An investigation of the challenges of unmanned aerial vehicle (UAV) application in construction projects [1]

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Abstract

This study is aimed at investigating the challenges of the application of Unmanned aerial vehicle's based technologies to construction project monitoring in Akwa Ibom State. The main objective of the study was to identify the challenges bedeviling UAVs deployment on construction project monitoring in Akwa Ibom. The research utilized a qualitative descriptive cross-sectional design to gather and analyze data. Specifically, data was gathered from construction experts and responses to questionnaires. Senior project managers and project engineers employed by construction firms that utilize UAVs participated in this study. The results indicate that lack of policies, security concerns, and employee resistance to UAV adoption were the main challenges. As a result of these discoveries, suggestions are put forth. This study provides a fundamental resource for subsequent research endeavors on the utilization of UAV technologies. This outcome would enhance the collective comprehension of the challenges associated with the implementation of UAVs for construction monitoring in Akwa Ibom state, Nigeria.

Keywords: *Akwa Ibom State, Challenges, Construction project, Unmanned aerial vehicle.*

1.Introduction

According to Ham et al. (2016), unmanned aerial vehicles (UAVs), which are also known as unpiloted aerial vehicles or drones, have recently received so much interest in the engineering, architectural construction, and other operations business. UAVs are aircraft systems that operate without a human pilot onboard. Initially developed for military applications, UAVs have evolved significantly and are now utilized across various industries, including construction, agriculture, and environmental monitoring. In addition, according to Zainudin (2015), drones are compact, extremely agile, and able to fly both indoors and outdoors. UAVs are synonymous with drones, yet anything that doesn't fly can't be called a drone. According to Janssen (2015), drones are "aerial modulus" that can be managed by manned remote control or by a programmed flight route. From each

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of these definitions, we are able to determine that drones are unmanned aerial vehicles that can be controlled remotely.

Construction projects, in general, have an inherent requirement for consistent monitoring and assessment of their progress. Before these many years, construction monitoring was performed manually by site engineers, civil engineers, project managers, and site inspectors. This method is not only incredibly time-consuming, but it also involves a great deal of risk and presents a number of potential hazards. As a consequence of this, the development of cutting-edge UAV technologies evolved, which were designed to cushion and ease the monitoring of construction sites and project stages (Ram, 2020). With the above mentioned, his study will seek to identify the various types of UAVs and the extent of their deployment on construction project monitoring in Akwa Ibom state.

2. Literature Review

Unmanned aerial systems (UAS), often known as unmanned aerial vehicles (UAVs) or drones, are cutting-edge equipment that may serve a variety of purposes in the building trades, as argued by Ibrahim (2017). According to Rao et al. (2016), UAVs may be defined as "any aerial vehicle that does not depend on an on-board human operator for flight," which might mean that they are fully autonomous or are controlled by a human operator on the ground. The potential of UAVs or drones to enhance the safety and efficiency of construction projects in construction sites has made it easy for it to be deployed to most construction sites. UAVs are deployed in construction projects in several ways and as technology advances and regulations become more user-friendly, the applications of these UAVs on construction projects continue to rise (Jacqueline et al, 2019). Notable applications of UAVs include military operations as military weapons, photography as aerial photography, maritime sector and great use in disaster management (Clarke, 2014). UAVs in the construction sector for site inspections, remote observation or sensing of construction projects, planning site layout amongst others. (Ham et al., 2016; Melo et al., 2017).

2.1 Classifications of UAVs

There are several drones available, each designed to fit a certain niche. The ability to meet such a wide range of operational niches while maintaining the basic concept of an unmanned air vehicle (UAV) is at the heart of what distinguishes drones. Drones can be classified in part based on their technical properties, such as the technology they employ, the degree of autonomy they possess, their size, weight, and the energy sources they rely on (Mithra, 2021). Drone weight was employed across all conventional distribution systems to categorize drones into nano, micro, mini, small, and tactical categories (Mitka and Mouroutsos 2017).

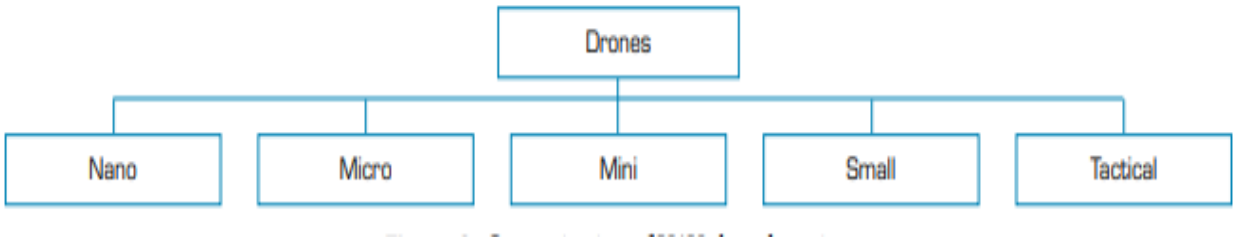

Figure 1: Classification of UAVs based on size (Mithra, 2021)

A possibility, considering certain general criteria like the time of the flight, range, and cargo, is provided in table 1.

Table 1 Unmanned aerial vehicle classification based on size, range, properties and applications (Mithra, 2021)

Type	Max. weight	Operating altitude (m)	Range (km)	Payload (kg)	Flight time (min)	Example model	Flying mechanism	Description	Applications
Nano	200 g	50	5	< 0.2	6–8	Kogan Nano Model	Multirotor	Easily manoeuvred and reach remote locations	Recreation
Micro	2 kg	< 90	25	0.2–0.5	45	Parrot Disco	Fixed-wing	Operated on low altitudes with limited space for fuel and battery	Recreation, military, spying task.
Mini	20 kg	150 < 300	40	0.5–10.0	18	DJI Spreading Wings	Multirotor	Maintain line of sight between the aircraft and the ground station.	Hobbies such as photography and cinematography
Small	25 to 150 kg	< 1500	150	5.0–50.0	180	Scout-B330 UAV Helicopter	Multirotor	Operated at low to medium altitudes and longer loiter capabilities	Transferring goods, military, used in remote locations
Tactical	> 150 kg	< 3000	200	25.0–200.0	1800	Predator B	Fixed wing	Operated at high altitudes, provide tracking or monitoring	Armed investigation, target acquisition

2.2 Deployment in construction project monitoring

The monitoring and planning of construction sites is an important industry that makes use of unmanned aerial vehicles (UAVs) for improved efficiency, velocity, and accuracy of information. Planners and architects in the ever-expanding building site business

frequently use drones as a real-time tool to evaluate their progress and determine whether or not it matches with their vision and imagination. The information that is obtained also motivates enterprises who are involved in construction sites and development to track their inventories. Traditional methods of monitoring construction projects have a number of important drawbacks, one of the most notable of which is that the execution process must be carried out in a strict manner, which allows little to no room for making last-minute adjustments. The precision of real-time data is frequently sacrificed due to the high probability of making mistakes while dealing with humans.

2.3 Transportation of goods within construction sites

Advanced procedures, such as the airborne delivery of equipment and materials to personnel operating in remote places or at challenging heights, can benefit from the utilization of drones as a tool (Mosly 2017). In the not-too-distant future, it is anticipated that drones will be used to direct and trace autonomous equipment. This will mark a significant turning point in the business. They are able to readily go across tough terrains and incomplete terrains due to the fact that they are so little. This enables them to provide certain vital information.

2.4 Monitoring of construction progress

For the sake of accurate real-time progress monitoring, it is very necessary to establish frequent fly routes over and around the building site before the project ever begins to fully realize the constructor's vision. These statistics are helpful to developers, stakeholders, and anybody else involved in the process of building anything. Weekly site visits are strongly recommended in order to maintain track of the progress being made toward the achievement of major corporate milestones. The use of drone data in the construction of project maps enables frequent monitoring and planning, which helps to minimize delays as well as additional costs. Monitoring the projects' progress ensures that they continue to advance in accordance with their plan, with no deviations. As a result of UAV-based progress monitoring, building and demolition sequences, crane locations, perimeter security, and a great number of other factors are visible (Shahmoradi et al. 2020).

2.5 Mapping and surveying

To keep the project's budget in check, drones are employed to quickly and accurately collect the necessary data. The use of drones to create maps has made the process easier, cheaper, and less taxing on civil engineers than previous techniques. Topographic surveys allow drones to readily visit any area, allowing for the creation of visual representations that may be used for evacuations, stockpile measures, and accurate transportation costs. Pix 4D software is used for live, interactive data mapping on computers (Getsov et al. 2017). Drones' high- resolution imagery allows

for the creation of 3D models, which can then be compared to the original blueprints to see how well they match reality (Tatum and Liu 2017). Errors that can be fixed before building even begins are uncovered by this inquiry. Government agencies can also benefit greatly from using drones to conduct aerial surveillance, locate unlawful building projects, and take corrective measures.

Volumetric measurement

To retain records of the raw materials that were utilized onsite throughout the building process in order to optimize efficiency and prevent stock waste. The volumetric measurements are not only very precise, but they are also very fast to get, very cost effective, and very handy since they do not interfere with any of the regular activities that take place on the premises. Using cutting-edge technology, such as machine learning, allows for volume estimations of stockpiles to be performed with a 99% degree of precision. The use of Equinox drones enables high-speed, accurate, and cost-effective volumetric measurements. (Fan and Saadeghvaziri, 2019).

3. Methodology

The research method employs four primary approaches, these are the exploratory, descriptive, diagnostic, and experimental approaches respectively.

It is a strategy for organizing one's research and addressing one's research issues in a structured manner (Shona, 2020). In this particular piece of research, a descriptive cross- sectional approach was used to data collection and analysis. A study design known as cross- sectional is one in which information is gathered from a number of different people working for a number of different companies at a particular moment in time. These people will typically have some characteristic in common (Lauren, 2020). Since the firms that were chosen have some characteristic in common, this research design is suitable for the project at hand (i.e. they are all into road, building and bridges construction).

A combination of both primary and was used for this study. Primary sources including use of structured questionnaire, and telephone interview were employed in collecting raw information from respondents. For the purpose of this study, a method known as purposive non-probabilistic sampling was used. The methodology is derived from the intended research study, and it is predicated on the discretion of the researcher in selecting the units to be researched, as well as on the researcher's prior experience with and understanding about UAVs. This methodology is appropriate for this research since the primary emphasis of the study is on important experts working for chosen companies. Excel and the Statistical Package for Social Sciences (SPSS) tool (version 23) were used by the researcher in the analysis of the data that was obtained. The utilization of closed-ended and open-ended questionnaires facilitated the collection of

both quantitative and qualitative data. The application of the descriptive statistics approach is essential for analyzing quantitative data. This method involves computing percentages, mean, standard deviation, and variance to assess the demographics of the respondents. The utilization of Statistical Package for Social Sciences (SPSS) computer software will facilitate the completion of this task. The utilization of SPSS was deemed suitable due to its capacity to facilitate the researcher in adhering to a well-defined set of quantitative data analysis protocols. This, in turn, enhances the validity and reliability of the data, while also elucidating the associations between the variables under investigation.

3.1 Results

This aspect of the study deals with the analysis of results using the methods presented in previous sections, which consist of proportions, percentages and tables, in order to investigate the challenges to the application of UAV's-based technologies to construction project monitoring in Akwa Ibom State, and to achieve the objectives listed initially. SPSS statistical software version 23 was used to run all the analysis.

Table 1: Socio-demographic Characteristics of respondents (N=333)

Variables	Category	Frequency (%)
Sex	Male	287 (86)
	Female	33 (14)
Age	Below 30	33 (10)
	31-35	158 (47)
	36-40	105 (32)
	41+	37 (11)
Educational level	None	0 (0)
	Primary	48 (14)
	Secondary	103 (31)

	Tertiary	182 (55)
Type of Employee	Permanent	137 (41)
	Contract	196(59)
	Others	0(0)
Years of Experience	0-5	98 (29)
	6-10	146 (44)
	11-15	59 (18)
	16+	39 (9)
Type of Construction Industry	Indigenous	200 (60)
	International	133 (40)

Socio-demographic details of a total of 333 participants shown in table 1 above were involved in the study. The majority of participants were male (86%), and those aged between 31 and 35 years old (47%) were the majority age group among respondents. Also, half (50%) of participants were married, and over a great majority of participants (55%) attained tertiary level of education. A greater number of participants (59%) were on contractual appointment, and a good number of study participants had 6 to 10 on-the-job years of work experience (44%). A whopping 60% of study participants were from indigenous construction industry. This study aimed to investigate the challenges to the application of unmanned aerial vehicle's-based technologies to construction project monitoring in Akwa Ibom State, Nigeria. To the best of knowledge, this is the first detailed study of this type conducted in Akwa Ibom State, Nigeria. Three hundred and thirty-three participants (n=333) were consented to complete the semi- structured questionnaires.

The majority of participants were male (86%), and those aged between 31 and 35 years old (47%), were the majority age group among respondents. Also, over a great majority of participants (55%) attained tertiary level of education, and a good number of study participants got 6 to 10 on-the-job years of work experience (44%). Also, half of all study participants (50%) were married, majority of respondents (59%) were on contractual service, and a majority of participants (60%) worked for indigenous construction companies. The data analysis shows that majority of construction workers reported being aware of a number of classes of UAVs in the construction industry. Majority of respondents appeared to have high perception of the nano class of UAVs. Also, respondents have high perception of tactical class of UAVs.

Conclusion

This study focuses on investigating the challenges to application of unmanned aerial vehicle's-based technologies to construction project monitoring. The descriptive cross-sectional research design was used for the investigation. The research design was deemed adequate since it examined the present situation in terms of challenges to application of UAVs among respondents. The descriptive technique comprises acquiring and describing and analysing data at a certain point in time deemed acceptable for the topic under consideration. Based on the findings on the challenges of UAVs in construction monitoring, majority of respondents had high perceptions on the challenge of absence of policy and procedures for using UAVs and high level of insecurity in the country. Poor attitude of workers towards the use of UAVs was also indicated by study participants as one of the challenges of UAVs' use in construction project monitoring.

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