

**6th UNDERGRADUATE
SEMINAR ON BUILT
ENVIRONMENT
AND TECHNOLOGY
(USBET) 2023**

**SUSTAINABLE BUILT
ENVIRONMENT**

25 - 27 SEPTEMBER 2023

E-PROCEEDING

USBET 2023



e-Proceeding

**6th UNDERGRADUATE
SEMINAR ON BUILT
ENVIRONMENT
AND TECHNOLOGY
(USBET) 2023
SUSTAINABLE BUILT
ENVIRONMENT**

Published by,

Department Of Built Environment Studies And Technology
Faculty Of Architecture, Planning & Surveying
Universiti Teknologi MARA Perak Branch, Seri Iskandar Campus
usbet.fspuperak@gmail.com

Copyright @ 2023

Department Of Built Environment Studies And Technology
Faculty Of Architecture, Planning & Surveying
Universiti Teknologi MARA Perak Branch, Seri Iskandar Campus

This work is subject to copyright. All rights are reserved by the Publisher. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording or any information storage and retrieval system without permission in writing from the copyright owners.

eISSN 2821-3076



9 7 7 2 8 2 1 3 0 7 0 0 2

02 October 2023 | Perak, Malaysia
Universiti Teknologi MARA, Perak Branch, Seri Iskandar Campus

EDITORIAL BOARD

Editors-in-Chief

SR. NORAZURA MIZAL AZZMI (BS)

NADIRA AHZAHAR (BS)

Editors

TS. ZURAIHANA AHMAD ZAWAWI (BS)

SR. NAZHATULZALKIS JAMALUDIN (BS)

SR. SITI ZUBAIDAH HASHIM (BS)

NURHIDAYAH SAMSUL RIZAL (BS)

SR DR. NURUL FADZILA ZAHARI (BS)

NUR FADHILAH BAHARDIN (BS)

SR TS. DR. ALIA ABDULLAH SALLEH (BS)

SR TS. DR. SURIANI NGAH WAHAB (BS)

SR TS. DR. HASNAN HASHIM (BS)

SR NOORAZLINA KAMARUZZAMAN (BS)

SR MARIATY MOHD BAHARI (BS)

SR AIDA AFFINA ABDUL GHANI (BS)

DR. NOR DIANA AZIZ (BS)

SR AMIR FASHA MAT ISA (BS)

SR DR. NOR AMIN MOHD RADZUAN (BS)

PROF. MADYA SR DR. MOHD FADZIL YASSIN (BS)

SR TS. KHAIRUL AMRI RAMLY (BS)

SR. MOHD ASRUL HASIN (BS)

SR TS. MOHD KHAZLI ASWAD KHALID (BS)

SR MOHD DZULKARNAEN SUDIRMAN (BS)

SR DR. IRWAN MOHAMAD ALI (BS)

SR DR. MOHAMMAD HASZIRUL MOHD HASHIM (BS)

DR NURHASYIMAH BT AHMAD ZAMRI (BCT)

DR. PUTERI YULIANA SAMSUDIN (TP)

Editors-in-Chief

6th Undergraduate Seminar on Built Environment and Technology 2023

- E- Proceedings-

Organized by,

College of Built Environment (KAB) UiTM Perak Branch



AUTOMATED BRICKLAYING ROBOT (ABR-1)

Syaima Mohd Fauzi^{*}, Ezzat Fahmi Ahmad^{1*}

¹Department of Built Environment Studies and Technology,
College of Built Environment,
Universiti Teknologi MARA Perak Branch,
32610, Seri Iskandar, Perak, Malaysia

2021483132@student.uitm.edu.my, *ezzafahmi@uitm.edu.my

ABSTRACT

In Malaysia, the conventional method is still widely used, though the Industrialised Building System (IBS) has been successfully adopted in the government sector. Malaysia's construction industry needs more workers as conventional methods are widely used. Right now, the Malaysian construction industry widely uses the convention method, in which skilled workers are needed to construct, and a lack of skilled workers led to the innovation of the automated bricklaying robot. Therefore, the objective of this research is to identify the current issues and problems of bricklayers, to assemble the simulation by improvising the design of bricklaying productivity and to demonstrate an entrepreneurial skill in proposing bricklaying productivity which can be marketable. Finding the current problems, suggesting and building a new machine, and assessing the marketability of the product were done in order to improve and remedy every flaw in the current bricklaying robot and technology. This research is based on a secondary data review (i.e., past data source by government publications, websites, books, journal article, internal records etc.) (Wagh, n.d.) and observation at the construction site to see the situation of bricklayers and also includes a SketchUp mockup of the machine. ABR-1, an automated bricklaying robot, is suggested as a solution to the problems of a shortage of skilled labourers, delays, and costs.

Keywords: "bricks; construction robot; automation; bricklaying; robot"

© 2023 USBET, JABT, UiTM Perak Branch, All rights reserved

INTRODUCTION

In Malaysia, the conventional method is still widely used, though the Industrialised Building System (IBS) has been successfully adopted in the government sector. The local construction company that still practices the conventional method must find skilled workers, especially bricklayers. Related to skilled workers, not just Malaysia have a shortage of skilled workers but has become a worldwide issue due to several factors. Based on (Lawani et al., 2021), the shortage issue of skilled workers causes by factors that influence career aspirations. According to the DPN 2030 initiative themed "Digitalization of the Construction Sector", which focuses on adapting technology in all processes. Based on (Reporters, 2021), the construction sites of the future will be "almost human-free" with the growth of Industrial Revolution 4.0 technologies in the industry. Work minister Fadhillah Yusof said the construction sector will "exponentially reshape" with the anticipated introduction of robotic applications at construction sites by 2030.

LITERATURE REVIEW

Literature research on the building industry and Industrialized Building System (IBS), concerns and problems related to the topic, and the development of an innovative proposal are all included in the second chapter. This chapter also includes studies on earlier innovations, such as the equipment and robots used in bricklaying, which helped shape the innovation idea. A bricklayer is a person in charge of laying the bricks, pre-cut stone, and concrete blocks in mortar (Team, n.d.). Based on Team, (n.d.), their work is to construct, repair and extend domestic and commercial buildings and other construction work such as foundations, walls, chimneys or decorative masonry. To become bricklayers, the workers must know the bond's term.

Issues And Problems Related To Bricklaying

According to Gerrard, (2022) article, there are four (4) most significant labour shortages in the construction industry, one of which is bricklayers. There is a spectacle in the construction industry, especially for bricklayers, as it was mentioned that their work is the most challenging to recruit. As the housebuilding demand increases, the bricklayer's occupation becomes the most wanted.

- The Malaysian construction industry is monopolized by foreigners

In Malaysia, the percentage of hiring foreign labour is high. According to (Adi, 2017), there are 70% of the total work in Malaysia that was coming from foreign, and the highest comes from Indonesia. Aside from Indonesia, Malaysia's construction industry is also full of foreigners from Nepal, Vietnam, Myanmar, India, Bangladesh, the Philippines, Pakistan, and others. Foreign workers were the most hired in the construction industry in Malaysia because

of the low wages, which helped the contractor to reduce expenses. Another reason why the construction industry was full of foreign workers was because of the local people's poor participation.

- Negative image of bricklayers

There also was a negative image due to the lack of career guidance, socio-economic impacts and many more. Some people understood that skilled workers that went to vocational training were not suited to the industry's needs, and even some left the construction sector. However, they already had qualified training from construction training institutions (Zaki et al., 2012). In Malaysia, most of the construction site workers were foreigners due to the local people's poor participation.

- Problem with inaccurate proportions

The layer during applying mortar depended on the workers' work and skill. Commonly, applicable codes and building papers emphasize measuring binder materials by weight or volume. However, this measure is typically disregarded when material mixing is done on the project site. When measuring, the number of shovels is occasionally used, although this method needs to be more accurate and results in erroneous mix proportions (Common Site Problems During Masonry Construction, 2018). The layer does not meet the requirement of sizing and causes the bricklayer to hollow (Kraynik, n.d.). Aside from that, one of the defects in brickwork that causes by poor quality is the failure to fill bed joints. Weak supervision causes the joint bed filling might be improper and cause a reduction in strength. As much as 33% can be seen due to the incompletely filled bed joints. However, a significant impact can be seen on flexural resistance instead of compressive strength.

- Health problems affected bricklayers

The bricklayer had a higher potential to have musculoskeletal disorders as it is one of the common occupational health problems, especially in the construction industry. Musculoskeletal disorders or MSDs are injuries that affect the human body's movement and musculoskeletal system, for example, muscles, tendons, ligaments, nerves, discs, blood vessels, etc. Based on Middlesworth, (2019), common musculoskeletal disorders include ligament sprain, tension neck syndrome, carpal tunnel syndrome, tendonitis, muscle/tendon strain, trigger finger/thumb and many more. These disorders occur when the wrong postures and lack of tools that make the postures and lack of tools that make the postures even worst during work.

Previous Innovation Approach

Based on Madsen, (2019), there are several disadvantages to using the equipment. The SAM100 takes a long time to set up unless the task begins from the ground up. The SAM100 must be precisely levelled, its tracks must line up, it must be anchored, and the lasers must be properly configured. The incentive to use the SAM100 would be substantially greater if any of these tasks could be streamlined and expedited.

The SAM100 has been found to perform better in several project categories. Large box-shaped structures, such as warehouses, are part of these projects. The outside of these buildings should be predominantly made of brick or other masonry components. To get the maximum usage out of the SAM100, the altitudes of the walls should be high, between 30 and 50 feet. For the machine to be useful on the project, the walls must also be long about 100 feet. The SAM100 does not appear appropriate for smaller masonry projects because the expense of employing it does not justify the advantages. (Madsen, 2019).

METHODOLOGY

In this section, it focused on the objective one which is to develop bricklaying productivity design ideas. During the selection idea, there are many references that researcher used to develop the idea. Data collection is known as a process that gathered data and measuring the information on variable of interest. During conducting the research, document analysis and observation at the construction site to see the situation of bricklayers were used. To clarify and enhance the information gathered, the document analysis uses physical evidence, private documents, and public records to explain and interpret bricklaying (*Document Analysis Guide*, 2023). The drawback of this study is that the assembly and functionality of the product are entirely demonstrated and evaluated using the SketchUp software, as opposed to a real prototype where findings might differ slightly.

RESULT AND DISCUSSION

Development of Innovation Project

To address all the shortcomings and problems faced by bricklayers, including the lack of skilled labor, labor shortage, delays, and traditional work practices. This homemade automatic bricklayer robot could be the ideal invention. This impromptu innovation is created by putting current technology to use and combining it with another piece of equipment to address a specific issue. An automated bricklaying

robot may allow the owner or the client to realize their ideal plan or design while also striving to reduce expenses and labor time, as opposed to the traditional ways where the personnel perform the activity manually. The goal of this project is to develop a robotic arm for a bricklayer robot that will help to solve the worker scarcity problem and expedite the bricklaying process.

- Laser sensor

The main idea for the laser sensor came from the stringline that is used during the bricklaying process which helps to align the bricks. During use, the laser sensor is meant to be lit to brick position. The laser sensor will be located at the robotic arm, and it will show during the process of placing the bricks.

- Mortar sections

The concept is taken from the SAM100 robot, where the mortar section is located below the robotic arm. As Malaysia's construction industry is practically bricklaying, the mortar section will be added. During the construction, the mortar still needs to be added, as mortar mixing will be done on the outside or using ready-mix concrete.

This chapter focuses on the design of the innovative product, which is decided by improving on the existing product. This section starts with the ideation process that the researcher came across to create the innovation in bricklaying robot and how to assemble them by improving The Hadrian X Bricklaying Robot so that the product will be upgraded from the previous one. Then, development is a crucial process of iterating ideas until they are pleased to determine whether the Automated Bricklaying Robot can be commercialised in the market.

Table1: Component of Automated Bricklaying Robot (ABR-1)

| N O | Features | Method | | | | |
|--------|------------------|-------------------------------------|--|------------------------|-----------------------------|--|
| | | Semi-Automated Mason (SAM100) | The Hadrian XBricklaying Robot | Conventional Method | Bricklaying Mould Equipment | Automated Bricklaying Robot (ABR-1) |
| 1 | Productivity | 3,000 bricks per day | 1000 bricks per hour | 300-500 bricks per day | 300-500 bricks per day | 1000 bricks per hour |
| 2 | Application | Required to load; bricks and mortar | Automatic loading, cutting, routing and placement bricks | Conducted Manually | Conducted Manually | Automatic loading, cutting, routing and placement bricks |
| 3 | GPS | ✗ | ✓ | ✗ | ✗ | ✓ |
| 4 | LIDAR technology | ✗ | ✓ | ✗ | ✗ | ✓ |
| 5 | Laser sensor | ✓ | ✗ | ✗ | ✗ | ✓ |
| 6 | Mortar section | ✓ | ✗ | ✗ | ✗ | ✓ |
| 7 | Robotic arm | ✓ | ✓ | ✗ | ✗ | ✓ |

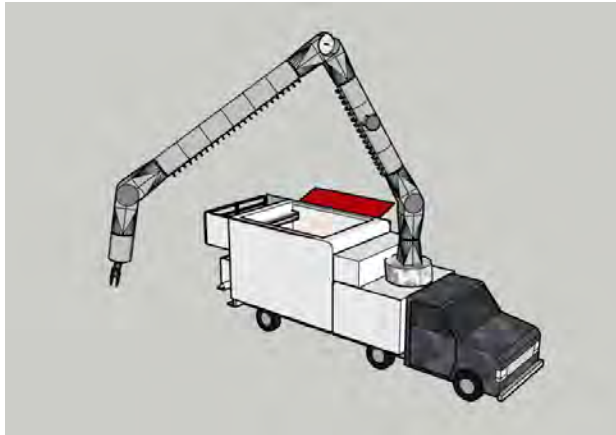


Figure 1: Automated Bricklaying Robot (ABR-1)

The characteristics and attributes of the material chosen are crucial to ensuring the product's durability and safety. The quality of the product is also influenced by the materials employed in its installation. The specifics of the recommended material for this project are explained in depth in this chapter.

- Metal

Aluminium is one of the most often used metals in nature. The Automated Bricklaying Robot (ABR-1)'s nearly all parts are covered by the suggested use of metal. The machine's body and the extension parts for the brick-and-mortar sections are made of aluminium metal. The fact that aluminium metal is lightweight is one of the main reasons for its use. Actually, aluminium weighs just about a third of what steel does. Although stainless steel is stronger, aluminium has a much better strength to weight ratio than stainless steel, which is why it is employed in the manufacturing of bicycles and aeroplanes. This lightweight material is more suitable for the product's installation and transportation in order to lower the weight of the suggested ABR-1. Since aluminium has high anti-corrosion properties that are advantageous to the product, it also does not rust. It is undeniable that stainless steel, which is composed of iron, nickel, chromium, manganese, and copper, has greater corrosion resistance, but aluminium has a considerably better strength to weight ratio.

This section was added to make it easier for ABR-1 to conduct the bricklaying, as the robotic arm will move to the piping at the mortar section. The mortar will be added via the ready-mix concrete truck to the mortar section. The worker still needs to check the mortar inside the mortar section to make sure it is in good condition or might need to top up.

- Mortar piping

The material for mortar piping will be metal to give resistance to the position of the pipe. This makes it easier to move when layering the mortar on the brick. If using an elastic material, the pipe needs to be accommodated by a hard material or tool to tighten the pipe structure.

- Laser sensor

The laser sensor will be attached to the robotic arm to make it easier to measure and arrange the bricks. Laser sensors are used for support to indicate both direction and height, used in checking the grade or deviation in a slope or rise. Used in landscaping to level the ground.

Assembly of Automated Bricklaying Robot (ABR-1)

In this section, the idea of making innovation on The Hadrian X by improving the robotic arm suite with the current bricklaying method in Malaysia. At the early stage of creativity, SAM100 is an exciting thing that attracts researcher because the robot arm can be used to apply mortars. The ideation of making an Automated Bricklaying Robot was to minimize the cost of waste and reduce the time during construction.

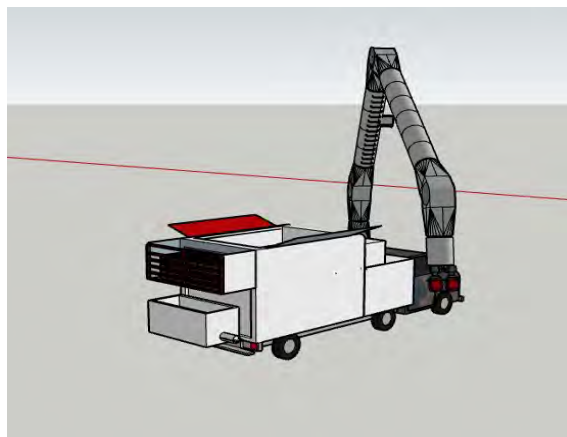


Figure 2: The overview of the Automated Bricklaying Robot

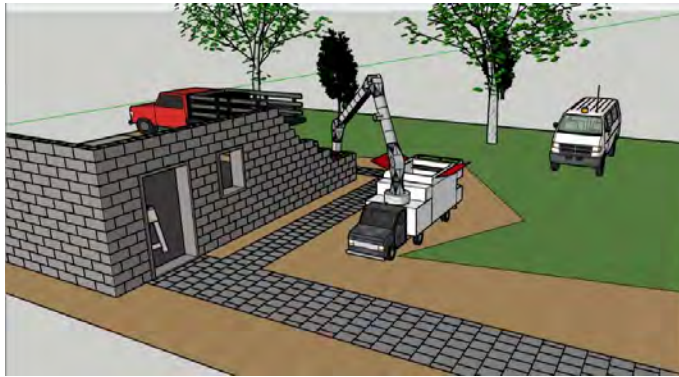


Figure 3 The position of Automated Bricklaying Robot -1 at the construction site

CONCLUSION

The Automated Bricklaying Robot (ABR-1) was developed to address the shortage of skilled workers and integrate robotic technology into Malaysia's construction industry. It consists of various components, including a robotic arm, mortar section, bricks section, and sensor system. The machine is made of lightweight aluminum metal, suitable for heavy loads. The research has limitations, as it is based on research papers and lacks marketability surveys. However, the ABR-1 can improve work quality, reduce costs, and make it easier for workers. Future improvements include more technology and components, a screen for data control, and software for data storage.

ACKNOWLEDGEMENT

The USBET 2023 committees and UiTM Seri Iskandar in Perak are to be thanked for providing the author with such a wonderful chance to present the research. Special appreciation to the research partner for their support, encouragement, and assistance to the improvement of the concepts. I'm grateful.

REFERENCES

- Adi, H. P. (2017). Technical skills requirement of Indonesian construction labors to work in Malaysia. *AIP Conference Proceedings*, 1818(1), 020002. <https://doi.org/10.1063/1.4976866>
- Common Site Problems During Masonry Construction*. (2018, June 6). The Constructor. <https://theconstructor.org/building/masonry-construction-problems/21825/>
- Document Analysis Guide: Definition and How To Perform It*. (2023, February 4). Indeed Career Guide. <https://www.indeed.com/career-advice/career-development/document-analysis>
- Gerrard, N. (2022, March 21). *The four biggest labour shortages in construction*. Construction Management. <https://constructionmanagement.co.uk/the-four-biggest-labour-shortages-in-construction/>
- Kraynik, S. (n.d.). *Best Solutions to Solve 5 Common Masonry Problems*. Retrieved October 18, 2022, <https://blog.buildmeetsworld.com/masonry-problems-and-solutions>
- Lawani, K., McKenzie-Govan, S., Hare, B., Sherratt, F., & Cameron, I. (2021). Skill shortage of bricklayers in Scotland. *Journal of Engineering, Design and Technology*, 20(1), 321–338. <https://doi.org/10.1108/JEDT-12-2020-0503>
- Madsen, A. (2019). The SAM100: Analyzing Labor Productivity. *Construction Management*. <https://digitalcommons.calpoly.edu/cmisp/243>
- Middlesworth, M. (2019, May 8). The Definition and Causes of Musculoskeletal Disorders. *Ergo Plus*. <https://ergo-plus.com/musculoskeletal-disorders-msd/>
- Reporters, F. M. T. (2021, September 30). *Buildings put up by robots on the way, says works minister*. Free Malaysia Today (FMT). <https://www.freemalaysiatoday.com/category/nation/2021/09/30/buildings-put-up-by-robots-on-the-way-says-works-minister/>
- Team, G. C. (n.d.). *Bricklayer Job Description (How to Become?)*. Go Construct. Retrieved November 5, 2022, <https://www.goconstruct.org/construction-careers/what-jobs-are-right-for-me/bricklayer/>

Wagh, S. (n.d.). *Research Guides: Public Health Research Guide: Primary & Secondary Data Definitions*. Retrieved August 22, 2023, from <https://researchguides.ben.edu/c.php?g=282050&p=4036581>

Zaki, S., Mohamed, S., & Yusof, Z. (2012). *Construction Skilled Labour Shortage – The Challenges in Malaysian Construction Sector* (SSRN Scholarly Paper 2115083). *Secondary Data Definitions*. Retrieved August 22, 2023, <https://papers.ssrn.com/abstract=2115083>

Surat kami : 700-KPK (PRP.UP.1/20/1)

Tarikh : 20 Januari 2023

Prof. Madya Dr. Nur Hisham Ibrahim
Rektor
Universiti Teknologi MARA
Cawangan Perak



Tuan,

**PERMOHONAN KELULUSAN MEMUAT NAIK PENERBITAN UiTM CAWANGAN PERAK
MELALUI REPOSITORI INSTITUSI UiTM (IR)**

Perkara di atas adalah dirujuk.

2. Adalah dimaklumkan bahawa pihak kami ingin memohon kelulusan tuan untuk mengimbas (*digitize*) dan memuat naik semua jenis penerbitan di bawah UiTM Cawangan Perak melalui Repositori Institusi UiTM, PTAR.

3. Tujuan permohonan ini adalah bagi membolehkan akses yang lebih meluas oleh pengguna perpustakaan terhadap semua maklumat yang terkandung di dalam penerbitan melalui laman Web PTAR UiTM Cawangan Perak.

Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

“BERKHIDMAT UNTUK NEGARA”

Saya yang menjalankan amanah,

SITI BASRIYAH SHAIK BAHARUDIN
Timbalan Ketua Pustakawan

nar

Setuju.

27.1.2023

PROF. MADYA DR. NUR HISHAM IBRAHIM
REKTOR
UNIVERSITI TEKNOLOGI MARA
CAWANGAN PERAK
KAMPUS SERI ISKANDAR