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CONSTRUCTION ROBOTICS IN MALAYSIA, CHINA, THAILAND AND INDONESIA

Farah Suhana Roslan[1] and Wan Nur Syazwani Wan Mohammad[2*]

[1,2]*Department of Built Environment Studies and Technology, Faculty of Built Environment, Universiti Teknologi MARA, Perak Branch, Seri Iskandar Campus, 32610 Seri Iskandar, Perak Darul Ridzuan, Malaysia*
[*]*wannur956@uitm.edu.my*

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ABSTRACT

The integration of robotics in construction enhances productivity, safety, and addresses labor shortages, particularly in developing countries. Developing countries face limited research and implementation. Challenges in these countries include hazardous working conditions, low productivity, and dependence on manual labor. Additional barriers to robotics adoption include high upfront costs, technological compatibility issues, regulatory limitations, gaps in human capital, and cultural resistance. Robotics can automate labor-intensive tasks like welding, concrete printing, and inspection, potentially resolving these challenges. This study provides stakeholders with a roadmap to leverage robotics for economic growth and modernization in the construction sector by addressing both limitations and opportunities present in emerging markets.

1. Introduction

The construction sector is poised for a technological revolution with robotic-automated machines enhancing task execution. This transformation aims to tackle labour shortages, safety risks, productivity challenges, and rising costs. Unlike other industries that have successfully integrated robotics, construction's complex environments, impacted by weather and topography, have hindered automation. However, advancements in robotics and Artificial Intelligent (AI) allow for better adaptability. Integration of robotic systems in tasks like surveying and demolition is increasing, yet, in developing countries, adoption remains limited due to inefficiencies, low productivity, and safety concerns (Bock, 2015).

2. Methodology

The study used content analysis based on prior studies on the implementation of construction robotics in various developing countries particularly in Malaysia, China, Thailand and Indonesia. The secondary data used is based on the impactful scientific literature review through journals and conference proceedings via articles and news. This methodology allows the identification of the current implementation of robotics in developing countries including its obstacles and outcomes which are unrevealed in detail and provides valuable insights for industry practitioners and academic researchers.

3. Result

The following section provides a literature result of the construction robotics implementation particularly for four (4) developing countries namely Malaysia, China, Thailand and Indonesia. The results are organised based on current implementation of construction robotics, obstacles and initiatives taken by these countries.

3.1 Malaysia

In Malaysia, construction robotics have progressed but face challenges due to the unique construction environment and landscape. While they offer benefits like faster operations and reduced human errors, safety improvements are also notable. However, these robots struggle with difficult obstacles, varied terrains, and unpredictable weather, limiting their effectiveness in real-world construction scenarios (Adlina, 2023). The Industrialised Building System (IBS) in Malaysia enhances construction automation through prefabrication and robotics which boasting an annual output of 1 million square meters yet improving efficiency and productivity in building processes. (Siti Azira et al., 2020).

“The National Construction Policy 2030” promotes digitalisation and robotics in the construction industry. The policy aims for autonomous machines to operate equipment, potentially enabling nearly human-free sites by 2050, transforming design, construction; and infrastructure maintenance through robotics integration (Syazmeena, 2022). Then, selected companies utilize an average of 6.9 digital technologies that include BIM and AI safety systems gives the enhancement robotics for better accuracy, safety and reduced construction timelines. This aligns with the government's Construction Strategy Plan 4.0 which increasing productivity and reducing manual labor (Ismail, 2024). Additionally, the National Robotics Roadmap 2021-2030 aims to increase robot usage in Malaysia to about 195 robots per 10,000 workers by 2030 which shows increase productivity and reducing foreign labor dependence. Finally, collaborative robots (cobots) will further improve efficiency in various industries including construction (Syazmeena, 2022).

3.2 China

China is increasingly adopting construction robots in hydroelectric dams, highways, and urban development. Autonomous rollers and robotic equipment enhance efficiency and safety on sites, transitioning the industry from labor-intensive to tech-driven (Chen, 2021). The integration of AI, 5G, and smart systems further improves accuracy, independence, and addresses labor shortages (Briefing, 2025).

However, construction robotics is still in an immature stage, facing challenges in complex environments. Advances are needed in autonomous navigation, environmental awareness, and flexibility to meet varied construction demands. Government support and sector research are crucial for progress (Zhai et al., 2023). China's robotics sector is rapidly growing, bolstered by initiatives like "Made in China 2025" and projected to reach one million operational industrial robots soon. This surge creates a rising demand for robot specialists, with China accounting for over fifty percent of global robot use (Chen, 2021).

AI-driven humanoid robots and semi-automated bricklaying machines enhance efficiency by performing precise tasks while reducing human labor. China's investments in Artificial Intelligent, sensors and supply chains solidify its position as a global leader in construction robotics innovation.

3.3 Thailand

Thailand's Building Construction Technology Expo 2025 in Bangkok showcases AI and robotics in construction, offering hands-on courses and certification to upskill the workforce, reflecting government priorities in technology advancement (Southeast Asia Construction, 2025). Thai government promotes robotics for productivity through policies (Chatrudee Theparat, 2017). In Thailand, construction robots address labour shortages and boost safety and productivity by performing tasks like bricklaying, concrete pouring, painting, and tile installation. This will enhance the accuracy in public housing projects (nationthailand, 2024). Thailand's construction sector uses robotics, Artificial Intelligent, drones, 3D printing, and BIM for efficient, sustainable project management (Marketing Communications, 2024). Thailand's robotics ecosystem is robust, supported by government initiatives and skilled university graduates. The country has many industrial robots and is developing AI-enabled domestic robots to meet construction automation needs (Thailand Board of Investment, 2025).

3.4 Indonesia

Seven projecting Indonesian construction state-owned enterprises (SOEs) such as PT PP, PT Waskita Karya and PT Wijaya Karya are developing diverse Construction Automation and Robotics (CAR) technologies into their projects (Yongki Alexander Tanne & Ni, 2023). Indonesia is progressing through development phases utilizing technologies like drones, virtual reality and prefabrication. Robotics such as rovers, 3D printing and wearable sensors shows less common and primarily limited to a few state-owned enterprises (Yahya et al., 2019).

Insufficient collaboration delays Indonesia's CAR development in construction, while technologies like Digital Twin and BIM enhance productivity and demand for CAR applications (Yahya et al., 2019). Indonesia's construction industry is adopting digital transformation for sustainability through government initiatives. Technologies like BIM, augmented reality, and Internet of Things improve efficiency, while the modular "Mobox" system enhances infrastructure in remote areas (Adlina, 2025).

4. Discussion

Table 1.0 highlights challenges in implementing construction robotics in Malaysia, China, Thailand, and Indonesia. Every country encounter significant expense associated with the implementation and upkeep of construction robotics, affecting smaller and medium-sized contractors because of their restricted budgets (Sun et al., 2024). Challenges in adapting to intricate and constantly evolving construction site contexts are frequent, with problems such as a mismatch between robotics and conventional construction methods. Thailand, Malaysia, China and Indonesia face a shared shortage of skilled workers and BIM/robotics knowledge, hindering successful implementation and use (Abioye et al., 2021; Asian Insider, 2025). This is particularly observed in Indonesia, yet elements of slow digital adoption can be seen in others too (Razi, 2019).

Meanwhile, the differences that can be seen is Malaysia's difficulties highlight the absence of defined regulatory frameworks and standards, coupled with operational hurdles and elevated expenses. Its approach is deficient in advanced follow-up R&D and primarily faces challenges with unclear guidelines and adoption issues (Nasir et al., 2024). Furthermore, China's difficulties center on the initial expense of obtaining robots and ongoing R&D challenges such as pilot testing. Its approach is characterized by significant governmental support and commitments to smart building, though technical and environmental factors raise concerns (Cai et al., 2020). Next, Thailand recognizes insufficient BIM expertise and a lack of skilled labor as major challenges, coupled with reluctance stemming from dependence on conventional 2D drawings and outdated permitting systems (Thailand Board of Investment., 2022). Its approach includes initiatives to combine BIM and foster knowledge, yet it encounters the resistance of conventional methods. Finally, Indonesia faces elevated expenses and the difficulty of aligning cutting-edge technologies with local construction conditions (Fact.MR., 2023). It also encounters restricted market demand and is in the initial phase of digital transformation, with continuous attempts to combine robotics with BIM and digital technologies.

Table 1. The construction robotics implementation challenges in Malaysia, China, Thailand and Indonesia

Countries			
Malaysia	China	Thailand	Indonesia
High Cost of Implementation and Maintenance • This encompasses not only the acquisition cost but also continuous operational and maintenance costs, which numerous contractors deem excessive, particularly smaller companies with restricted budgets (Abioye et al., 2021).	High Purchase and Implementation Costs • The substantial upfront expense of acquiring construction robots and incorporating them into current processes poses a major obstacle, even if it is not as essential as technological and environmental considerations (Jabr, 2023).	High Initial Investment and Cost • For examples, licenses for BIM software such as REVIT can be about the yearly pay of a junior engineer which making the price unaffordable for numerous small- and medium-sized contractors (Sierra & Rodboonpha, 2022).	High Costs and Technological Challenges • The high cost and upkeeping with advanced robotics technology gives challenges in adjusting these technologies to local construction environments especially impacts small and medium-sized contractors (Fact.MR., 2023).
Operational Barriers and Compatibility Issues • Construction robotics encounter difficulties in adjusting to the intricate, ever-changing, and chaotic settings commonly found at Malaysian construction sites. The mismatch between robotics and current traditional construction techniques and processes also creates a challenge (Inti & Eissn, 2020).	Technological Performance and Reliability • The dependability of robot technology is a crucial risk element. Challenges involve the robots' capacity to sense and adjust to intricate, unstructured construction settings and the disagreement between designers and users concerning the robots' abilities and anticipated performance (Chen et al., 2022).	Lack of Knowledge and Skilled Personnel • Numerous contractors possess restricted BIM knowledge or robotics expertise. Resulting in ineffective of utilization and dissatisfaction with the technology. The lack of skilled workers to manage and maintain robotics systems and BIM software is a major limitation (Thailand Board of Investment., 2022).	Limited Market Demand for Robotics • The present construction market in Indonesia has not strongly required the adoption of robotics, weak motivation for firms to knowingly invest in these technologies (Venkat k, 2020).
Lack of Regulatory Framework and Standards • The lack of explicit guidelines, construction standards, and regulatory structures for implementing digital and robotic technologies results in ambiguity, hindering adoption (Nasir et al., 2024).	Lack of Follow-up and Continuous R&D • Numerous promising research results fail to advance past initial prototypes because of insufficient ongoing R&D, pilot testing, and further development. This "subsequent problem" restricts the effective implementation of construction robotics (Cai et al., 2020).	Resistance to Change and Traditional Practices • Numerous contractors still depend on traditional 2D drawings and manual methods, partially because government regulations still mandate 2D documentation for permits, perpetuating outdated practices (Sierra & Rodboonpha, 2022).	Early Stage of Digital Transformation • Despite advancements in digitalization, the union of robotics with other digital technologies such as BIM and Digital Twin is still evolving. This shows the restricting towards the full advantages of robotics in the construction sector (Tanne & Indrayani, 2023).

5. Conclusion and Recommendations

In conclusion, the use of robotics in the construction industries of developing countries which namely Malaysia, China, Thailand and Indonesia that shows considerable promise for improving productivity, safety and tackling workforce shortages. Every country is at a distinct phase of implementation, shaped by specific environmental, financial, and regulatory conditions. Although innovations like AI, BIM, and prefabrication are forcing development, notable challenges remain such as elevated costs, technological integration problems, skill deficiencies and cultural disagreement. Another from that, the government programs measure significantly influence the adoption of robotics. However, the challenges such as ambiguous regulations, lack of R&D and inactive digital transformation delay complete implementation. Then, construction robotics offers a hopeful route for these developing markets to advance their construction sectors and enhance economic development, yet effective integration necessitates customized strategies that consider both technological and human aspects. Within than that, the recommendations by increasing investments in R&D from governments and the private sector, developing extensive training initiatives to enhance workers' skills in BIM, robotics operation and digital technologies, promoting collaborations among academia, industry and government; and integrating robotics with supporting digital technologies like AI, 5G, BIM, and Augmented Reality.

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