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Utilization of Drones Technology in Infrastructure Inspection and Maintenance

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ABSTRACT
The utilization of drones technology in infrastructure inspection and maintenance has become an important topic in civil engineering and infrastructure management studies. Adequate infrastructure supports the social and economic progress of a country, but requires regular maintenance to ensure its reliability. This research aims to investigate the effectiveness of utilizing drone technology in performing infrastructure inspection and maintenance, and to evaluate its impact on the efficiency and accuracy of the process. The research method used was a literature study and analysis of data from previous studies relevant to this topic. In addition, the research also involved primary data collection through interviews with experts in the field of drones and infrastructure technology. The results show that the utilization of drones technology can significantly improve the efficiency and accuracy in conducting infrastructure inspection and maintenance. Drones are able to reach areas that are difficult to reach manually and provide detailed and real-time data. The utilization of drone technology is a very potential solution in improving efficiency and accuracy in infrastructure inspection and maintenance. By utilizing drones, the process can be done more quickly, cheaply, and safely, so that it can support sustainable infrastructure development.

Keywords: *Infrastructure, Inspection, Technology*

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INTRODUCTION

Upside down is an apt representation of the challenges faced in infrastructure inspection and maintenance (Li & Liu, 2019). While infrastructure is an important foundation for a country's progress, attention to its maintenance is often reversed, with lower priority given to the development of new infrastructure (Shahmoradi et al., 2020). As a result, existing infrastructure becomes vulnerable to damage and failure, resulting in serious consequences for public safety and economic sustainability (Lykou et al., 2020 Piramida). The main problem faced in infrastructure inspection and maintenance is limited

access and inability to collect accurate data (Iost Filho et al., 2020). Conventional methods involving manual inspections are often inefficient and high-risk for personnel, especially when it comes to accessing hard-to-reach or hazardous areas.

This is problematic as failure to maintain infrastructure can result in huge losses both in terms of finances and human lives (Fish, 2020). Therefore, research on the utilization of drone technology in infrastructure inspection and maintenance is important to do in order to find a more effective and efficient solution in dealing with these problems (Hafeez et al., 2023). This research aims to solve the problem of limited access and inaccurate data collection in infrastructure inspection and maintenance by utilizing drones technology (Carrivick & Smith, 2019). As such, it is expected to improve efficiency, safety and accuracy in the process.

It is important to discuss the utilization of drone technology in infrastructure inspection and maintenance as this will not only improve the safety and sustainability of existing infrastructure, but will also support sustainable and quality infrastructure development (Atitallah et al., 2020). This research will explore the potential of drone technology in overcoming the problems of limited access and inaccurate data collection by conducting infrastructure inspection and maintenance more efficiently and effectively (Betlem et al., 2019). By collecting detailed, real-time data and reaching hard-to-reach areas, it is hoped that drone technology can be an innovative and affordable solution to these challenges.

This research aims to explore the use of drone technology in infrastructure inspection and maintenance, which is increasingly crucial in this modern era (Dubey, 2021). The reason this research was conducted lies in the increasing complexity of infrastructure and the demand for efficiency and accuracy in the inspection and maintenance process (Koroniotis et al., 2019). This research will contribute to filling the existing gap by introducing a new approach that combines drone technology with advanced data analysis (Gupta et al., 2024). We will address the gap by designing a comprehensive and integrated methodology, enabling more detailed inspections and timely maintenance.

Researchers will evaluate current technologies in the use of drones for infrastructure inspection, while proposing new innovations such as the use of multispectral sensors and artificial intelligence for more in-depth data analysis (Dering et al., 2019). The novelty of this article lies in the holistic approach that covers various aspects of infrastructure inspection and maintenance, compared to previous studies that often focus on one aspect only (Roldán-Gómez et al., 2021). For future research, we will conduct field trials to test the effectiveness of the proposed methodology and collect empirical data for further validation. We hope that this research can provide practical guidance for practitioners and serve as a foundation for further research in this area.

RESEARCH METHODOLOGY

Research Design

This research uses a quantitative research design, which is inputted into google form as many as 20 items (Payal et al., 2024). Which includes what influences will be caused when students use technology-enabled language learning (Favale et al., 2020). This method is used in order to formulate a new thought that is useful for every level of students (Spernjak, 2021). Then developed into a research that can be held accountable for its accuracy (Dong & Liu, 2023), which is tailored to each event experienced by the student (Selwyn, 2019). This collection method is useful to test the feasibility of language-based learning itself to improve student learning achievement (Shadiev & Yang, 2020). The quantitative method can also be interpreted as a research stage that begins with making a questionnaire containing 20 items (Gosal et al., 2019), then every answer given by students is processed using the spss application (Pardo et al., 2019). The data obtained can be proven accurate through a google form created by the researcher. And researchers also input the highest gain and also the lowest gain from the questionnaire distributed to each student. Then conclude these statements.

Research Procedure

The steps taken in this study began by asking permission from the campus and working with English teachers. Then each filled in by students (Else, 2023), from the beginning of the questionnaire made by the researcher until it reaches the acquisition of filling which the researcher considers to have met the expected acquisition by the researcher (Besser et al., 2022). Then the researcher is also very concerned about ethics in making questionnaires that use good language and are also polite (Kapasia et al., 2020). So that students can fill out this questionnaire in a short period of time (Chow et al., 2023), which makes it easier for researchers to examine various Exploring the Potential of Renewable Energy in Today's Engineering Development

Research Subjects

The subjects of this research are students of UIN Mahmud Yunus Batusangkar, the role of the researcher is to collect every answer given by students (Dube, 2020). Researchers are also assisted by English lecturers who teach at UIN Mahmud Yunus Batusangkar, especially educators who teach in the field of technology (Dubey, 2021). This study is to measure the ability of students using questions in the form of tests and then counted from the highest series of acquisition numbers to the lowest series of numbers (Hao & Ho, 2019). The researcher then inputted the scores obtained through the research subject which became a reference to determine the Utilization of Drones Technology in Infrastructure Inspection and Maintenance (Alma Çallı & Ediz, 2023). The type of research conducted is research that strongly considers every answer given by students, which aims to determine the effect of Exploring the Potential of Renewable Energy in Contemporary Engineering Development.

Research Ethics

Of the approximately 1000 students enrolled at Mahmud Yunus State Islamic University Batusangkar, only 50 students contributed to this study (Dwivedi et al., 2023). Of these. 50 students participated in this study, of which 25 were male and 25 were female with a maximum age of 19 years and 18 years (Maulida et al., 2023). The data collection

participants came from various villages or jorongs close to UIN Mahmud Yunus Batusangkar. This research has obtained permission from the lecturer who teaches language courses. This research uses several principles of research ethics (Oulaich, 2020). First, there is no coercion in filling out the questionnaire. This research only expects the volunteerism of students and female students who study here. Then every question must be answered completely without leaving any part of the questionnaire. This formular is very supportive and upholds rights and there is no coercion at all. This is done to ensure that the participants understand the essence of this study, out of 50 participants 80% expressed their willingness to fill out this questionnaire.

Data Collection Technique

The technique used by researchers in collecting data is to obtain various information that can be measured, compared, and calculated carefully. Through the google form format created by the researcher (Ibrar et al., 2019), which was filled in by 50 students of UIN Mahmud Yunus Batusangkar. Data collection was carried out on first semester students in the 2023/2024 academic year. After obtaining permission to conduct research from the language lecturer (Jansen et al., 2023), and also IT links online questionnaires distributed to students of various majors. This questionnaire was distributed from March 1, 2024 to March 30, 2024 (Memon et al., 2021). The process of processing data that has been collected from respondents in the research field. The questionnaire data is then downloaded into an Excel file and then transferred to SPSS. The final score data is recorded in the SPSS application which can be verified. Then recapitulated as interesting as possible so that readers are interested in reading articles made by researchers.

Data Collection and Analysis

Then the data that has been collected is inputted and processed using the SPSS application. Distributed in the form of tables and diagrams that can calculate the scores obtained from students (Teimouri et al., 2022). The way the data is analyzed is by comparing each answer given by each student with previously conducted studies (Cohen et al., 2020). Data is presented in the form of average scores and percentages (Castañeda-Babarro et al., 2020). Then the data was tested using the oneway anova test (Kang et al., 2022). Which compares the acquisition score of each group that fills in each statement related to the questionnaire made by the researcher (Loewen et al., 2019). Researchers also really take into account the scores obtained by each student who fills out the questionnaire previously made by the researcher (Betlem et al., 2019). And will never leave any answers given by students from the beginning of filling out the questionnaire until the last student fills out this questionnaire (Shadiev & Yang, 2020). Furthermore, the researcher will also summarize in an accurate conclusion.

Table 1. 1

Categories of Acquisition of Miniaturized Satellite Technology Development for Global Environmental Monitoring

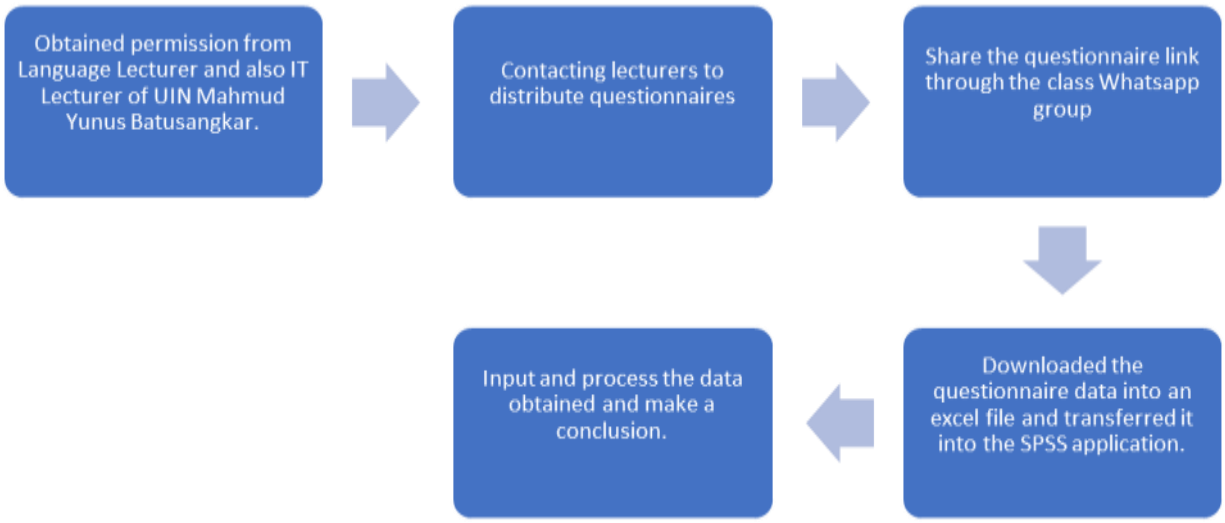
No.	Gain category	**Value interval**
1	Strongly agree	>90%
2	Agree	70-80%

3	Disagree less	50-60%
4	Do not agree at all	0-40%
Total		100%

Table 1. 2
Research Sample Details

No	Student Batch	Gender		Total
		Male	Female	
1	T.A 2022	10	10	20
2	T.A 2023	15	15	20
	Total	**25**	**25**	**50**

Flowchart of quantitative research



RESULT AND DISCUSSION

Table 1.3

Acquisition of Drones Technology Utilization in Infrastructure Inspection and Maintenance

No	Statement	SS	S	KS	SKS
1	Drone technology enables easier and safer access to areas of infrastructure that are difficult for humans to reach.	60%	40%	0%	0%
2	The use of drones in infrastructure inspection can reduce the risk of accidents and injuries for field officers.	50%	50%	0%	0%
3	Drones are equipped with cameras and sensors that can provide a clear picture of the condition of the infrastructure.	70%	30%	0%	0%

4	The use of drones can reduce operational costs in infrastructure maintenance compared to conventional methods.	65%	30%	5%	0%
5	Drones can be used to monitor changes in infrastructure condition over time, enabling early preventive action.	60%	40%	0%	0%
6	Drones can be used to monitor changes in infrastructure condition over time, enabling early preventive action.	80%	20%	0%	0%
7	The utilization of drones in bridge inspections can help detect cracks or structural damage that are not visible to the naked eye.	60%	40%	0%	0%
8	With drone technology, inspections of hard-to-reach areas such as waterways or underground pipes can be carried out without disturbing the surrounding environment.	75%	20%	5%	0%
9	Drones can be equipped with temperature and humidity sensors to detect potential problems in cooling systems or water lines.	65%	30%	5%	0%
10	Utilizing drones in infrastructure inspection and maintenance can improve overall system reliability.	70%	30%	0%	0%

Table 1.4
Acquisition of Drones Technology Utilization in Infrastructure Inspection and Maintenance Tested by One Way Anova Test

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
X.01	T. A 2022	2,400	4	,500	.	.
	T. A 2022	,000	5	,000		
	Total	2,400	9			
X.02	T. A 2022	1,100	4	,275	2,750	,148
	T. A 2022	,500	5	,100		
	Total	1,600	9			
X.03	T. A 2022	2,100	4	,525	.	.
	T. A 2022	,000	5	,000		
	Total	2,100	9			

X.04	T. A 2022	,900	4	,225	.	.
	T. A 2022	,000	5	,000		
	Total	,900	9			
X.05	T. A 2022	1,600	4	,400	4,000	,080
	T. A 2022	,500	5	,100		
	Total	2,100	9			
X.06	T. A 2022	2,100	4	,525	.	.
	T. A 2022	,000	5	,000		
	Total	2,100	9			
X.07	T. A 2022	1,600	4	,400	4,000	,080
	T. A 2022	,400	5	,300		
	Total	2,100	9			
X.08	T. A 2022	2,100	4	,525	.	.
	T. A 2022	,000	5	,000		
	Total	2,100	9			
X.09	T. A 2022	1,600	4	,400	.	.
	T. A 2022	,000	5	,000		
	Total	1,600	9			
X.10	T. A 2022	1,900	4	,475	4,750	,059
	T. A 2022	,500	5	,100		
	Total	2,400	9			

Utilizing Drones Technology in Infrastructure Inspection and Maintenance: The Future of Infrastructure Maintenance

In this modern era, infrastructure is the backbone of economic development and public welfare. However, the growing complexity of modern infrastructure demands a more innovative approach to its inspection and maintenance. This is where the role of drones or unmanned aircraft technology becomes increasingly important. In this paper, we will explain why the utilization of drone technology in infrastructure inspection and maintenance is an inevitable step forward, as well as its impact and implications on future infrastructure inspection and maintenance practices.

Before going further into the utilization of drones technology, it is important to understand why infrastructure inspection and maintenance is crucial. Well-functioning infrastructure is a prerequisite for sustainable economic growth, efficient transportation, and public safety and well-being. However, infrastructure is also vulnerable to damage from natural factors, overuse or environmental changes. Regular inspections and maintenance are required to ensure that infrastructure remains in optimal condition and can function as intended. However, this process is often time-consuming, costly and risky, especially if the infrastructure to be inspected is located in hard-to-reach or dangerous locations for field personnel.

The utilization of drone technology offers an innovative solution to the challenges of infrastructure inspection and maintenance. Drones, or remote-controlled unmanned aircraft, have attracted attention in various industries due to their flexibility, capabilities, and economic potential. In the context of infrastructure, the use of drones opens up new opportunities to change the way we understand, monitor and maintain infrastructure.

One of the main advantages of using drones is their ability to access areas that are difficult to reach or dangerous for humans. For example, high bridges, remote railroads, or tall power poles can be inspected more quickly and efficiently using drones without compromising the safety of field personnel. This reduces the risk of accidents and injuries that often occur in conventional inspections. In addition, drones are equipped with a variety of sensors and cameras that enable the capture of highly detailed data on the condition of the infrastructure. From visual images to thermal and geospatial data, drones can provide comprehensive information on damage, wear and tear or changes in infrastructure condition over time. This enables early detection of potential problems and timely preventive measures.

Implications of Utilizing Drones Technology

The utilization of drone technology in infrastructure inspection and maintenance has various significant implications for work practices and paradigms in this field. First of all, the use of drones will change the way we understand and map infrastructure. With their ability to map areas in detail and accurately, drones open up new opportunities for spatial analysis and more sophisticated infrastructure modeling. This can help in long-term maintenance planning and better decision-making.

In addition, the utilization of drones will also change the employment dynamics in infrastructure inspection and maintenance. Field officers will focus more on data analysis and decision-making, while routine tasks such as visual surveys will be taken over by drones. This can improve efficiency and productivity, as well as reduce the risk of accidents and injuries associated with field work. Despite its great potential, the utilization of drone technology in infrastructure inspection and maintenance is also faced with various challenges. One of them is the regulatory and safety issues related to the use of drones in the infrastructure sector. Clear regulations and strict safety standards are needed to ensure that the use of drones does not pose additional risks to infrastructure or the public. In addition, investment in technology development and workforce training is required to maximize the potential of utilizing drones in infrastructure inspection and maintenance. Further research and development is needed to develop more sophisticated sensors and data analysis algorithms, and to improve the reliability and safety of drone operations.

Faced with challenges, the utilization of drone technology in infrastructure inspection and maintenance also opens up new opportunities. With growing innovation, we can expect more efficient, accurate and sustainable infrastructure inspection and maintenance processes in the future. Drones are not only a technological tool, but also a catalyst for positive change in the way we build, maintain and use infrastructure in this modern era.

CONCLUSION

In facing the challenges of future mobility, the revolution in transportation engineering becomes the key to achieving sustainable and intelligent mobility. Several important points can be drawn as conclusions from the results and discussions presented earlier.

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