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CONCEPTUALIZING ORGANIZATIONAL ROLES IN COLLABORATIVE BIM PROJECTS: A CASE IN KLANG VALLEY

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Abstract:

Successful Building Information Modelling (BIM) deployment requires seamless organisational collaboration. However, role ambiguity stands as a primary barrier to adoption in Malaysia, stemming directly from fragmented teamwork and inadequate training initiatives. This study aims to clarify the organisational roles required for effective BIM implementation in construction projects. Guided by three core objectives, the research seeks to: (1) determine the main barriers faced by the organisations in achieving effective roles to drive collaboration

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in managing the BIM projects, (2) investigate the key indicators influencing the effective roles of organisations in managing BIM projects and (3) develop a conceptual framework that outlines the effective roles of organisations in the implementation of BIM projects. Adopting a mixed-methods design, a systematic literature review (SLR) was conducted to extract critical attributes, followed by a questionnaire survey administered to 30 BIM experts across the Klang Valley. Analysis revealed four overarching components central to both barriers and success indicators: Technology Tools, Management Process, Integrated Team, and Actor. Regarding the first objective, the Actor component emerged as the primary barrier, followed by Management Process and Integrated Team. Conversely, for the second objective, Management Process ranked highest as a key success indicator, followed by Actor and Technology Tools. Synthesizing the findings from objective 1 and objective 2, a conceptual framework was developed to delineate organisational roles, offering strategic guidance for stakeholders to optimize collaboration and advance BIM maturity across Malaysia's construction sector.

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Keyword:

Building Information Modelling, BIM, Collaborative, Organisational Roles, BIM Projects

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Introduction

Building Information Modelling (BIM), provides a digital representation of a facility's physical and functional characteristics. According to Mohamed et al. (2023), BIM comprised construction process, virtual design and its overall implementation. By several processes and technologies, BIM functions as an approach within the architectural, engineering, and construction (AEC) industry. Although BIM adoption in Malaysia's AEC sector remains inconsistent, an increasing number of construction players adopting the technology (Razali et al., 2024). Construction Industry Development Board (CIDB, 2021) released The Malaysia Building Information Modelling Report 2021 to examine the progress of BIM adoption nationwide that showing an increase from 49% in 2019 to 55% in 2021, whereby the report demonstrated growing implementation across the Malaysian construction industry.

Despite this progress, the Malaysian construction sector continues to suffer from fragmentation and inefficiency, thus making the organisations having a complexity to implement BIM (Noor et al., 2021a and Zulkifli et al., 2024). According to Andersson and Eidenskog (2023), BIM is an important tool for managing construction projects; however, certain key professionals, such as environmental managers, are often excluded from crucial BIM meetings, which limits their understanding and restricts their ability to leverage BIM effectively within their roles. Based

on previous research (Alreshidi et al., 2017; Noor et al., 2025), most project team members still have difficulty understanding their roles, resulting in role ambiguity that may contribute to ineffective collaboration in project management. Consequently, the transition to a fully integrated BIM workflow has led to confusion and role conflicts within project teams (Noor et al., 2021b, Chmeit et al., 2024 and Noor et al., 2025). Therefore, this lack of role clarity ultimately hinders the full potential of BIM implementation in projects.

This research aims to develop a conceptual framework that focusing particularly on organisational collaboration and roles for BIM implementation in Klang Valley. Specifically, the objectives of this study are to: (i) determine the main barriers organisations face in establishing effective collaborative roles in managing BIM projects, (ii) investigate key indicators influencing effective organisational roles in managing BIM projects, and (iii) develop a conceptual framework outlining these effective roles in BIM project implementation. Ultimately, a clearly defined framework aligns stakeholders, enhances project efficiency and construction quality, and supports sustainable development across the Malaysia construction industry.

Literature Review

According to van Dinter et al. (2021), a systematic literature review (SLR) is a research process that involves systematically process and integrating all relevant research on a particular issue or topic area. In ensuring comprehensive and evidence-based conclusions, this approach offers a structured and transparent approach in developing a comprehensive literature review. The SLR method includes a thorough strategy to assess the specific context and synthesise of literature into viewpoints that aligned with the research objective (Noor et al., 2021a). Thus, this approach enables the study to rely on validated data from numerous sources while achieving the research objective.

Therefore, for this study, a systematic search was conducted using the Scopus database to identify articles related to the barriers organisations face in establishing effective collaborative roles and the key indicators influencing these roles in managing BIM projects. Scopus was chosen as the primary database due to the extensive multidisciplinary scope and reliable indexing across management and engineering fields (Noor et al., 2021a). In the initial process, the search was limited to reviewed journal articles and conference proceeding papers published between 2014 and 2024. Based on targeted keyword searches across article titles including terms such as Building Information Modelling, BIM, collaboration, barriers, and BIM factors, the query yielded 194 references. Subsequently, a four-stage screening process was conducted to eliminate duplicate and irrelevant articles.

In the initial screening process, the search string TITLE-ABS-KEY ((‘BUILDING INFORMATION MODELLING’ AND ‘BIM’) AND (‘role*’ OR ‘responsibilit*’ OR ‘task’) AND (‘organization’)) was used to select relevant articles. A total of 120 articles were excluded, leaving 74 articles. Next, the second screening applied inclusion and exclusion criteria and filtering by field (Engineering), document type (journal articles and conference papers), language (English), and keywords such as ‘Building Information Modelling’, ‘BIM’, ‘Collaboration’, ‘Barriers’, and ‘BIM Factors’. Consequently, 43 articles were removed, and 31 articles remained. Finally, the fully review phase evaluated these 31 articles, focusing specifically on the barriers and indicators influencing organisational roles in BIM construction projects. Therefore, all 31 articles were retained for further analysis.

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Based on a synthesis of previous literature (Haron et al., 2013; Sinoh et al., 2020; Noor et al., 2021b), four main domains (i.e., actors, integrated team management, and technology tools) were identified as reference points to determine the barriers and indicators influencing the effective roles of organisations in BIM construction projects. Following the content analysis approach recommended by Merriam (2009), a comprehensive synthesis and analysis were conducted. As a result, 15 barrier factors faced by organisations in driving BIM collaboration were identified, while 16 indicators influencing organisational roles effectiveness were determined, as shown in Tables 1 and 2, respectively.

Barriers hindering effective organisational roles and collaboration in Building Information Modelling (BIM) projects can be evaluated through key performance metrics, including task execution, productivity, and project quality. Empirical studies indicate that inter-organisational collaboration remains minimal, underscoring systemic challenges to full-scale BIM adoption (Noor et al., 2021a; Jamaludin et al., 2022; Mohamed et al., 2023). Previous author, Haron et al. (2017) emphasize that BIM integration has advanced internationally, however the technological tools continue to contribute a significant bottleneck within the Malaysian construction sector. Consequently, these organisational barriers are categorized into four primary domains: actors, team integration, management, and technological tools as presented in Table 1.

Ashmori et al. (2022) identified a lack of knowledge as the most significant challenge to adoption as a primary organisational barrier to effective collaboration in BIM project management. In addition, communication breakdowns occur when stakeholders are confused about BIM procedures, tools, and techniques. Dakhil et al. (2019) emphasized that through establishing a foundation of BIM knowledge within client organisations is important for defining necessary competencies and project requirements. Similarly, Ang et al. (2022) stated that a lack of technological understanding leaves stakeholders on how to initiate BIM implementation, thereby hindering multidisciplinary relationships. The empirical research on BIM that is related to knowledge management remains limited, even though the industry's knowledge is equipped with intensive nature (Andersson & Eidenskog, 2023). A second critical barrier is the lack of strategic leadership required to drive collaborative roles. Leadership plays a vital role in aligning diverse goals specifically on client leadership where essential for BIM implementation and establishing strategies to build organisational (Dakhil et al., 2019). Effective leadership fosters a collaborative culture, although research regarding specific BIM leadership competencies remains as limited (Dakhil et al., 2019). A third barrier is inadequate organisational coordination. According to Cavka et al. (2018), seamless coordination across project team is fundamental to collaborative workflows, whereby to prevent project delays, conflicts, and miscommunication. Comprehensive coordination depends on highly skilled managers and broad technical competencies (Andersson & Eidenskog, 2023). Finally, a limited specialized BIM expertise contributes to lack of organisational collaboration. In Malaysia, this talent shortage influencing a major bottleneck to technological innovation (Ang et al., 2022; Ariono et al., 2022; Chan et al., 2022). Adopting BIM requires specialized technical proficiency and practical domain experience, yet recruitment is hindered by a limited number of BIM educators (Ang et al., 2022). Consequently, reliance on under skilled personnel contribute to the lack of project performance, throughout the BIM lifecycle (Noor et al., 2024).

A major technological barrier facing by project team is the lack of standardized BIM guidelines, which hinders multiorganizational collaboration during implementation (Ang et al., 2022; Chan et al., 2022). Standards establish a shared framework that ensures consistency,

interoperability, and effective communication. The fragmented guidelines created independently by individual entities cause confusion and foster mistrust among project team involved (Al-Ashmori et al., 2022; Ang et al., 2022). Standardized guidelines able to explain stakeholder roles, responsibilities, and deliverables, and validating accountability within the project structure (Dakhil et al., 2019; Noor et al., 2023a). In addition, another technological barrier is the lack of software compatibility across different BIM platforms. Cao et al. (2019) highlighted software compatibility remains an unresolved technical issue, while Chan et al. (2022) identified data interoperability as the single largest obstacle to effective 3D modelling collaboration. Besides, integrating models built through disparate platforms frequently causes data integration failures, thus requiring customized interoperability solutions (Oraee et al., 2019). Ultimately, software incompatibility disrupts workflows, restricts data sharing, and hinders project team collaboration (Cao et al., 2019). In addition, inadequate executive support and insufficient employee training influence collaborative organisational roles. Structured training among project team is necessary to keep personnel updated on software advancements and concepts (Noor et al., 2023b). In addition, untrained employees struggle to comprehend their roles within a BIM framework. Thus, executive leadership must prioritise training initiatives, as many professionals remain unaware of official BIM training programmes organized by CIDB (Chan et al., 2022). Finally, the complexity of BIM software acts as a major influence to ineffective collaboration, contributing to its slow adoption among project teams (Chan et al., 2022). Mastering BIM tools requires extensive technical knowledge in data process, clash detection, and spatial modelling. For unfamiliar teams, lack of technical knowledge reduces software proficiency and affected collaborative efficiency.

Individual resistance to cultural change can significantly influence collaboration and effective BIM adoption. Transitioning to BIM introduces substantial shifts in work practices (Andersson & Eidenskog, 2023). Although BIM requires modern collaborative tools, this transition is often hindered by project team, particularly older demographics, having difficulty to abandon conventional techniques compare to new approach (Ariono et al., 2022; Chan et al., 2022). Crucially, this scenario indicates that new knowledge practices have not yet fully implemented (Andersson & Eidenskog, 2023). Additionally, ambiguous roles and responsibilities generate confusion and reduce organisational accountability (Oraee et al., 2019; Villena et al., 2020). In addition, lack of responsibilities leads to operational gaps, overlapping duties, and schedule delays such as when delivery teams cannot supply required asset data without clear Asset Information Requirements (AIR) from clients (Dakhil et al., 2019; Oraee et al., 2019). In addition, a lack of clarity in information exchange leads to critical misunderstandings. Unclear communication channels produce confusion and increase problems, whereas project teams must actively negotiate and maintain mutual agreements to complete tasks, as a culture of blame severely restricts performance (Laine et al., 2014; Noor et al., 2021). Finally, a lack of hands-on experience with BIM software impacts integrated team collaboration. Teams unfamiliar with BIM applications struggle to navigate essential software functionalities, fostering psychological resistance and technical problems due to limited exposure (Hire et al., 2021; Ariono et al., 2022).

Within integrated teams, organisations frequently face a lack of a collaborative culture, which hinders effective BIM implementation. Establishing an organized BIM process requires project team to coordinate workflows effectively. In the absence of a collaborative culture, project teams would work in isolation, influence operational inefficiencies, misaligned project goals, and communication breakdowns (Noor et al., 2021a). Besides, a weak collaborative culture contribute resistance to new processes, arguments, mutual blame, and a reluctance to accept

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responsibility. Second, a lack of trust within integrated teams influences a critical barrier to fostering BIM collaboration (Noor et al., 2021b). Subsequently, a lack of trust lead to information withholding, miscommunication, and affects relationships among clients, consultants, and contractors. Third, a lack of communication skills limits the capacity of project teams to deliver project requirements and track progress, leading to delays and costly rework (Ariono et al., 2022; Andersson & Eidenskog, 2023). Finally, inadequate teamwork represents a major barrier to managing BIM projects. Weak teamwork results in fragmented contributions and discrepancies between design intent and technical execution (Chan et al., 2022). Defining clear roles and responsibilities within integrated teams is therefore essential to ensure accountability.

Table 1: Summarization of Barriers Faced by The Organisations in Achieving Effective Roles to Drive Collaboration in Managing the BIM Projects

The Main Barrier Faced by The Organisations in Achieving Effective Roles to Drive Collaboration in Managing the BIM Projects	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	TOTAL
MANAGEMENT PROCESS																
Lack of management leadership influencing effective roles of organisation collaboration to manage BIM construction project.	✓							✓				✓				3
Lack of knowledge in influencing effective roles of organisation collaboration to manage BIM construction project.					✓	✓		✓	✓	✓			✓	✓		7
Lack of BIM expertise among organisations, influencing effective collaboration to manage BIM construction projects.										✓	✓					2
Poor organisational coordination can hinder collaboration in BIM projects.			✓				✓								✓	3
TECHNOLOGY TOOLS																
Lack of compatibility between different BIM software tools, leading to data integration challenge.					✓	✓	✓									3
Lack of adequate training or support for the employees from top management, resulting in influencing effective roles of organisation collaboration to manage BIM construction project.	✓	✓														2
Lack of BIM standards and guidelines in influencing organisation collaboration to manage BIM construction project.	✓				✓	✓						✓			✓	5
The complexity of BIM software contributes to the slow adoption among integrated teams, hindering effective collaboration in managing BIM construction projects.						✓										1
ACTOR																

Lack of clarity in information exchange can lead to misunderstandings.			✓	✓	✓							✓			4
Unclear roles and responsibilities in BIM workflows can lead to confusion and reduced accountability among organisations.	✓	✓							✓				✓	✓	5
Individual resistance to culture changes can impede collaboration and the effective use of BIM.				✓		✓	✓	✓	✓	✓	✓			✓	8
Lack of experience in influencing effective roles of organisation collaboration in managing BIM construction project.										✓	✓				2
INTEGRATED TEAM															
A lack of a collaborative culture among integrated teams may hinder effective BIM implementation.	✓			✓	✓	✓		✓					✓		7
A lack of trust among integrated teams can influence the effectiveness of organisational collaboration in managing BIM projects.	✓		✓											✓	3
Lack of teamwork among integrated team in influencing effective collaboration to manage BIM construction project.						✓									1
Lack of communication skills limit the ability of integrated teams to discuss project needs and progress.				✓							✓				2

R1: (Noor et al., 2023b), R2: (Lindblad & Guerrero, 2020), R3: (Laine et al., 2014), R4: (Andersson & Eidenskog, 2023), R5: (Al-Ashmori et al., 2022), R6: (Chan et al., 2022) R7: (Cao et al., 2019), R8: (Dakhil et al., 2019), R9: (Villena et al., 2020), R10: (Hire et al., 2021), R11: (Ariono et al., 2022), R12: (Cavka et al., 2018), R13: (Oraee et al., 2019) , R14: (Pan et al., 2024), R15: (Ang et al., 2022)

Effective BIM project management relies heavily on key organisational indicators across four primary dimensions: Management Processes, Technology Tools, Actor Participation, and Integrated Team Collaboration. Understanding and optimizing these indicators directly impacts internal workflows and interactions across the AEC sector, fostering an environment that maximizes BIM potential to drive superior project outcomes, robust data management, and operational efficiency throughout the project lifecycle.

Enhancing management leadership is important for fostering effective collaboration in BIM construction projects. Effective leadership serves as a driver of BIM execution among diverse stakeholders achieved similar objectives and influencing an organisational culture grounded in open communication, mutual trust, and strategic alignment (Alreshidi et al., 2017). Organisation with leadership would having a clear vision and guidance, able to solve complexities more efficiently, whereby directly driving management strategies that boost project efficiency (Farouk et al., 2023). A critical indicator of organisational management is ensuring that every team member clearly understands their specific roles and responsibilities from initial project meetings (Alreshidi et al., 2017). By defining precise responsibilities eliminates operational ambiguity, mitigates task overlap, and specifies parameters regarding model element management across project teams (Ndwandwe et al., 2024). According to Alreshidi et al. (2017), multiorganizational role clarity remains as important domain to implement BIM and facilitating seamless collaboration. Also, supporting integrated teams in

continuously acquiring management process knowledge promotes interdisciplinary integration, mutual understanding of project team hierarchies, and enhances collective decision making and problem solving (Alreshidi et al., 2017). Finally, encouraging management teams to involve all relevant stakeholders in decision making to achieve the strategic planning framework by incorporating diverse domain expertise. Besides, through the inclusive decision making would allow potential design or operational conflicts to be identified early in the project lifecycle and improve through competent personnel to complement management leadership and streamline collaborative execution (Ndwandwe et al., 2024; Noor et al., 2021b).

Towards enhance organisational performance in BIM project management, executive leadership must develop and implement comprehensive software training programmes. According to Villena et al. (2020); Wang et al. (2020) and Farouk et al. (2023), structured training equips personnel with the foundational expertise needed to drive complex digital environments, which align with client support expectations, and fulfil regulatory submission procedures. In addition, multi training sessions able to prevent operational misunderstandings, resolve individual capability gaps, and elevate overall BIM implementation across all project stages (Bolpagni et al., 2017; Wang et al., 2022). Besides, by maintaining high-quality BIM implementation also demands, hands on exposure to use software platforms and digital libraries. In fact, routine software engagement would build practical team familiarity, enabling integrated teams to effectively manage extensive data regarding safety, quality, and cost while utilize the full potential of contractor experience (Ang et al., 2022; Sinoh et al., 2020; Hire et al., 2021; Farouk et al., 2023; Ndwandwe et al., 2024). Meanwhile, organisations must promote project team environment that actively guidance and inspiration from industry experts and governing bodies, such as the Construction Industry Development Board (CIDB)and directly expand industry awareness and governance (Othman et al., 2021). Besides, structured mentorship programmes led by expert BIM managers or senior practitioners further assist project teams in adapting to advanced digital tools (e.g., Autodesk Revit), whereby mitigate workflow problem, accelerate team competency, and align stakeholder goals for continuous operational improvement (Bolpagni et al., 2017; Ang et al., 2022; Andersson & Eidenskog, 2023; Farouk et al., 2023).

Another key indicator influencing organisational effectiveness is the active participation of project actors in continuous training programmes to upgrade technical. Even though, seminars enhance theoretical understanding of team, hands on practice improve core technical expertise and essential social competencies (i.e., communication, conflict resolution, negotiation, and teamwork) (Ndwandwe et al., 2024; Wang et al., 2022). Within the Malaysian construction sector, targeted comprehensive training covering BIM fundamentals, software application, collaborative workflows, and industry standards is important to improve project team proficiency (Ndwandwe et al., 2024). Additionally, providing mutual and continuous reinforcement of roles and responsibilities is critical for effective management and able to minimizes misunderstandings, and maintains strategic alignment within a BIM environment (Ahbabi & Alshawi, 2015; Farouk et al., 2023). The transparent information sharing is critical for aligning expectations, fostering accountability, and building project team trust. Finally, driving high levels of individual motivation and early team engagement particularly from client organisations responsible for delivering foundational design inputs able to strongly improve technology adoption, innovation, and directly enhance overall BIM maturity (Mohammed, 2020; Alreshidi et al., 2017; Wang et al., 2022; Chan et al., 2022).

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In addition, enhancing organisational collaboration within project teams requires active participation from all stakeholders, including clients, during early project stages such as collaborative workshops and regular progress meetings allows teams to achieve objective, establish clear communication, and systematically plan and evaluate project goals (Alreshidi et al., 2017).

Table 2: Summarization of Indicators Influences the Effective Roles of Organisations in Managing BIM Projects

The Key Indicator That Influences the Effective Roles of Organisations in Managing BIM Projects	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	TOTAL
MANAGEMENT PROCESS																	
Enhance management leadership in influencing effective collaboration in managing BIM construction.	✓		✓	✓		✓		✓					✓				6
Support the integrated team in being willing to acquire new knowledge about the management process to influence successful collaboration in managing BIM construction projects.		✓					✓			✓		✓			✓		5
Encourage the management team to involve all relevant team members in decision-making processes for BIM projects.														✓		✓	2
Ensure each member of the management team understands their roles and responsibilities in supporting BIM project goals.	✓	✓			✓						✓	✓					5
TECHNOLOGY TOOLS																	
Providing mentoring can help integrated teams adapt to advanced tools, which directly influences their effectiveness in managing BIM processes.					✓												1
Top management develop and implement comprehensive training programmes in handling BIM software in influencing effective roles of		✓		✓		✓		✓	✓	✓		✓	✓				8

organisations in managing BIM projects.													
Regular exposure to various BIM software enhances team experience and familiarity, fostering effective collaboration in managing BIM construction projects.			✓	✓		✓						✓	4
Encourage the integrated team to seek inspiration and motivation from industry experts to enhance creativity and foster effective collaboration in managing BIM construction projects.					✓							✓	2
ACTOR													
Openly sharing information to better understand expectations and actions, while demonstrating a willingness to help, enhances trust and confidence.	✓					✓			✓			✓	4
Provide a comprehensive combination of mutual clarification and reminders of roles and responsibilities.	✓		✓		✓			✓		✓			5
Encourage high levels of motivation and engagement among team members working on BIM projects.				✓							✓		2
Participate more in continuous training programmes to upgrade skills in BIM tools and methodologies.	✓	✓		✓	✓	✓			✓			✓	7
INTEGRATED TEAM													
Establish a culture where team members feel free to communicate, trust one another, and share information.						✓		✓					2
Encourage active participation from all stakeholders, including clients, to coordinate project expectations and outcomes.	✓			✓		✓					✓		4

Promote networking and cooperation with BIM professionals to enhance the knowledge and comprehension of how to effectively manage BIM construction projects.	✓				✓	2
Encourage team members to share best practices, lessons learned, and new insights on BIM processes to continuously improve team performance.		✓	✓	✓		3

R1: (Alreshidi et al., 2017) R2: (Baharuddin et al., 2019), R3: (Ndwandwe et al., 2024), R4: (Wang et al., 2022), R5: (Othman et al., 2021), R6: (Farouk et al., 2023), R7: (Wang, 2016), R8: (Ahankoob et al., 2022) R9: (Ahbabi & Alshawi, 2015) R10: (Bolpagni et al., 2017), R11: (Ahuja, 2018), R12: (Wang et al., 2020), R13: (Merschbrock et al., 2018), R14: (Mohammed, 2020) , R15: (Ahuja et al., 2018), R16: (Bosch et al., 2015)

Encouraging team members to share best practices, lessons learned, and novel insights regarding BIM processes is equally pivotal for elevating team performance. Capturing lessons learned from prior implementations significantly enhances contractor capabilities on future projects, while structured team meetings and Communities of Practice (CoPs) integrate knowledge-sharing into formal BIM management systems (Wang, 2016; Ahankoob et al., 2022; Chan et al., 2022). Based on Ahbabi & Alshawi (2015) and Mohammed (2020), through organisational culture with open communication, psychological safety, and mutual trust enables team members to exchange data confidently without fear of judgment, forming comprehensive structure for successful project delivery. Finally, active networking and collaborating with external BIM experts and professional bodies such as the Board of Engineers Malaysia (BEM) broadens organisational understanding and management capability, enabling project team to coordinate IT infrastructures (Noor et al., 2024).

Methodology

In the initial stage, a qualitative systematic literature review (SLR) was conducted to identify the main organisational barriers for effective roles and the key indicators influencing these roles in BIM project management. The result for content analysis from SLR has been presented in Table 1 and Table 2 in previous section. Subsequently, a quantitative questionnaire survey function as the primary data collection, targeting 30 practitioners involved in BIM implementation within the Klang Valley area. Additionally, purposive sampling was employed to select respondents with relevant BIM experience, as this approach ensured that the selected respondents have appropriate knowledge and expertise (Ahankoob et al., 2022). A total of 30 experts involved were selected based on criteria including more than five years of experience in the construction industry and at least one year of BIM experience. In addition, a pilot study was conducted and survey form distributed to five UiTM academics who are registered Professional Engineers (Ir.). The primary objective of the pilot study was to refine questionnaire clarity and enhance overall survey efficiency, adhering to Teijlingen (2014), noted that pilot testing evaluates research flows and familiarises researchers with study protocols. Due to time constraints, the questionnaire was distributed digitally via Google Forms and email to reach respondents with verified BIM construction experience. The gathered responses provided a sufficient data sample to evaluate the Klang Valley context, and aligning

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case selection principles outlined by Noor et al. (2018). The survey comprised three structured sections with closed-ended questions: (1) respondent profiles, (2) assessment of organisational barriers, and (3) evaluation of key role influencing indicators. Items were measured on a 5-point Likert scale ranging from 1 ("not at all important") to 7 ("extremely important"). The collected data were processed using the Statistical Package for the Social Sciences (SPSS) Version 26.0. Following the analytical approaches of Noor et al. (2018), Sinoh et al. (2020), and Yunus et al. (2023), a ranking analysis based on mean values and standard deviations was conducted to evaluate and rank the identified attributes. Subsequently, the attributes were ranked based on the mean values obtained for each component. For example, the Actor component recorded the highest overall mean value of 5.79, while the Management component recorded a overall mean value of 5.63. Therefore, the Actor component was ranked No. 1 based on the highest overall mean value, followed by the Management component (Rank 2).

Profiles of Respondents

Overall, Table 3 presents the distribution of respondents' company locations across the Klang Valley region. The highest concentration of respondents is based in Kuala Lumpur (37 per cent), followed by Petaling Jaya (20 per cent) and Subang Jaya (10 per cent). Additionally, Puchong, Putrajaya, and Shah Alam each achieving (7 percent), while Ampang, Cyberjaya, Kajang, and Selangor recorded (3 percent) each. This result indicates that Kuala Lumpur and Petaling Jaya serve as main states that organisations engaged in BIM collaboration, specifically more focus on commercial and urban areas in driving BIM development within the Klang Valley. In addition, this research comprises a balanced mix of respondents' organisations, focusing on client, contractor, and consultant entities comprised of various key roles (i.e., engineers, BIM modellers, BIM coordinators, BIM managers, architects, and quantity surveyors). Most respondents (37 per cent) were engineers, BIM modellers, and BIM coordinators who were directly involved in the management and operational practices of BIM projects (see Table 3). On average, the respondents possessed substantial experience in the construction industry, with 7 per cent having more than 16 years of experience and 10 per cent having 11–15 years of experience in managing BIM projects. Overall, all respondents were considered experts due to their average experience of 11–15 years in the construction industry and 1 to over 10 years of experience working on BIM projects. Furthermore, most respondents were involved in building, infrastructure, and industrial projects (i.e., large and mega-scale construction projects), both completed and ongoing, situated in strategic geographical locations (i.e., Selangor and Kuala Lumpur).

Table 3: Respondents' Background

Profile	Description	Percentage (%)
Location of the Company	Kuala Lumpur	37
	Petaling Jaya	20
	Subang Jaya	10
	Puchong	7
	Shah Alam	7
	Putrajaya	7
	Ampang	3
	Kajang	3
	Selangor	3
	Cyberjaya	3

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Type of Organisation	Consultant	57
	Contractor	33
	Client	10
Designation	Engineer	37
	BIM Modeller	23
	BIM Coordinator	20
	BIM Manager	10
	Architect	7
	Quantity Surveyor	3
Experience in Construction Industry	More than 15 years	10
	11 – 15 years	30
	6–10 years	60
Experience in BIM Construction Project	More than 10 years	3
	6–10 years	60
	1 – 5 years	37
Types of Project Involved	Building Construction	50
	Industrial Project	27
	Infrastructure Project	23

Findings and Discussion

Overall, this section presents the ranking of attributes and components related to the main barriers faced by organisations in achieving effective roles to drive collaboration in BIM project management, as indicated in Table 4. Ranking analysis assigns a numerical value to each attribute to determine its rank based on its mean and standard deviation. Mean and standard deviation are widely used in descriptive statistics, providing a clear overview of a dataset's distribution and characteristics (Zahedi-Serest et al., 2014).

Table 4 outlines the main component, sub-component, and attribute rankings for the main barriers faced by organisations in achieving effective roles to drive collaboration in managing BIM projects. The findings indicate that, with an overall mean value of (5.79), the "Actor" component is the most significant barrier. The highest subcomponent under this category is the lack of clarity in information exchange (mean value = 6.10). Noor et al. (2021) highlighted that collaboration requires mutual understanding and negotiation between parties, as inadequate communication can lead to mistakes and misunderstandings. This is followed by unclear roles and responsibilities in BIM workflows (mean value = 6.03). This aligns with research done by Villena et al. (2020) and Oraee et al. (2019), that highlighted a lack of role clarity is a major barrier to BIM implementation. Moreover, respondents agreed that there is a lack of experience in fostering effective organisational collaboration in managing BIM construction projects (mean value = 5.63), whereby many individuals in the construction sector have insufficient experience, primarily due to inadequate training in BIM processes. Lastly, a mean score of (5.40) presents that individual resistance to cultural change can prevent effective collaboration and use of BIM, in order to shifting from traditional methods to BIM. According to Chan et al. (2022) stated that the older generation is preferring to adopting traditional practices compared to BIM digital tool. Thus, this condition hinders efficient communication, role clarity, and the adoption of collaborative digital practices essential for successful BIM project delivery.

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The second main barrier is the management process component, with a mean value of (5.63), whereby initially demonstrates organisational inefficiencies in managing BIM that related to organisation roles which critically affect collaborative efforts. The most significant element under this component is personnel within the organisation having a insufficient knowledge regarding the BIM process (mean value = 5.77). This finding shows that diverse stakeholders still struggle to understand BIM procedures, tools, and techniques. As reported by Dakhil et al. (2019), sufficient organisational knowledge is essential for successful BIM implementation. Another critical barrier is the shortage of BIM expertise across organisations (mean value = 5.73). This is supported by studies conducted by Ang et al. (2022), Ariono et al. (2022), and Chan et al. (2022), which highlighted a shortage of qualified professionals and limited BIM education in Malaysia. Therefore, to ensure effective implementation, Noor et al. (2024) stated that skilled personnel are very important for facilitating organisation collaboration within BIM project. Moreover, ineffective management leadership (mean value = 3.80) also be another concern to be addressed, when project team fails to align stakeholder goals and foster collaboration. Dakhil et al. (2019) state that effective leadership is essential in bringing project stakeholders together to meet project needs.

Table 4: Ranking Analysis Based on Mean and Standard Deviation of Main Barriers Faced by the Organisations in Achieving Effective Roles to Drive Collaboration in Managing the BIM Projects

The Main Barrier Faced by The Organisations in Achieving Effective Roles to Drive Collaboration in Managing the BIM Projects.	Mean	Standard Deviation	Rank	Overall Mean	Overall Standard Deviation	Overall Rank
ACTOR						
Lack of clarity in information exchange can lead to misunderstandings.	6.10	0.96	1			
Unclear roles and responsibilities in BIM workflows can lead to confusion and reduced accountability among organisations.	6.03	1.07	2	5.79	1.10	**1**
Lack of experience in influencing effective roles of organisation collaboration in managing BIM construction project.	5.63	1.13	3			
Individual resistance to culture changes can impede collaboration and the effective use of BIM.	5.40	1.16	4			
MANAGEMENT PROCESS						
Lack of knowledge in influencing effective roles of organisation collaboration to manage BIM construction project.	5.77	1.07	1			
Lack of BIM expertise among organisations, influencing effective collaboration to manage BIM construction projects.	5.73	1.02	2	5.63	1.13	**2**
Lack of management leadership influencing effective roles of organisation collaboration to manage BIM construction project.	5.53	1.20	3			

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Table 4: Ranking Analysis Based on Mean and Standard Deviation of Main Barriers Faced by the Organisations in Achieving Effective Roles to Drive Collaboration in Managing the BIM Projects

The Main Barrier Faced by The Organisations in Achieving Effective Roles to Drive Collaboration in Managing the BIM Projects.	Mean	Standard Deviation	Rank	Overall Mean	Overall Standard Deviation	Overall Rank
INTEGRATED TEAM						
Lack of teamwork among integrated team in influencing effective collaboration to manage BIM construction project.	5.90	1.09	1			
Lack of communication skills limit the ability of integrated teams to discuss project needs and progress.	5.83	1.09	2	5.60	1.17	**3**
A lack of trust among integrated teams can influence the effectiveness of organisational collaboration in managing BIM projects.	5.53	1.28	3			
A lack of a collaborative culture among integrated teams may hinder effective BIM implementation.	5.13	1.22	4			
TECHNOLOGY TOOLS						
Lack of adequate training or support for the employees from top management, resulting in influencing effective roles of organisation collaboration to manage BIM construction project.	5.87	1.22	1			
Lack of compatibility between different BIM software tools, leading to data integration challenge.	5.47	1.12	2	5.56	1.22	**4**
The complexity of BIM software contributes to the slow adoption among integrated teams, hindering effective collaboration in managing BIM construction projects.	5.53	1.43	3			
Lack of BIM standards and guidelines in influencing organisation collaboration to manage BIM construction project.	5.37	1.13	4			

Lastly, poor organisational coordination (mean = 5.50) was widely recognised as a barrier. Andersson and Eidenskog (2023) emphasized that skilled coordination is crucial to integrate BIM tools for smooth communication and conflict avoidance among project team. Thus, training and support to enhance stakeholders' proficiency with BIM tools is needed, thereby improving teamwork and productivity. Overall, knowledge, leadership, strong coordination, and BIM expertise are important to solve management obstacles and enabling better collaboration in BIM project.

Integrated team challenges are ranked third among the critical barrier components. The primary element within this component is the lack of teamwork among integrated teams, which recorded a mean value of (5.90). In addition, teamwork is essential for multidisciplinary collaboration, as it fosters mutual understanding, supports information sharing, and ensures the alignment of project objectives. Besides, team members that fail to collaborate, and achieve problem solving capability would reduce overall project efficiency. The second element is the lack of communication skills (mean value = 5.83), which limits the ability of project teams to discuss project needs and track progress. Therefore, the misalignment would disrupt workflows

and making challenging for teams to maintain consistency to deliver projects aligned with objectives. Additionally, respondents strongly agreed that a lack of trust among integrated teams is another major element (mean value = 5.53). This finding aligns with Noor et al. (2021a), noted that in order to maintaining trust among project teams is a primary challenge during BIM implementation. Trust is essential to encourage openness and reduce conflict, especially in BIM projects that rely heavily on integrated workflows and shared responsibilities. Lastly, the lack of a collaborative culture among integrated teams recorded a mean value of (5.13), showing that teams prefer to work in silos without supportive environment. However, Noor et al. (2021a) emphasized that social collaboration among stakeholders is important for successful BIM projects. Therefore, assigning clear roles and responsibilities within integrated teams while promoting a supportive culture can ensure accountability and facilitate more collaborative BIM environment.

The fourth major barrier identified is the Technology Tools component (mean value = 5.87). The most important element in this category is the lack of adequate training or support for employees from top management, which received the highest mean value of (5.87). This finding suggests that insufficient training leads to errors, miscommunication, and delays throughout the BIM project lifecycle. Employees with improper trained struggle to operate BIM tools efficiently and understand their roles, thereby limiting the full implementation of BIM. In addition, the lack of compatibility between different BIM software tools ranks second (mean value = 5.47), indicating that design teams frequently face technical challenges when integrating diverse software platforms to develop BIM models such as, incompatibility disrupts workflows and restricts data exchange that prevent stakeholder collaboration (Cao et al., 2019). Meanwhile, the complexity of BIM software contributes significantly to the slow adoption among integrated teams (mean value = 5.53). According to Chan et al. (2022), local practitioners still find BIM software overly complex to operate. Lastly, the lack of BIM standards and guidelines is another barrier under technology tools (mean value = 5.37), whereby clear standards and guidelines are critical for establishing a shared framework that promotes consistency, interoperability, and clear communication. Dakhil et al. (2019) state that clear BIM standards able to validate stakeholder roles and support smooth coordination throughout the project lifecycle. Overall, these results emphasize that comprehensive training, executive support, user friendly software solutions, and clearly defined standards are important for improving stakeholder understanding of BIM roles and responsibilities.

In summary, the analysis of the main barriers highlighted four key components: actor, management process, integrated team, and technology tools. The "Actor" component exposed as the most significant barrier, with a mean value of (5.79). Thus, the dominance of the "Actor" component indicates that clarifying roles, responsibilities, and communication channels is a foundational action toward enhancing collaboration. Besides, multiple stakeholders interact via digital tools and shared platforms, clear role definition is considered as critical. Thus, without this digital foundation, even advanced tools and processes cannot deliver their full potential. Therefore, to ensure successful BIM implementation, organisations must invest not only in technology and training, but also in resolving interpersonal and role-related challenges across all levels. Furthermore, as noted by Noor et al. (2021a), effective collaboration in complex environments like BIM projects heavily depends on how individuals and organisations interact and relate to one another.

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Table 5 outlines the main component, sub-component, and attribute rankings for the key indicators influencing the effective roles of organisations in managing BIM projects. Based on Table 5, the "Management Process" received the highest score among the four key indicators, with an overall mean value of 5.92. Respondents strongly agreed that the most important sub-component of the management process is ensuring each member of the management team understands their roles and responsibilities in supporting BIM project goals (mean = 6.37). According to Alreshidi et al. (2017), clearly establishing responsibilities across disciplines is essential to overcoming challenges in BIM adoption and enhancing team collaboration. Next, the second ranked subcomponent is enhancing management leadership to influence effective collaboration in managing BIM construction projects, with a mean value of (6.13). This present that most respondents acknowledged leadership as a key component of effective BIM project management. Alreshidi et al. (2017) also emphasized that strong leadership is a critical factor in improving BIM collaboration among project teams. Moreover, encouraging the management team to involve all relevant team members in decision making processes for BIM projects has been ranked third (mean value = 5.67). This highlights the importance of incorporating diverse expertise and involved all relevant team members in decision making phase can significantly enhance teamwork. Ndwandwe et al. (2024) highlighted the ability of project team to collaborate and communicate effectively during decision making and information sharing stages is important for successful project delivery. Lastly, the fourth subcomponent (mean value = 5.50) identified the importance of supporting integrated teams in remaining open to acquiring new knowledge about management processes. Thus, team members must be encouraged to have BIM continuous learning to foster effective collaboration. As Alreshidi et al. (2017) pointed out, project team with knowledgeable and adaptable are critical to achieve successful outcomes of BIM projects. In overall, these findings highlighted the crucial role of the management process in strengthening collaboration in BIM environments, particularly in promoting leadership and role clarity.

"Actor" is ranked second among the main key indicators influencing the effective roles of organisations in managing BIM projects (mean value = 5.84). The top ranked indicator with (mean = 6.17) shows the importance of active participation in continuous BIM training programmes to upgrade skills. Regarding BIM adoption within Malaysia's construction industry, Baharuddin et al. (2019) stated that efficient training programmes are required to improve construction professionals' BIM expertise. Most of respondents agreed that by providing a comprehensive reminder of roles and responsibilities is another critical indicator with (mean = 5.93). Clear roles and responsibilities are essential for avoiding confusion and ensuring accountability to be serve as the foundation for effective collaboration (Ahbabi & Alshawi, 2015). The third ranked indicator with (mean value = 5.67) is related to openly sharing information in order to enhance understanding, foster transparency, and demonstrate a willingness to support one another. Alreshidi et al. (2017) state that because BIM projects are complex, team members must adopt efficient communication, collaboration, and coordination techniques for BIM workflows effectively. Besides, another key indicator has been identified as encouraging high levels of motivation and engagement among team members working on BIM projects with (mean = 5.57). Whereby, motivation plays a key role in maintaining productivity and sustaining collaborative efforts throughout the project lifecycle such as when team members are motivated and actively engaged, they are more likely to take ownership of their tasks and contribute to project success. Thus, these findings highlighted the importance of human factors such as skill development, role clarity, open communication, and motivation as essential drivers for enhancing organisational collaboration and achieving successful of BIM implementation.

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The "Technology Tools" is ranked as the third highest component with (overall mean value = 5.63). The highest subcomponent within this category is the implementation of comprehensive training programmes in handling BIM software by top management (mean = 6.17). This result indicates that operating complex BIM tools effectively requires the regular, targeted training sessions and promote continuous skill development (Bolpagni et al., 2017). Moreover, Farouk et al. (2023) emphasized that the importance of training at specific organisational levels is to ensure a proper understanding of BIM processes, while Wang et al. (2020) stated that client and team level support significantly affects BIM implementation success. The second subcomponent is the importance of regular exposure to various BIM software to enhance team experience and familiarity in project (mean value = 5.93). This result highlights that consistent and exposure would help team members become familiar with software functionalities and improve their knowledge of BIM processes. According to Sinoh et al. (2020), this exposure is important due to software aligned with digital libraries that support interoperability, would enable integrated teams to work together more efficiently. Additionally, respondents agreed that by providing mentoring can help integrated teams to adapt advanced tools (mean value = 5.30), which directly influencing their effectiveness in managing BIM processes. Through regular and specialized mentoring with practical training adapting the real project scenarios, project teams can better utilize BIM tool. Finally, the last subcomponent with (mean value = 5.13) identified that encouraging integrated teams to have an inspiration and motivation from industry experts can enhance creativity and foster effective collaboration. This demonstrates that learning from industry leaders would promotes an organisational culture of continuous learning, which is crucial for BIM adaptation and collaboration (Othman et al., 2021). Overall, it can be concluded that frequent training, hands on exposure, and strong organisational commitment are essential to improving BIM efficiency and overall project performance.

Lastly, the "Integrated Team" component is ranked fourth among the main indicators with (mean value = 5.56), indicates that there is a need of active stakeholder involvement and collaboration. The most critical subcomponent under this indicator is establishing a culture whereby team members feel free to communicate, trust one another, and able to share information with (mean value = 5.70). Therefore, this highlighted the necessity for organisations to be expose with an environment whereby, information is shared confidently without fear among project team. Previous research conducted by Ahbabi and Alshawi (2015) supports this statement, where an effective BIM project delivery should depend on trust, open communication and collaborative decision making. The second ranked indicator with (mean value = 5.70) highlights the importance to expand active participation from all project teams, including clients whereby to align with project outcomes. Besides, by engaging project team early in the project would help to shape goals and ensure the alignment in the workflow (Alreshidi et al., 2017), eliminating misunderstandings and enabling to solve the issue resolution. Moreover, promoting networking and cooperation with BIM professionals with (mean value = 5.57) was strongly agreed upon by most of respondents, recommend that connections with BIM experts would enhancing the operational management knowledge and practices. Finally, attributes of encouraging team members to share best practices, lessons learned, and new insights regarding BIM processes received a mean value of (5.27). This finding aligns with previous literature Ahankoob et al. (2022), that emphasized a contractor's ability to fully utilise BIM in future projects as greatly enhanced by learning from lessons learned from previous experiences. Overall, these findings able to demonstrate that integrated teams would play an important role in enabling an effective organisational role in BIM project.

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In summary, the finding presented in (Table 5) highlighted four key indicators influencing the effectiveness of organisational roles in managing BIM projects comprised of Management Process, Actor, Technology Tools, and Integrated Team. It can be highlighted that, the Management Process component ranks highest with (mean value = 5.92), indicating that most of respondents strongly view it as the most influential factor that supporting an effective collaboration and role execution for BIM project. This in line with Ikramov (2025), that emphasized role clarity, which specifically focus on leadership and managerial levels, is important for driving performance and ensuring best alignment towards BIM project goals.

Table 5: Ranking Analysis Based on Mean and Standard Deviation of Key Indicator Influences the Effective Roles of Organisations in Managing BIM Projects in Managing the BIM Projects

The Key Indicators Influencing the Effective Roles of Organisations in Managing BIM Projects	Mean	Standard Deviation	Rank	Overall Mean	Overall Standard Deviation	Overall Rank
MANAGEMENT PROCESS						
Ensure each member of the management team understands their roles and responsibilities in supporting BIM project goals.	6.37	0.80	1			
Enhance management leadership in influencing effective collaboration in managing BIM construction.	6.13	0.82	2	5.92	0.99	**1**
Encourage the management team to involve all relevant team members in decision-making processes for BIM projects.	5.67	1.21	3			
Support the integrated team in being willing to acquire new knowledge about the management process to influence successful collaboration in managing BIM construction projects.	5.50	1.17	4			
ACTOR						
Participate more in continuous training programmes to upgrade skills in BIM tools and methodologies.	6.17	0.83	1			
Provide a comprehensive combination of mutual clarification and reminders of roles and responsibilities.	5.93	0.79	2	5.84	0.95	**2**
Openly sharing information to better understand expectations and actions, while demonstrating a willingness to help, enhances trust and confidence.	5.67	0.99	3			
Encourage high levels of motivation and engagement among team members working on BIM projects.	5.57	1.17	4			

Based on findings, Management Process located as the highest ranked indicator represent that a very clear managerial direction, structured workflows, and formalised role definitions could play a main role in enabling successful of BIM collaboration. Besides, these processes ensure the individuals involved understand not only their own individual responsibilities but also understand their work interconnects with others within the project team. Therefore, organisations focus to enhance their BIM performance are always encouraged to prioritise strong management practices alongside sufficient tools and training. It can be concluded that,

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without this foundational structure, a highly skilled teams and advanced tools may struggle to achieve their full potential to adopt with BIM environment.

Table 5: Ranking Analysis Based on Mean and Standard Deviation of Key Indicator Influences the Effective Roles of Organisations in Managing BIM Projects in Managing the BIM Projects

The Key Indicators Influencing the Effective Roles of Organisations in Managing BIM Projects	Mean	Standard Deviation	Rank	Overall Mean	Overall Standard Deviation	Overall Rank
TECHNOLOGY TOOLS						
Top management develop and implement comprehensive training programmes in handling BIM software in influencing effective roles of organisations in managing BIM projects.	6.17	0.99	1			
Regular exposure to various BIM software enhances team experience and familiarity, fostering effective collaboration in managing BIM construction projects.	5.93	0.79	2	5.63	1.10	**3**
Providing mentoring can help integrated teams adapt to advanced tools, which directly influences their effectiveness in managing BIM processes.	5.30	1.26	3			
Encourage the integrated team to seek inspiration and motivation from industry experts to enhance creativity and foster effective collaboration in managing BIM construction projects.	5.13	1.33	4			
INTEGRATED TEAM						
Establish a culture where team members feel free to communicate, trust one another, and share information.	5.70	0.95	1			
Encourage active participation from all stakeholders, including clients, to coordinate project expectations and outcomes.	5.70	0.95	2	5.56	1.12	**4**
Promote networking and cooperation with BIM professionals to enhance the knowledge and comprehension of how to effectively manage BIM construction projects.	5.57	1.12	3			
Encourage team members to share best practices, lessons learned, and new insights on BIM processes to continuously improve team performance.	5.27	1.36	4			

It can be concluded that, 15 barrier attributes and 16 indicators influence an effective role of organisations in managing BIM projects have been consolidated and form into a conceptual framework, as illustrated in Figure 1. Towards an effective of BIM implementation in construction projects needs a strong organisational collaboration, whereby to achieve a high level of integration and coordination in the projects. Additionally, the success of collaboration is underpinned and supported by key interrelated components including actor, integrated team, management, and technology tools. Subsequently, the "Actor" and "Management" components verified as core elements, that playing a pivotal role in fostering project team collaboration

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towards effective roles of organisations in managing BIM projects. Meanwhile, the influence of the actor and management components is strengthened and supported through the others external components including integrated team and technology tools.

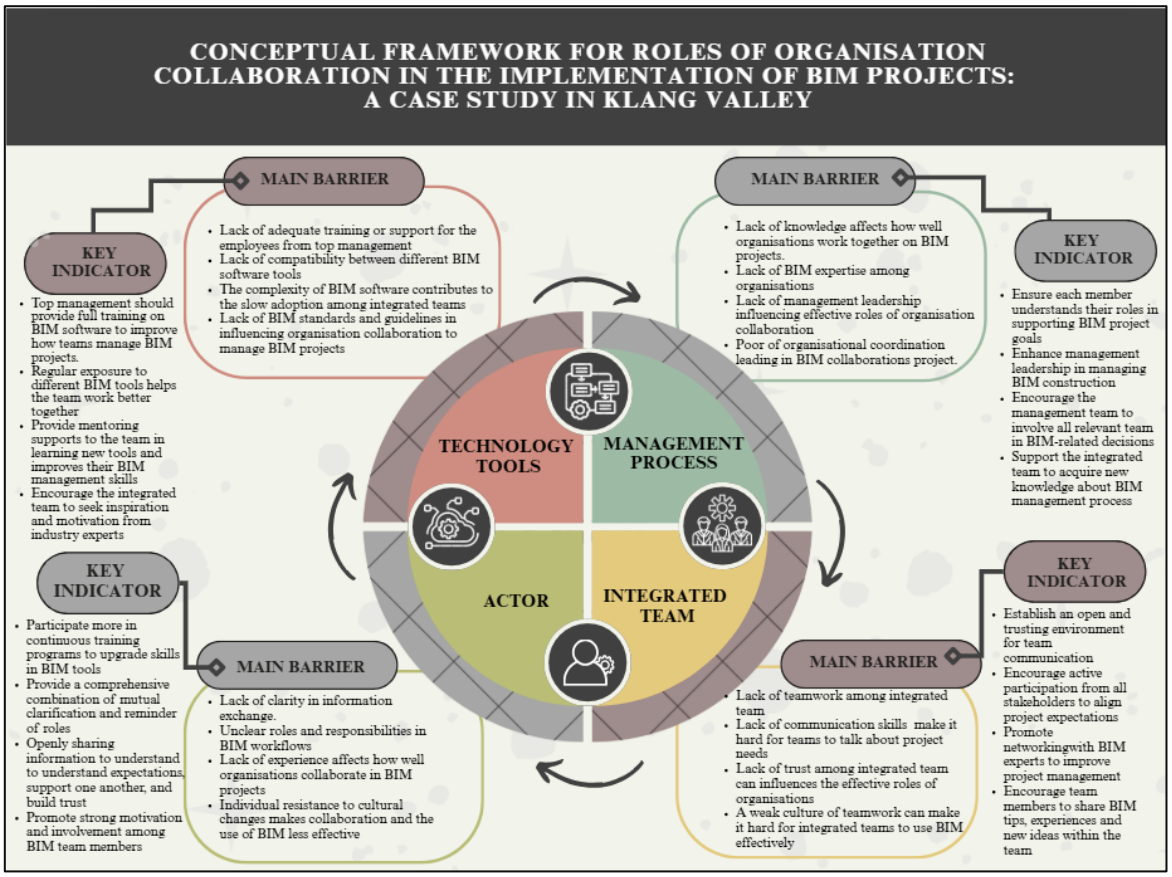


Figure 1: Conceptual Framework for Roles of Organisational Collaboration in the Implementation of BIM Projects

The interdependence of these components highlights the need for a holistic and integrated approach to organisational collaboration to ensure the comprehensive and successful implementation of BIM across construction projects.

The proposed framework comprises specific organisational roles, relationships, and responsibilities among project team members, providing a structured approach to improving legal and contractual management for BIM adoption in Malaysia. It helps organisations clarify responsibilities and minimize disputes, assists policymakers in standardising BIM regulations, and supports educational bodies in developing legal BIM training. Its adoption advances legal clarity, industry alignment, and digital transformation readiness.

Conclusion

This research provides comprehensive overview of barriers and indicators influencing an effective role of project team in managing BIM projects, thereby establishing a conceptual framework for organisational collaboration in the BIM execution. Using a questionnaire survey focussing on BIM construction practitioners, this study assesses the importance of relevant attributes to enhance BIM professionals' understanding of the factors contribute to the

successful of BIM. In overall, the findings identified 15 barrier attributes and 16 indicators contribute to organisational roles and have been divided into four (4) key components (i.e., actor, management, integrated team and technology) and whereby form a consolidated of conceptual framework (see Figure 1) as a critical reference for organisations executing BIM projects. The development of conceptual framework offers a reference point to deepen multiorganizational understanding and streamline BIM implementation. Ultimately, this would contribute to advancing Construction Strategy 4.0 by fostering digital tool integration and specifically modernising working environments across the Malaysian construction sector.

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