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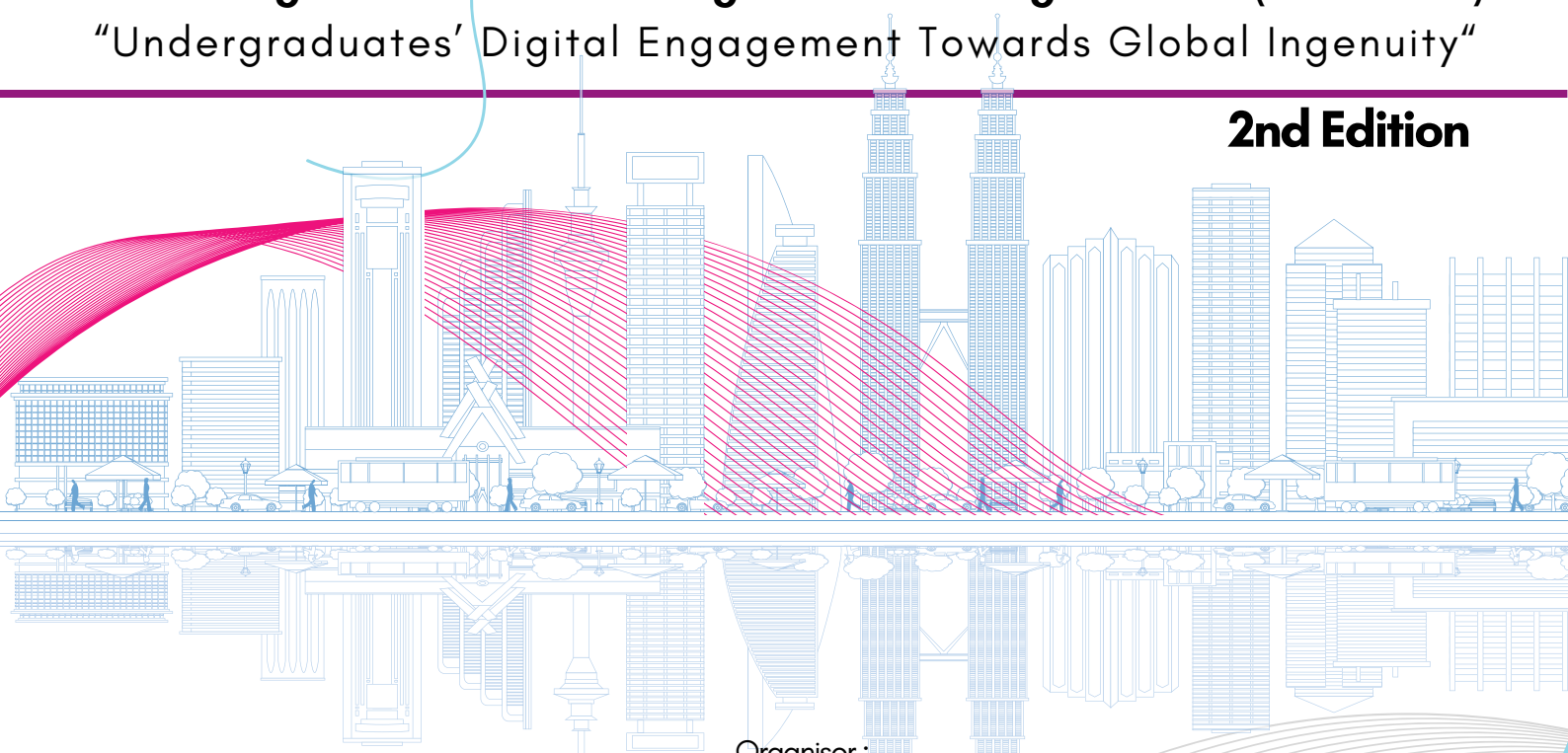
Proceeding for International Undergraduates Get Together 2024 (IUGeT 2024)

"Undergraduates' Digital Engagement Towards Global Ingenuity"

2nd Edition



Organiser :

Department of Built Environment Studies and Technology, College of Built Environment, UiTM Perak Branch

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INSPIRED 2024. Office of Research, Industrial Linkages, Community & Alumni (PJIMA), UiTM Perak Branch

Bauchemic (Malaysia) Sdn Bhd

Universitas Sebelas Maret

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Publication date :

November 2024

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Perpustakaan Negara Malaysia Cataloguing in Publication Data

No e- ISBN: 978-967-2776-42-0

Cover Design: Muhammad Anas Othman
Typesetting : Arial

e-ISBN: 978-967-2776-42-0

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e-ISBN: 978-967-2776-42-0

THE TILES INSTALLER ROBOT

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Abstract
This comprehensive study delves into the Tiles Installer Robot, highlighting its inception, progression, and integration into the construction field. The methodology employed involves rigorous experimentation, wherein the robot's efficiency and precision in tile installation undergo meticulous evaluation within a controlled setting. Our design framework incorporates features aimed at enhancing problem-solving capabilities and providing factual visualizations aligned with predefined research parameters. Extensive desk research provides invaluable insights into public perception, practical applications, pricing structures, capabilities, and commercial availability. Advancing the Tiles Installer Robot relies heavily on the meticulous analysis of data, which illuminates technological intricacies, installation process efficacy, and the robot's adaptability to diverse environments. The design study meticulously examines the conceptual underpinnings of the project, encompassing structural components, navigation techniques, tile installation methodologies, and the utilization of simulations to gauge performance across various scenarios. The design carefully integrates ergonomics and user interface considerations, resulting in a solution that aligns seamlessly with project objectives. Domain specialists collaboratively crafted this avant-garde solution, meticulously detailing it within the report's chapters. The research findings not only enrich the burgeoning realm of robotic technologies in construction but also underscore the paramount importance of innovative design and evidence-based decision-making in fostering excellence in construction robotics.

Keywords: *The Tiles Installer Robot, Construction sector, Experimental design, Technological complexities, Evidence-driven decision-making*

1. INTRODUCTION

The urgent need for sustainable and innovative solutions within the construction sector is driven by population growth and climate change. The industry's focus on planning, design, and construction economics underscores this necessity, emphasizing its commitment to sustainability. However, challenges such as poor Industrialized Building System (IBS) construction management have hindered progress, leading to delays, subpar craftsmanship, and budget overruns. These issues highlight the importance of contractors comprehensively understanding and adeptly handling categorization challenges (Jabar et al., 2013).

In Malaysia, sustainability is paramount, as evidenced by the government's initiatives outlined in the Construction Industry Master Plan (2005–2015). These initiatives aim to integrate IBS features, promoting green construction practices and ensuring long-term economic stability. The principles of sustainability inherent in IBS contribute not only to environmental protection but also to addressing pressing concerns such as air and water quality, solid waste reduction, and conservation of natural resources (Kamar et al., 2010; Musa et al., 2014)).

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Prefabrication techniques, such as volumetric construction and modular housing, offer significant advantages in terms of speed, efficiency, and quality. For example, modular homes are factory-built structures that allow for rapid on-site assembly, reducing construction time and costs (Jessica, 2022; Steinhardt & Manley, 2016).

The integration of automation and robotics into construction processes holds immense potential for enhancing efficiency, quality, and safety, particularly within the framework of IBS construction. However, a comprehensive understanding of the factors influencing their performance is crucial to maximizing their potential benefits (Rashid et al., 2019).

In conclusion, this report highlights the transformative potential of automation, robotics, and prefabrication techniques in the construction industry. By embracing innovative technologies and sustainable practices, the industry can overcome traditional challenges and pave the way for a more efficient, resilient, and environmentally conscious future.

2. MATERIALS AND METHODS

A design framework constitutes a structured approach or set of guidelines that underpins the design process. It ensures a systematic and organized method for designing a product, service, or system, thereby guaranteeing uniformity, efficiency, and effectiveness in design tasks. Figure 1 illustrates the research flow for the Tiles Installer Robot project. The research phase commences with an extensive literature review, followed by the stages of design and prototyping, and moves to evaluation and validation. This phase includes the formulation of research problems and the establishment of research objectives. The subsequent phase delves into the conceptualization of the Tiles Installer Robot, addressing aspects such as a safe working environment, maintenance protocols, and floor surface considerations derived from previous studies on floor tile issues. This phase also encompasses observation, analysis of experimental data, and an online survey. The process then advances to the selection and decision-making regarding floor tile materials and properties. The final phase involves the development and implementation of the Tiles Installer Robot, focusing on overcoming the identified challenges and enhancing the efficiency and quality of tile installation. This comprehensive approach ensures that the project not only addresses existing issues but also sets new benchmarks for innovation in the construction industry.

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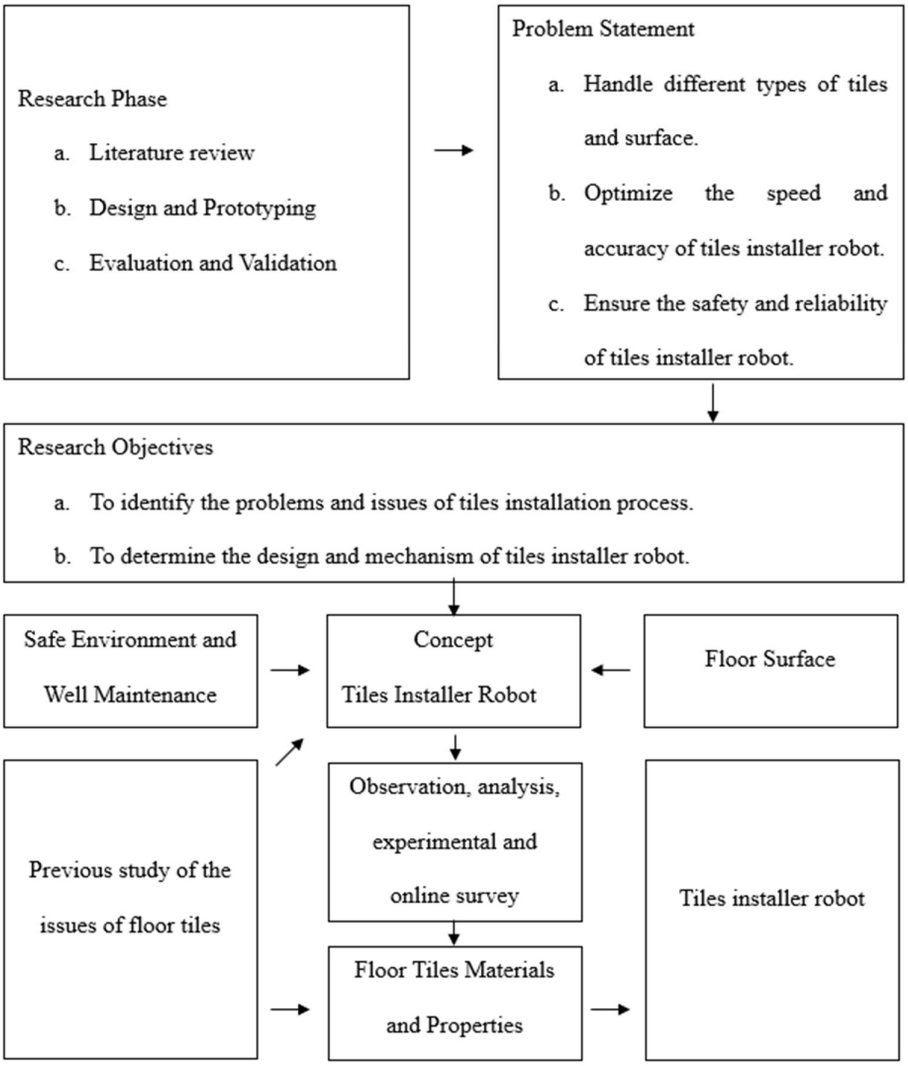

Figure 1. Research flow of the Tiles Installer Robot Innovation project

3. RESULTS AND DISCUSSION

3.1 Performance of Proposed Innovation Product

A product's performance plays a critical role in determining its marketability and penetration. Product innovation is essential for businesses to maintain competitiveness, growth, and progress over time. People widely recognize that a company's ability to innovate is crucial for its long-term success. The innovative product, Tiles Installer Robot, will continue to be relevant and beneficial to stakeholders in the construction industry by incorporating performance-based features. Table 1 presents a comparison and analysis of the manual tile installation method, which is the traditional method, and the Tiles Installer Robot.

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Table 1. Comparison and analysis of the manual tile installation method

Feature	Tiles Installer Robot	Traditional Method
Cost Savings	Reduces labor costs through automation	Labor costs contribute to expenses
Aesthetic Quality	Enhances aesthetic appeal of the final product	Quality depends on the installer's skill
Time to Finish	1-2 days / 100m^2	5-7 days / 100m^2
Installation Speed	50-100 m^2/hour	10-15 m^2/hour
Long-term Durability	Promotes long-term durability and precision	Durability depends on the installer's skill

4. COMPONENTS OF TILES INSTALLER ROBOT

Figure 2 shows the detailed components of the Tiles Installer Robot consisting of an electric vacuum, a robotic arm, a TileControl Pad, a rotation motor, a LiDAR sensor, and rubber wheels.

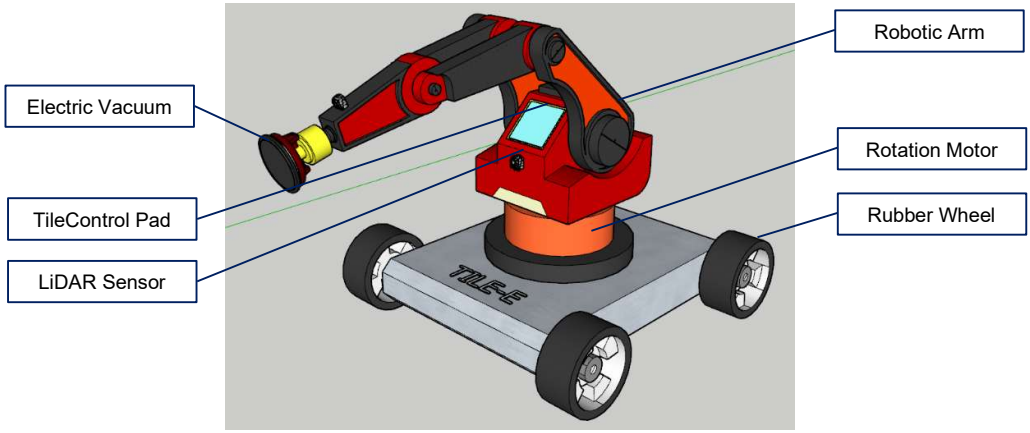

Figure 2. The components in the body part of the Tiles Installer Robot

Meanwhile, Figure 3 shows the detailed components of the in-body part of the Tiles Installer Robot from the front view consisting of a TileControl Pad, LiDAR Sensor, electric vacuum, rotation motor, and a rubber wheel.

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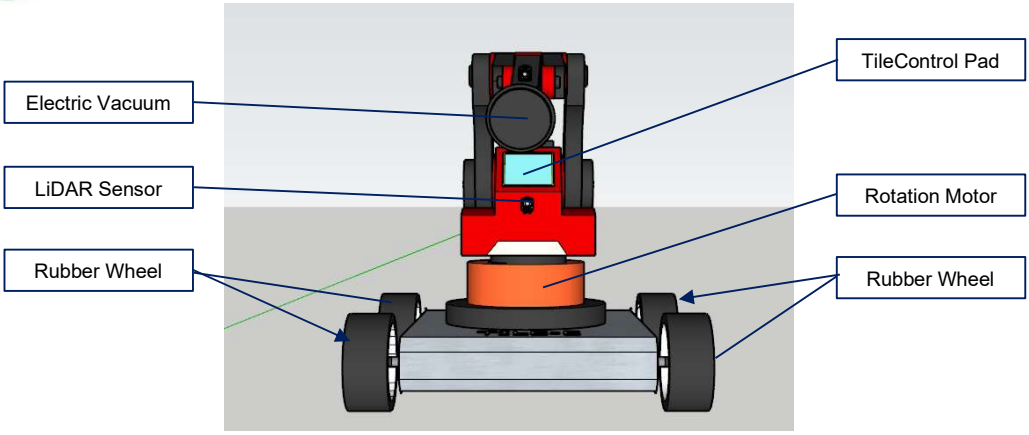

Figure 3: The component in the body part of the Tiles Installer Robot from the front view

Finally, Figure 4 shows the detailed components of the in-body part of the Tiles Installer Robot from the rearview consisting of a rubber wheel, robotic arm, and rotation motor.

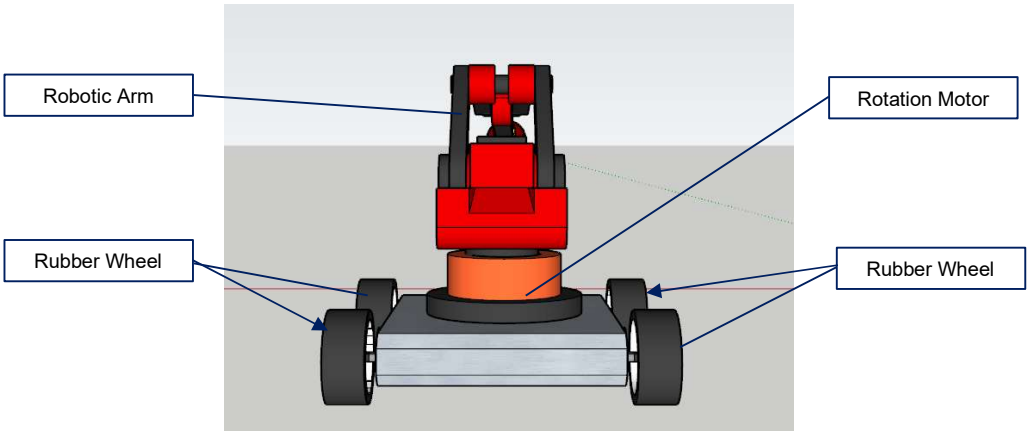

Figure 4. The component in the body part of the Tiles Installer Robot from the rearview

5. CONCLUSION

The Tiles Installer Robot innovation project represents a pivotal advancement in addressing sustainability, safety, and efficiency within the construction sector. By integrating robotic technology into the Industrialized Building System (IBS), this project offers numerous advantages that align with broader sustainable development goals. The project began with a recognition of the innovative implications of IBS, particularly within Malaysia's construction industry, reflecting the government's long-standing efforts since the 1960s to adopt advanced building methods. The need to shorten project cycles, enhance productivity, and optimize investment returns underscores the critical role of automation and robotics in modern construction. Focusing on Tiles Installer Robot highlights its functional and aesthetic benefits, particularly in commercial and industrial settings, where precision and efficiency are paramount. This innovation aligns with Sustainable Development Goal 9, which emphasizes sustainable industrialization, resilient infrastructure, and fostering innovation.

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The comprehensive study revealed substantial benefits, like increased productivity, enhanced safety, reduced labor costs, and minimized material waste.

The Tiles Installer Robot project demonstrates how the construction industry is committed to progress and using modern technologies to solve traditional problems. By improving efficiency, reducing environmental impact, enhancing workplace safety, and elevating project quality, the Tiles Installer Robot demonstrates how technological advancements can drive sustainable development. This innovation has the potential to transform industry standards and create opportunities for a more robust and efficient future in the evolving construction sector.

6. ACKNOWLEDGMENT

We extend our heartfelt appreciation to the committee of the International Virtual Undergraduates Competition on Technological Innovation (iVUTI 2024) for providing an invaluable platform that fosters knowledge exchange and cultivates professional networking among students.

7. REFERENCES

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