CONCEPTUAL FRAMEWORK FOR REALIZATION OF MULTI-ORGANISATION COLLABORATION IN BUILDING INFORMATION MODELLING (BIM) CONSTRUCTION PROJECTS BASED ON CONTRACTOR PERSPECTIVES

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Abstract:

The continuous advancement of Building Information Modelling (BIM) influences the paradigm shift of collaboration, among multi-organisations for better digital data information generation, sharing, and management. In Malaysia, the utilization of BIM in construction projects is limited due to various challenges faced by multi-organizations including disputes in handling BIM collaboration which create a complex situation for the contractor to manage the construction phase. In fact, from the contractor's perspective, there is less specific procedure and reference to refer to as a guideline to implement BIM among multi-organisations. Thus, the conceptual framework is an initiative created as best practice to influence the success of collaboration among organizations in managing BIM construction projects based on contractor perspectives. This research study focused on three main objectives;

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(i) to determine the challenges faced among multi-organisations in enhancing collaboration in managing BIM construction projects, (2) to investigate the indicators that influence the multi-organisation in enhancing collaboration in managing BIM construction projects, and (3) to establish the conceptual framework in enhancing multi-organisation collaboration in managing BIM construction project based on contractor perspective. The methodology for this research study is a systematic literature review (SLR) and questionnaire survey were involved 30 BIM experts who have experience in managing BIM construction projects. The data from the questionnaire survey was processed and analyzed using the ranking analysis via mean and standard deviation to rank the factor for both objectives. Finally, based on the consolidated findings, a conceptual framework for multi-organization collaboration in managing BIM construction projects based on contractor perspectives was developed. The conceptual framework serves as an initial reference database and guideline platform for the contractor and other organizations to enhance BIM collaboration in construction projects in the context of the virtual environment.

Keywords:

Conceptual Framework, Building Information Modelling (BIM), Multi-Organisation Collaboration, Construction Projects

Introduction

According to Sinoh et al. (2020), Building Information Modelling (BIM) is the recent technology to improve digital information management and communication whereby capable to collaborate multi-organisation in real platform. In Malaysia context, BIM in the construction projects shows a positive trend after years of implementation (CIDB, 2020). Towards encourage local organisation changes from traditional to BIM-based technology practice, the strategy on the yearly structured programs (i.e., seminars, exhibitions and workshops) were executed, where generate wonderful chance to raise the awareness and excelled in promoting the BIM application in construction industry (Al-Ashmori et al., 2020). Furthermore, to accelerate BIM implementation in Malaysia, BIM has been mandatory to be use for all public and private sector construction projects worth RM10mil and above, and National BIM e-Submission (NBeS) has been introduced by CIDB as first-of-its-kind Auto Checker system for the review and approval of Building Plans at the Local Authority (PBT) approval level, involving digital building plan submission and review.

The BIM implementation process was strengthened by the cooperative efforts of many stakeholders involved in BIM-enabled projects (Abbasnejad et al., 2021). The collaboration in BIM may have some challenges due to different points of view and strategies. This can be problematic in the project-based context in the short term, especially when organisations have a lack collaborative working expertise and this is a significant concern for large-scale infrastructure projects (Abbasnejad et al., 2021). Thus, multi-organisation in BIM construction projects must have the same plan and strategy when making decisions to avoid the delayed projects and arguments between the project organisations. According to Oraee et al. (2019), collaboration is crucial element for realization of BIM implementation in the delivery of construction projects. According to theoretical lenses study introduced by Sackey et al. (2015) sociotechnical system suggested that organizational work system consists of two subsystems: social and technical components and both interact and influence each other. In the context of BIM collaboration, the human interaction process and strategy in the structure organizational (socio component) is the main characteristic, while technical tools are used to facilitate the

process of collaboration (Noor et al., 2021a). Hence, the socio-technical driver is considered as main driver for collaboration and brings numerous benefits for construction projects lifecycle. The higher level of cooperation among multi-organisation are needed to ensure the successful of BIM construction projects (Noor et al., 2021a and Noor et al., 2024). Based on Othman et al. (2021), there are lack of participation among contractor to collaborate during working activities in managing the BIM project due to in adequate understanding of BIM utilization and collaboration.

Therefore, this research has focused to achieve these objectives which are: (i) to determine the challenges faced among multi-organisation in enhancing collaboration in managing BIM construction projects based on contractor perspectives; (ii) to investigate the indicators that influence multi-organisation in enhancing collaboration in managing BIM construction projects based on contractor perspectives; and (iii) to establish the conceptual framework in enhancing multi-organisation collaboration in managing BIM construction project based on contractor perspective.

Literature Review

A systematic search was conducted using the Scopus search engine to identify articles related to the challenges faced among multi-organisation in enhancing collaboration in managing BIM and indicators influence the multi-organisation in enhancing BIM construction projects based on client perspectives internationally and within Malaysia. Scopus was selected due to its accuracy and broad coverage of different research areas including management, business and engineering (Baas et al., 2020; Noor et al., 2021a). The search was limited to articles and review papers published in academic journals after 2019 until 2023. Through the general keyword title "Building Information Modelling", this search returned 10536 references. Subsequently, three stages of screening processes were conducted to remove duplicate and unrelated articles.

In the first screening process, the full search code was TITLE-ABS-KEY (("building information model*" AND "collaboration") AND ("BIM" AND "multi-organisation" AND ("BIM" AND "challenges") AND ("BIM" AND "multi-organisation" AND "indicator enhancing collaboration")) AND PUBYEAR > 2019 AND (LIMIT-TO (LANGUAGE , "English")) was used to select relevant articles. There were 6906 articles which were removed and 3630 remained. Then, the second screening focused on inclusion and exclusion criteria, filtering articles based on keywords like 'BIM,' 'Building Information Modelling,' 'software,' 'collaboration' and selecting only English-language articles. Thus, there were 3524 articles which were removed and 106 remained. Finally, the second screening process involved the reviewing of the "full text reading" specifically focusing on the challenges and indicators influence the factor the multi-organisation collaboration in BIM construction projects based on contractor perspectives. A total of 76 articles were carefully removed and the remaining 30 articles were selected for a further process.

According to the synthesize of previous literatures (i.e., Haron et al., 2013: Noor et al., 2021b), identified four main domains (i.e., technology tool, government enforcement, management and people), which were used as references to determine the related factors for challenges and indicators influencing the multi-organisation collaboration in BIM construction projects based on contractor perspectives. Thus, through the content analysis approach recommended by Merriam (2009), the comprehensive synthesize and analyse were conducted, 15 factors associated with challenges influencing multi-organisation collaboration in the BIM

construction projects BIM were identified, while 15 indicators related influencing the multi-organisation collaboration in BIM construction projects based on contractor perspectives were determined as shown in Table 1 and Table 2, respectively.

Challenges faced among multi-organisation collaboration in BIM construction projects based on contractor perspectives, can be measured by observing the level of performance of task, productivity and quality of project implemented. According to the previous study (i.e., Noor et al.,2021a, Noor et al.,2022, Jamaludin et al., 2022), collaboration level among multi-organisation remains as minimum level, thus shown a lack of level of collaboration among multi-organisation to fully implement BIM in their projects. Therefore, the challenges faced by multi-organisation collaboration in BIM construction projects can be categorize into 4 main domains which are technology tool, government enforcement, management and people. Thus, the summarization of factors for challenges faced by multi-organisation to collaborate in BIM construction projects has been highlighted in Table 1.

According to El Hajj et al. (2023), the main important factor lead to the challenges of multi-organisation collaboration in BIM construction projects that highlighted in the technology tool domain is lack of widespread expertise in using BIM for the construction. There are the general shortage of information technology (IT) which has an impact on BIM knowledge, competency and capabilities for the architect, engineering and contractor professionals in the construction sector (El Hajj et al., 2023). Therefore, to ensure that multi-organisation can adopt new technologies, continuously training and practicing BIM technology must be mandatory for project team in order to enhance the personal capable of effortlessly integrating BIM and building projects. Furthermore, Kong et al. (2020) highlighted that BIM processes required longer periods of time at the design stage because of the detail needs a higher level and consideration compared to conventional methods. This situation continuously happen, since most of project team had very minimal expertise in conducting BIM process such as drawings production, modelling, coordination and clash detections process. Besides, the higher cost of BIM technology also considered as main challenges contribute to the multi-organsiation collaboration in managing BIM project. According to El Hajj et al. (2023), the higher investment in the technology software licensing, upgraded hardware, intensive BIM employee training, premium staff salary of BIM expert and high-cost for BIM consultancy fees would be the main barrier for project team to fully adopted BIM in projects. In addition, the general contractors faced the significant expenditures in the beginning stage of project due to the need of huge investment for BIM project. In addition, the cost of implementing BIM is necessary for the long term since the software needs to be updated for the latest version as to reduce the bug in the operation of the software. Thus, not many companies are willing to use BIM due to the high initial expenses involved in implementing BIM (Kong et al., 2020).

The other important domain contribute to the challenges faced by multi-organisation to collaborate in managing BIM construction projects is management aspect. According to Chen et al. (2022), in term of management domain the main challenges faced by multi-organisation is the changing of the workflow process from conventional method to the technology. Due to the lack of understanding and practice to execute the BIM tool, most of project team more comfortable to implement the conventional process rather than use the modern BIM tool. Furthermore, the minimal of commitment among top management in providing project team with comprehensive and continously training especially for contractor sector would cause the

project team having less understanding and refusing in changing the method of workflow to implement BIM in construction phase (Chen et al., 2022).

According to Chen et al. (2022), the people aspect was considered the main domain contributing to the challenges of multi-organization collaboration in managing BIM projects. Most of previous literature (e.g., Jamaludin et al., 2022, and Chen et al., 2022) identified that a lack of communication among project teams and a minimal understanding of their roles and responsibilities in implementing BIM would make it difficult for the project team to collaborate in managing BIM projects. Yet, the lack of expertise and skill in managing the BIM tools is considered as main challenges faced by contractor. According to Doan et al. (2021), in particular, the contractor sector also facing the barrier in term of expertise for BIM technicalities, thus this would contribute the complexity for them to managing the BIM project. Based on Chen et al. (2022), the continously upskilling is needed to increase the knowledge of BIM (Doan et al., 2022). Other than that, lack of confidence of the stakeholder in the project team also considered as the main challenges lead to complexity of project team collaboration in BIM (Jamaludin et al. 2022). Confidences must be built among the project team, thus BIM can be implement in the construction sector.

The other domain contribute to the challenges faced among multi-organisation collaboration in the government enforcement domain was government subsidies aspect. According to El Hajj et al. (2023), the government should offer substantial assistance, particularly in terms of financial support, given that it was the government that initially adopted and promoted the utilization of BIM within the construction industry. Lack of government funding can prevent top management from sending employees to BIM training programs. Additionally, governments must provide adequate funding for BIM package purchases and training (i.e., hardware and software, upgrade software, and installation and infrastructure costs) (El Hajj et al., 2023 and Kineber et al., 2023). As the investment in BIM is higher, most contractors refuse to adopt BIM in the construction phase.

However, according to previous studies (i.e., Jamaludin et al., 2022 and etc) mentioned that there are several indicator influencing the multi-organisation collaboration in BIM construction projects based on contractor perspectives where can be categorize into four main domain: (1) technology tool; (2) management; (3) people and (4) government enforcement, as stated in Table 2.

Technology tool is one of the indicator influencing the success of collaboration among multi-organisation in managing BIM construction project based on contractor perspectives. The indicator that involve in this domain is commitment of top management providing the essential hardware and software facilities for project team access the BIM tool in the projects (Adel et al., 2022). Other than that, the collaboration with proficient BIM service enables project teams to establish direct mechanism for learning BIM, potentially improving their competency in BIM practices (Chen et al., 2022).

Management is one of the crucial domain influencing the success of collaboration among multi-organisation in managing BIM project based on client perspectives. The effective management between top management among multi-organisation (i.e., client, consultant and contractor) is important factor for the success of collaboration (Adel et al., 2022). Furthermore, these benefits have a significant impact on the contractor, leading to a higher demand in the construction

project. Increasing awareness of BIM among project team stakeholders is crucial for promoting its implementation in construction projects. According to Alaathary and Salloum (2020), internal and external stakeholders needs to have carefully and extra consideration in handling complicated and huge building project. Project team in the overall infrastructure project are considered external stakeholders while internal stakeholders are those involved in the same subproject as the primary contractor. Hence, effective management of BIM technology is essential, requiring a scientific and comprehensive approach due to the collaborative involvement of various parties across the entire project life cycle.

Large construction projects will involve various stakeholders in project team collaboration. Due to the complexity of these projects, integrated BIM technology would be required and beneficial in enhancing construction management (Lin et al., 2020). Contractors play an important role in ensuring the smooth running of the construction process and must also develop leadership skills for effective project management. To increase project team collaboration, leaders should consider organizing seminars or workshops to deepen their understanding of BIM. Providing training for both employers and employees is important, as it improves their efficiency in using BIM tools. According to Evans et al. (2020), to improve the overall performance of the construction project, it is necessary to change the unfavorable culture among sector partners and to perfect the relationships between important project teams.

Furthermore, the success of collaboration among multi-organisation influenced by people characteristics. Each of the stakeholders has responsibilities in ensuring the successful of collaboration. As there are various roles of stakeholders in the field, it becomes crucial for all individuals to comprehend the adoption and enhancement of their skills in utilizing BIM tools. Therefore, each stakeholder should prioritize their participation in seminars or workshops to gain a comprehensive understanding. It is established that positive traits can enhance project performance and create a sense of mutual respect, trust, and understanding between project participants (Omer et al., 2022). The positive traits need to be implemented among all the stakeholders that participate in the construction phase to enhance confidence and gain more exposure through the use of BIM tools. In addition, to strengthen collaboration, the project team needs to have very good communication among them for better improvement in the construction process (Rui Li, 2022).

Table 1: Summarization of Challenges Faced Among Project Team in Enhancing Collaboration in Managing BIM Construction Projects Based on Contractor Perspectives

Challenges Faced Among Project Team in Enhancing Collaboration in Managing BIM Construction Projects	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Total Hits
Challenges in Terms of Technology																
Lack of expertise and BIM awareness among the project team members to use BIM tools	/	/	/		/	/	/	/		/	/	/	/	/	/	13
Lack of general information technology in handling the BIM software	/				/	/	/			/	/		/	/		8

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Total
High cost of purchasing software for the implementation of BIM technology	/	/	/	/	/	/		/	/		/	/				10
Insufficient hardware facilities for accessing software		/		/		/		/		/		/				6

Table 1: Summarization of Challenges Faced Among Project Team in Enhancing Collaboration in Managing BIM Construction Projects Based on Contractor Perspectives (Continue)

Challenges Faced Among Project Team in Enhancing Collaboration in Managing BIM Construction Projects	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Total Hits
Challenges in Terms of Management																
Lack of collaboration among the project team members in handling BIM	/	/	/			/	/	/	/	/	/	/	/	/	/	13
Lack of demand from clients to use BIM	/	/		/	/							/				5
Inadequate BIM training among project team (employer and employee)	/			/	/	/	/	/								6
Lack of leadership skill among the project team member					/					/		/				3
Lack of knowledge in managing BIM among the project team's members		/		/	/		/		/	/	/		/	/		10
Challenges in Terms of People																
Lack of skill in managing the BIM tool	/	/		/	/	/	/	/	/	/	/	/	/	/		13
Lack of confidence and exposure to the BIM tool in construction projects				/	/		/	/		/	/			/	/	8
Lack of communication among the project team's members		/		/	/		/		/		/			/		7
Lack of understanding of roles in implementation BIM	/				/	/		/		/	/		/			7
Challenges in Terms of Government Enforcement																
Lack of government subsidies to support the implementation of BIM		/		/		/										4
Lack of promotion of the benefits of using BIM in construction projects	/		/	/	/	/		/	/					/		8
Lack of support and providing workshops and seminars related to BIM	/			/	/						/		/		/	6
Lack of increasing BIM competency by not spreading awareness of BIM	/	/	/	/		/		/	/			/	/	/		10

R1: (Kong et al., 2020), R2: (El Hajj et al., 2023), R3: (Kineber et al., 2023), R4: (Syed Jamaludin et

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al., 2022), R5: (Sriyolja et al., 2021), R6: (Manzoor et al., 2021), R7: (Oraee et al., 2019), R8: (Shojaei et al., 2022), R9: (Ali et al., 2022), R10: (Majzoub & Eweda, 2021), R11: (Chen, Chen, et al., 2022), R12: (Jang & Collinge, 2020), R13: (Moses et al., 2020), R14: (Doan et al., 2021), R15: (Bou Hatoum, 2021)

Table 2: Summarization of Indicators That Influence the Project Team in Enhancing Collaboration in Managing BIM Construction Projects Based on Contractor Perspectives

Indicators That Influence the Project Team in Enhancing Collaboration in Managing BIM Construction Projects	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Total Hits
Indicators For Technology																
Providing exposure to BIM tools to increase knowledge			/	/		/	/		/			/		/		9
Providing training on the BIM tool to increase skills in handling software	/					/	/	/	/	/	/		/	/	/	9
Willingness of top management to allocate finance to purchase software for BIM								/	/	/			/			4
Provide adequate hardware facilities for accessing the software	/									/	/					5
Indicators For Management																
Providing a seminar or workshop for project team members to increase their knowledge of BIM					/	/		/	/		/		/			6
Promoting the benefits of using BIM tools to increase high demand in construction projects	/		/		/	/			/				/	/		7
Provide training for employers and employees to have skills in the BIM tool	/					/	/		/	/	/		/	/	/	9
Improving the leadership skills is necessary for the projects to run smoothly	/		/	/		/		/	/	/			/	/	/	10
Promoting awareness of the implementation of BIM in construction projects	/	/		/	/	/				/	/			/		9
Indicators For People																
Improving skills by taking a seminar for better understanding of the BIM tool	/	/	/			/	/		/	/	/		/	/	/	12
Enhancing confidence and gaining more exposure through the use of BIM tools	/	/		/	/	/	/			/				/	/	10
Strengthen the communication skills among the project team member	/		/	/		/		/	/	/				/		8
Companies need to provide workshops				/	/		/		/	/	/	/				6

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for project team members to understand
theirindividual roles

According to Jamaludin et al. (2022), the government is in charge of enhancing and standardizing the standard manual and guidelines for applying BIM in projects and enforcing certain rules to settle BIM disputes. All stakeholders in the project team must follow the guidelines set by the government because of the efficiency resulting from its ability to reduce working hours. Besides, to address the demand for BIM expertise among new graduates entering the workforce, the government should develop a comprehensive national BIM curriculum (Sinoh et al., 2020). Hence, to generate interest and participation, the government should offer subsidies for workshops and seminars aimed at raising awareness about BIM. By implementing this approach, firms can confidently adopt BIM as graduates entering the workforce possess the necessary skills and knowledge. Therefore, the summarization of indicator influencing the collaboration among multi-organisation in BIM construction projects based on contractor perspectives has been highlighted in Table 2.

Table 2: Summarization of Indicators That Influence the Project Team in Enhancing Collaboration in Managing BIM Construction Projects Based on Contractor Perspectives (Continue)

Indicators That Influence the Project Team in Enhancing Collaboration in Managing BIM Construction Projects	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Total Hits
Indicators For Government Enforcement																
Providing subsidies to the construction sector in support ofthe implementation of BIM					/			/	/			/				4
Promoting BIM benefits by spreading awareness of BIM	/	/	/	/		/		/	/	/				/	/	10
Providing workshops and seminars to attract the interest ofconstruction sector companies					/		/	/		/	/		/	/		7
Promoting BIM efficiency as aresult of its ability to decrease the duration of work	/			/			/			/			/	/		7

R1: (Wang et al., 2023), R2: (Rui Li, 2022), R3: (Alaathary & Salloum, 2020), R4: (Al-Ashmori et al., 2020), R5: (Chen, Yan, et al., 2022), R6: (Lin et al., 2020), R7: (Manzoor et al., 2021), R8: (Omer et al., 2022), R9: (Saznizam Sazmee Sinoh et al., 2020), R10: (Shojaei et al., 2023), R11:(Wu & Loza, 2020), R12: (Kineber et al., 2023), R13: (Evans et al., 2020), R14: (Adel et al., 2022a), R15: (Sun et al., 2021)

Methodology

In the initial stage, a systematic literature review (SLR) through qualitative method was conducted to explore the attributes relating to the challenges and indicators that influence the project team in enhancing collaboration in managing BIM construction projects based on contractor perspectives. Subsequently, the questionnaire survey through quantitative method was selected as the main data collection involving 30 contractor practitioners that implement BIM in the projects in Klang Valley area. A pilot study was conducted and distribute among 5 numbers of academics at UiTM that have an expertise as professional engineer (Ir). The main goal of performing the pilot study is to increase the quality of information in questionnaire and efficiency of the performed survey. According to Malmqvist et al. (2019), the pilot study was used in this study as it is commonly performed to evaluate the effectiveness of research tools, improve the main study's quality and efficiency and help researchers gain experience with the study approach. Due to research constraint in term of time research period, this research distributed questionnaire using Google Form and telephone interview. The responses from the respondents were sufficient and satisfying to present the case studies in Klang Valley. According to Noor et al. (2018), selection of case studies is appropriate to describe the detailed study of single groups or organisations and projects. The closed-ended questions had been designed comprising of three parts (i.e., respondent profiles and assessment of attributes that are related to challenges faced among project team and indicators that influence the project team in enhancing collaboration in managing BIM construction projects based on contractor perspectives). This set of survey used the 5-point of Likert-type scale (1: not significant to 5: very significant). The data collection were process through Statistical Package for the Social Science (SPSS) version 26.0. The ranking analysis was executed based on mean value and standard deviation as suggested by Sinoh et al. (2020), Mishra et al. (2019) and Noor et al. (2018), to indicate the rank for the attributes related to the challenges faced among project team and indicators that influence the project team in enhancing collaboration in managing BIM construction projects based on contractor perspectives.

Profiles of Respondents

In overall, this research comprise of good mixture of organisation of respondents specifically focus on contractors from varies main designations (i.e., project manager, BIM modeller, Engineer, engineer, BIM coordinator, BIM manager, director and senior BIM executive), whereby a majority of respondents (73 per cent) were project manager, BIM modeller and engineer who were directly involved in the management and operations in BIM project working practices (see Table 3). On average, the respondents had more than 16 years of experience in construction industry and there were (7 per cent) of respondents have more than 16 years experience and (10 per cent) of respondents have 11 – 15 years of experience in managing BIM project. In overall, all of respondents were considered as experts due to the year of experience in average between 11-16 years in construction industry and 11-16 years of experience working in BIM projects. Besides, most of the respondents are mostly involved in building and infrastructure project (i.e., large and mega-scale construction projects) which are completed and being constructed in the strategic geographical location (i.e. Selangor and Kuala Lumpur. Additionally, majority of respondents have experience and involved with project delivery methods such as conventional and Design and Build (D&B) contract. This is supported by the fact that both the Design and Build (D&B) and conventional procurement systems are widely used methods in Malaysia (Noor et al., 2021a).

Table 3: Respondent's Background

Profile	Description	Percentage (%)
Designation	Project Manager	30
	BIM Modeller	23
	Engineer	20
	BIM Coordinator	10
	BIM Manager	7
	Director	4
	Senior BIM Executive	6
Experience in Construction Industry	More than 16 years	30
	11 – 15 years	10
	6 - 10 years	10
	1-5 years	34
Experience in BIM Construction Project	More than 16 years	7
	11 – 15 years	10
	6 -10 years	23
	1 – 5 years	53
	Less than 1 year	7
Experience Working in BIM Project	11 – 15 years	13
	6 - 10 years	87
Types of Project Involved	Building	50
	Infrastructure	43
	Building and Infrastructure	7
Types of Contract	Conventional	20
	Design and Build	27
	Conventional and Design & Build	53

Ranking Analysis and Findings

In overall, this section presents the ranking of the attributes and components related to the challenges faced among project team in enhancing collaboration in managing BIM construction projects based on contractor perspectives as indicated in Table 4. Ranking analysis assigns a number to each attribute to indicate its rank based on their mean and standard deviation values. The mean and standard deviation used in descriptive statistics, providing a rapid overview of a dataset's distribution and its characteristics (Zahedi-Serest et al., 2014).

Having ranked the attributes and component for challenges faced among project team in enhancing collaboration in the BIM construction projects based on contractor perspectives, the ranking analysis indicates that the highest mean values for component was "Technology" (mean value = 3.733) was given rank of 1, which comprised of the top four attributes including "High cost of purchasing software for the implementation of BIM technology" (mean value = 3.93), followed by "Lack of general information technology skills in handling the BIM software (mean value = 3.73), "Insufficient hardware facilities for accessing the software" (mean value = 3.67) and "Lack of expertise and BIM awareness among the project team members in using BIM tool" (mean value = 3.60). This is in line with previous literature (e.g., Ismail et al., 2022), which mentions that it has been widely recognized that a major challenge

lies in the expenses associated with investing in BIM software and hardware, which contribute to the complexity of BIM implementation in the construction project.

Meanwhile, "Government Enforcement" component was ranked as No. 2 which highlighted four important attributes for challenges faced among project team in enhancing collaboration managing BIM construction projects based on contractor perspectives. There were four attributes highlighted under "Government Enforcement" (mean value = 3.558) which includes "Lack of government subsidies to support the implementation of BIM" (mean value = 3.83), "Lack of promotion regarding the benefits of using BIM" (mean value = 3.53), "Lack of effort in spreading BIM awareness and increasing BIM competency" (mean value = 3.50) and "Lack of support, workshops and seminars on BIM" (mean value = 3.37). In addition, "Management" was ranked as No. 3 with (mean value = 3.526), which comprised of five important attributes includes "Inadequate BIM training among the project team members (employers and employees)" (mean value = 3.80), "Lack of demand from clients for BIM" (mean value = 3.63), "Lack of collaboration in handling BIM among the project team members" (mean value = 3.57), "Lack of leadership skills among the project team members" (mean value = 3.33), followed by "Lack of knowledge of managing BIM among the project team members" (mean value = 3.30).

In addition, "People" component was ranked as No. 4, with (mean value = 3.508), which highlighted four important attributes, which includes "Lack of skill in managing BIM tools" (mean value = 3.67), "Lack of understanding of roles in implementing BIM" (mean value = 3.53), "Lack of confidence and exposure to use BIM tools" (mean value = 3.43) and followed by "Lack of communication among the project team members in using BIM tools" (mean value = 3.40).

Table 4: Ranking Analysis Based on Mean and Standard Deviation of The Challenges Faced Among Project Team in Enhancing Collaboration Managing BIM Construction Projects Based on Contractor Perspectives

The Challenges Faced Among Project Team in Enhancing Collaboration in Managing BIM Construction Projects Based on Contractor Perspectives	Mean	Std. Deviation	Rank	Mean Overall	Std. Deviation Overall	Overall Rank
Challenges in Terms of Technology						
High cost of purchasing software for the implementation of BIM technology	3.93	0.98	1			
Lack of general information technology skills in handling the BIM (software)	3.73	1.01	2			

Insufficient hardware facilities for accessing the software	3.67	1.27	3	3.733	1.105	1
Lack of expertise and BIM awareness among the project team members in using BIM tool	3.60	1.16	4			
Challenges in Terms of Government Enforcement						
Lack of government subsidies to support the implementation of BIM	3.83	1.09	1			
Lack of promotion regarding the benefits of using BIM	3.53	1.17	2			
Lack of effort in spreading BIM awareness and increasing BIM competency	3.50	1.20	3	3.558	1.155	2
Lack of support, workshops and seminars on BIM	3.37	1.16	4			
Challenges in Terms of Management						
Inadequate BIM training among the project team members (employers and employees)	3.80	0.92	1			
Lack of demand from clients for BIM	3.63	1.07	2			
Lack of collaboration in handling BIM among the project team members	3.57	1.14	3	3.526	1.108	3
Lack of leadership skills among the project team members	3.33	1.12	4			
Lack of knowledge of managing BIM among the project team members	3.30	1.29	5			
Challenges in Terms of People						
Lack of skill in managing BIM tools	3.67	1.03	1			

Lack of understanding of roles in implementing BIM	3.53	0.97	2			
Lack of confidence and exposure to use BIM tools	3.43	1.07	3	3.508	1.035	4
Lack of communication among the project team members in using BIM tools	3.40	1.07	4			

Table 5 shows the main indicators that influence the project team in enhancing collaboration in managing BIM construction projects from the perspective of contractors. This results comprised of four components (government enforcement, management, technology and people). The main criteria of "Technology" was ranked as No. 1 with 4.160, which highlighted four (4) domain including "Top management's willingness to allocate finance for purchasing BIM software" (mean value = 4.27), followed by "Providing adequate hardware facilities to access BIM software" (mean value = 4.27), "Providing exposure to increase knowledge on BIM tools" (mean value = 4.07) and "Providing training to increase skills in handling BIM tools and software" (mean value = 4.03).

Meanwhile, "Government Enforcement" was ranked as No. 2 with 3.950, which comprised four (4) domain including "Providing workshops and seminars to attract the interest of construction sector companies" (mean value = 3.97), followed by "Providing subsidies to the construction sector in support of BIM implementation" (mean value = 3.97), "Promoting and enhancing awareness of the benefits of BIM implementation" (mean value = 3.93) and "Promoting BIM efficiency and ability in decreasing the duration of work" (mean value = 3.93).

Subsequently, "People" was ranked as No. 3 with 3.825, which consists of four (4) domain including "Gaining a lot of exposure on BIM implementation and enhancing confidence by using BIM tools" (mean value = 3.97), followed by "Giving instructions to project team members about their individual and teamwork roles" (mean value = 3.83), "Attending seminars to enhance understanding of BIM and improving skills for using BIM tools" (mean value = 3.77) and "Strengthening communication skills among project team members" (mean value = 3.73).

In addition, component for "Management" has ranked as No. 4, whereby this component was underpinned with five (5) domain including " Promoting awareness of the BIM implementation in construction projects" with (mean value = 4.03), followed with "Improving leadership skills for the smooth running of the projects" (mean value = 4.03), "Providing training sessions for employers and employees to enhance their skills in using BIM tools" (mean value = 4.00), "Providing seminars or workshops to increase knowledge of BIM" (mean value = 4.00) and "Promoting the benefits of using BIM tools to increase high demand in construction projects" (mean value = 3.93).

Table 5: Ranking Analysis Based on Mean and Standard Deviation of The Main Indicators Influence Project Team in Enhancing Collaboration Managing BIM Construction Projects Based on Contractor Perspectives

The Main Indicators That Influence the Project Team in Enhancing Collaboration in Managing BIM Construction Projects Based on Contractor Perspectives	Mean	Std. Deviation	Rank	Mean Overall	Std. Deviation Overall	Overall Rank
Indicators for Technology						
Top management's willingness to allocate finance for purchasing BIM software	4.27	0.87	1			
Providing adequate hardware facilities toaccess BIM software	4.27	0.91	2			
				4.160	0.955	1
Providing exposure to increase knowledge onBIM tools	4.07	1.01	3			
Providing training to increase skills in handlingBIM tools and software	4.03	1.03	4			
Indicators for Government Enforcement						
Providing workshops and seminars to attract the interest of construction sector companies	3.97	1.00	1			
Providing subsidies to the construction sector in support of BIM implementation	3.97	1.07	2	3.950	1.043	2
Promoting and enhancing awareness of the benefits of BIM implementation	3.93	1.05	3			
Promoting BIM efficiency and ability in decreasing the duration of work	3.93	1.05	4			
Indicators for People						
Gaining a lot of exposure on BIM implementation and enhancing confidence by using BIM tools	3.97	1.13	1			
Giving instructions to project team members abouttheir individual and teamwork roles	3.83	0.95	2	3.825	1.058	3

Attending seminars to enhance understanding ofBIM and improving skillsfor using BIM tools	3.77	1.17	3			
Strengthening communication skills amongproject team members	3.73	0.98	4			
Indicators for Management						
Promoting awareness of the BIM implementation in construction projects	4.03	0.89	1			
Improving leadership skills for the smooth running of the projects	4.03	1.07	2			
Providing training sessions for employers and employees to enhance their skills in using BIM tools	4.00	1.02	3	3.558	1.155	4
Providing seminars or workshops to increase knowledge of BIM	4.00	1.17	4			
Promoting the benefits of using BIM tools to increase high demand in construction projects	3.93	1.08	5			

In overall, it can be concluded that all of 17 attributes of challenges and 17 indicators that influence multi-organisation in enhancing collaboration in managing BIM construction projects based on contractor perspectives has been comprehensive consolidated in a form of conceptual framework as described in Figure 1. Effective implementation of BIM in construction projects necessitates strong organizational collaboration, which must be deliberately emphasized to achieve a high level of integration and coordination. The success of such collaboration is underpinned by four key, interrelated components: government enforcement, people, management, and technology. Among these, the "people" component serves as the core element, playing a pivotal role in fostering project team collaboration for the effective management of BIM initiatives. However, the influence of the people component is strengthened when supported by the other three—namely, management practices, government enforcement, and technology tool. The interdependence of these components highlights the need for a holistic and integrated approach to organizational collaboration in order to ensure the comprehensive and successful implementation of BIM across construction projects.

The proposed framework provides a structured approach to enhance legal and contractual management for BIM adoption in Malaysia's construction industry. It enables contractors to clarify responsibilities and reduce disputes, guides policymakers in standardising BIM regulations and contract templates, and supports training bodies in developing legal-BIM education. Its adoption promotes greater legal clarity, industry alignment, and readiness for digital transformation.
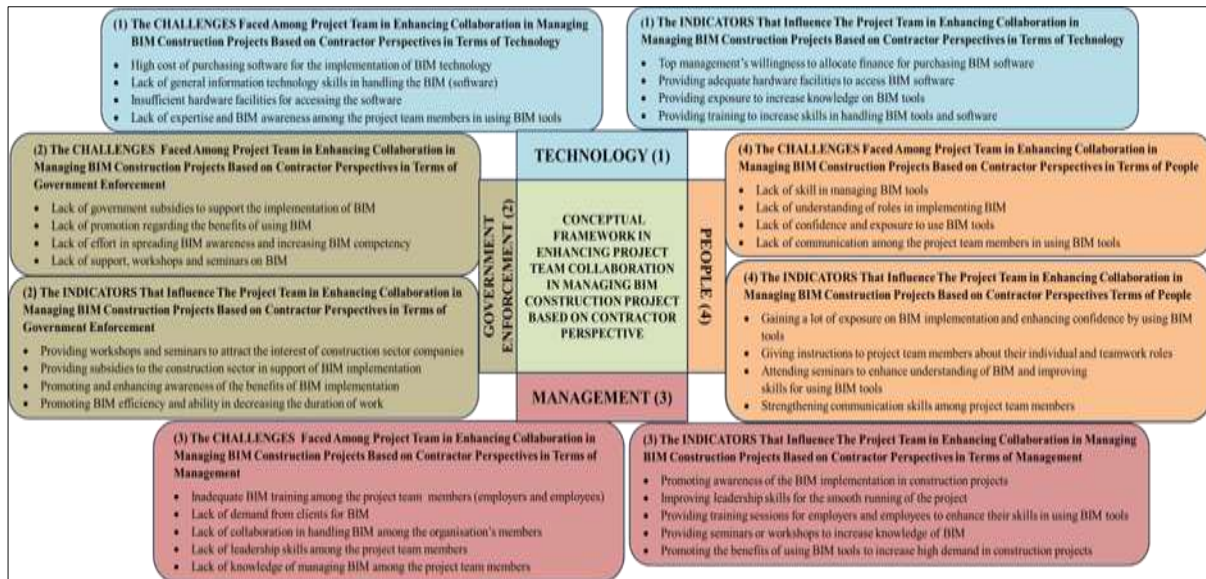
Figure 5: Conceptual Framework in Enhancing Project Team Collaboration in Managing BIM Project Based on Contractor Perspective

Conclusions

This research study has highlighted an overview of the challenges and the indicators that influence multi-organisation in enhancing collaboration in managing BIM construction projects based on contractor perspectives in order to establish the conceptual framework in enhancing multi-organisation collaboration in managing BIM construction project based on contractor perspective. Using a questionnaire survey with responses from BIM construction practitioners, this study assessed the importance of relevant attributes as a reference to enhance construction practitioners' understanding of the factors contributing to successful BIM implementation in projects. The findings identified 17 attributes of challenges and 17 indicators that influence multi-organisation in enhancing collaboration in managing BIM construction projects based on contractor perspectives which has been classified into four main components (i.e., government enforcement, people, management, and technology) which has further been consolidated in the conceptualize framework (see Figure 1), that needs to be emphasized for organisation reference in order to execute BIM in construction projects.

Moreover, the findings of this study indicate that practitioners' varying levels of knowledge and experience within construction settings contribute to responses that reflect actual industry practices, particularly in the management of BIM-based projects. Accordingly, the proposed conceptual framework may serve as a valuable reference for BIM practitioners, facilitating a more comprehensive understanding of BIM implementation within organizational contexts. This framework has the potential to support organizations in adopting BIM more effectively and systematically. Ultimately, this initiative may contribute to advancing Construction Strategy 4.0 by promoting the integration of advanced technological tools and fostering a shift in the working environment, particularly within the Malaysian construction industry.

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