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Bridging Safety and Innovation: Integrating Building Information Modelling (BIM) with Fire Safety Evacuation Compliance Checking Process

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ABSTRACT

Fire safety evacuation is an essential aspect in building design, directly impacting the safety of occupants during fire incidents. However, the conventional approach in checking the fire safety compliance is prone to errors and could not accommodate complex buildings. With the growing emphasis on proactive measures to mitigate fire risks and ensure swift evacuations, leveraging the compliance checking process through Building Information Modelling (BIM) demonstrates significant potential in this field. In Malaysia, the current compliance checking process grapples with challenges related to manual processes, fragmentation, and lack of automation. Hence, this paper aims to identify the potential of integrating BIM in the fire safety evacuation compliance checking process in Malaysia. Interview sessions were conducted with fire authority, architects, and engineers who are experienced in fire safety design and compliance checking. The study highlights the need for an integrated BIM platform for fire safety compliance checking with user-friendly interfaces, real-time collaboration tools, advanced simulation features, and smooth integration with existing fire safety systems. Collaboration through continuous feedback and cloud-based platforms for information sharing is also paramount in this integration. Tailored training programmes, strong leadership, and gradual implementation are the key elements in ensuring a successful BIM integration in this field. Future works involve identifying the key features needed for local authorities to check fire safety evacuation compliance using BIM, followed by creating a framework for the system.

Keywords: Building Information Modelling (BIM), fire safety, evacuation, compliance checking, code checking

INTRODUCTION

During the design phase of construction projects, collaboration among various disciplines is crucial. Effective communication between all project participants is essential to ensure smooth project execution. The information generated in the early stages of the project is vital for subsequent phases such as construction and maintenance, making its management and utilisation important for effective collaboration [1]. In recent decades, the growing size and complexity of buildings have led to increased uncertainty and decreased reliability of the information created. Additionally, the demands for interdisciplinary collaboration have intensified, leading to the emergence of Building Information Modelling (BIM) as a solution to address these challenges.

Conversely, effective fire safety is essential at every stage of a construction project, from planning to operation, to ensure the safety of occupants and personnel [2]. During the design phase, architects evaluate key factors such as fire compartments, escape routes, distances, and necessary fire safety provisions. In the operational phase, occupants and users of the building need to be familiar with egress routes in case of a fire, while facility managers and maintenance contractors must have access to information about fire safety equipment and ensure that it is properly maintained [3].

The global situation reveals that even with established regulations, fire safety systems and evacuation processes within buildings continue to pose challenges and difficulties. In Malaysia, for instance, despite the application of Uniform Building By-Laws 1984 (UBBL 1984) and other relevant regulations, issues with fire safety systems and evacuation plans persist. Conventional evacuation planning often fails to adequately address critical factors such as spatial navigation, dynamic occupant behaviour, and accessibility for individuals with disabilities [4]. Furthermore, visualising the entire evacuation process in large or complex buildings using traditional methods can be difficult and prone to errors.

In essence, every building regardless of its level of complexity, must include evacuation measures to protect occupants in emergencies. For simpler buildings, compliance with prescriptive requirements during the design phase is usually sufficient. However, more complex structures often require advanced computational tools for engineering analysis and simulation, with BIM serving as a valuable resource for providing the necessary information. BIM facilitates effective information sharing throughout the project's lifecycle [5]. Hence, this paper aims to identify the potential of integrating BIM in the fire safety evacuation compliance checking process in Malaysia by conducting semi-structured interview sessions with fire safety experts consisting of fire authority, engineers, and architects to gain their perspectives on the integration. This study focuses on identifying their views on the limitations of the current process, their needs and preferred approach, as well as their views on the challenges and mitigation plan to integrate BIM in the compliance checking process. The findings from this study will become the initial step in developing a BIM-based fire safety evacuation compliance checking process in Malaysia.

LITERATURE REVIEW

Various studies have highlighted the importance of fire safety evacuation and the role of Building Information Modelling (BIM) in diverse circumstances. The next subsections cover the current scenario of the fire safety evacuation process in Malaysia, followed by a brief review of the technological advancements on the compliance checking in other countries, and lastly, the potential benefits of integrating BIM into the fire safety evacuation compliance checking process in Malaysia.

A. Fire Safety Evacuation Process in Malaysia

Fire safety regulations are a crucial component of public safety, designed to mitigate the devastating impacts of fire on both property and human lives [6]. These regulations encompass a wide range of measures, from building codes and emergency response protocols to fire prevention strategies. Evacuation plans, in particular, designate escape routes, assembly points, and other crucial information to ensure a swift and orderly departure from the building during emergencies [7]. Compliance with fire safety regulations is typically enforced by local and national authorities. Non-compliance may result in penalties or legal consequences, emphasising the seriousness of adhering to these regulations. The enforcement of fire safety regulations not only protects individual buildings and occupants but also contributes to community-wide safety by reducing the risk of large-scale fires with far-reaching consequences [8]. Compliance with these regulations is necessary in minimising the risk of fires and their potential catastrophic consequences, underlining the paramount importance of fire safety in the communities [9].

In Malaysia, Uniform Building By-Laws (UBBL) 1984, which were adopted under the Street Drainage and Building Act 1974, mandate that all new constructions must obtain design approval from a designated submitting authority, such as a Professional Architect or Professional Engineer, before commencing construction. In 2004, the Malaysian Government established One-Stop Centre (OSC) in all Local Authorities in Peninsular Malaysia which allowed for the standardisation of the application process rules and the enhancement of the local authority level delivery system [10]. The One-Stop-Centre (OSC) approval process in Malaysia is a multifaceted system that simplifies and centralises the often complex and time-consuming administrative procedures associated with development projects and business operations. The involvement of the Fire and Rescue Department of Malaysia (FRDM) in the OSC is a critical aspect of ensuring fire safety and emergency responses preparedness for buildings. One of the key responsibilities of FRDM is to review fire safety plans proposed for a building. This entails a meticulous examination of the design and installation of various fire suppression systems, such as sprinklers and fire alarms, as well as the layout and accessibility of fire exits. Designers bear the responsibility of ensuring optimal fire safety in a structure. Compliance with the minimum fire safety standards of UBBL 1984 is imperative for a smooth OSC approval process and ultimately enhances the safety of building occupants. Designing for fire safety is a challenging task, requiring an in-depth understanding of fire safety regulations [11]. If designers propose alternative designs deviating from UBBL 1984's minimal requirements, they must suggest suitable solutions to FRDM [12]. While OSC provides an online platform for plan submissions, the compliance verification by FRDM still requires hardcopy records [10].

The challenges encountered within the One-Stop-Centre (OSC) approval process can be traced to several key factors. Firstly, meticulous recording of applications, requiring accurate documentation and capture of all necessary information, may introduce delays if not executed efficiently [13]. Secondly, the distribution of applications to relevant departments may pose challenges due to inefficiencies, leading to potential bottlenecks. Thirdly, the compilation of comments and feedback from various departments, crucial in the decision-making process, may experience delays in gathering and organising comments promptly [5]. Lastly, the task of setting meeting dates for decision-making within the OSC can introduce delays, particularly when scheduling and coordinating the availability of all necessary participants proves challenging. Additionally, the choice of delivery method, whether by postal services or hand delivery, significantly impacts the overall duration of the process, each carrying its own timeframes and potential sources of delay. Addressing these potential delays is crucial for optimising efficiency and minimising unnecessary wait times within the OSC.

B. Integrating BIM in Fire Safety Evacuation Compliance Checking Process

Over the past two decades, other countries have explored various approaches to the development of an automated code compliance checking system. One noteworthy initiative in this field is the BP-Expert system introduced in Singapore as early as 1995. It aimed to reengineer and streamline construction industry work processes, achieving significant improvements in turnaround time, quality, and productivity. Subsequently, the e-PlanCheck system, part of the Construction and Real Estate NETwork (CORENET) project, replaced BP-Expert in 2000. Currently, it is known as CORENET BIM e-Submission which integrates BIM into the compliance checking process [14]. In Australia, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the University of Sydney explored potential platforms for automated code checking, with a particular emphasis on accessible design regulations [15]. Two platforms, Solibri Model Checker (SMC) and Express Data Manager (EDM), were considered for this purpose. The outcome of this selection process led to the development of an automated code checking system called Design Check [16]. However, the development of Design Check was discontinued [17]. Meanwhile, SMC has become quite a successful software application with 300 preformatted rules related to egress, space management, and accessibility [18]. Nowadays, SMC is being implemented in model validation in the United States [19].

With the advancement of BIM in this field in other countries, it is imperative that Malaysia should integrate BIM into the fire safety evacuation compliance checking process. BIM offers a comprehensive, 3D digital representation of a building's design, encompassing architectural, structural, mechanical, electrical, and plumbing components. This rich visual model can significantly improve the assessment of fire safety features and evacuation routes [20]. One of the most compelling aspects of BIM for fire safety is its ability to facilitate fire safety simulation. BIM software can be equipped with tools for real-time fire modelling, evacuation simulations, and smoke propagation analysis [21]. Designers and fire safety engineers can use these simulations to assess the potential impact of different design choices on evacuation routes, helping to identify potential fire hazards more effectively [16]. These simulations allow stakeholders to gain valuable insights into the performance of fire safety measures in the virtual environment, well before construction begins.

Furthermore, BIM can serve as a centralised repository for data related to fire safety. This includes the precise locations of fire alarms, sprinkler systems, fire exits, and emergency lighting. Standardising this information in the BIM model ensures that it is easily accessible to relevant stakeholders, including fire safety authorities [22].

One of the key benefits of integrating BIM into the fire safety compliance checking process is the automation of regulatory compliance checks. BIM software can be programmed to automatically cross-reference the building design with specific fire safety regulations and codes [23]. This automated verification process helps ensure that the design adheres to the minimum fire safety requirements mandated by regulations, which is particularly critical during the development plan approval stage.

The collaborative nature of BIM is another significant advantage. It encourages architects, engineers, fire safety professionals, and regulatory authorities to work together seamlessly, enhancing the exchange of critical information. In a collaborative BIM environment, all stakeholders can access and contribute to the development of the digital model, fostering efficient communication [24]. Additionally, BIM allows for the creation of 3D visualisations and walkthroughs, aiding in the communication of fire safety measures and evacuation plans to building occupants, emergency responders, and regulatory authorities [25]. These visualisations enhance the understanding of the building's layout and evacuation routes, ultimately contributing to better preparedness and safety.

BIM models also serve as an invaluable tool for documentation and record-keeping. The digital model contains a comprehensive and up-to-date record of the building's fire safety features, simplifying the compliance checking process and ensuring that all information is readily accessible for authorities [26]. BIM's adaptability and change management capabilities are crucial for the dynamic nature of construction projects. When design changes occur during the construction process, BIM can automatically update the 3D model and associated data, ensuring that compliance checks remain aligned with the latest design revisions [27].

The incorporation of BIM technology in fire safety compliance checking processes presents a transformative opportunity for the construction industry in Malaysia. In integrating BIM into the fire safety evacuation compliance checking process, the Requirement Engineering (RE) process and Socio-Technical Systems (STS) theory could be adopted. The Requirements Engineering (RE) process is integral to managing requirements in BIM-based fire safety evacuation compliance checks [28]. The RE process involves five main stages, consisting of feasibility study, requirements elicitation, requirements specification, requirements verification and validation, and lastly, requirements management [29]. To integrate BIM initially in the fire safety evacuation compliance checking process, the first two stages of RE process could be adopted, namely, the feasibility study and requirements elicitation. The RE process starts with eliciting needs from potential users through interviews and workshops, followed by refining and prioritising these requirements to ensure they are feasible and aligned with project goals [30]. The requirements are then formally documented. After documentation, the requirements are validated to ensure they meet stakeholder needs. Finally, the process includes ongoing management to monitor and adapt requirements as the project evolves, ensuring continuous improvement [31]. The STS theory provides a framework for integrating social and technical elements in BIM-based fire safety evacuation compliance. It emphasises effective collaboration and communication, addressing resistance to change, and managing both technical complexities and human factors [32]. Iterative feedback and continuous improvement ensure that BIM tools remain user-centric and adapt to real-world conditions.

In conclusion, the incorporation of BIM technology in fire safety compliance checking processes presents a transformative opportunity for the construction industry in Malaysia. By leveraging the multidimensional capabilities of BIM, stakeholders can not only enhance the accuracy and efficiency of compliance assessments but also improve overall communication, collaboration, and safety outcomes. The adoption of BIM signifies a progressive step towards a future where fire safety is seamlessly integrated into the design, construction, and approval phases, ensuring a safer built environment for all.

RESEARCH METHODOLOGY

In this paper, a semi-structured interview method was adopted to achieve the research objective. This method strikes a balance between structure and flexibility where it entails a set of predetermined open-ended questions, allowing for exploratory discussions while ensuring that key topics are covered [33]. The semi-structured format helps to probe further into particular points of interest and adapt the conversation based on the participants' responses. In this paper, the questions are designed based on the Requirement Engineering (RE) process and Socio-Technical Systems (STS) theory in which the users' needs and perceptions were gathered. Each question aims to explore the potential aspects of BIM integration in the fire safety evacuation compliance checking process in Malaysia. The interview questions are divided into three sections, where Section A focuses on the respondents' current roles and responsibilities and their views on the limitations of the current process, Section B explores their past experiences in managing new technologies, while Section C inquire on their experience in using BIM in terms of challenges and mitigation in adopting BIM and their preferred approach in implementing BIM in an organisation.

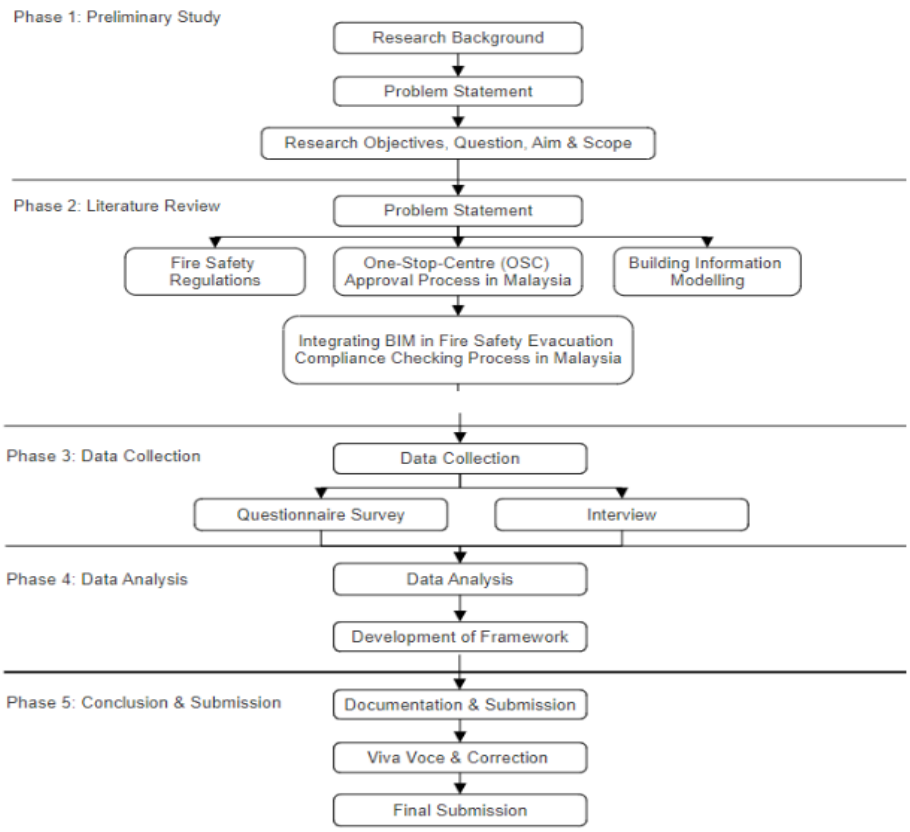

Figure 1: Methodology flowchart

This research framework offers a thorough five-phase method for examining how Building Information Modelling (BIM) is used into Malaysian fire safety evacuation compliance checks. The Preliminary Study is the main emphasis of Phase 1, which also defines the problem statement, objectives, questions, scope, goal, and research background. A thorough literature review covering fire safety laws, the One-Stop-Centre (OSC) approval procedure, and BIM principles is part of phase two, which ends with an emphasis on BIM integration for compliance verification. Phase 3 includes gathering data via questionnaires and interviews. Data analysis and framework development are part of phase four. Documentation, viva voce, revisions, and final submission mark the end of Phase 5.

15 respondents were interviewed, consisting of 10 Fire and Rescue Department of Malaysia (FRDM) officers, 3 fire engineers, and 2 architects. The respondents were chosen based on purposive sampling where the respondents have an experience of at least 10 years in either fire safety design or the fire safety compliance checking process and are well-informed with the One Stop Centre approval process in Malaysia and BIM implementation. A pilot study was conducted prior to the interview sessions to identify any ambiguities, redundancies, or questions that might have brought confusion to the respondents, contributing to the accuracy and relevance of the data collected in this study. After the interview sessions, the data were then analysed through content analysis to identify the meaningful patterns, themes, and insights within the data. A coding framework was developed, which consists of keywords and short phrases to categorise and label segments of the data. The coding process was iterative, where continuous refinement of the coding framework was conducted. Subsequently, patterns and themes were identified within the coded segments. The data is then

condensed, summarised, and interpreted within each theme, providing a concise representation of the content. The next section provides the themes and supporting evidence from the data, in a structured manner.

FINDINGS AND DISCUSSION

In this section, the key findings from this study are presented and analysed, which explores the potential of BIM integration in the fire safety evacuation compliance checking process. The main themes are categorised into five parts – key components to be considered in the compliance checking process, the limitations of the current process, the respondents' experience using new technologies, their preferred approaches in integrating BIM into the checking process, and lastly, the challenges and mitigation plans in the foreseeable future due to this integration. These themes are presented according to the following subsections.

A. Key Components in Fire Safety Evacuation Compliance Checking Process

The current fire safety compliance process involves several key components, such as evaluating the design and placement of fire doors, signage, and passive fire protection measures. The fire engineers and architects stated that while the regulations are the main guideline in fire safety design, particular attention is given to evacuation procedures to guarantee the safe evacuation of occupants in the event of fire. Based on FRDM officers, their roles and responsibilities include verifying evacuation plans, inspecting fire exits, and conducting drills. For example, Respondent 7, an FRDM officer, stated that "For fire safety, we zero in on the essentials: checking evacuation routes, inspecting fire suppression systems, and ensuring evacuation drills are carried out properly".

By addressing fire safety requirements during the design phase, potential hazards can be identified and mitigated before the hazards become critical issues. Most respondents highlighted the importance of early identification and assessment of fire hazards, which are essential steps in the initial stages of building design. This involves evaluating potential fire risks and incorporating necessary safety measures to mitigate them. Respondent 4, a fire engineer, mentioned, "One of the biggest strengths we've noticed is the early identification and mitigation of potential fire hazards, this really fosters a collaborative environment among everyone involved". Collaboration among stakeholders—building owners, designers, engineers, and regulatory authorities—is essential for effective implementation and continuous improvement of fire safety practices. In summary, this process involves early hazard identification, strategic design planning, and ensuring buildings meet safety standards and protect occupants in case of a fire. Each stakeholder plays a crucial role in ensuring that buildings are safe and compliant with fire safety regulations, ultimately contributing to the protection of occupants in case of a fire.

B. Identification of Limitation of the Current Process

Although the respondents were well-informed on their specific roles and responsibilities in the fire safety design and compliance checking process for evacuation, they believed that there are limitations to the current process. One of the limitations include the reliance on prescriptive requirements, which can be rigid and not always suitable for modern building designs. The need for ongoing education and training to keep up with evolving technologies and standards was also mentioned, as well as bureaucratic delays that can slow down the approval and inspection processes. As described by Respondent 3, an FRDM officer, "We need ongoing education and training to keep up with evolving technologies and standards, plus, the bureaucratic delays can slow down the approval and inspection processes".

Common challenges faced across various roles include resistance to change, technical complexities, and resource constraints. These issues can hinder the adoption and implementation of new technologies like BIM. For instance, Respondent 7, an architect, pointed out that reluctance to embrace new methods and technologies can slow down progress, while integrating new systems often requires specialised skills and knowledge. Additionally, resource limitations, such as staffing and budget constraints, further complicate these efforts. The respondent believed that overcoming these obstacles requires effective communication and collaboration. By fostering an open and supportive environment, stakeholders can share knowledge, address challenges, and pool resources to ensure successful implementation and operation.

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C. Experience with New Technologies

The respondents discussed their experiences with new technologies which include mobile inspection applications and BIM implementation. In managing BIM software effectively, the fire engineers and architects stressed the importance of support and training. One of the fire engineers highlighted the transformative impact of BIM on the planning and execution phases of construction projects noted. The fire engineers further noted that BIM enables the creation of highly detailed digital models that significantly enhance the accuracy of structural designs and improve coordination across different teams. However, they also acknowledged the steep learning curve associated with mastering BIM software. The complexity of the tools requires comprehensive training and ongoing support, which are essential to fully leverage BIM capabilities. The fire engineers emphasised the importance of having access to continuous technical support and updates to keep up with the rapidly evolving features of BIM software.

Architect echoed similar sentiments, appreciating the ability of BIM to facilitate better visualisation of building designs and more efficient collaboration with other stakeholders, such as engineers and fire safety consultants. BIM allows architects to visualise potential fire hazards in the design phase and to implement necessary adjustments before construction begins, thereby reducing risks and improving overall safety. However, architects also pointed out challenges in using BIM, such as the need for significant time investment in learning the software and the initial cost of implementation. They underscored the need for role-specific training programmes that focus on the aspects of BIM most relevant to architectural design and fire safety.

n the other hand, the FRDM officers shared their experiences with mobile applications for inspections, emphasising the importance of iterative feedback and pilot testing to ensure the technology works effectively in the field. Respondent 10 explained, “When we first started using the mobile apps, we encountered several issues, but through pilot testing, we were able to gather valuable feedback from the users. This iterative feedback process allowed us to make necessary adjustments and improvements. It’s not just about deploying the technology; it's about making sure it actually works in the field and meets the needs of the inspectors. This approach significantly improved our overall efficiency and effectiveness during inspections”. As stated by Paul et al. (2020), the iterative feedback process significantly improved the overall efficiency and effectiveness of a technology, as it allowed for real-world adjustments based on user experiences [34].

The experience with new technologies among respondents reflects both the opportunities and challenges of integrating tools like BIM into fire safety compliance checking. While the benefits of improved accuracy, collaboration, and efficiency are evident, the successful adoption of these technologies’ hinges on a socio-technical approach that includes comprehensive training, ongoing support, and effective communication. This approach addresses resistance and ensures that both the technical and social aspects are aligned, facilitating a smoother transition and enhancing the overall effectiveness of the technology in practice.

D. Approaches in Integrating BIM into Fire Safety Evacuation Compliance Checking Process

While the respondents’ levels of expertise with BIM vary, all respondents recognize its advantages. Architects typically have extensive experience in using BIM to design buildings that meet fire safety requirements. Engineers are skilled in creating and managing digital building models to expedite compliance processes and enhance overall fire safety management. Although BIM has yet to be integrated in the compliance checking process by fire authority in Malaysia, the FRDM officers are familiar with the advantages of BIM in construction projects especially during design stages.

In ensuring successful adoption of BIM in the construction industry, particularly for fire safety evacuation compliance checking, an efficient and firm management strategy is required. Respondent 9 explained, “As an architect, I can tell you that having strong leadership to steer the process, clear communication so everyone is on the same page, and extensive, practical training that’s tailored to each specific role are essential for successfully implementing new technology”. This is aligned with Graham (2017) where strong leadership, effective communication, and specialised training programs are essential for successful adoption of new

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technologies [35]. Respondent 9 further explained that the training programmes must be realistic, experiential, and customised to the particular requirements of each function to ensure that all users are properly equipped to implement BIM.

The respondents suggested that the BIM software used for compliance checking should feature user-friendly interfaces, real-time collaboration, advanced simulation tools, and seamless integration with existing fire safety systems. These features enhance communication, coordination, and compliance with fire safety regulations, leading to safer and more reliable building designs. To fine-tune and enhance BIM implementation, the respondents recommended incorporating user feedback through surveys, interviews, and frequent discussions. This continuous feedback loop helps to identify areas for improvement and ensures that the technology remains aligned with users' needs and regulatory requirements. For example, Respondent 3, an FRDM officer clarified, “In my opinion, it’s imperative to introduce BIM in a holistic manner. This entails considering the unique demands of regional authorities and incorporating comprehensive training initiatives and adoption-promoting rewards”.

In summary, the successful adoption of BIM for fire safety compliance depends on strong leadership, clear communication, specialised training, and well-equipped software. By focusing on these elements, stakeholders can improve fire safety and streamline compliance processes.

E. Challenges and Mitigation in Integrating BIM into Fire Safety Evacuation Compliance Checking Process

Most respondents mentioned that the challenges in implementing BIM in construction projects are often similar to the common barriers in adopting new technologies which include technical difficulties and resistance to change. To address these challenges, the respondents believed that specialised training programs and strong support networks are crucial. Tailored training ensures users can effectively understand and utilise BIM, while effective communication keeps all stakeholders aligned and informed throughout the implementation process.

One of the respondents recommended a phased implementation strategy to ease resistance and technical challenges, allowing users to gradually adapt to the technology. Respondent 8, a fire engineer explained, “As an engineer, I think that tackling resistance and technical difficulties through gradual adoption is a good strategy. By introducing the technology gradually, we lessen the initial shock and facilitate a smoother transition by allowing consumers to progressively become accustomed to it. This step-by-step method facilitates more efficient troubleshooting and technological adaptation”.

Fostering a collaborative environment is essential for successful fire safety compliance. One of the respondents suggested frequent coordination meetings and the use of cloud-based platforms for real-time information sharing significantly enhance efficiency and teamwork. This is aligned with Zamiri and Esmaeili (2024) where it was highlighted that a collaborative system provides real-time updates and seamless communication among diverse parties, ensuring that everyone stays informed and can respond promptly to any changes [36]. The respondents emphasised the importance of teamwork and communication, suggesting several improvements to the process. First, implementing centralised digital platforms for real-time information sharing offers stakeholders a single location to view and update relevant data. This ensures that everyone is aware of the latest developments and could react immediately. Second, encouraging proactive interaction and feedback from all parties involved fosters a more transparent and dynamic process. This approach not only expedites the approval process but also enhances its overall efficacy by ensuring comprehensive evaluation and implementation of fire safety measures.

In summary, overcoming barriers to BIM adoption in construction requires specialized training, effective communication, and a gradual implementation strategy. By promoting collaboration and using centralized digital platforms, stakeholders can improve coordination and efficiency, leading to more effective fire safety compliance.

CONCLUSION AND FURTHER RESEARCH

Implementing BIM in fire safety compliance offers significant advancements in accuracy, efficiency, and collaboration among stakeholders. To fully leverage these benefits, BIM should be integrated into all stages of fire safety planning and maintenance, with a focus on real-time communication between authorities, contractors, engineers, and architects. Overcoming challenges related to standardization, training, and resistance to change is crucial for successful adoption, ensuring that all parties are equipped to handle evolving safety requirements. Key components for effective BIM-based fire safety include user-friendly interfaces, real-time collaboration tools, advanced simulation features, and smooth integration with existing fire safety systems. User-friendly interfaces make BIM accessible to all stakeholders, encouraging wider adoption. Real-time collaboration ensures all participants are updated and can contribute effectively to decision-making. Advanced simulations allow for precise modelling of fire scenarios, improving safety measures. Integration with current systems streamlines data and processes for comprehensive fire safety management. A solid implementation plan is essential, including training and education programs tailored to various stakeholders, ensuring that FRDM officers, engineers, and architects are proficient with BIM. Continuous feedback and cloud-based platforms for information sharing, along with regular coordination meetings, will enhance the efficiency and effectiveness of fire safety compliance. In summary, successful BIM-based fire safety compliance requires strong leadership, clear communication, comprehensive training, and robust support systems. By addressing these needs, local authorities could improve their fire safety processes, leading to safer buildings and more efficient evacuation protocols during emergencies. Future works include determining the relevant features for BIM-based fire safety evacuation compliance checking by local authorities, and subsequently, developing a framework for the system.

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