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EXPLORING THE PERSPECTIVES OF GRADUATING CONSTRUCTION FIELD STUDENTS ON DRONE TECHNOLOGY APPLICATIONS IN CONSTRUCTION PROJECTS

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Abstract: *As drone technology continues to reshape global construction practices, its adoption in Malaysia remains limited, raising questions about the readiness of future construction professionals to embrace this innovation. This study investigates the perspectives of final-year construction field students in Malaysia regarding the applications and implementation barriers of drone technology in construction projects. A quantitative survey was conducted among 103 students from 3 universities in Malaysia which are Universiti Teknologi Malaysia (UTM), Universiti Sains Malaysia (USM), and Universiti Teknologi Mara (UiTM), utilizing purposive sampling and a structured questionnaire distributed via Google Forms. The findings reveal that students demonstrate a moderate to high level of awareness, particularly in areas such as progress tracking, visual inspection, and survey mapping. However, significant barriers persist, including complex legal regulations, technical limitations, and financial constraints, which may hinder wider industry adoption. This study highlights the need for enhanced educational exposure, regulatory clarity, and strategic investment to equip the next generation of professionals with the competencies required to integrate drone technology into mainstream construction practices.*

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Keywords: *Drone technology, construction education, student perception, barriers to adoption*

Introduction

Inspections are vital as they provide success, quality, and safety of projects through in-depth investigation processes that ensure strict adherence to industry standards, legality, and strict safety requirements. Salvi & Kerkar (2020) stated that inspections are crucial to identify possible risks, identifying defects in a building and confirming the craft's quality.

As time goes, new technology emerged including for the construction industry. In Malaysia, these transformations were driven by the Fourth Industrial Revolution (IR 4.0), emphasizing automation, digitization, and data integration. One of the emerging technologies reshaping construction workflows is drone technology. Drones, or UAVs, are increasingly employed in construction projects for site inspection, progress tracking, and many other types of analysis (Alsamarraie et al., 2022).

Despite the growing use of drones in construction globally, their adoption in Malaysia is still in its infancy and does not have worthy impact towards Malaysia construction industry (Yahya et al., 2021). A critical gap exists in understanding the readiness of future construction professionals, namely construction field students to adapt to this shift. This study plans to explore the perceptions of graduating construction field students regarding drone applications and aims to identify knowledge gaps and strategic improvements for industry integration.

Literature Review

Drone Technology in Construction

Drones are defined as unmanned aircraft systems controlled remotely and used for diverse purposes, including surveillance, mapping, cargo delivery, construction site inspection or even military operation (ICAO, 2011). Fitted with high resolution camera and stabilization system, drones are able to record exceptional photos or videos used in film making or even surveying in construction field purpose from areas which were hard to be reached.

Drone can also be blend together with Building Information Modelling (BIM) system. They facilitate aerial photography, real-time site analysis, which can be integrated with Building Information Modelling (BIM) (Rahnamayiezekavat et al., 2022). Their applications in BIM include:

Progress Tracking

Drones are beneficial and versatile tool for construction, covering a wide range of project management and site operations tasks. Capturing real-time images to monitor construction milestones (Devers, 2019). Drones can be used by contractors to effectively and efficiently monitor construction sites, track site progress, and create plans compared to conventional techniques (Mahajan, 2021). AlRushood et al., (2023) supported that drones regularly capture data which can be used systematically at regular intervals.

Volumetric Measurement

Drones can be used to measure volumetric measurements. Alsamarraie et al. (2022) stated that aggregates, gravel, sand and other construction materials can be measured by using drones which helps to predict cost estimations in the construction industry. Not only that advanced

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sensory equipped drones facilitate the capturing of precise and comprehensive data regarding the volume and distribution of these materials within construction sites (Mahajan, 2021).

Survey Mapping

Survey mapping is defined as high-resolution imagery and geospatial data collection by using drones, for the purpose of producing intricate and detailed 3D maps. (Zakiyyatuddin et al., 2021). A study by Mahajan (2021) found that as drone seen to be adaptive with the surrounding, it is used more and more for mapping and surveying land which has given tremendous impact towards project development. Drones can complete survey work in 60% to 70% less time than conventional land-based surveying methods, making the process more efficient and cost-effective. According to a recent study conducted by Zakiyyatuddin et al. (2021), the use of drones equipped with intelligent flight batteries and high-resolution cameras can effectively map large areas of land and buildings in 3D.

Visual Inspection

Drones can carry out a diverse range of construction inspection tasks. Falorca et al. (2021) stated that drones are capable of monitoring a buildings or other structures' state. This can be done while reducing the numbers of accidents at site as it is controlled remotely. The capability of drones to monitor worksites and equipment offers a continuous flow of information, enabling swift responses to emerging safety concerns. Ramirez Rufino et al., (2023) stated that drone can maximise the staffs' efficiency, speeds up the work progress while reduce accidents and costs.

Defect detection

Drones mounted with high resolution cameras have the ability to capture extraordinary clearness and high-definition images which allows for comprehensive visual inspection and enable defect identification which might be missed out during traditional inspection. The capability of inspecting closed up objects or structures helps in identifying uneven surfaces, cracks and other types of defects (Qiu & Lau, 2024).

Environmental Analysis

Drone is seen to be a promising and effective approach for the purpose of environmental analysis. This helps in the management of construction and demolition debris at site. Jiang et al. (2022) conducted a study in which employs advanced technological tools and methodologies utilizing drone photogrammetry, GIS, and deep learning techniques to streamline the identification and measurement process. The study's findings highlight the potential for these technologies to enhance efficiency, accuracy, and safety in the management of construction and demolition waste. The drones will analyse the demolition debris to keep the waste pollution at bay. This will help in making an Environmental Impact Analysis for the construction industry.

Barriers to Implementation

Even though multiple advantages are offered through drones' usage, there are several barriers which hinders their widespread use.

Legal and Regulatory Barriers

Drone usage is regulated by complex legal frameworks, which vary across jurisdictions. In Malaysia, the Civil Aviation Authority of Malaysia (CAAM) oversees drone operations and mandates permits for flights exceeding 120 meters, over no-fly zones, or above private premises (Azmi, 2021). These regulatory requirements, while necessary for public safety, present

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administrative burdens and time delays. Operators often encounter intricate application processes, which are especially challenging under tight project timelines (Alsamarraie et al., 2022).

Technical Limitations

Technical constraints such as limited battery life, signal range, and payload capacity hinder drone efficiency on large or complex sites. UAVs often struggle to maintain signal integrity in expansive or obstructed environments, which undermines their utility in high-rise or remote construction settings (Liang et al., 2023). These issues reduce operational effectiveness and restrict the full capabilities of drone technology.

Environmental Constraints

Environmental conditions significantly affect drone performance. Inclement weather, including strong winds and rain, may halt operations due to safety risks and the potential for data inaccuracy (York et al., 2020). Additionally, extreme temperatures reduce battery performance and compromise mechanical reliability. Drones also face difficulties accessing confined or obstructed areas such as tunnels or indoor spaces with signal interference.

Financial Constraints

High initial investment costs pose a major barrier. Construction firms must invest in drones, associated hardware, software, and operator training (Onososen et al., 2023). Ongoing costs, such as regulatory compliance and maintenance, further burden smaller firms. These financial challenges may deter widespread drone adoption, especially among resource-constrained companies.

Safety Concerns

Safety remains a critical issue. Drones can pose hazards if malfunctions occur, leading to collisions with workers, equipment, or structures. The noise produced by UAVs may distract personnel, increasing accident risk (Liang et al., 2023). The prospect of mechanical failure adds to safety concerns, necessitating strict operational protocols to prevent injury or property damage.

Security Challenges

Drone surveillance introduces data security risks. Unauthorized access to footage or data breaches can compromise proprietary project information. In Malaysia, operators must also adhere to legal restrictions on airspace use to avoid trespassing, particularly in urban or residential areas (Yahya et al., 2021). These challenges highlight the need for robust data management and security policies.

Privacy Issues

The presence of drones on construction sites may erode employee trust and morale. Workers might perceive surveillance as invasive, leading to discomfort and decreased job satisfaction (Onososen et al., 2023). Ethical concerns arise when drones capture images or footage without explicit consent, potentially violating privacy norms (Mahmood et al., 2024). Transparent communication and ethical guidelines are therefore essential for maintaining workplace harmony.

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Knowledge and Expertise Gaps

Effective drone operation requires both technical and contextual knowledge. A lack of trained personnel can lead to improper implementation, misinterpretation of data, and safety risks (Emimi, Khaleel & Alkrash, 2022). Operators must understand not only drone mechanics but also construction-specific variables to accurately interpret UAV-acquired data. Interdisciplinary collaboration with experts in construction engineering and materials science is often necessary (Liang et al., 2023).

Research Methodology

This study adopted a quantitative survey method by utilizing Google Form which were distributed to final year construction field students regarding the application of drone technology in construction projects. The questions were stipulated based on authors and research of previous literature.

In research regarding construction students' perceptions and attitudes towards adopting Building Information Modelling (BIM), Zakaria et al. (2013) stated that students' readiness and positive perspectives are critical in ensuring the future workforce is technologically competent, thereby influencing the industry's progress. Other than that, Irizarry & Johnson (2014) which explored civil engineering students' understanding and perception of Unmanned Aerial Vehicles (UAVs) or drones in construction. found that students play a crucial role in shaping the future use of such technologies through their academic exposure and openness to innovation.

Purposive sampling was used to recruit participants from accredited Malaysian higher education institutions offering construction field programmes. Inclusion criteria required participants to be in their final year of study and to have academic or practical exposure to construction technology. Large sample survey or experiments help researchers minimise bias and systematically measure, thus enhanced the validity and reliability of the results (Babbie, 2020).

Ethical approval was obtained from the institutional research ethics committee, and participants were assured of confidentiality, anonymity, and the right to withdraw at any stage. Based on a population of approximately 7,692 students, the sample size calculated using the Raosoft, a minimum of 366 responses were recommended. In this research, the total of 103 responses were attained. Fellow & Liu (2021) stated that a response rate of 20–25% is often realistic and still usable when it is related to construction research surveys. The data were then analysed using SPSS v28, applying descriptive statistics and reliability test using Cronbach's Alpha.

Results and Discussion

A total of 103 responses were attained from the survey done. These responses, who were final year students from Universiti Teknologi Malaysia (UTM), Universiti Sains Malaysia (USM) and Universiti Teknologi Mara (UiTM), responded the survey through Google form shared to them.

Awareness of Drone Applications

A total of 7 questions in this section were asked towards the respondents regarding the understanding and awareness of drone applications. The question asked were listed in the table below.

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Table 1: Awareness of Drone Application

Variable	Mean	Rank
1. Progress Tracking Application of Drone Technology	4.19	1
2. Visual Inspection Application of Drone Technology	4.08	2
3. Survey Mapping Application of Drone	3.92	3
4. Defects Recognition Application of Drone Technology	3.92	4
5. Environmental Analysis Application of Drone Technology	3.86	5
6. Drones can be integrated seamlessly with BIM software, contributing to enhanced project planning and coordination	3.74	6
7. Volumetric Measurement Application of Drone Technology	3.69	7

The result tabulated from the table indicated that a high level of awareness among final year construction field students regarding drone applications. This is shown that most respondents mean value in the questionnaires are valued higher than 3.50 in their awareness and understanding of drone technology. It also shows that these students possess some knowledge concerning the integration of drone technology within their field of study. These results reflect an encouraging familiarity among students, possibly due to their academic environment and digital exposure.

Drone Applications' Barrier

A total of 8 questions were asked towards the respondents regarding the barriers that were seen to affect the drone implementation in the industry. The question asked were listed in the table below.

Table 2: Barriers in Drone Applications

Variable	Mean	Rank
1. Laws and Regulations of Drone Technology	4.19	1
2. Technical Issue of Drone Technology	4.09	2
3. Financial Issue of Drone Technology	4.06	3
4. Safety Issue of Drone Technology	4.06	4
5. Environmental Issue of Drone Technology	3.95	5
6. Lack of Knowledge and Expertise in Drone Technology	3.93	6
7. Security Issue of Drone Technology	3.93	7
8. Privacy Issue of Drone Technology	3.83	8

From the table 2 above, it can be concluded that the regulatory complexity or law and regulations of drone technology were seen to be the main barriers in drone applications. Different law and regulations in different countries makes it difficult for users to adapt and follow the regulations religiously.

Other than that, technical issues of drone technology were also seen as one of the major barriers in drone applications. Short battery lifetime, limited range and payload capacity affect the operational efficiency and effectiveness of drone technology. The respondents expressed concern that these challenges may discourage firms from adopting drones unless supported by clearer guidelines and government incentives.

Conclusion

The study concludes that most graduating construction field students possess moderate to high awareness of drone applications in construction industry. However, significant barriers, particularly regulatory and technical issues of drone technology hinders the implementation.

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Future professionals, such as architects, engineers, and quantity surveying graduates, will be pivotal in driving construction innovation. Their readiness to embrace drone technology can reshape project management practices, enhance efficiency, and improve construction outcomes in Malaysia and beyond.

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