous studies or research on the topic. The fourth and fifth sections asked respondents to evaluate the challenges and advantages of BIM in the AEC industry, respectively. The statistical data describing the variables are presented in Table 1.

Table 1. Statistical Data that Describes Variables.

Questions	N	Mean	SD
Part 1 (BIM awareness)			
I have an idea about BIM (‘’Yes’’=1 ‘’No’’=2)	85	1.38	.49
multiple-choice scale questions (5.00 = "Extremely High" ", 4.00 = "High", 3.00 = "Medium", 2.00 = "Poor", 1.00 = "Very Poor")			
I already know that Revit and ArchiCAD are BIM programs	85	3.42	1.37
I use BIM technology programs at work	85	2.94	1.41
I have an idea about how to use and implement BIM technology programs	85	3.20	1.24
I have Knowledge about using the BIM application	85	3.20	1.27
Some of my university courses dealt with the topic of Building Information Modeling (BIM) technology	85	2.94	1.37
I have read some research and studies on Building Information Modeling (BIM) technology before	85	2.79	1.40
Part 2 (Barriers to the application of BIM)			
High initial cost	85	3.27	1.42
Lack of expertise	85	3.33	1.37
Insufficient interoperability of computer software	85	3.08	1.34
Lack of training/courses	85	3.16	1.39
Cultural barrier (resistance to change)	85	3.19	1.35
Poor collaboration among project participant	85	3.13	1.35
. Organizational structure that does not support BIM	85	3.20	1.39
Lack of subcontractors who can use BIM technology	85	3.36	1.36
Security risk	85	3.00	1.35
Lack of industry standards	85	3.28	1.36
Difficulties in measuring the impacts of BIM	85	2.99	1.16
Shortage of BIM implementation data in the construction phase	85	3.05	1.32
Part 3 (Benefits to the application of BIM)			
Improve project quality	85	3.32	1.50
Better understanding of design	85	3.24	1.36
Provide life cycle data	85	3.27	1.37
Scope clarification	85	3.20	1.33
Speed up the design process	85	3.14	1.43
Reduce construction cost	85	3.08	1.32

Better cost estimates and control	85	3.22	1.37
Better construction planning	85	3.29	1.33
More efficient communications	85	3.32	1.36
Reduce project duration	85	3.13	1.36
Improve safety performance	85	3.25	1.43
Enhance organizational image	85	3.41	1.37

3 Analysis and discussion of survey findings

The study's findings unambiguously point out the main barriers to BIM implementation in the Middle East region's construction sector. The sample for this study consists of participants who were chosen based on their management positions, areas of knowledge, and experience. The survey data shown in table 2 reveals that the majority of respondents were from Jordan (28.2%), Palestine (14.1%), and Syria (8.2%), with representation also from the Arabian Gulf countries and North Africa. The respondents were primarily from Contractor organizations (48.2%), followed by Clients (35.3%), and Consultants (16.5%). Most organizations specialized in Building (72.9%), with others focusing on Roads (15.3%), Water & Sewerage (8.2%), and other areas (3.5%). The respondents varied in their years of experience in the construction industry and the number of BIM-enabled construction projects they had worked on. This diverse respondent pool provided a comprehensive perspective on the adoption and application of BIM in the Middle East region's construction industry.

The majority of respondents (88.3%) have a bachelor's degree, with only 6.4% having a master's degree and 5.3% having a doctorate. The most common qualification among respondents is Civil Engineer (58.5%), followed by Electrical Engineer (14.9%), Architect (13.8%), and Mechanical Engineer (8.5%). In terms of experience, the majority of respondents (52.1%) have 2 to 5 years of experience in the construction industry, followed by 6 to 10 years (21.3%). 18.1% of respondents have at least 15 years of experience.

Table 2. Demographics of survey respondents

Respondent demographics	Size	Percentage
Country		
Jordan	24	28.2
Palestine	12	14.1
Syria	7	8.2
Saudi Arabia	8	9.4
United Arab Emirates	6	7.1
Kuwait	7	8.2
Qatar	4	4.7
Type of your organization or company		
Client	30	35.3
Contractor	41	48.2
Consultant	14	16.5
Specialization of your organization/company		
Building	62	72.9
Roads	13	15.3
Water & Sewerage	7	8.2
Others	3	3.5

Number of years that you have experience in the construction industry		
0-5 years	20	23.5
6 – 10 years	21	24.7
11-15 years	16	18.8
16 – 20 years	16	18.8
More than 20 years	12	14.1
Number of years that your organization / company have experience in construction		
0-5 years	12	14.1
6 – 10 years	16	18.8
11-15 years	9	10.6
16 – 20 years	18	21.2
More than 20 years	30	35.3
Experience with BIM-enabled construction projects		
None	22	25.9
1-2 Projects	29	34.1
3-4 Projects	17	20
5 Projects or more	17	20

3.1 Respondents' awareness of and familiarity with BIM

Table 3 provides an overview of the respondents' awareness and familiarity with Building Information Modelling (BIM). A significant number of respondents (23 each for 'High' and 'Extremely High') are aware that Revit and ArchiCAD are BIM programs. However, BIM technology is not extensively used in their workplaces, with 22 respondents rating their usage as 'Very Poor'. There is a moderate understanding of how to implement BIM technology, with 27 respondents 'Fairly Agreeing'. Knowledge about using BIM applications varies among respondents, with 23 rating their knowledge as 'High'. The data also suggests a lack of BIM education in university courses, with 18 respondents rating their exposure as 'Very Poor'. Most respondents (21) have not engaged much with BIM research or studies, rating their engagement as 'Very Poor'. Overall, the respondents exhibit a mixed level of awareness and familiarity with BIM, indicating potential areas for improvement such as workplace usage, education, and research engagement.

Table 3. Statistics describing the awareness of and familiarity with BIM.

BIM awareness questions	Very Poor	Poor	Fairly agree	High	Extremely High
I already know that Revit and ArchiCAD are BIM programs	12	9	18	23	23
I use BIM technology programs at work	22	8	20	23	12
I have an idea about how to use and implement BIM technology programs	10	13	27	20	15
I have Knowledge about using the BIM application	10	16	21	23	15
Some of my university courses dealt with the topic of (BIM) technology	18	15	19	20	13
I have read some research and studies on (BIM) technology before	21	17	19	15	13

3.2 Barriers to BIM implementation in the Middle East

3.2.1 Ranking results

Despite the growing number of BIM-adopted projects, the Middle East region and Africa are still seen as being in the "beginning phase" of BIM adoption ([30]; [31]; [15]). One important aspect that has influenced the adoption of BIM in nations like the UK is the development of required policies by governments or public organisations to encourage the use of BIM [32]; [33]). Respondents rated the significance of each aspect on a five-point Likert scale, with one (1) indicating "extremely poor" and five (5) indicating "extremely high".

Table 4 displays the survey findings for the ranking of the obstacles to using BIM. From the lowest mean score of M = 2.99 for "Difficulties in measuring the impacts of BIM" to the highest mean value of M = 3.36 for "Lack of subs who can use BIM technology" the mean (M) values span the 12 obstacles that have been found. The table reveals that the most significant barrier to BIM deployment across all respondent groups is the lack of subcontractors who can use BIM technology, with an overall mean score of 3.36. This suggests that there is a shortage of skilled professionals in the market who are proficient in BIM technology, which could be a major obstacle to its widespread adoption.

The second most significant barrier, with a mean score of 3.33, is the lack of expertise. This indicates that there is a knowledge gap in the industry regarding BIM technology and its applications. This could be due to a lack of adequate training or education programs that focus on BIM. The third barrier is the lack of industry standards for BIM, with a mean score of 3.28. The absence of a standardized approach to BIM could lead to inconsistencies in its application, making it difficult for different stakeholders to collaborate effectively. The majority of respondents agreed that the incorporation of construction management techniques has been hampered by the delayed implementation of this innovative approach [29], increasing the workload of professional personnel and workers currently in place. Furthermore, according to the majority of respondents, the introduction of BIM without modifying certain organizational structures and tactics [11] could not inspire employees to become knowledgeable about and utilize this technology in their jobs.

Interestingly, the perceptions of the barriers vary among the different stakeholder groups. Clients perceive the lack of industry standards as the top barrier, while Contractors view cultural barriers or resistance to change as their main challenge. On the other hand, Consultants consider the lack of subcontractors who can use BIM technology as the most significant barrier. Other notable barriers include high initial costs, unsupportive organizational structures, and lack of training or courses. These barriers highlight the financial and organizational challenges associated with BIM adoption. The majority of respondents agreed that the incorporation of construction management techniques has been hampered by the delayed implementation of this innovative approach [29], increasing the workload of professional personnel and workers currently in place. Furthermore, according to the majority of respondents, the introduction of BIM without modifying certain organizational structures and tactics [11] could not inspire employees to become knowledgeable about and utilize this technology in their jobs. Lack of training/courses (M=3.13) ranked 4 by both contractor and consultant" and "Lack of expertise (M=3.33) ranked 2 by client and Contractor and ranked 3 by a consultant" underline how important those obstacles are for adoption. In the complex setting of the multidisciplinary AEC industry, there is a lack of knowledge related to information and communication technologies in general. This is consistent with the findings of [34]), which emphasize the necessity for workshops/seminars and training to be organized by various bodies. In conclusion, the table provides a comprehensive understanding of the barriers to BIM adoption from the perspective of different stakeholders. Addressing these barriers requires targeted strategies, such as

investing in training programs, developing industry standards, and fostering a culture of change and innovation in the construction industry. By doing so, the industry can fully leverage the benefits of BIM and enhance the efficiency and effectiveness of construction projects.

Table 4. Ranking of the barriers to BIM deployment.

Barrier	Total		Client		Contractor		Consultant	
	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
Lack of subcontractors who can use BIM technology	3.36	1	3.33	3	3.20	5	3.93	1
Lack of expertise	3.33	2	3.33	2	3.32	2	3.36	3
Lack of industry standards	3.28	3	3.47	1	3.07	7	3.50	2
High initial cost	3.27	4	3.27	5	3.27	3	3.29	8
Organizational structure that does not support BIM	3.20	5	3.33	4	3.05	8	3.36	5
Cultural barrier (resistance to change)	3.19	6	2.93	10	3.34	1	3.29	7
Lack of training/courses	3.16	7	2.93	12	3.27	4	3.36	4
Poor collaboration among project participant	3.13	8	3.10	7	3.20	6	3.13	12
Insufficient interoperability of computer software	3.08	9	3.17	6	3.02	9	3.07	11
Shortage of BIM implementation data in the construction phase	3.05	10	3.03	8	2.98	11	3.29	9
Security risk	3.00	11	2.97	9	2.90	12	3.36	6
Difficulties in measuring the impacts of BIM	2.99	12	2.93	11	2.98	10	3.14	10

3.3. Benefits of BIM implementation in the Middle East

3.3.1. Ranking results

Table 5 displays the results of the survey assessing the advantages of implementing BIM. From the lowest mean score of M = 3.08 for "Reduce construction cost" to the highest mean value of M = 3.41 for "Enhance organizational image "the mean (M) values for the 12 advantages that were discovered range.

The table 6 reveals that the most significant benefit of BIM deployment across all respondent groups is enhancing the organizational image, with an overall mean score of 3.41. This suggests that the adoption of BIM technology can significantly improve the reputation and credibility of an organization in the construction industry. The second most significant

benefit, with a mean score of 3.32, is more efficient communications [35]. This indicates that BIM technology can facilitate better communication among different stakeholders, leading to improved coordination and collaboration in construction projects. The third benefit is improving project quality, also with a mean score of 3.32. This suggests that the use of BIM can enhance the quality of construction projects by enabling more accurate and detailed designs, better planning and coordination, and more effective management of resources [36].

Interestingly, the perceptions of the benefits vary among the different stakeholder groups. Clients perceive providing life cycle data and improving safety performance as the top benefits, while Contractors view enhancing the organizational image and better construction planning as the most significant benefits. On the other hand, Consultants consider enhancing the organizational image and more efficient communications as the most significant benefits. Other notable benefits include better construction planning, providing life cycle data, improving safety performance, better understanding of design, better cost estimates and control, scope clarification, speeding up the design process, reducing project duration, and reducing construction cost. The client and consultant groups, however, show that another item "Provide life cycle data" [37], [38] was as important, therefore those two groups took into consideration the elements they ranked as the top three most important. The results are in line with the notion that clients always priorities safety and quality, and consultant group respondents believe that life cycle data and a deeper understanding of design are made possible by BIM models. The Contractor and Consultant groups both chose "Improve organizational image" as their top priority. In conclusion, the table provides a comprehensive understanding of the benefits of BIM adoption from the perspective of different stakeholders. These benefits highlight the potential of BIM to transform the construction industry by improving efficiency, quality, safety, and cost-effectiveness. However, realizing these benefits requires overcoming the barriers to BIM adoption, as identified in Table 5. This underscores the need for targeted strategies to promote BIM adoption and address the challenges faced by different stakeholders.

Table 5. Ranking of the benefits to BIM deployment

Benefits	Total		Client		Contractor		Consultant	
	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
Enhance organizational image	3.41	1	3.33	5	3.37	1	3.71	1
More efficient communications	3.32	2	3.33	4	3.20	7	3.64	2
Improve project quality	3.32	3	3.37	3	3.24	3	3.43	5
Better construction planning	3.29	4	3.20	8	3.34	2	3.36	10
Provide life cycle data	3.27	5	3.37	1	3.12	10	3.50	3
Improve safety performance	3.25	6	3.37	2	3.24	4	3.00	7
Better understanding of design	3.24	7	3.17	10	3.24	5	3.36	4

Better cost estimates and control	3.22	8	3.23	7	3.24	6	3.14	9
Scope clarification	3.20	9	3.23	6	3.15	8	3.29	11
Speed up the design process	3.14	10	3.07	11	3.10	11	3.43	8
Reduce project duration	3.13	11	3.20	9	3.05	12	3.21	12
Reduce construction cost	3.08	12	3.00	12	3.15	9	3.07	6

4 Conclusions

Following the examination of the survey data, the following significant findings were drawn:

1. The awareness and familiarity with Building Information Modelling (BIM) among the respondents are mixed, with a significant number of respondents aware of BIM programs like Revit and ArchiCAD, but less usage of BIM technology in their workplaces.

2.The barriers to BIM adoption vary among different stakeholders, with the lack of subcontractors who can use BIM technology, lack of expertise, and lack of industry standards being the top barriers.

3.The benefits of BIM adoption also vary among different stakeholders. However, enhancing the organizational image, more efficient communications, and improved project quality are seen as the top benefits overall.

Some recommendations can be drawn:

1 Given the mixed awareness and familiarity with BIM, it would be beneficial to invest in training and education programs. These programs could focus on BIM programs like Revit and ArchiCAD, and aim to increase the usage of BIM technology in workplaces. This could also help to overcome the barrier of lack of expertise.

2 As the lack of subcontractors who can use BIM technology is a significant barrier, it would be useful to foster collaborations with subcontractors who are proficient in BIM. This could involve creating partnerships with subcontractors who are already using BIM, or providing training to existing subcontractors to enhance their BIM capabilities.

3 It would be beneficial to work towards the development of industry standards for BIM. This could involve collaborating with other stakeholders in the industry, or lobbying relevant industry bodies or government agencies. Having clear standards could also enhance the organizational image, improve communication efficiency, and lead to better project quality, which are seen as the top benefits of BIM adoption.

These conclusions and recommendations could help to address the barriers to BIM adoption and leverage its benefits, ultimately leading to more widespread and effective use of BIM in the construction industry.

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