The Capabilities and Readiness of Unmanned Aerial System (UAS) implementation in Construction Work Progression

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Abstract

Nowadays, the implementation of Unmanned Aerial Systems technology is becoming increasingly widespread in the construction industry. Unmanned Aerial Systems (UAS) have evolved over the past decade as both advanced military technology and off-the-shelf consumer devices. Nowadays, the implementation of Unmanned Aerial Systems technology is becoming increasingly widespread in construction industry. The uses of drones are increasingly moving towards successful remote procedures which can take place in a range of in building industry. Unmanned Aerial Systems remote sensing equipment is a way in which current building construction work progress can be analysed and inspected. Therefore, this study would be beneficial as eye opener for building construction practitioner that this remote sensing equipment can replaced the manual paper-based supervision and unsystematic database of current conventional construction work progression process.

Keywords: Capabilities, Readiness; Unmanned Aerial System; Construction Work Progression

1. Introduction

Traditionally, monitoring construction progress is a labour-intensive task. Daily or weekly reports are mostly used to document the quantity of work done on site. Although these reports are flexible and offer many kinds of information, including resource availability, possible hazards, inventory checklists, and incidents, they fail to collect geometric three-dimensional (3D) data from the finished job [1]. Progress information collected using existing processes for manual progress measurement is prone to mistakes and takes time [2]. In addition, approximately 30 to 50 percent of the time a project manager spends on data processing and analysis. Accurate and fast data collection, analysis, and visualisation of a project's as-built state are important components of effective project progress monitoring. This increased burden leads to further mistakes, as project teams hurry to synthesise data and make timely effective project control choices. Accurate and frequent progress reporting on building projects allows the project team to know their project status and make educated choices. [3] stated that the progress reporting of the construction project is according to an important component of the management of the construction projects. From the report information, the project team can understand how the project progresses, budgets are respected, the necessary quality is reached and safety precautions are followed via a frequent and accurate status report. This information leads them via educated choices and remedial action. There is a positive connection between performance and a person is exposed to the quantity of information. The performance of an individual "declines quickly" if too much information is given to the person. Moreover, conventional progress reports offer a snapshot of progress over a period (bi-weekly, weekly, or monthly), but management must understand the progress trend of the project up to assessment date in order to make informed choices. Current methods to monitor progress are not as precise, consistent, dependable or fast to allow effective choices for controls to maintain a project on schedule. Manual non-spatial data gathering procedures, such as checklists and daily reports with a huge number of visual data from the construction site may be collected in a short period, are the methods most often employed. Substantial delays may occur before foremen are analysed on a daily or weekly basis and any relevant information is communicated to the parties involved. The entire procedure may avoid timely corrective measures and lead to delayed schedules.

2. Unmanned Aerial System (UAS) technology capabilities

Additionally, the Architecture, Engineering, and Construction (AEC) business has gradually embraced Unmanned Aerial System (UAS) technology. UASs have been used in a wide variety of AEC applications, ranging from traffic surveillance [4]; and landslide monitoring [5] to cultural heritage conservation [6]; [7] and city planning [8]. Construction, in particular, has seen an exponential increase in the use of UAS, owing to the advantages connected with their capacity to enter inaccessible or dangerous regions and their ability to accomplish jobs safely and effectively [9]. Unmanned Aerial System (UAS), Unmanned Aerial Vehicles (UAV), Unmanned Aircraft System (UAS), Aircraft Operated Remotely (ROA), and Remote Pilot (RPA) are among other terms used today for various purposes, the whole world recognizes it as a drone. Previously, Unmanned Aerial System or drone technology originally mainly developed for military purposes. Unmanned Aerial System as powered aerial vehicles not carrying a human operator, so the aerial vehicles can fly autonomously or be remotely piloted. This system presents opportunities for an Unmanned Aerial System effective with remote procedures. With that Unmanned Aerial Systems as both advanced aircraft hardware and off-shelf consumer devices developed in the last decade [10].

In recent years unmanned aircraft have become an important research area. Today, because of their mechanical simplicity, they are more and more recruited for civil applications with regard to surveillance and infrastructure inspection. Aerial vehicles are often differentiated by their capacity to fly at different speeds, to maintain their position, to hover over a destination and to carry out manoeuvres near to obstacles and, whether fixed or loitering, to fly inside and outdoors. These characteristics make them ideal for human replacement when human involvement is hazardous, difficult, costly or exhausting [11]. Previous research has examined the use of Unmanned Aerial Systems for building systems inspection, focusing on the deployment and workflow of drones, 3D model reconstruction, and anomaly detection image data analytics.

The use of the Unmanned Aerial System has increasingly grown and has now proven to be regarded as a standard analysis method for the collection of photographs and other information on demand in an area of interest. [12] discovered that drones are among the current technologies that are considered suitable to replace the monitoring of progress done manually which describes the drone technology as capable of collecting data on the construction site in a short time and monitor on site build large-scale in real time more often. The combination of the technology will continue to permeate a variety of fields because applications, innovations and the capabilities are discovered and improved according to the current situation.

3. Technology Readiness Index (TRI)

Technology readiness classifies individuals' willingness to embrace and use emerging technology to accomplish goals in home life and at work. Development can be interpreted as an overall state of mind arising from a combination of mental enablers and inhibitors that collectively decide the predisposition of a person to use new technologies. The scale of items to be easier to incorporate as part of analysis questionnaires. The initial scale also consists of four measurements that are optimism, innovation, discomfort, and insecurity [13]. With the advancements in technology, operating conditions have improved tremendously. Additionally, the intellectual challenge, recognition, increased knowledge base, growing world population, and rising economies gain are just a few drivers of technological advancement. Additionally, technology will change over time and the rapid growth of new technology has led to an updated and simplified Technology Readiness Index (TRI) being created. Hence, the method developed by Parasuraman consists of 4 which is optimism, innovation, discomfort and security. TRI is a measure that has been updated to suit the changes in the technology environment, while at the same time streamlining the measure. With that, the scale of items to be easier to incorporate as part of analysis questionnaires. The initial scale also consists of four measurements that are optimism, innovation, discomfort, and insecurity [14]. Optimism element is a positive view of technology and a belief that it offers improved power, flexibility and efficiency in people's lives. It generally captures the optimistic feelings of technology. While the innovativeness element is classified as a propensity to be a pioneer in technology and a leader in thought. In general, this dimension tests to the degree individuals consider themselves to be at the front of adoption of technology. The discomfort element is like a perceived loss of technology power and a sense of being confused by it. This aspect usually tests fear, and when faced with technology, concerns people's experience. Hence, the insecurity element is a lack of technology and uncertainty about its ability to operate properly. This aspect focuses on concerns that people might have in the face of transactions based on technology.

Technically, the use of construction automation and robotics follows the same route, with particular focus on assembling and installing components using these technologies. Any country's readiness to implement construction automation and robotics technologies can be evaluated in terms of costs or financial obligations, technological expertise and equipment such as the availability of components and machinery, compatibility with existing practices and current construction activity, labour situation, construction characteristics and market culture.

4. Methods

A quantitative approach was employed in this research. A self-administered questionnaire with close-ended questions using a five-point Likert scale ranging. The final questionnaire has been through the preliminary tests which consist of validity and reliability analysis. Content validity is applied by inviting a group of five experts to be selected to pre-test and to review the set of questionnaires. They consist of two academicians working in universities as lecturers and researchers in the area of construction and safety management and three practitioners or project managers who have experience in managing construction projects. Meanwhile, the internal consistency of data reliability in this research was verified by using the Cronbach's Alpha coefficients through the pilot survey, where 30 usable responses from the pilot survey. It was found that the questionnaire coefficient of Cronbach's alpha was more than 0.7 which was deemed as reliable for quantitative data collection. In order to distribute the final survey, a simple random sampling was applied in this research as the population sample is known. In this research, the targeted population is 74 construction organizations from total G7 contractor-grade in Pulau Pinang. Pulau Pinang has a high number of constructions and is considered as a positively developing state in Malaysia. A total of 66 required samples were successfully obtained and usable for analysis. Data collected were analysed using IBM SPSS Statistical Software which descriptive analysis has been employed in order to achieve the research objective.

5. Results and Discussion

5.1 The level of the capabilities and readiness of Unmanned Aerial System implementation in construction work progression

Table 1 shows the means and standard deviation based on each variable which is for capabilities factor of Unmanned Aerial System technology. The variables consist of Control System (mean=4.60, sd.=0.34), Data Collection (mean=4.47, sd.=0.44), Safety Element (mean=4.43, sd.=0.44), Building Factor (mean=4.41, sd.=0.47) and Visual Element (mean=4.38, sd.=0.52). Furthermore, for the readiness elements of implementation Unmanned Aerial System technology are Optimism (mean=3.56, sd.=0.44), Innovative (mean=3.24, sd.=1.38), Discomfort (mean=3.06, sd.=0.95) and Insecurity (mean=3.12, sd.=1.37). The mean value score interpretation of the variables used in this study were be interpreted based on the suggestion by [15].

Table 1. Descriptive Analysis

Variables	Mean	Std. Deviation	Mean Value Score Interpretation
Capabilities Factors			
Control System	4.60	0.34	High
Data Collection	4.47	0.44	High
Safety Element	4.43	0.44	High
Building Factor	4.41	0.47	High
Visual Element	4.38	0.52	High
Readiness Elements			
Optimism	3.56	0.44	High
Innovative	3.24	1.38	Moderate
Discomfort	3.06	0.95	Moderate
Insecurity	3.12	1.37	Moderate

Note: The mean value categorized into three levels: low = 1.00 to 2.66; moderate = 2.67 to 3.33; and high = 3.34 to 5.00.

Based on the result illustrated in the Table 1, it can be concluded that technology advances in recent years have resulted in Unmanned Aerial System technology more capable and can offer a wide range of uses on construction sites. In addition, the usage of Unmanned Aerial Systems on workplaces also means savings in time and expenses while doing activities and improving safety compared to other more conventional methods. However, there are complex factors that should be stressed that may inhibit the readiness level of the Unmanned Aerial System implementation that cause the moderate relationship findings. However, it may be influenced by Unmanned Aerial Vehicles having general budget difficulties. They are extremely costly including regulation, maintenance, insurance, training, image processing software and software navigation related to Unmanned Aerial Vehicles operations. Therefore, the discovery of potential complex factors should need further input in order to get a solid substantial value in order to develop an effective strategy to improve the readiness level of Unmanned Aerial System implementation in construction work progression.

6. Conclusions

As summarised, the building sector is critical to the nation's economic progress. Construction projects are time-sensitive; any delays may cost a significant amount of money and must be avoided. To do this, building progress should be regularly monitored to guarantee that deadlines and objectives are reached on time. A great deal of work goes into developing a system for tracking progress, without which the project may become unorganised. The Unmanned Aerial System is regarded as an efficient assessment and reward system for quality improvement. The applicability of using Unmanned Aircraft System (UAS) can be an alternative to the conventional construction work progress at site which is in line with the era of digitization construction of the fourth industrial revolution (IR 4.0).

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