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# Drone Adoption Challenges in Malaysia's Construction Industry

Yuhani binti Jamian[1]
Shahrun Nazida binti Salleh[1]
Salsabila binti Harisman[1]

[1]Affiliation: Politeknik Melaka, Malaysia
Correspondence E-mail : yuhani@polimelaka.edu.my

## Abstract

**Introduction/Main Objectives:** This study explores the challenges faced by the Malaysian construction industry in adopting drone technology. It is guided by three objectives: 1) to identify technological barriers, 2) to examine organizational and environmental factors, and 3) to analyze relevant demographic correlations.

**Background Problems**: The construction industry recognizes the potential of drone technology, but its widespread adoption is hindered by various significant barriers.

**Novelty:** This study aims to fill a specific research gap by focusing exclusively on the challenges hindering drone adoption within the Malaysian construction industry. Its novelty lies in seeking deep, practical insights directly from on-the-ground industry practitioners (engineers, contractors, supervisors, project managers), whose firsthand perspectives on technical, operational, regulatory, and organizational constraints remain underexplored, especially when compared to studies focusing on general benefits or applications of the technology.

**Research Methods:** The study used a quantitative questionnaire administered via Google Form. Respondents were individuals directly involved in construction (site supervisors, engineers, contractors, technical personnel). Data were analyzed using the Statistical Package for the Social Sciences (SPSS).

**Finding/Results:** Technological Barriers: High cost of equipment (mean=4.00), lack of skilled personnel (mean=4.00), low awareness (mean=4.15), and safety/privacy concerns (mean=4.25) were key challenges. Organizational & Environmental Factors: Key barriers included legal/regulatory restrictions (mean=4.11), lack of technical support (mean=4.22), uncertainty about ROI (mean=4.16), resistance to change (mean=4.11), and weather conditions (mean=4.35). Demographic Correlations: Age was moderately correlated with skill limitations (r=.432), qualification with organisational resistance (r=.542), and experience showed a weak correlation with weather-related challenges (r=.210).

**Conclusion:** Overall, while the industry sees drone technology's potential, multiple barriers impede adoption. To increase preparedness and confidence, the industry may benefit from more focused training, awareness campaigns, clearer regulatory guidance, and structured cost-benefit analyses.

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**Keywords:** construction technology, drone challenges

## Introduction

The global construction sector is undergoing rapid digital transformation as new technologies reshape the way projects are monitored, managed, and delivered. Among these innovations, unmanned aerial vehicles (UAVs), or drones, have become one of the most influential tools due to their ability to capture real-time data, enhance visibility, and support safer and more efficient site operations. Internationally, drones are widely used in countries such as the United States, Japan, and China for tasks including surveying, 3D mapping, defect detection, and remote inspection (Merkert & Bushell, 2023). Their integration with Building Information Modelling (BIM), photogrammetry, and artificial intelligence has further strengthened their role in modern construction workflows by enabling faster analysis and more reliable decision-making (Nwaogu et al., 2023).

In Malaysia, drone utilization has grown significantly across construction, surveying, agriculture, and other related sectors, with reports showing an increase exceeding 100% in many industries (CIDB, 2023). Several large-scale developments, such as the Tun Razak Exchange (TRX) and the MRT extension, have already demonstrated how drones can support better monitoring and documentation on project sites (Asean Post, 2019). However, despite this positive trend, the overall adoption of drones among Malaysian construction companies, especially small and medium-sized firms, remains relatively limited when compared to more technologically advanced nations (Yusof et al., 2023).

A growing body of literature points to a wide range of challenges that continue to hinder drone adoption in Malaysia. These include technological barriers such as high equipment costs, short battery life, weather limitations, and the need for specialized skills to operate drones safely and effectively (Alsamarraie et al., 2022). Organisational factors also play a significant role; many companies lack trained personnel, structured training programmes, or clear investment strategies for drone technology. In some cases, management hesitancy stems from uncertainty about financial returns or fear of operational risks, including equipment damage and liability during accidents (Tan et al., 2024).

Regulatory and environmental barriers further complicate the situation. The Civil Aviation Authority of Malaysia (CAAM) imposes strict rules governing drone operations, including mandatory registration, flight restrictions, no-fly zones, and requirements for operational approval (CIDB, 2024). While these regulations are crucial for safety, they can be difficult for smaller firms to navigate, leading to reluctance or avoidance of drone usage. Environmental challenges such as unpredictable weather, strong winds, and the physical layout of construction sites also limit the practicality of drone deployment.

Despite growing global acceptance of drone technology, there remains a research gap in Malaysia. Most existing studies discuss the benefits or general applications of drones, but only a limited number focus specifically on the challenges faced by Malaysian construction practitioners. Understanding these challenges from the perspective of engineers, contractors, supervisors, and project managers is essential because they are the individuals who directly influence technology decisions on-site.

This study focuses exclusively on examining the challenges that hinder drone adoption in Malaysia's construction industry. By narrowing the scope, the research aims to provide deeper insights into the real issues faced by industry players—from technical and operational barriers to regulatory and organisational constraints.

## Research Methods

This study employed a quantitative research design using a structured questionnaire to identify the challenges that hinder drone adoption in Malaysia's construction industry. The methodology was designed to ensure consistency, systematic data collection, and reliable interpretation of findings.

### Research Design

This study employed a quantitative research design using a structured questionnaire to identify the challenges that hinder drone adoption in Malaysia's construction industry. The methodology was designed to ensure consistency, systematic data collection, and reliable interpretation of findings.

### Population and Sampling

Target population consist of Malaysia's South construction practitioners (site supervisors, engineers, contractors, technical personnel) at Malacca, Negeri Sembilan and Johore. Purposive sampling was adopted. Sample size adequate for descriptive This study employed a quantitative research design using a structured questionnaire to identify the challenges that hinder drone adoption in Malaysia's construction industry. The methodology was designed to ensure consistency, systematic data collection, and reliable interpretation of findings.

### Research Instrument

Questionnaire via Google Forms with three sections: demographics, the challenges of using drone technology in the construction industry, and the last section is to receive general feedback. Likert scale 1–5. Instrument validated by experts; Cronbach Alpha ≥0.70 which is 0.945.

### Data Analysis

Descriptive statistics (mean, standard deviation and Pearson Correlation analysis). Data cleaning performed. Objective-based analysis aligned with technological and organizational /environmental challenges. Mean values were interpreted using the equal-interval approach recommended by Gay, Mills, and Airasian (2009) for Likert-scale data. Based on a five-point scale, mean values between 1.00–2.49 indicated low perception, 2.50–3.49 moderate, 3.50–4.19 high, and values above 4.20 critical. This classification allowed a structured and consistent interpretation of the respondents' perceptions of drone adoption challenges.

### Ethical Considerations

Ethical guidelines were strictly observed throughout the study. Participation was voluntary, and informed consent was obtained prior to data collection. No identifying information was collected, ensuring participant anonymity. All data were used solely for academic purposes.

### Methodological Limitations

This study is limited by the use of purposive sampling and self-reported questionnaire data, which may introduce response bias and restrict generalisability. The geographical focus on three southern states may not fully represent drone adoption challenges across Malaysia. Future studies could expand sampling coverage and incorporate observational or performance-based measures of drone usage.

## Result

The results of this study are presented in accordance with the three research objectives, beginning with the technological challenges, followed by the organisational and environmental challenges affecting drone adoption in the construction industry. The final section examines the relationship between demographic factors and the perceived challenges of drone implementation. The analysis includes descriptive statistics, reliability analysis, and correlation testing to provide a clearer understanding of how each factor contributes to the overall readiness and acceptance of drone technology among construction practitioners.

Objective 1: To identify and analyse the technological challenges that hinder drone adoption.

**Table 1 Mean and Standard Deviation for Technological Challenges Affecting Drone Adoption**

| No | Item | Mean | SD | Interpretation |
|---|---|---|---|---|
| 1 | Cost of drone equipment | 4.00 | 0.878 | High challenge |
| 2 | Lack of skilled personnel | 4.00 | 0.899 | High challenge |
| 3 | Limited awareness | 4.15 | 0.752 | High challenge |
| 4 | Safety and privacy concerns | 4.25 | 0.795 | Critical challenge |

Objective 2: To examine the organisational and environmental challenges that affect the implementation of drone technology at construction sites.

**Table 2 Mean and Standard Deviation for Technological Challenges Affecting Drone Adoption**

| No | Item | Mean | SD | Interpretation |
|---|---|---|---|---|
| 1 | Legal and regulatory restrictions | 4.11 | 0.892 | High challenge |
| 2 | Lack of technical support and maintenance | 4.22 | 0.806 | High challenge |
| 3 | Resistance to adopting new technologies | 4.16 | 0.841 | High challenge |
| 4 | Uncertainty about return on investment (ROI) | 4.11 | 1.026 | High challenge |
| 5 | Weather and site environmental conditions | 4.35 | 0.818 | Critical challenge |

Objective 3: To determine whether demographic factors significantly influence practitioners' perceptions of technological, organizational, and environmental barriers to drone adoption.

**Table 3 Mean and Standard Deviation for Technological Challenges Affecting Drone Adoption**

| Demographic | Challenge Item | r-value | Strength | Interpretation |
|---|---|---|---|---|
| Age | Lack of skilled personnel | +.432 | Moderate | Older staff perceive skill gap more strongly |
| Experience | Weather Issues | +.210 | Weak | Less experienced staff more affected by weather |
| Qualification | Resistance | +.542 | Moderate | Lower qualification → higher perception of resistance |
| Position | ROI uncertainty | +.226 | Weak | Critical challenge |

## Discussion

The overall findings of this study reveal that the adoption of drone technology in the Malaysian construction industry is influenced by a combination of technological, organisational, environmental, and demographic factors. For Objective 1, the results in **Table 1** show that technological challenges remain a major barrier to drone implementation, with all items recording high mean scores (4.00–4.25). The cost of acquiring drone equipment was identified as a significant concern, reflecting the financial burden associated with purchasing and maintaining commercial-grade drones (Alsamarraie et al., 2022; Li et al., 2023). The lack of skilled personnel was also perceived as an important limitation, indicating that many practitioners are not yet adequately trained in drone operation, data handling, and safety compliance—an issue consistent with previous research highlighting technical skill gaps in the construction workforce (Nwaogu et al., 2023; Abdullah & Rahim, 2021). Limited awareness and knowledge further contribute to low adoption readiness, in line with findings showing that digital literacy and exposure strongly affect technology acceptance (CIDB Malaysia, 2023; Merkert & Bushell, 2023). Safety and privacy concerns emerged as the most critical technological barrier, echoing global studies emphasising that operational risks and privacy issues affect organisational confidence in drone deployment (Salvo et al., 2018; CAAM Malaysia, 2021).

For Objective 2, the results in **Table 2** indicate that organisational and environmental constraints also play an important role, with mean values ranging from 4.11 to 4.35. Regulatory restrictions were reported as substantial obstacles, demonstrating that practitioners continue to face challenges complying with CAAM operational requirements, approval processes, and no-fly zone limitations—an issue repeatedly identified in drone adoption studies (Merkert & Bushell, 2023; Stolaroff et al., 2018). The lack of technical support and maintenance services further emerged as a major limitation, consistent with findings showing that insufficient repair facilities, limited trained technicians, and weak after-sales support reduce the operational sustainability of drone usage (Khosravi et al., 2022; Nwaogu et al., 2023). Resistance to new technologies also remains an issue within construction organisations, particularly among staff accustomed to traditional work practices, a trend similarly documented in research on digitalisation barriers (Olanrewaju et al., 2021; Ahmed & Kassem, 2018). ROI uncertainty recorded high variability, suggesting that practitioners hold different levels of confidence toward the financial value of drone investment, which aligns with studies showing that unclear cost–benefit expectations hinder technological uptake (Li et al., 2023; Alsamarraie et al., 2022).

Weather and environmental conditions were identified as the most critical barrier under this objective, reinforcing findings that Malaysia's tropical climate—characterised by rain, wind, dust, and heat—significantly disrupts drone flight stability and operational feasibility (Sampedro et al., 2018; CIDB Malaysia, 2023; Han et al., 2022).

For Objective 3, the correlation analysis demonstrates that demographic characteristics influence how respondents perceive drone adoption challenges. It is clearly shown in **Table 3** that age showed a moderate positive correlation with the lack of skilled personnel (r = .432), suggesting that older practitioners are more likely to view skill limitations as significant barriers, possibly due to lower exposure or confidence with digital tools (Nwaogu et al., 2023; Abdullah & Rahim, 2021). Experience displayed a weak correlation with weather-related challenges, indicating that less experienced workers are more affected by environmental risks—consistent with studies showing that situational judgement improves with years of on-site learning (Han et al., 2022). Qualification demonstrated a moderate correlation with resistance to new technologies, meaning respondents with lower academic qualifications perceived greater organisational resistance, aligning with findings that digital readiness is shaped by educational exposure (Olanrewaju et al., 2021; Ahmed & Kassem, 2018). Job position showed a weak positive correlation with ROI uncertainty, suggesting that site-level staff are less confident about the financial returns of drone implementation, as financial insight is typically limited among operational-level workers (Li et al., 2023). Overall, these demographic variations reveal that technological and organisational challenges are perceived differently depending on age, experience, and qualification, while environmental challenges tend to be universally experienced across all groups.

In addition to the quantitative findings from the three research objectives, the study also collected open-ended responses to gather practical suggestions for improving drone adoption. These responses were analysed thematically to identify key areas of improvement perceived by construction practitioners as per shown in **Table 4**.

**Table 4 Thematic Analysis of Respondents' Suggestions for Improving Drone Adoption**

| **Theme** | **Description** | **Examples of Respondent Comments** |
|---|---|---|
| **Training & Skills Development** | Need for structured training, hands-on practice, certification for workers | "More practical training for site staff"; "Workers need proper training and guidance." |
| **Cost Reduction & Financial Support** | Equipment cost too high; need affordable models, rental schemes, or financial aid | "Drone equipment is too expensive"; "Need cheaper models and cost support." |
| **Regulatory Improvements** | Simplify CAAM rules, easier licencing, clearer SOP | "Easier licensing process is needed"; "Clear government guidelines." |
| **Technical Support & Maintenance** | Need better servicing, repairs, and vendor support | "Good maintenance support is needed"; "More technical backup." |
| **Awareness & Exposure** | More awareness campaigns, demos, workshops | "Awareness course by private/government agencies." |

| | | |
|---|---|---|
| **Integration With Digital Tools** | Integrate drone data with BIM, simpler mapping software | “Integrate drone data with BIM”; “Mapping software should be simpler.” |

The thematic analysis of respondents’ suggestions reveals that demographic characteristics such as age, experience, job role, and qualification appear to shape the type of improvements they prioritise for wider drone adoption. Younger and less experienced respondents tended to emphasise the need for structured training, hands-on practice, and skill-based workshops, indicating that they require additional exposure and confidence in handling drone operations. This aligns with the quantitative findings, where age and experience showed positive correlations with perceived skill limitations, suggesting that respondents with less industry exposure recognise the need for practical upskilling. Meanwhile, respondents with higher qualifications or those holding managerial and technical roles more frequently proposed improvements related to digital integration, such as linking drone data with BIM or enhancing mapping software. This reflects their greater involvement in digital coordination and project analysis tasks. In contrast, respondents from operational or site-based positions highlighted cost-related concerns, maintenance support, and the complexity of drone regulations, indicating that practical, financial, and procedural barriers are more prominent among on-site workers. Additionally, geographic differences may explain why some respondents emphasised the need for better technical support and servicing facilities, particularly in states where vendor access is more limited. Overall, the suggestions demonstrate that demographic attributes influence respondent priorities, with younger and less experienced groups focusing on skills, senior personnel prioritising digital workflow integration, and operational staff highlighting cost, regulatory, and maintenance challenges. These demographic-linked insights help clarify how different categories of construction practitioners perceive and experience drone adoption barriers in practice.

## Conclusion

This study concludes that the adoption of drone technology in the Malaysian construction industry is influenced by several key factors. Technological challenges such as the high cost of equipment, limited operator skills, lack of awareness, and concerns related to safety and privacy were found to be major barriers, as reflected in the high mean scores across these items. Organisational and environmental challenges also play an important role. Issues such as complex regulations, insufficient technical support, resistance to new technology, uncertainty about return on investment, and the impact of weather conditions regularly affect the use of drones on construction sites. The correlation analysis further shows that demographic factors—particularly age, qualification, experience, and job position—shape practitioners’ perceptions of these challenges. Older respondents were more concerned about skill limitations, while those with lower qualifications perceived greater resistance within organisations. These findings indicate that although drones have strong potential to improve construction monitoring, several readiness gaps still hinder their widespread adoption.

This study is not without limitations. The sample was limited to respondents from Melaka, Negeri Sembilan, and Johor(South of Malaysia), which may not fully represent the entire Malaysian construction sector. The data were also based on self-reported perceptions, which may be influenced by individual background and exposure to drone technology. Future research should involve a larger and more diverse sample, as well as comparisons across different regions and types of construction projects. Studies may also explore practical drone performance, integration with digital tools such as BIM and automated data analytics, and the development of standard operating procedures for safer and more efficient drone usage. These findings can support policymakers, industry leaders, and educational institutions in designing training programmes, improving regulatory processes, and strengthening technical support systems to encourage broader and more confident adoption of drones in the construction industry.

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