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WELCOME SPEECH FROM THE CHAIRMAN

RISM 17th International Surveying Conference for Undergraduates (ISCU 2025)

بسم الله الرحمن الرحيم السلام

عليكم ورحمة الله وبركاته

Greetings to all,

It is with great pleasure that I welcome you to the 17th RISM International Surveying Conference for Undergraduates (ISCU 2025), themed “*Embracing Construction Revolution 4.0: Transforming Malaysia’s Built Environment.*” On behalf of the Royal Institution of Surveyors Malaysia (RISM), I also wish to express our sincere appreciation to Universiti Teknologi MARA (UiTM), Perak Campus, for graciously hosting this significant event.

As we navigate the era of the Fourth Industrial Revolution (IR4.0)—or in our context, Construction Revolution 4.0 (CR4.0)—we are witnessing transformative advancements across the global construction sector. Technologies such as Building Information Modelling (BIM), the Internet of Things (IoT), artificial intelligence (AI), robotics, big data analytics, and cloud computing are redefining the way we build, manage, and interact with our built environment. For Malaysia, embracing CR4.0 is a strategic imperative to achieve our socio-economic and environmental goals.

This conference serves as a vital platform to unite surveying undergraduates from various disciplines, fostering critical dialogue on industry challenges, enhancing professional networking, and preparing a new generation of talent for the rapidly evolving construction landscape. It is also an opportunity for employers to engage with and inspire our future professionals.

I would like to extend my heartfelt thanks to all industry speakers, paper presenters, judges, and participants for their time, contributions, and support in making ISCU 2025 a success. I also commend the organising committee for curating a meaningful and dynamic conference experience.

May the knowledge gained, connections formed, and ideas exchanged during this event inspire all participants to lead and innovate in their future endeavours.

Wishing everyone a productive and memorable conference.

Prof. Ts Sr Dr. Adi Irfan Bin Che Ani'

Chairman, Universities' Partnering Committee

RISM Session 2024/2025

May 2025

WELCOME SPEECH FROM CO-CHAIRMAN

RISM 17th International Surveying Conference for Undergraduates (ISCU 2025)

Bismillahirrahmanirrahim.

السلام عليكم ورحمة الله وبركاته and greetings to all.

It is my great pleasure to welcome everyone to the 17th International Surveyor Conference for Undergraduates (ISCU 2025), proudly hosted by Universiti Teknologi MARA (UiTM) Perak Branch in collaboration with the Royal Institution of Surveyors Malaysia (RISM). This event is a meaningful platform for students in the built environment to share ideas, showcase innovations, and build professional networks. We are honoured by your presence and enthusiastic participation, with 135 accepted papers and 78 poster presentations this year.

UiTM Perak, home to the College of Built Environment, has long been a hub for academic excellence in architecture, planning, and surveying. Our commitment remains strong in nurturing competent graduates who meet industry demands and contribute to nation-building.

While you're here, we invite you to experience the heritage and culture of Perak Tengah from the architectural richness of Rumah Kutai to the historical towns of Pasir Salak, Bota, and Kampung Gajah.

To all presenters and winners, congratulations on your achievements. Let your work today be a catalyst for future success and academic growth. We hope this conference will inspire you to explore new ideas, foster collaboration, and make lasting memories.

My deepest thanks to the Royal Institution of Surveyors Malaysia (RISM) and the organising committee for making this event a success.

We hope your experience here will be rewarding and unforgettable.

Thank you. Selamat datang dan selamat berjaya.

Associates Professor Dr. Nur Hisham Ibrahim, *PMP*

Co-Chairman, Universities' Partnering Committee

RISM Session 2024/2025

May 2025

WELCOME SPEECH FROM THE PROJECT DIRECTOR

RISM 17th International Surveying Conference for Undergraduates 2025

Alhamdulillah, all praise to Allah S.W.T. for His guidance and blessings in making the RISM 17th International Surveying Conference for Undergraduates (ISCU) 2025 a reality.

It is with great honour and gratitude that I welcome all participants, guests, academicians, and industry professionals to this prestigious event, proudly organized under the Royal Institution of Surveyors Malaysia (RISM). This 17th edition of ISCU stands as a proud testament to our collective dedication toward academic excellence, professional collaboration, and youth empowerment in the field of surveying.

I extend my heartfelt appreciation to RISM for its unwavering support, to the hardworking ISCU 2025 Organising Committee, and to all 16 partnering universities across Malaysia for their commitment and contributions. Your efforts have shaped this conference into a dynamic platform for knowledge exchange, innovation, and professional growth.

To the academicians and practitioners present, your insights are invaluable in bridging the gap between academic theory and real-world practice. To our undergraduate participants, your passion, curiosity, and commitment are the very foundation of our future. May this conference not only deepen your academic journey but also ignite a spirit of leadership, integrity, and sustainable thinking.

Let this gathering serve as more than an academic milestone. May it foster lifelong networks, inspire transformative ideas, and chart new directions in our shared professional journey.

Wishing everyone a rewarding and inspiring conference experience.

Sr Dr. Nurul Fadzila Zahari

Project Director

RISM 17th ISCU 2025

A CONCEPTUAL FRAMEWORK IN QUANTIFYING MOVEMENT CHARACTERISTICS OF PRE-SCHOOL CHILDREN IN FIRE EVACUATIONS: TOWARDS DATA- DRIVEN DESIGN FOR SAFE EGRESS

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ABSTRACT

Pre-school children are highly vulnerable during fire emergencies, yet empirical data on their movement characteristics during evacuations in Malaysia remain scarce. This study aims to establish key movement parameters, mainly travel speeds, flow rates and density through evacuation drills to inform the design of fire-resilient pre-school buildings. Fire evacuation drills will be conducted in three Malaysian pre-schools to collect quantitative data on children's movement. Travel speeds, movement flow, and density effects will be analysed in relation to factors such as corridor length, staircase configuration, exit width, and the level of physical assistance provided. Statistical and spatial analyses will be employed to derive critical movement parameters specific to pre-school environments. This study examines pre-school children's movement patterns including speed variations and assisted mobility to improve evacuation modelling and fire-resilient building design. Although limited to three pre-schools, the findings emphasize the need for expanded research to refine movement models across different environments. The results will guide age-appropriate evacuation routes, exits, and architectural designs, addressing gaps in Malaysia's pre-school fire safety standards. These insights will help designers, and policymakers create safer educational spaces by integrating fire resilience into early design stages. Future studies should incorporate larger datasets and assess movement behaviour in varied emergency scenarios.

Keywords: Fire evacuation, Fire safety, Movement characteristics, Pre-school children.

I. INTRODUCTION

Fire evacuation studies are critical for understanding and improving safety protocols during emergencies, particularly in high-risk environments such as hospitals and underground commercial areas. Research highlights the importance of simulating evacuation scenarios to assess the impact of various factors, including fire dynamics, human behaviour, and psychological responses. For instance, simulations in medical centres revealed that inadequate emergency exits significantly hinder evacuation efficiency, with many individuals unable to escape during a fire (Jahangiri et al., 2024). Additionally, time pressure models have been developed to reflect how fire conditions affect pedestrian decision-making and evacuation rates, demonstrating that environmental factors like heat and smoke influence behaviour and route choices (Yao et al., 2023).

Based on Hurley et al. (2016), Gwynne and Boyce mentioned the engineering timeline as shown in Figure 1.0 below represents the total evacuation process. This shows the overall evacuation movement from detection of fire to egress of the evacuee out of danger based on stimulation using computation software. This paper seeks to develop a conceptual framework for understanding evacuation readiness among pre-school children.

Based on Hurley et al. (2016), Kuligowski identified a timeline of human response during a building fire emergency as shown in Figure 2.0. This timeline includes a movement period encompassing a protective action phase. During this phase, individuals may engage in activities such as gathering personal belongings or assisting others in preparation for evacuation, actions intended to protect themselves or others before commencing evacuation.

Understanding these phases is crucial, as the pre-evacuation period can, in certain building types or emergency scenarios, be substantially longer than the subsequent movement period. This paper aims to quantify evacuation movement of Malaysian pre-schoolers, a group that has often been overlooked in existing models as most of the existing research revolves around adult settings (Hudina et al., 2019; Ishak et al., 2023; Noumeur et al., 2025).

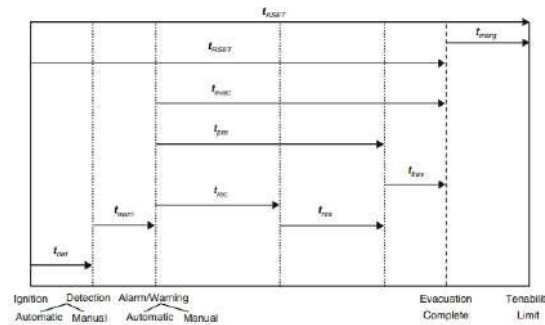


Figure 1.0: Evacuation timeline based on engineering and computational models
Source: Gwynne & Boyce, 2016

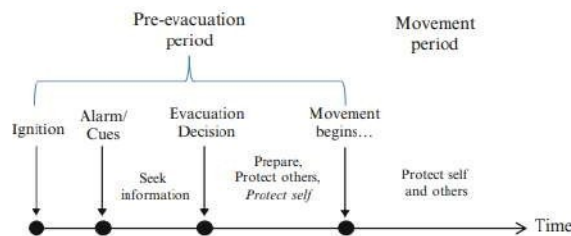


Figure 2.0 Evacuation timeline based on human response to a building fire emergency
Source: Kuligowski, 2016

Given the vulnerability of young children, fire outbreaks in pre-school and kindergarten buildings represent a particularly serious safety concern, with incidents reported both in Malaysia and worldwide. This study adopts a children-centered design to re-frame fire evacuation planning and design in educational buildings. A graph consisting of fire incident records based on different types of building occupancy from 2014 to 2023 is plotted as shown in Figure 1.3. The graph visualises a fluctuating trend for the fire incidents in school buildings from 2014 to 2018 and spiked up in 2019. However, there is a huge down trend starting from 2019 till 2021. The main reason for the down trend from 2019 to 2021 is because of the outbreak of COVID-19. All educational institutions in Malaysia were subject to closure on March 18, 2020, concurrent with the commencement of the first Movement Control Order (MCO) (Asadullah & Tham, 2023). Hence, most of the school started to implement online learning and not using the school building. Starting from 2021 to 2023, a rising trend of fire incidents in school buildings has been noted since schools reopened, highlighting a safety concern for children in educational institutions.

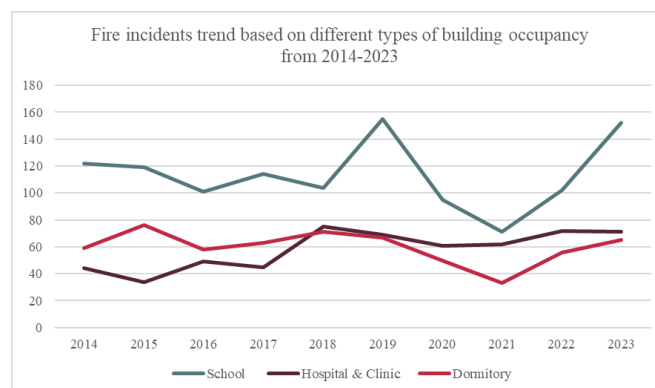


Figure 3.0 Fire incidents trend based on different types of building occupancy from 2014-2023
Source: Adopted from FRDM, 2025

Based on the statistics of Fire and Rescue Department of Malaysia (FRDM) (FRDM, 2023) as presented in Table 1.2 below, it shows the number of fire incident happened to the school building has increased from 71 cases in 2021 to 102 cases in 2022 and further increased to 152 cases in 2023. The substantial increase of 114% in school building fire incidents from 2021 to 2023 presents a grave concern for the safety of children in Malaysia.

Table 1.0 Statistic of Fire Incident according to Types of Structures from 2021 to 2023

Type of Structure	2021	2022	2023	Total
Residential	4177	4669	5267	14113
Apartment/Condominium	515	536	645	1696
Hotel	30	52	46	128
Dormitory/Hostel	33	56	65	154
School	71	102	152	325
Higher Education Institution	18	22	24	64
Hospital	26	14	32	72
Clinic	36	58	39	133
Office	199	160	183	542
Shop	804	903	982	2689
Shopping Mall	21	36	50	107
Assembly Hall	36	59	48	143
Store/Warehouse	273	233	257	763
Factory/Workshop	408	409	417	1234
Petrol Station	12	7	14	33
Special Structure	87	51	119	257
Others	731	981	1012	2724
Total	7477	8348	9352	25177

Source: Adapted from Annual Report 2023 FRDM, 2023

II. LITERATURE REVIEW

2.1 Pre-school Settings

Pre-school children are typically defined as those aged between 0 to 6 years, with a focus on the critical developmental phase from birth until they enter formal schooling. Various sources, including the National Association for the Education of Young Children (NAEYC), recognize early childhood as encompassing ages from birth to eight, while others narrow it down to 2 to 5 years for practical educational purposes (Mrazek, 2013; V.Vashchenko et al.). In educational contexts, pre-school education is specifically designed for children aged 0 to 5, provided through institutions such as nursery schools and kindergartens, which facilitate their growth and development in a structured environment (Wang, 2023). This period is crucial for fostering language skills, autonomy, and foundational cognitive abilities, preparing children for future academic challenges (Mrazek, 2013). The design of pre-school buildings significantly influences evacuation efficiency, particularly due to the unique movement characteristics of young children. Key design elements include corridors and staircase dimensions, which directly affect evacuation times; for instance, wider corridors (3.0 m) and staircases (3.6 m) have been shown to optimize evacuation performance, with corridor width being particularly impactful (Lian et al., 2023). Additionally, the design of staircases, including their width and the angle of junctions with corridors, plays a crucial role; optimal configurations can enhance movement efficiency and reduce congestion (Zhou et al., 2020). Furthermore, children's evacuation behaviour differs markedly from adults, as they exhibit slower speeds and are more prone to falls, which can significantly hinder evacuation processes (Fang et al., 2018; Zhang et al., 2020). Based on Mohidin et al. (2015), there are two types of kindergarten in Malaysia, which are building based and shop lot based. Normally, a dwelling-based kindergarten design which is under building based, can be often seen in Malaysia due to their optimal environment for the pre-school children. Understanding these dynamics is essential for creating safe and effective evacuation strategies in pre-school environments.

2.2 Active Fire Protection System

Active fire protection systems in pre-school buildings are essential for ensuring the safety of young occupants and staff. These systems typically include automatic fire sprinklers, which are crucial for controlling fires and preventing their spread, particularly in structures with various fire hazards and materials (Östman et al., 2022). Additionally, the design of fire protection systems must comply with updated regulations that emphasize safe evacuation routes and the effectiveness of emergency response measures (Pekhotikov et al., 2022). According to the Tenth Schedule of the Uniform Building (Amendment) By-Laws 2021, minimum installation requirements for fire alarm and fire extinguishment systems are specified based on building category. Table 2.1 below shows the requirements for the specification of pre-school buildings.

Table 2.0 Table Of Requirement for The Fire Alarm System and Fire Extinguishment System

Occupancy hazard	Extinguishing System	Fire Alarm System
II. Institutional (Education occupancy - Building used for the instructional purpose only.)		
i) Open corridor design		
aa) Two storeys and below	-	-
ab) Three to five storeys	hose reel system	manual electric fire alarm system
ac) Six storeys and above	hose reel system	automatic fire detection system & manual electric fire alarm system
ii) other designs		
aa) Less than 500 square metres per floor	-	-
ab) 500 to 1,000 square metres per floor.	hose reel system	manual electric fire alarm system
ac) 1,001 to 2,000 square metres per floor or 18 metres to 30 metres in height.	hose reel system	automatic fire detection system & manual electric fire alarm system
ad) Exceeding 2,000 square metres per floor or above 30 metres in height.	automatic sprinkler system & hose reel system	manual electric fire alarm system, public address system, fireman intercom system and fire command centre & automatic fire monitoring system

Source: Uniform Building (Amendment) By-Laws 2021, 2022

2.3 Travel Phase during the Fire Evacuation

Based on the study by Hurley et al. (2016), the travel phase is critical to ensure the safety of all occupants. This phase involves moving from the point of origin to a designated safe area, following established evacuation routes. It is essential to remain calm and composed, as panic can lead to accidents and hinder the evacuation process.

Occupants should be aware of the nearest exits and alternative routes in case the primary path is blocked by fire or smoke. It is important to stay low to the ground to avoid inhaling smoke, which can be more dangerous than the fire itself. If possible, cover your mouth and nose with a cloth to filter out harmful particles.

In a structured evacuation, individuals should follow the instructions of designated fire wardens or emergency personnel. These leaders are trained to manage the evacuation process and ensure that everyone reaches safety efficiently. Avoid using elevators, as they can become inoperative or expose occupants to smoke and fire. Instead, use stairwells, which are typically designed to be fire-resistant and provide a safer means of egress.

During the travel phase, it is crucial to assist those who may need help, such as the elderly, children, or individuals with disabilities. Ensure that everyone is accounted for and that no one is left behind. Once you reach the designated safe area, do not re-enter the building until it has been declared safe by emergency responders.

2.3.1 Horizontal Movement

The horizontal movement of pre-school children during fire evacuation is characterized by age-dependent travel speeds and behavioural patterns. Research indicates that Junior children (ages 3-4) exhibit lower mean travel speeds on horizontal routes, averaging around 1.9 m/s in corridors, compared to their Senior counterparts (ages 5-6), who also demonstrate a tendency to run during evacuations (Najmanová & Ronchi, 2023). The evacuation behaviour is influenced by the physical environment, with children moving faster in corridors than in doorways or on stair landings, where speeds drop to approximately 0.99 m/s (Najmanová & Ronchi, 2023). Additionally, pre-evacuation times are longer for younger children, which can impact overall evacuation efficiency. The findings emphasize the

necessity of considering these movement characteristics in fire safety design to enhance evacuation procedures for children (Kholshchevnikov et al., 2012; Larusdottir & Dederichs, 2011)

2.3.2 Vertical Movement

The vertical movement of pre-school children during fire evacuations is characterized by distinct behavioural patterns influenced by age, psychological factors, and environmental conditions. Research indicates that younger children (ages 4-6) exhibit slower vertical travel speeds, averaging around 0.53 m/s, and are more cautious on stairways compared to older peers (Yao & Lu, 2020). Observations from multiple evacuation drills reveal that children often rely on peer leadership, which can enhance movement speed, particularly in stairwell scenarios (Hamilton et al., 2019). Hamilton et al. (2019) also found that the specific flow rates at exits and stairways are significantly higher for children than adults, with a mean specific flow of 1.6 persons/second/metre noted. These findings underscore the necessity for tailored fire safety designs in pre-school environments that accommodate the unique movement characteristics of children during emergencies (Najmanová & Ronchi, 2023).

2.4 Movement Characteristics of Children in Fire Emergency

Children exhibit distinct movement characteristics and behaviours during fire emergencies, influenced by factors such as age, gender, and environmental conditions. Research indicates that younger children tend to have longer pre-evacuation times and slower movement speeds, particularly on stairways, compared to older peers, who are generally more agile and confident (Hamilton et al., 2019). Experimental studies reveal that children often prefer crawling to avoid toxic smoke, although this posture is more physically demanding than upright walking (Zhang et al., 2022). Additionally, behaviours such as running and pushing are common, significantly impacting evacuation times, with simulations confirming that the prevalence of pushing behaviour can prolong evacuations (Liang et al., 2024). Observational data from multiple evacuation drills highlight variations in speed and flow based on age groups, emphasizing the need for tailored safety protocols that consider these unique characteristics (Najmanová & Ronchi, 2023). Overall, understanding these behaviours is crucial for improving fire safety designs in child-centric environments.

2.5 Fire Evacuation Plan for Pre-School

Effective fire evacuation plans for pre-school children should incorporate several key recommendations based on recent research. Firstly, it is crucial to recognize the physiological differences in movement among children; for instance, stoop walking is recommended over crawling during evacuations to minimize physical strain and enhance speed while accessing breathable air (Zhang et al., 2022). Additionally, the design of evacuation routes should include clear signage and pathways tailored for young children, as their low visibility and response capabilities necessitate easily navigable escape routes (Choi & Kwon, 2015). Furthermore, evacuation drills should be regularly conducted to familiarize children with procedures, as they tend to follow established routines during emergencies (Larusdottir & Dederichs, 2011). Lastly, the integration of alarm systems can significantly reduce pre-evacuation times, ensuring a more efficient response (Larusdottir & Dederichs, 2011). Yoko et al. (2016) has highlighted 4 key considerations when making framework for fire evacuation plan for pre-school. This includes the time for the educators to prepare the evacuation, the characteristics of evacuation abilities of the pre-school children, the design of the stair in the pre-school buildings and the length of the evacuation route. Overall, these strategies aim to enhance the safety and effectiveness of fire evacuations for pre-school-aged children.

2.8 Overview

Existing research has explored aspects of safety in educational settings, such as educators' preparedness for emergencies (Hudina et al., 2019) and the awareness and knowledge of fire safety among kindergarten teachers in Malaysia (Ishak et al., 2023). Additionally, experimental studies on children's movement and behaviour during fire outbreak have been conducted in regions such as Prague, Czechia (Najmanová & Ronchi, 2023). However, there is a noticeable gap in research focused specifically on the behaviour of Malaysian pre-school children during fire outbreaks and the adequacy of emergency preparedness measures within local pre-school settings. Given the vulnerability of pre-school children and the increasing frequency of fire-related incidents, there is an urgent need for more robust and effective fire evacuation plans tailored to the Malaysian context (Julie et al., 2017; OECD, 2019). The current body of research on fire evacuation has largely overlooked pre-school children in Southeast Asian settings. By focusing specifically on Malaysian pre-school evacuation data, this study provides essential empirical evidence to address this significant research gap. Addressing this gap is critical to improve the safety and health outcomes of children in pre-school and kindergarten environments for Malaysian community. Therefore, this research aims to establish key movement parameters such as travel speeds and flow rates by collecting movement data through evacuation drills to ensure the design of pre-school buildings is fire resilient.

1.0

III. METHODOLOGY

In this study, the conceptual framework was developed through an iterative literature review process, involving continuous dialogue between sourcing and analyzing relevant academic works. Key sources were identified via ScienceDirect and the Scopus Library collection, prioritizing peer-reviewed journal articles, conference papers, academic books, and reports to ensure scholarly rigor (Jabareen, 2009; Waladt, 2020). There are three phases in developing the framework for this study (Jabareen, 2009; Barua et al., 2024), Figure 2.1 shows the process of the phase development for the framework. Conceptual model framework can be constructed by integrating the key components into a coherent structure that aligns with research aim (Waladt, 2020). Based on the literature review studied, 4 key components for this study have been identified which are spatial layout, child age, assistance type and evacuation time. A conceptual framework should consider to include the relationship between the key components of the study (Luft et al., 2022). Figure 2.2 represents the conceptual model framework for this study by illustrating hypothesised relationships between spatial layout, child age, assistance type, and evacuation timing

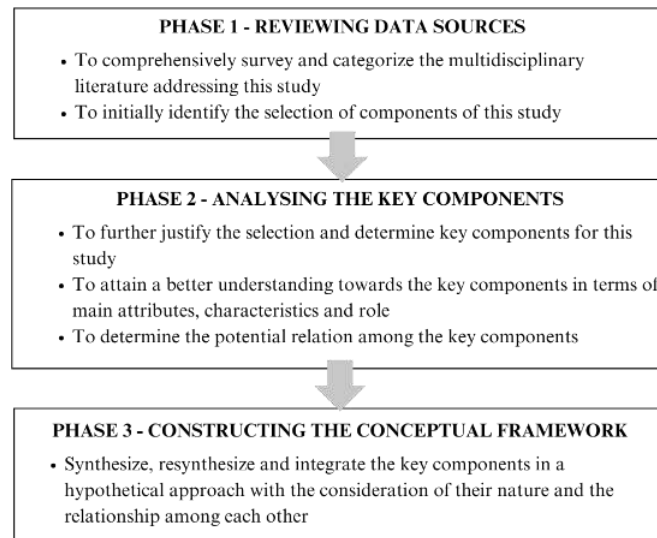


Figure 2.1: Phase development of the conceptual framework

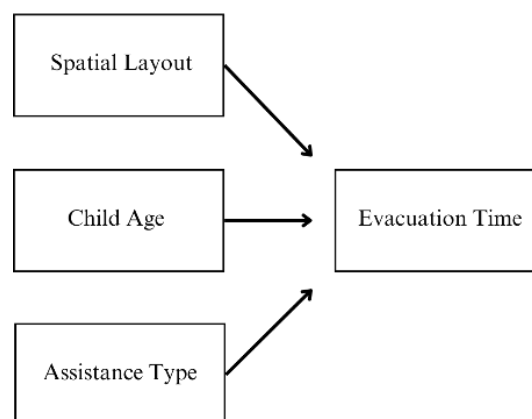


Figure 2.2: Conceptual model framework illustrating the link between the key concepts

To manifest the conceptual framework to collect the movement data, the method that will be used to conduct this study is mainly through quantitative data collection and analysis. The primary quantitative data collection method for this study is case studies that involves non-participant observation experiment, in the form of fire drill at the selected pre-school buildings. Non-participant observation will be implemented during the fire drill experiment, where the research team will set up visual devices and observe the fire drill without engaging or influencing the participants' action and behaviour. The focus of the case study is on pre-school buildings which cater pre-school children from the ages of 3 to 6 years old in Malaysia. Prior to commencing the research, ethical approval will be secured from the institute's research ethics committee. Given the involvement of children, implementing proper ethical safeguards and procedures is essential from the outset. Parental consent will be acquired through a passive approval process, whereby information letters will be distributed to parents outlining the study details and providing them the option to withdraw their child by returning a signed form. The project timeline for this study is estimated to commence for 7 months. The breakdown of the 7 months is shown as below:

- 3 months for preliminary preparation which includes the acquisition of the ethical approval and contacting the pre-schools.
- 2 months for 2 fire drill experiments for each pre-school with an interval time of 1 month
- 2 months for data analysis and discussion writing

Through these case studies, movement data will be gathered via observations and documentation such as building layout, providing rich insights into the research topic.

A comprehensive literature review has conducted and contributed to the initial stage of the research. The supporting material found will serve as a secondary data source for this study. Key themes such as pre-school, travel phase, horizontal movement and vertical movement has been focused for the review. This review serves as a fundamental reference for developing the experiment plan, ensuring that the primary data collection is well-planned and aligned with existing knowledge.

The quantitative data obtained from the experiment in the form of fire drill will undergo detailed analysis. Data analysis will be the primary method used to quantify the movement data, mainly towards the horizontal and vertical travel speed, flow rate and density. By integrating both primary and secondary data, the research aims to provide valuable assessments of both educator and student performance, enabling evaluation of existing evacuation facilities and plans while identifying potential shortcomings, ultimately leading to data-driven improvements in safety procedures, infrastructure, and emergency preparedness strategies.

IV. EXPECTED FINDINGS AND CONCLUSION

This study will define movement characteristics of pre-school children, including speed variations under different spatial constraints and the influence of physical assistance. These parameters will serve as fundamental inputs for evacuation modelling and the development of fire safety design guidelines tailored to pre-school buildings. While the study is limited to three pre-schools, its findings highlight the need for further research across diverse settings to refine movement models. Future studies should integrate larger datasets and explore variations in movement dynamics under different fire scenarios. Additionally, the development of a standardized fire safety framework for Malaysian pre-schools is recommended. The findings will support the design of optimized evacuation routes, age-appropriate exit configurations, and child-responsive architectural elements. This study underscores the importance of designing pre-school environments that facilitate efficient movement during evacuations, enhancing fire resilience at the design stage. Addressing a critical gap in fire safety research, this study systematically quantifies the movement characteristics of pre-school children during evacuations. The findings provide architects, fire safety engineers, and policymakers with essential data to develop evidence-based design and regulatory frameworks for safer pre-school buildings in Malaysia.

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