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JTMB

http://penerbit.uthm.edu.my/ojs/index.php/jtmb
ISSN : 2289-7224 e-ISSN : 2600-7967

Journal of Technology Management and Business

The Challenges of Drone Application in the Construction Industry

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DOI: https://doi.org/10.30880/jtmb.2021.08.01.003
Received 04 March 2021; Accepted 03 June 2021; Available online 24 June 2021

Abstract: Drone technology is currently being used in many areas, and the increasing prevalence of drones is evident in all areas. Drones were first used for military purposes and now they have become an important part of military actions. In recent years, drone technology has become widespread in various industries including journalism, filmmaking, aerial photography, shipping, delivery. However, drone technology is still in its infancy and has not had a significant impact on the construction industry in Malaysia. Therefore, the study's objective was to assess the challenges preventing the application of drone technology in the Malaysian construction industry. The methodology used for this research was qualitative, which is data collection through interviews with three drone experts. The respondents in this research were directors of construction companies that use unmanned aerial vehicles for their operations. The findings showed that drones faced the challenges of unfamiliarity, lack of knowledge, reticence to adopt new technologies, privacy issues, and security issues. These challenges faced by drone technology will not prevent its application in the Malaysian construction industry. However, government support is important in promoting the use of drone technology and raising people's awareness of drone technology in the construction industry.

Keywords: Challenges, construction, drone, qualitative

1. Introduction

The UAV technology, also known as a drone, is an aircraft that requires no pilots, nor the operator equipment, nor the data link connecting the aircraft and the ground base (Tatum & Liu (2017). Other names for these aircraft include unmanned aerial vehicles (UAV), unmanned ground vehicles (UGV), and unmanned aircraft systems (UAS) (ROA). Over recent years, drone technology has become highly popular. Drone technology is advancing, becoming smaller, lighter, more efficient, and cheaper. Thus, drones will become increasingly available to the public and will be used for a broader range of purposes. For example, a defibrillator was delivered to a cardiac arrest victim in 2014 using a drone developed by TU Delft (TU Delft, 2014). Drone technology has recently matured to the point where it is both user-friendly and reasonably priced (Joyce, 2015). A drone is powered by jet aircraft, reciprocating engines, or electric engines, despite being piloted by humans. Moreover, drones can obtain extremely high-resolution data from relatively inaccessible places such as mountain summits, coastlines, and islands (Gao Xu, Klinger, Woerd, & Tapponnier, 2017). Inspections can be completed with a camera drone from the ground, which decreases the costs and dangers of high-altitude inspections. In addition to devices fitted with regular cameras, drones equipped with special sensors can be used to check whether the maximum limit is not exceeded. This would enhance capabilities such as obtaining geospatial data in real-time at a low cost (Fornace, Drakeley, William, Espino & Cox, 2014).

Drone technology has become widely used in a variety of industries, including construction, in recent years. Construction companies use drones in the construction industry to check for leaks and cracks in buildings and bridges

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(Floreano & Wood, 2015). A contractor typically uses a drone to inspect the entire structure of a building or its portion. Drone on construction sites will bring about significant changes in the industry. Drones have started to alter construction methods and make things easier. They will only grow in popularity in the future. The use of drone technology in the construction industry could help detect structural flaws and serve as a supplement to structural inspection. Drone technology can also be used for construction project inspection and maintenance. Due to a scarcity of human resources, the thoroughness of drone applications may suffer. Management of construction sites could be assisted using drone-based data collection. This includes tracking the location of facilities, such as buildings, where the drone's data will be used to generate a point cloud. A drone camera will work in tandem with classifying software to identify the objects the drone sees. In addition, Bieda *et al.* (2013) indicated that identifying the location of materials on a construction site in real-time through the use of a particular software layer can show investors where their money has gone if a very important operator is located in a different city or state. Photos of the property to be renovated can be broadcast live to the public. Furthermore, new technology can be used to detect possibilities of construction flaws (Balaras & Argiriou, 2002). In architecture, drones can be used to capture images and footage for virtual 3D renderings that can be used to determine the design of buildings (Uzialko, 2017). By creating high-resolution aerial shots, architects can cheaply place architectural concepts in their designs. The ability to produce accurate designs is critical to the creation of useful products.

Despite its abundance of advantages, Ab Rahman (2019) revealed that drone technology is not as prevalent in every part of the country as previously thought. Some things prevent widespread drone deployment in Malaysia. For instance, a lack of drone technology interest among Malaysian consumers is attributed to the military's negative association. Cruise missiles were designed to carry and launch ammunition, while military drones were designed to carry ammunition. So many people assumed the use of all drones had led to bloodshed and killing. There are also security issues, such as criminals can utilise drones for their criminal intent, and the victims are at risk of privacy violations. For example, the user might zoom in to a house window to snap a photo, record a video covertly, or use a drone to drop a bomb. The next major issue with drone technology in Malaysia is how long it takes to obtain the proper licensing. It was issued by the DCA, which requires every drone operator to possess a private pilot licence when buy and use, and this license might take up to a year to attain. This situation would encourage people to give up using this technology because obtaining a permit is a trouble and waste time. Similarly, these issues sometimes make drone technology in Malaysia's construction industry be overlooked since this technology is still in its nascent stages in Malaysia (Ida, 2017). Therefore, this research's main objective is to examine the challenges of drone application in the Malaysian construction industry.

2. Literature Review

2.1 Drone Technology

Zainudin (2015) claims that drones are small and highly maneuverable, capable of indoor and outdoor flight. All drones are UAVs, but non-flying drones are not a drone. The different types of drones can be distinguished by how autonomous they are, how small they are, and how much they weigh. Most of the drone is operated automatically, while human control a few. While according to Samad *et al.* (2013), a drone is known as an autonomous navigation system as it uses the Global Positioning System (GPS) and checks the telemetry at Ground Control Station (GCS). Based on Janssen (2015), drones, also known as unmanned aerial vehicles (UAVs) are aerial modulus operated by manned remote control or scheduled flight path. These aircraft are remote controlled and can be flown through preprogrammed flight plans in a robotics system. Under Federal Aviation Administration (FAA) regulations, drones must be operated within line of sight and within the operator's line of sight. The term unmanned aircraft system (UAS) includes drones, remote controls, control stations, control links, binaries, payloads, launch and recovery equipment, etc.

2.2 The Implementation of Drone Technology in the Construction Industry

According to Arcadis (2017), drones' use eliminates the need for workers to work at heights and dangerous places to check assets, such as bridges. Neil & Shields (2014) indicates that drones using conventional cameras can assist construction inspectors with their work. Arcadis (2017) found that drones are more cost-effective than scaffolding and mobile equipment for surveys and inspections because they eliminate the need for scaffolding or mobile equipment. Construction projects are typically lit at night to provide security and visibility for security guards. Lights required for construction sites will take more energy and, therefore, increase the cost of energy. Based on the American Society for Engineering Education (ASEE) research, drones are used for a multitude of building inspection tasks. In structural fires, a thermal imaging camera can be mounted on the drone to capture heat flow, thus enabling the analyst to assess the fire's spread.

Danielak (2018) has also revealed that using thermal imaging on drones is possible, but it has only recently become a commercially viable option. Chartering helicopters or aircraft can reduce costs and provide you with greater flexibility when shooting aerials. Wingtra (2020) shows that aerial drone's most common use is to carry out aerial photography in and out of construction sites. Drone technology provides the client with the ability to see the project's specific specifications by seeing photos taken at the site. The drone is used to take a picture of a structure each week and turn it into a time-lapse video. They are coordinating the logistical work to coordinate the work and provide progress updates

to the remote stakeholders. Drone technology always provides an efficient means of monitoring progress of a project (Arcadis, 2017).

2.3 The Challenges Facing Drone Technology in the Construction Industry

2.3.1 Limited Drone Battery Life

One of the biggest challenges facing drone applications in the construction industry is the limited flight time due to the little battery power. The drone will be in the air for 25 minutes while charging. Although multiple battery packs allow the drone to fly for the entire day, it must be recharged every 25 minutes. Of course, this is entirely inconvenient. Drones have a shorter service life, according to Grind Drone (2017). Although the drone is extremely convenient, the camera used to capture images or videos is much shorter than a traditional camera. Because the battery is less designed and cannot last more than 4 hours to perform extensive activities, most drones have at least 4 hours of battery life.

2.3.2 Vulnerability to Damage and Bad Weather

Drones tend to have more limitations in extreme weather. They are not suitable for use at extreme temperatures, such as those in construction sites (Neil & Shields, 2014). Flight control for drones can be problematic at freezing temperatures. In cold weather, a battery will usually not function as well. Unless the weather is favourable, the drone cannot provide accurate geographic data. Images from a drone may need ground truth to verify what is happening in the area of interest to the drone. According to Grind Drone (2017), drones are vulnerable to wild animals when drones fly into areas where wild animals are dense, usually deemed a creature. Large flying animals such as hawks attack and capture unmanned aerial vehicles (UAVs), because they typically attack them while flying through the atmosphere and taking important photos or videos. Users can be identified when their drones unexpectedly disappear. Workers eventually discover that their drones are seen at the lair or on the nest's flying creatures.

2.3.3 Complexity

Janssen (2015) discovered that while drone flight can be controlled more easily, a good video feed requires collaboration between two people. In particular, when using a hot camera under an unmanned aircraft, the camera operator knows what to focus on. Although the drone can fly without human intervention, the remote controller must be used if GPS is lost. When trying to plan a flight mission with a drone, the more difficult it is to monitor construction progress and to get construction work accepted. It is diverse because it must combine and reflect the different sources of information.

2.3.4 Security Issues

As drones capture detailed data about power and utility infrastructure, there is more risk to confidential information (Labovich, 2017). This safety concern necessitates a security system to ensure effective protection against attacks. Many of the data collected by drones are transmitted to the cloud via Wi-Fi or Bluetooth, increasing a drone's vulnerability to cyberattacks. Therefore, drones are easily susceptible to cyber-attacks. Hackers may exploit the drone's lack of sufficient security and obtain sensitive data. To solve this problem, it is necessary to conduct data and connection security for data safety. According to Grind Drone (2017), hackers can easily penetrate the drone's main control system and manipulate it as a new driver or controller for the device. The drone's network and control system contain valuable information that hackers can use, but only if they are aware of how to access it. After being privy to the private information, the hacker began to delete the file because it was no longer needed. When users attach their social media files directly to the drone, all confidential information becomes vulnerable and allows unauthorised individuals to steal the files.

2.3.5 Confidential Information

The next challenge is privacy issues which the user of the drone will be able to use drone zoom to take video and photo secretly (Zhao, 2020). Because drones can fly anywhere and capture footage on private property, drone owners who invade others' privacy will be subject to liability. The unclear regulations are a significant cause of this problem. The research found that criminals can use drones to accomplish their criminal objectives, their targets are now vulnerable to privacy. If the user launches the drone into the atmosphere, any land creature will not hear the propeller audio and think it is natural. Aerial drones are equipped with heat and nighttime sensors that detect any life signs, including individuals who are currently interested in groups or institutions. The drone will collect data throughout the operation without the knowledge of individuals, groups, or authorities.

2.3.6 Safety Problems

Operational safety is a risk factor in the deployment of drone technology in the construction industry. According to Labovich (2017), drones' use brings numerous benefits and has several operational consequences and hazards. The

growing use of drone technology has increased aviation accidents and ground crashes. Human error, signal loss between drone and pilot, and technical errors can cause real public safety threats such as drones falling at high and hitting people. Amor (2012) found that drone technology's major challenge in the construction industry was endanger workers on the construction site. The safety risks workers are exposed to due to working with drones. The risks associated with operating a drone require additional security measures to be employed to prevent accidents. Besides that, Srewil (2015) stated that safety is a priority inside the workplace, especially issues such as distractions and even drones. This demonstrates that drones are causing accidents to occur in the construction industry.

3. Methodology

The research employed a qualitative technique with the utilization of semi-structured interviews. According to Srinivasan (2001), structural interviews provide researchers with uniform and extensive information to achieve data comparability. The researcher interviewed the director of a drone service company and a land survey company about their opinions on using drone technology in their projects. The researcher selected the respondents using a purposeful sampling technique based on their work experience and expertise in Malaysia's drone applications. The target respondents are a drone company manager who provides drone service and contractor that have used drone technology in construction projects in Kuala Lumpur and have sufficient data and information to support the research objectives. Ten invitation letters have been administrated to potential respondents for their agreement to be interviewed, subsequently, only three participants were agreed to participate. Our sample numbers are small because most of the invited potential respondents were reluctant to participate, but our methods generated exceptionally rich data. Despite the small sample size, clear themes emerged from the narratives that were sufficient for this exploratory investigation (Nier, 2020). As Morse (1995) argues that the more useable data are collected from each person, the fewer participants are needed. She also urges researchers to consider several significance parameters, such as the scope of study, the nature of topic (i.e. complexity, accessibility), the quality of data, and the study design.

The interviews took place in the respondents' offices and were digitally recorded. The interview sessions lasted between 30 and 45 minutes. The recorded interview session was then transcribed verbatim for easy analysis. Content analysis was used to analyse the verbatim data, which was then categorised into appropriate themes. According to Krippendorff (2019), the content analysis uses the study of texts or other meaningful things to make replicable and valid inferences. Because it can be applied to the analysis of any writing or occurrence of recorded communication, the data collection must be used to gain a more accurate and complete understanding of content analysis.

4. Analysis and Discussion

4.1 The Respondent’s Demographic

Table 1 showed the demographics of the respondents. Respondent 1 (R1) is a Business Development Director in a drone service company. He had seven years of work experience in the construction industry and covered the market for emerging technologies such as AI and drone technology. While Respondent 2 (R2) was appointed as the Technical Director in a land survey and mapping company. He had 20 years work experience in the construction industry, and he has been involved in many GIS, GNSS, and Remote Sensing consultancy works. In addition, Respondent 3 (R3) currently serves as the Managing Director of a land survey and mapping company. He had 32 years of work experience in the construction industry and leveraged his vast experience spanning thirty years in Positioning and Height determination using GPS and Topographical Survey and Mapping. Even though these three respondents did not work with construction companies, they have extensive experience providing drone services for various organizations in the Malaysian construction industry.

Table 1 - The respondent’s demographic

Item	**Respondents**		
	R1	R2	R3
Position	Business Development Director	Technical Director	Managing Director
Types of company	Drone service company	Land survey and mapping company	Land survey and mapping company
Work experience	7 years	20 years	32 years

4.2 The Challenges that Impede the Application of Drone Technology in the Malaysia Construction

The findings from Table 2 show a wide range of responses to the challenge of applying drone technology in the construction industry. Respondent R1 conveyed concern about the lack of knowledge about drone technology and opposition to new technologies. As a result of the unfamiliarity of drone technology, drone adoption will not take place. Many people believe that all drones have been used in military warfare, causing unintended deadly consequences. Additionally, respondent R1 commented that people are not familiar with how drones are used in the industry. For instance, Jansen (2015) claims that construction practitioners lack knowledge about the applications of drones in the construction industry and the lack of use of the technology in the construction industry. Respondents also revealed that people are reluctant to adopt drones and instead rely on conventional drone technology operation methods. The difficulty in convincing construction experts who are likely to adopt new technology using traditional methods is because they are used to traditional methods for many years and do not want to learn new things to accomplish the same task. When asked, respondents identified challenges as privacy and security issues. The employee may use a drone to illegally do things like invading a person's privacy by zooming into their property. For security concerns, R2 was concerned that hackers could exploit drones to steal sensitive data. PricewaterhouseCoopers (2017) found a higher likelihood that UAVs' technology is vulnerable to hacking.

Table 2 - The challenges of drone technology application

No	Challenges	R1	R2	R3
1	Lack of familiarity with drones	/		
2	Do not know how the drone technology can add value to the construction industry.	/		
3	People hesitate adopting drone technology and rely on conventional practice methods of operating	/		
4	Privacy issues		/	
5	Security issues		/	
6	Procedure for regulations and permit still messed up and not efficient			/
7	The unstable weather in our country			/

The response given by R3 is how regulations and permits are not efficient, and the procedure still is messed up. According to The Star (2016), a private pilot needs a license to operate drones, and that one might take years to obtain. Furthermore, respondent R3 also specified that changes in weather conditions and environmental factors within Malaysia would influence drone technology in the construction industry in Malaysia. Neil & Shields (2014) discuss the limitations of using drones in adverse weather conditions. Table 2 also shows that all respondents remained separate on how best to apply drone technology in Malaysia's construction industry. The respondent's two main challenges with drone technology are lack of knowledge about the technology and opposition to new technologies. Respondent highlights the potential of drone technology and how it may benefit the construction industry. Lack of awareness about drone technology prevented fewer effective applications of the technology in the construction industry. Respondent R1 said that "*People are unfamiliarity to drone and do not know how the drone technology can add value to the construction industry.*"

In addition, Wilson (2014) pointed out that one of the major problems in applying drone technology is that drones are associated with the military. Cruise missiles were designed to carry and launch ammunition, while military drones were designed to carry ammunition. Lack of knowledge regarding drone technology has contributed to numerous unfounded beliefs regarding the harms that drones cause. Moreover, Janssen (2015) stated that potential drone users, such as contractors and project managers, have little knowledge about the possible use of drones in the construction industry, which prevents the use of drone technology in the construction industry.

Respondent R1 also mentioned that "*People are hesitate to adopting drone technology and rely on conventional practice methods of operating*." The difficulty in persuading experts in the construction industry who were prone to traditional methods of operation to adopt new technology was because those experts had been accustomed to using traditional methods for many years and were unwilling to learn new things to complete the same task. These issues may unreasonably slow the adoption of drone technology in the Malaysian construction industry. Respondent R2 also mentioned that challenges were associated with issues involving privacy and security. The employee may use a drone to illegally do things like invading a person's privacy by zooming into their property. Page (208) states that drones are commonly used for taking photos of private property. The drone will report any suspicious activity without the consent or permission of authority.

Compliance challenges are not about privacy concerns, the regulatory frameworks for drone use must be developed by the government. The legislation governing drone use will influence drone sales in a country. For privacy challenges, respondent R2 highlighted that "*The challenges are not the privacy issues but relating to how regulatory framework surrounding drone application needs to be shaped by government. The law for drone technology will influence the adoption of drone technology in a country*." Drone regulation in Malaysia, for example, allows drone flights over designated areas (areas for residential, commercial, industrial, and recreational purposes) with a permit from the Department of Civil Aviation (DCA). If the government prohibits drone use in residential areas, the construction industry in Malaysia will suffer. Respondent R2 stated that "*Data collected by drones may hack by hacker to steal the confidential information of that company*." According to Labovich (2017), there was a greater risk of hackers gaining access to confidential drone technology information because data collected by drones was typically transmitted to the cloud via Wi-Fi or Bluetooth, increasing the risk of cyber-attacks. The drone's network and control system contain sensitive data that hackers can access without the original user's knowledge. Hackers can control the drone's interface and obtain sensitive data by using insecure connections. The hacker may destroy the stolen files to avoid any trace of the theft. When users attach social media files directly to the drone's controller, all private information is exposed and is at risk of being exploited.

Respondent 3 offered that the post-service operation such as regulations and permits still breaks down and does not function efficiently. Malaysia has enforced operating permit and private pilot's license is required for flying commercial drones (Ab Rahman, 2019). Respondent R3 noted that inefficient regulations and tedious permitting procedures contribute to the delay to use drone technology. Obtaining a permit for every flight when operating your drone is required. This situation can slow down the completion and progress of any project. He stated that "*Inefficiency of procedure for regulations and permit result to spend more time for getting the permit to apply drone technology. Must obtain a permit for every flight when intend to operate drone. This situation may cause some activities delay and over completion time of a project*" DCA (2008) regulated that a contractor must apply for a permit with the DCA, and the licence is required to wait for three months. The owners must declare where they want to fly the aircraft.

Furthermore, respondent R3 also specified that changes in weather conditions and environmental factors within Malaysia will influence the application of drone technology in the construction industry in Malaysia. Due to gustily strong wind and intensity rainfall, which may disrupt the planned path and telecommunication stability, flight reliability of drone operation can be a critical issue for the flight controller. The applicability of applying UAV in severe weather conditions is restricted. According to Neil & Shields (2014), they discuss the limitations of using drones in adverse weather conditions. "*The unstable weather of Malaysia which is often rains will cause drone cannot operate because drone did not have waterproof and may broke if get wet in the rain*," said respondent R3. The weather and the drone's ability to manoeuvre and navigate itself through different kinds of objects are important factors when choosing a drone. Weather conditions had a similar effect on manned and unmanned aircraft as the effects on both depended on the size and design of the aircraft. Weather such as thunderstorms and precipitation are commonly associated with flight accidents and may cause accidents.

Besides that, all respondents indicated that the issues referred to in the survey would not prevent the implementation of drone technology in construction in Malaysia. The factor of lower construction cost would cause individuals to incorporate drones more into the marketplace in the future. However, respondent mentioned that the drone technology has already been applied in the construction industry, and there are a lot of start-ups in Malaysia. The only challenge was narrowing down the service providers to choose from. Respondent R1 said that:

"The challenges mentioned above will not put a complete block to drone technology adoption but will nevertheless hinder the adoption rate speed from its fullest potential. It was because drone technology can reduce the cost of construction. The factor of cost would drive people to incorporate drones more widespread down the line."

It was due to the low labour cost associated with drone construction. The increasing cost of using drones would encourage their wider use down the road. In addition, the same problem faced by many countries was privacy issues. However, they still used drone technology in construction because it can provide significant savings. From respondent R3, the technology is already being used in construction. Many start-up companies are emerging in Malaysia. The only problem was figuring out who the winner was.

5. Conclusion

In a nutshell, this research has shown the challenges posed by drone technology applications in the construction industry in Malaysia were unfamiliar with drone technology, lack of knowledge of drone technology, opposition to the adoption of new technologies, problems with privacy and security, the inefficiency of regulatory and licensing procedures, and instability in the country. However, all respondents agreed that all the challenges mentioned would not prevent the application of drone technology in the construction industry in Malaysia. Drone technology can reduce the construction cost and drive people to incorporate drones more widespread down the line. Therefore, lots of efforts need to be done including but not limited to, training, education, roadshow, to encourage the application of drone technology within the Malaysian construction industry.

Acknowledgment

The authors appreciate the support they have received from the Faculty of Technology Management & Business and Universiti Tun Hussien Onn Malaysia (UTHM).

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