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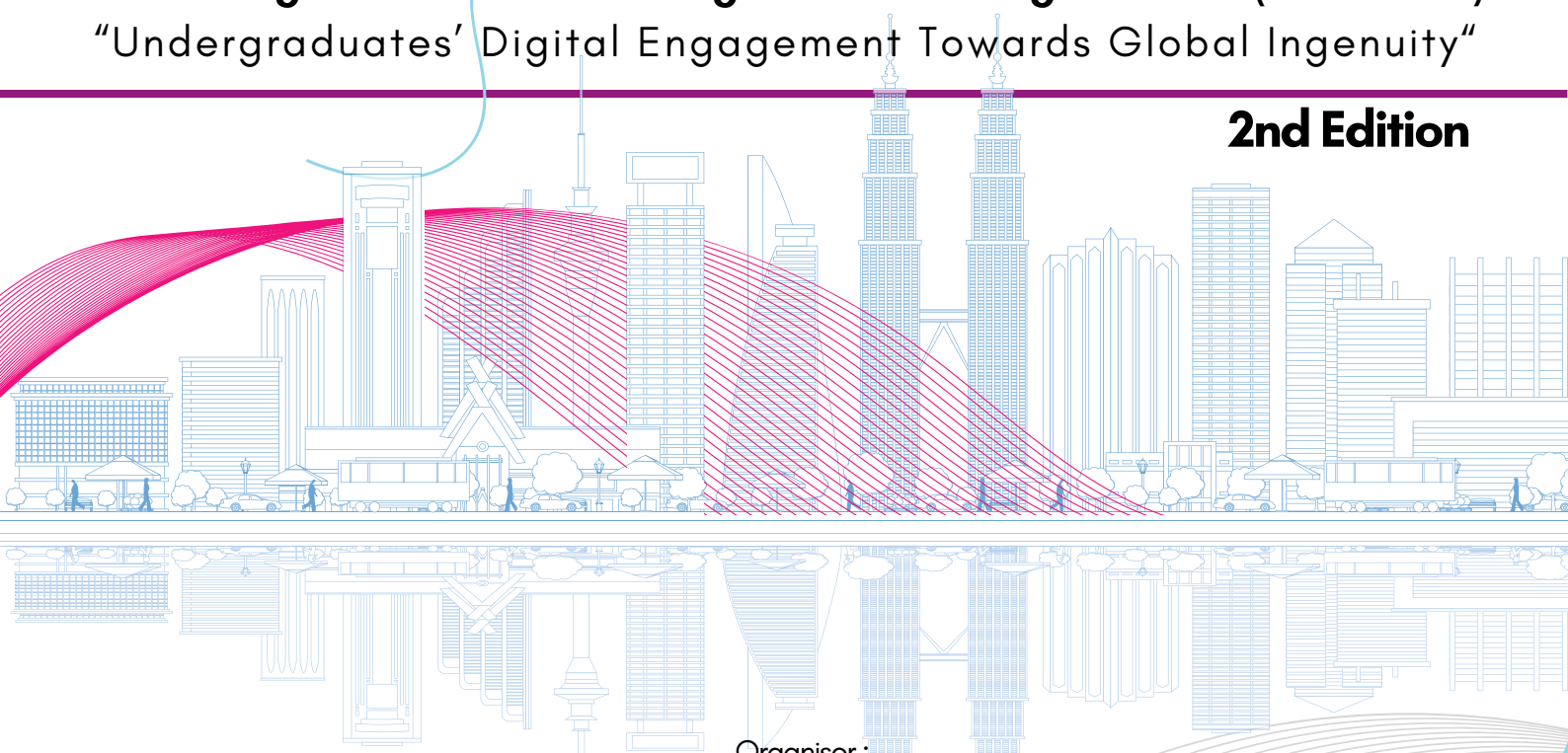
"Undergraduates' Digital Engagement Towards Global Ingenuity"

2nd Edition



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PORTABLE AMPHIBIOUS HOUSE

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Abstract
This comprehensive innovation report delves into the challenges associated with traditional amphibious housing. It proposes an innovative solution in the Portable Amphibious House, tailored explicitly for flood-prone regions, focusing on Malaysia's East Coast. An extensive literature review identifies critical issues such as prolonged construction times, inadequate sewerage systems, and the visibility of Expanded Polystyrene (EPS) foundations. The Portable Amphibious House introduces a ground-breaking concept that integrates the principles of prefabrication, amphibious design, environmental resilience, disaster preparedness, and cost-effective resilience. With a modular construction approach, prefabricated elements enhance construction efficiency, ensuring swift adaptation to dynamic environmental conditions. The Portable Amphibious House's buoyant design mitigates flood damage, improves occupant safety, and promises long-term cost savings. The marketability analysis underscores its potential relevance in flood-prone areas, particularly on Malaysia's East Coast, where seasonal monsoons pose recurrent challenges. By combining adaptability, sustainability, and reduced flood impact, the Portable Amphibious House emerges as a forward-thinking and resilient housing solution, aligning with Malaysia's commitment to innovative and sustainable development practices.

Keywords: *Portable amphibious house, flood-prone regions, prefabrication, environmental resilience, disaster preparedness*

1. INTRODUCTION

Floods represent the most frequent and devastating natural disaster globally, significantly impacting over 260 million people in the last decade alone. From 2006 to 2016, floods accounted for more than half of all natural disasters, with the 2016 flood resulting in nearly 4,000 deaths. In Malaysia, regions such as Johor, Kelantan, and Terengganu are particularly vulnerable to flooding (Roslan et al., 2019). The annual average loss due to floods in Malaysia includes property damage, fatalities, and other economic impacts, making up 98.7% of the total (Shariff & Hamidi, 2019). This highlights the urgent need for innovative and resilient housing solutions. This study aims to develop a Portable Amphibious House designed to mitigate flood damage and enhance occupant safety in flood-prone areas. Traditional amphibious housing solutions have been plagued by prolonged construction times, inadequate sewerage systems, and visible Expanded Polystyrene (EPS) foundations, which compromise their effectiveness and acceptance. This study addresses these challenges by proposing a portable and prefabricated amphibious house that can swiftly adapt to dynamic environmental conditions and provide long-term cost savings.

The methods employed in this study include an extensive literature review to identify the limitations of current amphibious housing designs and the incorporation of prefabrication principles to enhance construction efficiency. Additionally, buoyancy control mechanisms and advanced sewerage systems are integrated into the design to ensure sustainability and functionality during flood events.

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The marketability of the proposed design is evaluated through a comprehensive analysis of its potential application in Malaysia's flood-prone regions. The main results of this work indicate that the Portable Amphibious House offers a viable and innovative solution to the challenges posed by flooding. Its modular construction enhances adaptability and reduces construction time, while its buoyant design mitigates flood damage and improves safety.

2. LITERATURE REVIEW

This literature review explores two innovative concepts in contemporary architecture: portable buildings and amphibious houses. Portable buildings, often called modular constructions, represent a paradigm shift in construction methodology by offering movable rather than permanent structures. Originating from the Modern Methods of Construction (MMC), these buildings have gained popularity in developed countries like the USA and UK due to their flexibility, cost-effectiveness, and sustainability. They can be swiftly constructed, relocated, and reused without traditional foundations, making them suitable for various applications such as temporary shelters, mobile homes, and modular units in residential and commercial settings (Lawson et al., 2012; Sun et al., 2020).

The review emphasises the historical roots of movable structures, tracing back to ancient times when humanity devised portable shelters to adapt to diverse environmental conditions. Today, advancements in materials and construction techniques have enhanced the versatility and efficiency of modular buildings, promoting their integration into mainstream construction practices. Key advantages include reduced construction timelines, minimised material wastage, improved build quality, enhanced safety for construction workers, and the potential for energy-efficient designs utilising recyclable materials (Cerrahoglu & Maden, 2020).

In contrast, the concept of amphibious houses introduces a novel approach to architectural resilience against flooding. These structures, engineered to float during flood events while remaining anchored on stable foundations during normal conditions, represent a hybrid architectural solution. By utilising innovative building materials such as lightweight polystyrene, ferrocement blocks, and prefabricated components, amphibious houses mitigate flood risks effectively and offer practical benefits such as cost-effective flood prevention and enhanced accessibility for vulnerable populations (Robert Barker, n.d.; Urkude et al., 2019).

Integrating these concepts into contemporary architectural practices underscores their potential to address pressing challenges such as urban resilience, sustainable construction practices, and adaptive building solutions in the face of climate change. By synthesising historical precedents with modern engineering and design innovations, portable and amphibious houses exemplify a forward-thinking approach to architecture that prioritises flexibility, sustainability, and resilience in built environments.

3. METHODOLOGY

This section comprehensively reviews the methodologies and materials employed in the research on portable amphibious houses. The research process began with identifying the research problem, followed by a systematic approach outlined, guiding the sequential progression through interconnected scientific steps (Singh, 2021).

A preliminary literature review was conducted to establish foundational knowledge of portable and amphibious houses. This review encompassed design flexibility, construction methods, and environmental considerations (Research Concept Paper, n.d.; Torres, n.d.). It aimed to identify existing gaps and potential areas for innovation in portable housing solutions.

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Simulation methodologies were employed to gather and analyse data, utilising historical records and real-time data collection. These simulations aimed to model the behaviour and performance of portable amphibious houses under various environmental conditions (Ghosh, 2017).

The interpretation of data involved synthesising findings from the analysis to conclude the performance and potential applications of portable amphibious houses. This step was crucial in understanding how these houses could mitigate flood risks and contribute to sustainability in urban environments (Calzon, 2023).

4. RESULT AND DISCUSSION

This section delves into the results and discussions stemming from the objectives outlined in Section 1. It critically examines the identified issues and challenges associated with amphibious housing and introduces the innovative concept of the Portable Amphibious House as a potential solution.

According to the literature reviewed, the primary challenges with traditional amphibious houses include extended construction times and high costs. These houses, integrating flood-resilient features with conventional building methods, often face delays due to specialised engineering needs and additional materials. This can lead to heightened construction expenses and reduced economic viability compared to alternative building methods (Research Concept Paper, n.d.; Torres, n.d.).

In response to these challenges, the concept of the Portable Amphibious House was proposed to streamline construction processes and enhance adaptability. This innovation combines portability with amphibious design principles, allowing for quicker assembly and adjustment. This amphibious house aims to significantly reduce on-site construction time by leveraging prefabricated components, thereby improving overall efficiency (Sedano & Nopia, 2017).

The Portable Amphibious House is designed to cater to individuals and communities living in flood-prone or dynamically changing environments. It incorporates several key features to enhance resilience and functionality. Notably, its buoyant design enables it to float during floods, ensuring the safety of occupants. The structure includes buoyant materials and a robust framework supported by mooring poles, facilitating smooth vertical movement in response to varying water levels (Celik & Kamali, 2018).

Moreover, the Portable Amphibious House is characterised by its quick assembly capability, which is crucial for emergencies such as natural disasters. Prefabricated elements ensure a seamless construction process and minimal environmental disruption, offering a practical solution for rapid deployment in crisis scenarios (Kamsiah et al., n.d.).

In terms of construction materials, the foundation of a Portable Amphibious House typically incorporates components like pad footings, telescoping vertical guidance posts, and coated Expanded Polystyrene (EPS) buoyancy blocks. These materials are selected for their durability, buoyancy, and ability to withstand environmental challenges, ensuring the house remains stable and functional in flood conditions (Sedano & Nopia, 2017; Celik & Kamali, 2018).

Additionally, the structural framework of the Portable Amphibious House utilises lightweight steel for columns and bracing, optimising strength and resilience while minimising weight. This material choice supports the house's adaptability and longevity in aquatic environments, making it suitable for disaster-prone regions (Kamsiah et al., n.d.).

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Furthermore, visualisation tools like SketchUp Pro 2021 have been employed to illustrate the operational procedures and responses of the Portable Amphibious House under varying conditions. Figures 4.1 and 4.2 provide an overview of the innovation's overall looks and include labelling for reference. Figures 4.3 to 4.4 depict the house's behaviour during non-flood and flood scenarios, showcasing its dynamic response to water levels and highlighting its effectiveness in safeguarding residents and property (Sedano & Nopia, 2017).

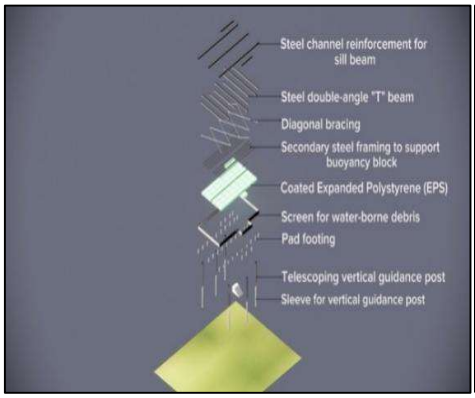

Figure 4.1: Foundation details and labelling

Figure 4.2: House details and labelling

Figure 4.3: Amphibious house in non-flood

Figure 4.4: Amphibious house in flood event

5. CONCLUSION

This paper underscores the need for innovative solutions in amphibious housing, which was identified through a thorough literature review. Highlighting challenges such as construction timelines, infrastructure deficits, and material visibility, it calls for novel approaches.

The Portable Amphibious House is a promising solution in Malaysia, particularly in flood-prone regions like the East Coast. Tailored to adapt to rising water levels, it offers resilience against seasonal floods and aligns with Malaysia's sustainable development goals.

The Portable Amphibious House represents a significant stride as Malaysia strives for environmental sustainability and disaster resilience. Combining adaptability with cost-efficiency, it holds the potential to safeguard communities and foster a more sustainable future.

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