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BARRIERS TO THE ADOPTION OF UNMANNED AERIAL VEHICLES IN INFRASTRUCTURE DEVELOPMENT

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Abstract
The aim of the study is to critically evaluate the factors bedeviling the adoption and use of Unmanned Aerial Vehicles for monitoring and evaluating infrastructural projects in Nigeria. A mixed study methodology was employed, utilizing a stratified random sampling technique and Taro Yamane's formula to ascertain a sample size of 266 respondents from a population of 802 practitioners throughout three areas in Nigeria. The data collection strategy comprised a focus group discussion and a meticulously designed questionnaire delivered to 266 participants. The gathered data was displayed through frequency distribution in tables and charts utilizing IBM SPSS Statistics version 26.0. Exploratory Factor Analysis (EFA) was employed to examine the study's objective. The findings identified six significant components: high operational and maintenance costs of UAVs, regulatory and legal constraints, insufficient operational expertise, resistance to adopting UAV technology, lack of awareness regarding UAV capabilities, and absence of an integration framework for UAV adoption. Six components were derived from sixteen factors identified during focus group discussions. These components are considered the primary factors hindering UAV acceptance and utilization in infrastructure projects. This report advocates for a coordinated effort to foster heightened awareness regarding the deployment of UAVs. Efforts should be directed at subsidizing the acquisition costs of UAVs to facilitate accessibility for industry stakeholders.

Keywords: *Evaluation, Exploratory factor analysis, Infrastructural projects, Monitoring, Unmanned aerial vehicle.*

INTRODUCTION

The increasing complexity and scope of infrastructure projects has resulted in a greater demand for efficient and effective monitoring and assessment systems. A system that can overcome the limitations of traditional monitoring and evaluation. Unmanned airborne Vehicles (UAV), which can gather high-resolution airborne data, have emerged as a viable tool for improving monitoring and evaluation of infrastructure projects (Utin, 2025). The technological capabilities of UAVs can assist in navigating the project site in record time, hence lowering costs, improving accuracy, and improving decision making in Infrastructure Project

Management. An Unmanned Aerial Vehicle (UAV) is a remotely piloted aircraft capable of prolonged flight; it can be operated remotely by a UAV operator or automatically by navigation algorithms. Because of their aerial superiority and data collecting capabilities, unmanned aerial vehicles can be used for remote surveillance, progress monitoring, volumetric estimation, safety monitoring, site communication, and surveying. Okaka et al. (2020). Despite UAV's promise, adoption has been limited in Nigeria due to a number of hurdles. The first and most significant hurdle to adoption is a lack of awareness of UAV capabilities among stakeholders Utin, Amade, Asiegbu, and Ukwuoma (2024), as well as a view that UAVs can cause disturbance during project execution, raising safety concerns. Also, there is a sense that UAV capabilities are unproven. Lack of competence or expertise in the operation of UAVs is another huge factor in their adoption, along with the idea that UAVs are technological. Complexity of operation has also resulted in opposition to change. The risk of storing sensitive project data and a cyber-attack has raised concerns among stakeholders about data security. The lack of a standardised integration framework as an adoption strategy, the high acquisition, operational, and maintenance costs, and the complex set of regulations and laws have all hampered the successful adoption and utilisation of UAV in infrastructure projects. Okaka et al. (2020) discovered several issues while conducting an empirical study on the successful usage of drones in UAV adoption and application in building construction. Despite his efforts, his publication contains considerable research gaps. One of the gaps is the study's geographical limitations. The study focusses primarily on Enugu Metropolis, restricting its generalisability to other parts of the country. Aside from his research, there is no literature on the critical assessment of barriers to Unmanned Aerial Vehicle acceptance and utilisation for infrastructural project monitoring and evaluation in Nigeria. The absence of empirical research in Nigeria sparked this study. This study will contribute by building on the work of Okaka et al. (2020) by examining the barriers to unmanned aerial vehicle uptake and utilisation in infrastructure project monitoring and evaluation. This study will provide significant insights for parties involved in Nigerian infrastructure project monitoring and assessment, ultimately contributing to the proper adoption and use of UAV technology in infrastructure projects. As a result, the study will focus on geography, substance, and target scope. The geographical scope of the study would include infrastructure projects in Rivers State, Abuja, and Lagos. The study's scope is confined to examining the barriers to unmanned aerial vehicle uptake and utilisation in infrastructure project monitoring and evaluation. Exploratory Factor Analysis is used to examine the barriers to the adoption and use of UAV in infrastructure monitoring and evaluation projects. The study will include stakeholders (project managers, civil engineers, UAV technology experts, government officials, and industry decision makers) involved in infrastructure projects.

LITERATURE REVIEW

Infrastructure is the collection of infrastructure and systems that serve a country, city, or other location, including the services and facilities required for the economy to function. Infrastructure includes structures like roads, railways, bridges, tunnels, water supply, sewage, power grids, and telecommunications. Monitoring and evaluation is a systematic process that includes ongoing data collection, analysis of performance measures, and comparison of actual progress to project plan. The tools required for project monitoring and evaluation are the Gantt chart, Earned Value Analysis, Project Evaluation Review Technique (PERT), and Critical Path Method (CPM).

Factors impeding the adoption and utilization of unmanned aerial vehicle in infrastructure projects

Presented below is table 1 showing barriers impeding the adoption of Unmanned Aerial Vehicle in monitoring and evaluating infrastructural projects.

Table 1: Factors impeding the adoption of unmanned aerial vehicle in infrastructure projects

S/N	Factors	Authors
1.	Atmospheric condition	Albeaino & Gheisari (2021), Fan & Saadeghvaziri (2019) Golizadeh et al., (2019), Okaka et al., (2020); (Utin, 2025)
2.	Lack of awareness	Utin et al., (2024) Albeaino & Gheisari (2021), Onososen et al., (2023), Ikuabe et al., (2022), Nwaogu & Chan (2022)
3.	Lack of skill in operation of UAVs	Albeaino & Gheisari (2021), Jeelani & Gheisari (2021), Vite & Morbiducci (2021), Onososen et al., (2023)
4.	Perceived technological complexity	Ikuabe et al., (2022), Soon et al., (2024), Abdullah et al., (2023), Onososen et al., (2023)
5.	Resistance to change	Ikuabe et al., (2022), Puppala et al., (2023)
6.	Lack of integration framework	Vanderhorst et al., 2021
7.	High operational and maintenance cost	Mendes et al., (2022), Ozkan et al., (2021), Ikuabe et al., (2022), Yıldız et al., (2021), Onososen et al., (2023), Nwaogu & Chan (2022), Soon et al., (2024)
8.	Regulations and Laws	Albeaino & Gheisari (2021), Golizadeh et al., (2019), Okaka et al., (2020), Onososen et al., (2023), Kim & Irizarry (2019), Liang et al., (2023), Ikuabe et al., (2022)
9.	Limited flight time	Fan & Saadeghvaziri (2019), Mosly (2017), Yıldız et al., (2021), Okaka et al., (2020), Abdullah et al., (2023)
10.	Data security	Irizarry & Costa (2016), Karpowicz, 2017b, Ikuabe et al., (2022), Bolaji et al., 2024

11.	Public privacy concerns	Mosly (2017), Okaka et al., (2020), Yıldız et al., (2021), Onososen et al., (2023), Bolaji et al., (2024)
12.	Perceived risk	Albeaino & Gheisari (2021),Fan & Saadeghvaziri (2019) Mosly (2017), Yıldız et al., (2021), Okaka et al., (2020) Albeaino & Gheisari (2021), Fan & Saadeghvaziri (2019)
13.	Cost of operational permit	Albeaino & Gheisari (2021), Onososen et al., (2023), Liang et al., (2023), Ikuabe et al., (2022)
14.	Communication loss	Albeaino & Gheisari (2021), Fan & Saadeghvaziri (2019) Mosly (2017), Okaka et al., (2020)
15.	Quality of images	Mosly (2017), Okaka et al., (2020)
16.	Collision of UAV with properties	Albeaino & Gheisari (2021), Mosly (2017), Yıldız et al., (2021), Golizadeh et al., (2019), Okaka et al., (2020)

METHODOLOGY

The research employed a mixed-methods design. The study population comprises 802 practitioners from Abuja, Rivers State, and Lagos in Nigeria. The data gathering and survey instrument comprised focus group discussions and a meticulously prepared questionnaire, administered to participants engaged in infrastructural projects. Respondents comprise project managers, civil engineers, UAV technology specialists, government officials, and industry decision-makers. The sample size of 266 participants was determined using Taro Yamane's formula (1967) through a stratified random sampling method from a population of 802 practitioners. To ascertain the instrument's reliability, Cronbach's alpha was utilised, yielding a result of 0.876, which signifies consistency and dependability of the instrument. The questionnaire comprises two sections, A and B, with the former focussing on the demographic information of respondents and the latter addressing the primary purpose of the study. A 5point Likert scale was utilised to acquire quantitative data from the respondents. To ascertain the validity of the instruments (Questionnaire), the study exposed them to face validity by presenting them to professional statisticians, academicians, and the researcher's supervisors. Exploratory Factor Analysis was employed to evaluate the obstacles hindering the implementation of unmanned aerial vehicles (UAV) in the monitoring and assessment of infrastructure projects.

RESULTS

Presented in table 2 is the background information of the respondents utilized for this study.

Table 2: Background Information of Respondents

Categories	Description	Frequency	Percentage (%)

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Nationality	Nigerian	221	88.05
	Foreigner	30	11.95
	Total	251	100
Profession	Project Manager	38	15.14
	Engineer	43	17.13
	Architect	52	20.72
	Quantity Surveyor	40	15.94
	Builder	51	20.32
	Others	27	10.76
	Total	251	100
Highest Academic Qualification	PhD	7	2.79
	MBA/MSc	84	33.47
	BSc/B.Tech	148	58.96
	HND	12	4.78
	Total	251	100
Years of Experience	1-5 Years	32	12.75
	6-10 Years	45	17.93
	11-15 Years	52	20.72
	16-20 Years	103	41.04
	Over 21 Years	19	7.57
	Total	251	100
Infrastructural Project Executed	Building	174	69.32
	Road	38	15.14
	Bridge	22	8.76
	Others	17	6.77
	Total	251	100

Factors impeding the adoption of unmanned aerial vehicles (UAVs) in infrastructural projects

Table 2 presents a Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, which provided a value of 0.781, signifying that the sample is sufficient for Factor Analysis. Table 2 also presents Bartlett's test of Sphericity, which produced a value of 1322.105, demonstrating statistical significance ($p < 0.001$). This

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signifies that the correlation matrix is not an identity matrix, therefore rendering factor analysis appropriate for the data. The Cronbach's alpha rating of 0.876 signifies an acceptable degree of internal consistency and reliability for both the measures and the scale.

Table 2: KMO and Bartlett's test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.781
Bartlett's Test of Sphericity	Approx. Chi-Square	1322.105
	Df	215
	Sig.	.000

The results of the analysis performed with IBM SPSS Statistics version 26.0 are presented in Table 3. The research produced six (6) component factors that accounted for a cumulative variance of 74.004%. The initial factor's percentage variance accounted for 21.485%. The second factor represented 15.670% of the variation. The third component represented 13.070% of the variance, whereas the sixth and final factor accounted for 6.738% of the variance. The total variance explained exceeds the recommended threshold of 50%. The nomenclature of the six components was established according to the factor demonstrating the highest loading within the cluster.

Table 3: Communalities, total variance explained and component matrix for factors impeding adoption and application of Unmanned Aerial Vehicles

Component Matrix[a]							
	Communalities	Component					
	.971	1	2	3	4	5	6
High operational and maintenance cost of UAVs	.728	.704					
Privacy concerns as a result of operation of UAVs	.776	.685					
Perceived risk (labour and work disruption/distraction)	.512	.675					
Communication loss	.543	.635					
Quality of images	.678	.562					

Collision of UAVs with properties	.688	.560					
Challenges as a result to atmospheric condition	.557	.510					
Regulations and laws	.721		.791				
Perceived technological complexity	.639		.782				
Limited flight time	.749		.690				
Data security	.958		.650				
Lack of skill in operation of UAVs	.946			.591			
Resistance to change to the adoption and application of UAVs	.958				.569		
Cost of operational permit	.946				.559		
Lack of awareness concerning the capabilities of UAVs	.982					.654	
Lack of integration framework for UAVs adoption	.971						.556
% variance		21.485	15.670	13.070	10.034	7.008	6.738
Cumulative %		21.485	37.155	50.225	60.259	67.266	74.004
Extraction Method: Principal Component Analysis.							
a. 6 components extracted.							

Table 3's Rotated Component Matrix indicates the presence of six unique components, with each variable predominantly linked to a single factor. Component one comprises seven variables: high operational and maintenance costs of UAVs (0.704), privacy concerns arising from UAV operations (0.685), perceived risk (labour and work disruption/distraction) (0.675), communication loss (0.635), image quality (0.635), UAV collisions with properties (0.560), and challenges due to atmospheric conditions (0.510).

The second component has four variables: regulations and laws (0.791), perceived technological complexity (0.782), limited flight time (0.690), and data security (0.650). In the third component, one variable was detected. It encompasses a deficiency in the operation of UAVs (0.591). In the fourth component, two variables exhibited peak loading. The factors include: Resistance to change regarding the adoption and application of UAVs (0.569) and the cost of the operational permit (0.559). The fifth component identifies one challenge: a lack of awareness on the potential of UAVs (0.654). In the sixth instance, one (1) variable was maximally loaded. The difficulty encompasses the absence of an integration framework for the use of UAVs (0.556). The numerical values included represent the factor loadings exceeding the 0.5 criterion. The designation of the six (6) component factors will be based on the variables with the highest factor loadings. Component factor one (1) will be redefined as high operational and maintenance costs of UAVs, component factor two (2) will be redefined as regulations and laws, component factor three (3) will be redefined as Inadequate proficiency in the operating of UAVs will be designated as component factor four. Resistance to change regarding the adoption and implementation of UAVs will be designated as component factor five (5). Insufficient awareness on the capabilities of UAVs and component factor six (6) will be identified. Absence of an integration framework for the adoption of UAVs.

Discussion

This study investigated the factors hindering the adoption and implementation of unmanned aerial vehicles in infrastructure projects, identifying six critical elements through exploratory factor analysis (EFA), as presented in table 3. Economic concerns, including elevated operational and maintenance costs, significantly hinder the uptake and utilisation of UAVs in infrastructure projects. This result aligns with the findings of Onososen et al. (2023), who, through Exploratory Factor Analysis, similarly identified Economic/Cost-Related Factors as significantly influential in constraining the adoption of Unmanned Aerial Vehicles for the monitoring and evaluation of infrastructure projects. The research findings from this study align with those of Olawumi & Chain (2019), who similarly recognised cost-related considerations as extremely relevant in the adoption of technology in infrastructure projects. The high operational and maintenance cost refers to the expenses required to successfully operate and sustain a UAV system over time. This aspect is a significant obstacle hindering the effective acceptance and utilisation of UAVs in poor nations, as demonstrated in this study. The expense of procuring a UAV appropriate for infrastructural projects is a significant consideration. Aiyetan and Das (2022). The conclusion corroborates the findings of Onososen et al. (2023), which similarly identified technical and regulatory considerations as significant challenges hindering the acceptance and utilisation of UAVs in the monitoring and evaluation of infrastructural projects. The nomenclature may vary significantly, although the regulations and laws in this study align with the technological and regulatory considerations, both addressing aspects relating to UAV legislation, flight duration, and data protection. A significant divergence is the incorporation of the challenge of obtaining safety or industryspecific training within the technical and regulatory aspects in Onososen et al. (2023). This driver is associated with a distinct component in the current investigation. Education and organization-related aspects encompass variables such as limited industry understanding, as noted by Onososen et al. (2023). This outcome aligns with the current study, which similarly identified a deficiency in awareness regarding UAV capabilities. Both studies highlight concerns about the limited knowledge and comprehension among stakeholders regarding the functionalities and potential advantages of UAVs in monitoring and evaluation. This deficiency in awareness obstructs the acknowledgement of UAVs as a viable instrument in the industry.

The six component factors identified using Exploratory Factor Analysis demonstrate moderate concordance with the findings of Okaka et al. (2020), who assessed limiting factors based on mean scores. Although both studies emphasised certain similarities, significant discrepancies are evident, including the absence of an integrative framework for UAV deployment and the expense of operational permits. Opposition against the integration and utilisation of UAVs, the absence of awareness of the capabilities of UAVs is identified as a primary worry in the current study, although it is not addressed in the research conducted by Okaka et al. (2020). The current study organised linked items into a cohesive latent construct, indicating a more systematic relationship among component factors and variables.

CONCLUSION AND RECOMMENDATIONS

The research concludes that the barriers to the adoption and utilisation of unmanned aerial vehicles for monitoring and evaluating infrastructural projects in Nigeria include: high operational and maintenance costs of UAVs, regulatory constraints, insufficient operational skills, resistance to change, lack of awareness regarding UAV capabilities, and absence of an integration framework for UAV adoption. The study recommends a concerted effort to enhance awareness of the benefits and capabilities of UAV utilisation in monitoring and evaluating infrastructural projects, including real-time data collection, improved accuracy, and cost savings. Clear communication to stakeholders in the building industry is essential to promote adoption. Awareness campaigns, workshops, and live demonstrations highlighting the advantages of UAVs in monitoring and evaluation can address the deficiency in awareness concerning UAV capabilities. To address the deficiency in UAV operation skills, a comprehensive training program must be established to provide experts with essential technical and operational knowledge. This curriculum must be customised for diverse stakeholders in the infrastructure sector, such as project managers, engineers, and UAV operators, and might be delivered via universities, industry groups, and UAV manufacturers.

The study's findings suggest that to facilitate the effective adoption and utilisation of UAVs in the Monitoring and Evaluation of infrastructure projects, policies should be established to subsidise UAV acquisition and ensure their accessibility to industry stakeholders. Existing laws that hinder UAV adoption, primarily due to security concerns, should be reassessed and reformed to prevent obstruction of UAV integration in infrastructure projects. Efforts should also be put towards developing a plan to facilitate the implementation of Unmanned Aerial Vehicles in infrastructural projects. This implementation strategy must be formulated based on the essential success criteria or enablers that will facilitate UAV adoption.

REFERENCE

Abdullah, A. R., Seow, T. W., & Mohamed, S. (2023). The Use of Drone Technology for Project Monitoring in Construction Sites. Research in Management of Technology and Business, 4(2), 495-506.

Aiyetan, A. O., & Das, D. K. (2023). Use of Drones for construction in developing countries: barriers and strategic interventions. International Journal of Construction Management, 23(16), 2888-2897.

Albeaino, G., & Gheisari, M. (2021). Trends, benefits, and barriers of unmanned aerial systems in the construction industry: a survey study in the United States. J. Inf. Technol. Constr., 26, 84-111.

Bolaji, W. A., Olatunde, O. T., Valentine, N. N., & Fatai, O. B. (2024). Investigation of the Use of Drones by Construction Professionals in Addressing Built Environment Tasks. Green Building & Construction Economics, 1-16.

Fan, J., & Saadeghvaziri, M. A. (2019). Applications of drones in infrastructures: Challenges and opportunities. International Journal of Mechanical and Mechatronics Engineering, 13(10), 649-655.

Goodhue, D. L. (1995). Understanding user evaluations of information systems. Management science, 41(12), 1827-1844.

Goodhue, D. L., Klein, B. D., & March, S. T. (2000). User evaluations of IS as surrogates for objective performance. Information & management, 38(2), 87-101.

Golizadeh, H., Hosseini, M. R., Edwards, D. J., Abrishami, S., Taghavi, N., & Banihashemi, S. (2019). Barriers to adoption of RPAs on construction projects: a task–technology fit perspective. Construction Innovation, 19(2), 149-169.

Ikuabe, M., Aigbavboa, C., Akinradewo, O., Adekunle, S., & Adeniyi, A. (2022). Hindering factors to the utilisation of UAVs for construction projects in South Africa. Modular and Offsite Construction (MOC) Summit Proceedings, 154-160.

Jeelani, I., & Gheisari, M. (2021). Safety challenges of UAV integration in construction: Conceptual analysis and future research roadmap. Safety science, 144, 105473.

Kim, S., & Irizarry, J. (2019). Human performance in UAS operations in construction and infrastructure environments. Journal of Management in Engineering, 35(6), 04019026. Liang, H., Lee, S. C., Bae, W., Kim, J., & Seo, S. (2023). Towards UAVs in construction:

advancements, challenges, and future directions for monitoring and inspection. Drones, 7(3), 202..

Mendes, E., Albeaino, G., Brophy, P., Gheisari, M., & Jeelani, I. (2022). Working safely with drones: A virtual training strategy for workers on heights. In Construction Research Congress 2022 (pp. 622-630).

Mosly, I. (2017). Applications and issues of unmanned aerial systems in the construction industry. Safety, 21(23), 31.

Nwaogu, J. M., Yang, Y., & Chan, A. P. (2022). Challenges and enablers for drone application in the construction industry.

Okaka, P. O., Nnadi, E. O., & Ajaelu, H. C. (2020). Effective use of Quadcopter drones for safety and security monitoring in a building construction site: Case study Enugu Metropolis Nigeria. Journal of Engineering and Technology Research, 12(1), 37-46.

Onososen, A. O., Musonda, I., Onatayo, D., Tjebane, M. M., Saka, A. B., & Fagbenro, R. K. (2023). Impediments to construction site digitalisation using Unmanned Aerial Vehicles (UAVs). Drones, 7(1), 45. Impediments to construction site digitalisation using Unmanned Aerial Vehicles (UAVs). Drones, 7(1), 45.

Ozkan Yerebakan, M., Hao, S., Xu, K., Gheisari, M., Jeelani, I., & Hu, B. (2021, September). Effect of illumination on human drone interaction tasks: An exploratory study.

In Proceedings of the Human Factors and Ergonomics Society Annual Meeting (Vol. 65, No. 1, pp. 1485-1489). Sage CA: Los Angeles, CA: SAGE Publications.

Vanderhorst, H. R., Suresh, S., Renukappa, S., & Heesom, D. (2021). Strategic framework of Unmanned Aerial Systems integration in the disaster management public organisations of the Dominican Republic. International Journal of Disaster Risk Reduction, 56, 102088.

Vite, C., & Morbiducci, R. (2021). Optimizing the sustainable aspects of the design process through building information modeling. Sustainability, 13(6), 3041.

Yıldız, S., Kıvrak, S., & Arslan, G. (2021). Using drone technologies for construction project management: A narrative review. Journal of Construction Engineering, Management & Innovation (Online).

Zigurs, I., & Buckland, B. K. (1998). A theory of task/technology fit and group support systems effectiveness. MIS quarterly, 313-334.

Utin, I. C., Amade, B., Asiegbu, B. C., & Ukwuoma, F. P. O. (2025). UAV in Monitoring and Evaluating Infrastructural Projects: Awareness and Extent of Adoption Study. International Journal of Management Sciences and Business Research, Aug-2024 ISSN (2226-8235) Vol-13, Issue 8.

Utin, I. C. (2025). Development of a framework for the adoption and application of unmanned aerial vehicle (UAV) in monitoring and evaluation of Infrastructural Projects. A PhD Dissertation of the Federal University of Technology Owerri, Nigeria.