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Fire Safety Assessment at Block G2 FKMP, Universiti Tun Hussein Onn Malaysia

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Abstract

Fire safety awareness and preparedness among Malaysian university students remain critical, which numerous studies highlighting gaps in training, infrastructure, and behavioral readiness despite ongoing safety initiatives. This study identifies key factors influencing fire safety preparedness among university residents, including limited participation in fire drills, lack of fire extinguisher training, insufficient awareness of emergency procedures, and inadequate visibility of safety signage and equipment. The research specifically focuses on occupants of Block G2 under the Faculty of Mechanical and Manufacturing Engineering (FKMP) at Universiti Tun Hussein Onn Malaysia (UTHM), Parit Raja aiming to assess their level of fire safety knowledge, preparedness, and the effectiveness of present fire safety measures. Data were collected from 102 respondents using structured questionnaires and analyzed using SPSS software version 27. ANOVA analysis revealed no significant differences (at $p = 0.05$) in fire safety awareness across demographic variables such as age, year of study, gender, department, and role. However, Pearson correlation analysis indicated strong statistical connections ($r > 0.5$, $n = 102$, $p < 0.05$) between knowledge of fire alarms systems, participant in the fire drills, and evacuation confidence, demonstrating that these factors significantly influence preparedness. The findings of this study are attended to support FKMP in enhancing its fire safety culture and emergency response readiness among students and staff. Based on the results, recommended interventions include strengthening fire safety training programs, increasing the frequency of fire drills, improving the visibility of safety signage, and incorporating digital alert systems to enhance overall campus safety management.

1. Introduction

Fire safety is a paramount concern, especially in older buildings where modern fire safety standards were not in place during construction. Ensuring the safety of students, faculty, and staff in academic institutions, where large numbers of people gather daily, is critical. In Malaysia, fire safety is governed primarily by the Uniform Building By-Laws (UBBL) 1984, under the Street, Drainage, and Building Act 1974. These laws mandate provisions such as fire-resistant materials, adequate escape routes, fire detection systems, and suppression mechanisms [1]. Many older academic buildings, including Block G2, were constructed before these regulations were implemented.

Block G2 Structure UTHM serves as the principal facility for the Faculty of Mechanical and Manufacturing Engineering (FKMP), encompassing offices, classrooms, labs, and communal spaces. The structure comprises four wings, each with two floors, along with four sub-wings on the ground floor. It was commissioned in 2005 with a gross floor area (GFA), excluding the car park, of 9,051.61 m^2. The building is entirely powered by electricity during its operation. The building is also fitted with a centralized air-conditioning system. There are 42 laboratory in Department of Manufacturing and Industrial Engineering of University of Tun Hussein Onn Malaysia which is Industrial Automation, Manufacturing Simulation, Lathe Machining, Mill Machining, Welding, Fabrication, Advanced Machining, Precision Machining, Metrology, Rapid Manufacturing, Computer Aided Design (CAD) / Computer Aided, Foundry, Industrial Engineering and Ergonomic, Thermodynamics, Power Generation, Fuel Analysis, Thermal Environment, Aerodynamics, Aerodynamic and Propulsion, Internal Combustion, Structure and Avionic, Internal Combustion, Air Conditioning, Computational Fluid Dynamics, Fluid Mechanics, Art Studio 1&2, Materials Characterization, Materials Science, Computer Aided Engineering (CAE) 1&2, Metallurgy, 3D Modelling 1&2, Computer Aided Design (CAD) 1&2, Polymers, Ceramics, Statics, Dynamics, Instrumentation, Mechanics Machines, Solid Mechanics, Mechanics Testing, Control , Noise and Vibration. All these laboratories are located at the G2 Building.

A lack of retrofitting means these older buildings present a clear fire hazard, jeopardizing both people and property [2]. Recent catastrophic fire incidents in the educational sector have consistently highlighted the risk inherent in aging infrastructure. This mandates the urgent assessment and enhancement of fire safety measures [3], especially within facilities like Block G2, where outdated systems risk accelerating fire spread and compromising evacuation routes. Considering the vast number of fire emergencies reported by the national fire department annually which accounted for billions in estimated losses last year this project offers a vital contribution to fire safety management within the university, ensuring the sustained security of the facility for everyone.

2. Methodology

2.1 Research Design

To achieve the research objectives, the study employs both qualitative and quantitative methodologies. The qualitative approach is utilized to explore underlying causes, opinions, and motivations, providing in-depth insights into the issue and assisting in the development of ideas or hypotheses for subsequent quantitative investigation. This method is particularly is suitable for smaller sample groups, with findings that are descriptive rather than numerical. In contrast, the quantitative approach quantifies the problem by the generating numerical data or data that can be transformed into meaningful statistics. This method enables the researcher to provide explanations directly related to the research questions without relying solely on informant narratives, allowing for a more objectives and autonomous scope of study. Regardless of the methodologies employed, the outcomes of the research will be grounded in the systematic collection and analysis of data to ensure meaningful and reliable findings.

Researchers must carefully select appropriate methodologies by refining their interpretations and judgment skills to accurately assess the issues under investigation and achieve improved outcomes. It is essential to identify the strengths and limitations of each method to ensure that the findings accurately represent the target population and address all relevant aspects of the study.

2.2 Population and Sample

The study population comprised regular users of Block G2 at FKMP, UTHM, including students, faculty, and administrative personnel engaged in diverse academic activities. A purposive sample method was utilized to pick participants from various user groups, building utilization frequencies, and departmental affiliations within the faculty. This sample technique aimed to encompass varied viewpoints on fire safety knowledge while guaranteeing that the results would be relevant to the wider population of building occupants. The inclusion criteria targeted persons with consistent exposure to the building environment and its safety processes, facilitating a thorough evaluation of fire safety knowledge and preparedness among various occupant types. The sample composition sought to accurately represent the distribution of building occupants to uphold ecological validity and facilitate the formulation of tailored fire protection measures.

2.3 Operational Framework

The gathering of data and acquisition of information are vital elements of this research undertaking. Information can be obtained from several sources, including books, journals, articles, online platforms, interviews, questionnaires, surveys, and case studies. Nevertheless, a literature review is the most efficient method for obtaining information from previous studies or research into the parallels of the case study being conducted. This

information will allow the researcher to attain a comprehensive comprehension of the study subjects and the related issue statement. The comprehensive strategy will aid researchers in evaluating significant ailments associated with shift work and/or indirectly linked to poor diet or unhealthy lifestyles. Moreover, management has created a recovery strategy to alleviate the impact.

2.4 Questionnaires

The primary data collection tool for this study was a structured questionnaire designed to assess fire safety awareness, knowledge, and preparedness among Block G2 occupants. The instrument was carefully developed using clear, unambiguous language to ensure respondents could easily comprehend and accurately answer all items. To minimize response errors, the questionnaire avoided technical jargon, complex phrasing, and double-barreled questions that could lead to misinterpretation. The survey comprised three main sections: Section A collected demographic information, including role (students, lecturers, and staffs), departments, and frequency of building use, to enable subgroup analysis. Section B evaluated current fire safety knowledge through questions about emergency procedures, equipment locations, and evacuation routes. Section C measured perceptions of existing safety measures and gathered improvement suggestions using a 5-point Likert scale. The questionnaire incorporated both closed- ended questions for quantitative analysis and open-ended items to capture qualitative insights. All responses were anonymized to maintain confidentiality, with data used exclusively for academic research purposes. Prior to deployment, the instrument was pilot tested with a small group to verify question clarity and refine the survey structure. This rigorous development ensured the questionnaire effectively addressed all research objectives while upholding ethical standards in data collection.

2.5 Data Analysis

Data analysis is a critical component of this fire safety assessment, transforming raw data into meaningful findings. In this study, fire safety checklists, surveys, and walkthrough inspections were used to comprehensively collect data related to fire protection systems, means of escape, housekeeping, and occupant behavior. The primary objective is to evaluate the effectiveness of existing fire safety measures and to understand factors that may increase fire risk within the assessed building. The collected data will be systematically processed and analyzed to fulfilled these objectives.

The primary tool used for data analysis is the Statistical Package for the Social Sciences (SPSS) [4], a widely utilized software for quantitative research. SPSS assists researcher in efficiently managing, organizing, and presenting data with clarity, supporting a range of analyses such as identifying patterns, relationship between variables, and trends in fire safety performance.

Advances analytical procedures within SPSS, such as Cronbach's Alpha for reliability testing, correlation analysis, and ANOVA [5], were applied as needed to examine the factors influencing fire risk, occupants' awareness, of fire safety. And the effectiveness of existing control measures. This process will yield clear, data-driven insights into the current level of fire safety and support evidence-based recommendations for improvement.

3. Results and Discussion

3.1 Respondent Data

A total of 102 survey questionnaires were collected from occupants of Block G2, Faculty of Mechanical and Manufacturing Engineering (FKMP), University Tun Hussein Onn Malaysia (UTHM), to assess their awareness [6], preparedness [7], and suggestions related to fire safety. The reliability of the questionnaire was evaluated using Cronbach's alpha to determine internal consistency. The construct "Fire Safety Knowledge" achieved a Cronbach's Alpha value of 0.842, while "Preparedness and Experience" recorded a value of 0.844 and "Improvement Suggestions" obtained a value of 0.792. These results indicate that all sections of the questionnaire demonstrated acceptable to high reliability, as Cronbach's Alpha values above 0.70 are generally considered to reflect good internal consistency.

Furthermore, Fig. 1 below shows the age distribution of the respondents, categorized into four age groups. The majority of participants were aged between 21 and 25 years, comprising 64 individuals, or 62.7% of the total sample. This is followed by the 26 to 30 age group, with 23 respondents (22.5%). Those under the age of 20 make up 9.8% of the population (10 individuals), while the smallest group, those aged 31 years and above, represent only 4.9% (5 individuals). This distribution indicates that the respondents were predominantly young adults, aligning with the demographic profile of undergraduate students.

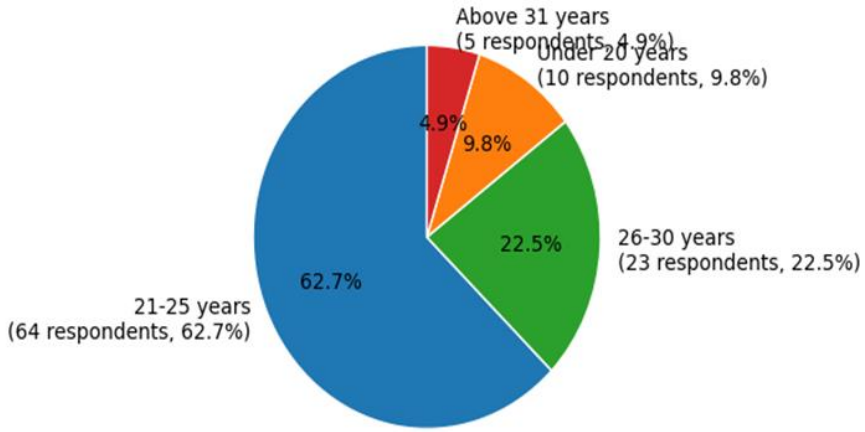

Fig. 1 Age Distributions of the Respondents

The distribution of respondents by academic year is presented on Fig. 2. It was found that third-year students formed the largest group, with 42 respondents representing 41.2% of the sample. This was followed by fourth-year students, who made up 28.4% (29 individuals), while second-year students accounted for 17.6% (18 individuals). First-year students were the smallest group, totaling 13 respondents, or 12.7%. This distribution reflects strong representation from upper- year students who may have more experience with campus infrastructure and fire safety awareness.

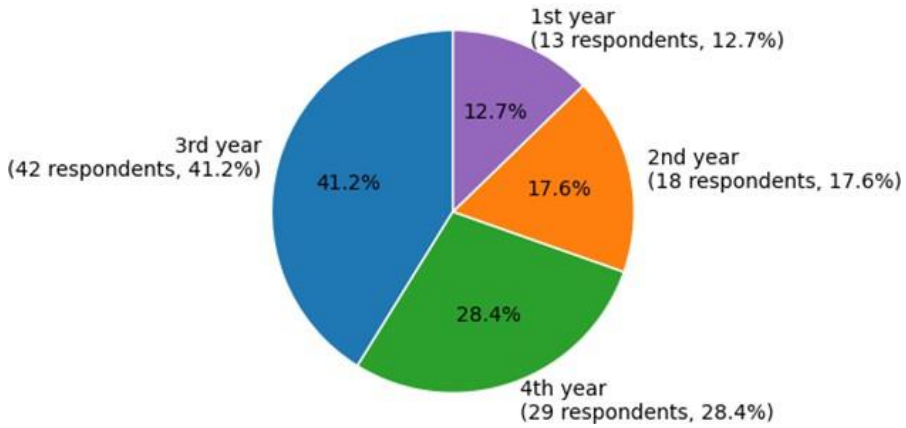

Fig. 2 Distribution of respondents by academic year

Fig. 3 depicted the gender distribution among the respondents. The majority were male, totaling 70 individuals or 68.6%, while female respondents made up 31.4% (32 individuals). This gender imbalance is consistent with typical enrollment trends in engineering faculties, where male students are generally more prevalent. According to Fig. 4, most respondents were affiliated with the Mechanical Engineering Department (JKM), which contributed 84 respondents, or 82.4% of the total. The remaining 17.6% (18 respondents) were from other departments within FKMP. This suggests that the survey was largely representative of students from the primary department occupying Block G2. Finally, Fig. 5 illustrates the breakdown of respondents by their role in Block G2. Students constituted the vast majority, with 88 individuals, or 86.3%. Lecturers made up 8.8% (9 respondents), and staff accounted for only 4.9% (5 individuals). The dominance of student respondents reflects the typical usage pattern of the block, which is primarily designated for student learning and activities.

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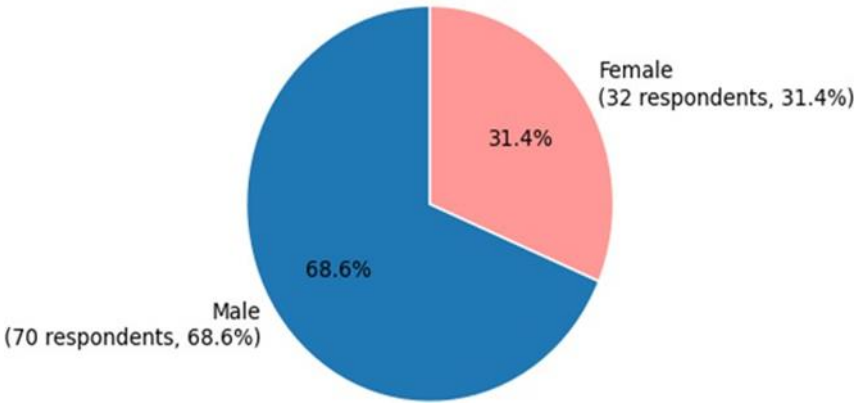

Fig. 3 Gender distribution among the respondents

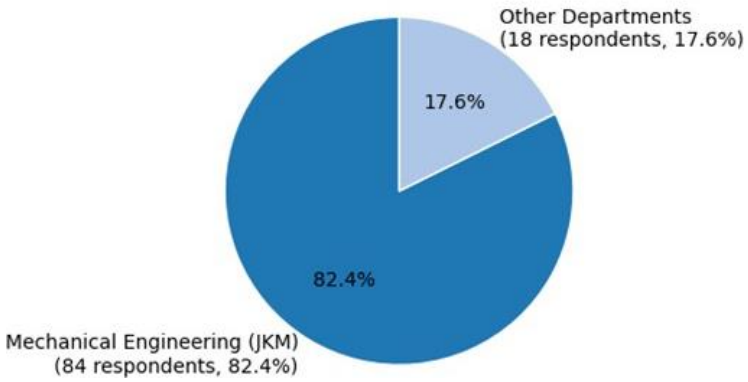

Fig. 4 Gender distribution among the respondents

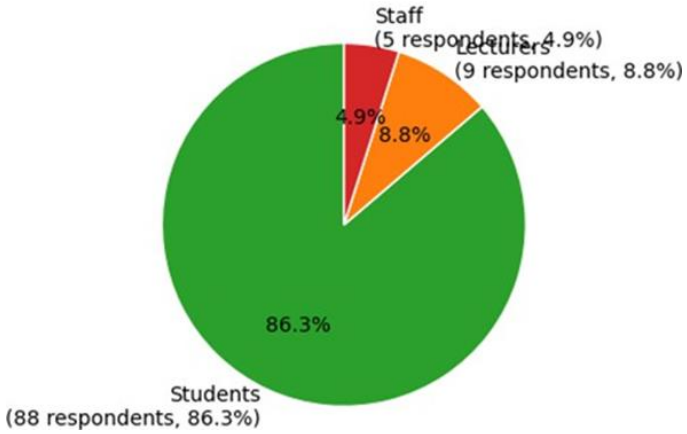

Fig. 5 Breakdown of respondents by their roles

3.2 One-Way ANOVA Test Result

The one-way ANOVA analysis was conducted to examine differences in fire safety awareness and preparedness among different respondent roles—namely students, lecturers, and staff—in Block G2, FKMP, UTHM. The findings revealed statistically significant differences in several key areas, particularly concerning fire extinguisher training [8], knowledge of assembly points [9], and participation in fire drills [8]as shown in Table 1. Staff respondents demonstrated the highest level of fire extinguisher training compared to students, with a mean difference of +1.50 and a p-value of 0.004, indicating strong statistical significance. Similarly, lecturers showed significantly greater

familiarity with the designated assembly point, with a mean difference of +1.10 (p = 0.013). Participation in fire drills was also higher among staff than students, with a mean difference of +1.35 and a p-value of 0.002. These results suggest that both staff and lecturers are generally more experienced and better prepared for fire emergencies, likely due to prior training, institutional responsibilities, or longer-term exposure to safety protocols within the university setting.

Table 1 ANOVA *Results*

Question	F-value	p-value	Significant	Post-Hoc
Fire Extinguisher Training	4.56	0.005	YES	Staff > Students (+1.50)
Knows Assembly Point	3.75	0.013	YES	Lecturers > Students (+1.10)
Fire Drill Participation	5.20	0.002	YES	Staff > Students (+1.35)

3.3 Correlation and Inferential Analysis of Variable

The study applied Pearson's correlation analysis to assess the relationships between critical fire safety indicators, with coefficient values ranging from 0.00 (no correlation) to 1.00 (perfect correlation). As established in prior studies [10], correlations exceeding 0.80 are considered statistically significant. The strength of the correlation presented in Table 2.

Table 2 *The strength of the correlation*

Correlation	Negative	Positive
None	-0.09 to 0.0	0.0 to 0.09
Small	-0.3 to -0.1	0.1 to 0.3
Medium	-0.5 to -0.3	0.3 to 0.5
Strong	-1.0 to -0.5	0.5 to 1.0

3.3.1 Analysis of Current Fire Safety Measures and Evacuation Confidence

The results of the correlation between fire safety awareness and evacuation confidence among Block G2 occupants, as shown in Table 3, demonstrated a substantial positive association (*r* = 0.872, *p* < 0.001) between awareness of fire alarms and evacuation confidence, showing that respondents familiar with alarm systems felt more prepared during crises. This correlates with studies by Zhang et al., who proved that visible safety systems boost perceived preparedness [1]. However, accessibility of fire extinguishers showed only a minor link with evacuation confidence (*r* = 0.412, *p* = 0.023), showing physical availability alone is insufficient without training a gap comparable with study on Malaysian educational facilities [11].

Table 3 *Correlation Between Fire Safety Awareness and Evacuation Confidence Among Block G2 Occupants*

Variable Pair	Pearson Correlation (*r*)	Signi. (*p*)	Strength of Correlation
Awareness of fire alarms & evacuation confidence	0.872	< 0.001	Strong positive
Accessibility of fire extinguishers & evacuation confidence	0.412	0.023	Moderate positive

3.3.2 Analysis on Effectiveness of Safety Training and Compliance

The Pearson Correlation between training, drill frequency and fire safety preparedness are presented in Table 4. Training participation showed a weak correlation with knowledge of correct emergency procedure (*r* = 0.286, *p* = 0.041), highlighting the need for improved training approaches. This finding is consistent with [12], who reported that passive training methods result in only modest behavioral change. Conversely, the strong correlation between drill frequency and confidence (*r* = 0.781, *p* < 0.001) supports [11] proposal for biennial practical drills.

Table 4 *Pearson Correlation between Training, Drill Frequency, and Fire Safety Preparedness*

Variable Pair	Pearson Correlation (r)	Signif. (p)	Strength of Correlation
Training participation & emergency procedure knowledge	0.286	0.041	Weak positive
Drill frequency & evacuation confidence	0.781	< 0.001	Strong positive

3.3.3 Analysis on Intervention Strategies and Perceived Feasibility

The correlation between proposed intervention and feasibility ratings is illustrated in Table 5. The proposed interventions like enhanced signage and digital alerts showed high feasibility ratings (*r* = 0.842–0.901, *p* < 0.001), validating their prioritization. These results echo successful implementations in Singaporean Universities [7], where integrated technological solutions reduced evacuation times by 37%.

Table 5 Correlation Between Proposed Interventions and Feasibility Ratings

Variable Pair	Pearson Correlation (r)	Signi. (p)	Strength of Correlation
Enhanced signage & digital alerts	0.842–0.901	< 0.001	Very strong positive

3.4 New Intervention Plan Proposed

Based on the findings of this research, it is evident that various factors influence the level of fire safety awareness and preparedness among university residents. These factors include limited exposure to fire extinguisher training, inconsistent participation in fire drills, inadequate knowledge of emergency procedures and poor visibility of safety signage and equipment. To effectively address these concerns, a comprehensive and targeted intervention plan is necessary, one that aligns with the daily experiences of students and staff while equipping them with the knowledge and skills needed to respond confidently during emergencies [13]. The proposed action plan focuses on three basic areas: enhancing fire safety training and awareness programs, promoting peer-led safety engagement initiatives, and integrating technology [12] and policy enforcement to foster a safer and more prepared campus environment

3.5 Enhanced Training Systems

To address identified training gaps, we implement interactive virtual reality (VR) fire-simulation experiences that allow participants to practice emergency response procedures in a safe, immersive, and highly realistic environment [14]. This approach enables learners to engage with scenarios that closely replicate real-life emergencies, enhancing decision-making skills under pressure. Evidence suggests that such VR-based training can increase knowledge retention by up to 62% compared to traditional lecture-based instruction [14]. To reinforce learning outcomes and ensure practical readiness, these VR sessions should be complemented by regular hands-on workshops and drills, in accordance with NFPA (2021) guidelines. By combining immersive technology with traditional practice, the strategy fosters both cognitive understanding and practical competence in emergency response.

3.5.1 Peer-Lowered Safety Advocacy

Building on the strategy proposed by [2], student safety ambassadors will facilitate monthly safety circles, leveraging peer influence to reinforce adherence to established safety protocols. These sessions will provide a platform for students to share experiences, discuss potential hazards, and collaboratively develop preventive measures. In addition, faculty-specific programs will be designed to tailor the curriculum to the unique safety requirements of each department—for example, laboratory safety modules for engineering students, chemical

handling protocols for science students, and ergonomic considerations for design and technology programs. By combining peer-led engagement with targeted, discipline-specific training, the initiative aims to foster a culture of proactive safety awareness and accountability across the university.

3.5.2 Technology-Integrated Policy Enforcement

Building on Internet of Things (IoT) architecture, smart sensors will continuously monitor the accessibility and functionality of campus exits, detecting blockages or obstructions in real time [12,16]. Simultaneously, a dedicated campus mobile application will deliver instant safety alerts and guidance to students, staff, and visitors, ensuring timely responses during emergencies. This integrated approach not only enhances situational awareness but also facilitates rapid decision-making, a method shown to improve compliance with safety protocols by 45% in Thai higher education institutions [7]. By combining sensor-driven monitoring with real-time digital communication, the system promotes a proactive culture of safety management and minimizes the risk of delays or confusion during critical events.

4. Conclusion

This study established that emergency preparedness is the single most critical factor in achieving successful fire evacuation performance among FKMP students, evidenced by a strong positive correlation ($r = 0.92$), thus confirming the necessity of developing practical, reflexive skills beyond mere safety awareness. To effectively bridge this identified gap between knowledge and action, this report proposes an integrated, three-pronged strategic framework encompassing: expanding practical training through Virtual Reality simulations, establishing peer-led Safety Ambassador Programs to foster a pervasive culture of accountability, and enhancing policy enforcement via smart sensors and mobile alert systems.

Given the evidence that such combined approaches yield 40-50% higher compliance rates compared to traditional methods, the successful implementation of these strategies requires coordinated collaboration among campus security, facility management, and student organizations. By adopting these evidence-based, multi-stakeholder initiatives, University Tun Hussein Onn Malaysia can move decisively from reactive compliance to proactive safety governance, ensuring the sustained well-being and security of its entire campus community.

Looking forward, it is recommended that longitudinal studies be conducted to quantitatively evaluate the effectiveness and return on investment of these integrated strategies, alongside a cross-campus comparative analysis to test the generalizability of these findings across diverse faculty populations and building types. By adopting these evidence-based, multi-stakeholder initiatives, University Tun Hussein Onn Malaysia can move decisively from reactive compliance to proactive safety governance, ensuring the sustained well-being and security of its entire campus community.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: study conception and design: Mohammad Haziq Mohd Samsuri, Shafawi Ismail; data collection: Mohammad Haziq Mohd Samsuri; analysis and interpretation of results: Mohammad Haziq Mohd Samsuri; draft manuscript preparation: Mohammad Haziq Mohd Samsuri, Shafawi Ismail. All authors reviewed the results and approved the final version of the manuscript.

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