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Application of Internet of Things (IoT) in Monitoring and Controlling Engineering Equipment

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ABSTRACT
Research Background: The development of Internet of Things (IoT) technology has presented new opportunities in the field of monitoring and controlling engineering equipment. The use of IoT in this context enables real-time data collection and automatic control of equipment via internet networks, bringing the potential to improve the efficiency and performance of engineering systems. Research Objectives: This research aims to explore the application of Internet of Things technology in the monitoring and control of engineering equipment, and to evaluate its benefits in the context of operational efficiency and cost reduction. Research Methods: The research methods used include literature review, system requirements analysis, IoT infrastructure design, prototype implementation, and functionality testing. The collected data were analyzed to evaluate the performance of the system and the benefits obtained. Research Results: The implementation of IoT in the monitoring and control of engineering equipment successfully shows an increase in operational efficiency and cost reduction. The developed system is able to collect data in real-time, provide accurate and timely information, and enable automatic or remote control of equipment via the internet. Research Conclusion: The application of the Internet of Things in monitoring and controlling engineering equipment promises significant advances in operational efficiency and resource management. By leveraging this technology, organizations can increase productivity, reduce operational costs, and improve overall system reliability.

Keywords: *Engineering Equipment, Internet of Things (IoT), Monitoring and Controlling*

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INTRODUCTION

Inverted pyramid (Chettri & Bera, 2020), as a metaphor to describe the existence of technical infrastructure (Koroniotis et al., 2019), highlights the classic challenges in engineering equipment management (Shafique et al., 2020). Traditional (Manavalan & Jayakrishna, 2019), This infrastructure relies on manual monitoring and control methods that tend to be reactive and limited (Al-Garadi et al., 2020). This creates a number of

pressing issues to address (Ayaz et al., 2019). The main issue that arose was the lack of ability to access and monitor engineering equipment in an efficient and timely manner (Mohamad Noor & Hassan, 2019). Manual processes involving hands-on inspections are time- and resource-consuming (Singh et al., 2020), and is prone to human error and system failure.

In an era where operational efficiency and timeliness are key to business success (Tang et al., 2019), weaknesses in the management of engineering equipment can lead to decreased performance (Stoyanova et al., 2020), financial loss (Khanna & Kaur, 2019), and even serious security risks.

This research aims to solve this challenge by applying Internet of Things (IoT) technology in the monitoring and control of engineering equipment (Hossein Motlagh et al., 2020). By utilizing IoT's ability to collect real-time data and provide automated control (Nižetić et al., 2020), expected to create a more efficient system (Boursianis et al., 2022), Reliable (Lu & Xu, 2019), and responsive (El-hajj et al., 2019). The importance of addressing this issue lies not only in improving operational efficiency and risk management, but also in improving risk management (Tahsien et al., 2020), but also in utilizing the potential of technological innovation to support digital transformation in various industrial sectors.

In this article (Shafiq et al., 2020), researchers will explore the implementation of IoT technology in the context of monitoring and controlling engineering equipment (Gupta & Quamara, 2020). With a system integration-focused approach (Elazhary, 2019), data analysis (Javaid & Khan, 2021), and process automation (Dhingra et al., 2019), The researcher will outline how IoT can be used to address challenges in engineering equipment management and provide significant benefits to organizations.

This research was conducted in response to the pressing need for improved efficiency and reliability in the monitoring and control of engineering equipment (Ayoub et al., 2019). With the increasing complexity of engineering systems and the demand to optimize operational performance (Brous et al., 2020), phe application of Internet of Things (IoT) technology has become a major focus to address these challenges (Liu et al., 2021). Therefore, this research aims to explore the potential and benefits of applying IoT in that context.

This research is expected to fill the gap between conventional practices in monitoring and controlling engineering equipment and a more innovative and responsive approach using IoT technology (John Dian et al., 2020). We will use an integrated approach between system requirements analysis (Wu et al., 2018) , IoT infrastructure design, and prototype development to address these gaps.

In the context of the state of the art (Bhuiyan et al., 2021), This research will evaluate recent advances in the application of IoT in the monitoring and control of engineering equipment. Furthermore, we will propose innovations in system development that include the integration of smart sensors, real-time data analysis, and the use of automation algorithms to improve system responsiveness and efficiency.

The novelty of this article lies in the holistic approach we take in integrating IoT technology in the monitoring and control of engineering equipment. We will not only explore the technical possibilities of IoT implementation, but will also incorporate managerial and operational perspectives to come up with a more holistic and integrated solution.

Furthermore, the researcher will conduct further testing of the developed prototype, as well as evaluation of the system's performance in a real operational environment. We hope that this research will provide valuable insights for future researchers in developing more sophisticated and applicable solutions in this field.

RESEARCH METHODOLOGY

Research Design

This research uses a quantitative research design, which is inputted into google form as many as 20 questions (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 every student filled in, from the beginning of the questionnaire made by the researcher until it reached the acquisition of filling which the researcher considered to have met the expected acquisition by the researcher. Then the researcher is also very concerned about ethics in making questionnaires that use good language and are also polite. So that students can fill out this questionnaire in a fast period of time, which makes it easier for researchers to examine various Exploring the Potential of Renewable Energy in Contemporary 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 score obtained through the research subject which became a reference to determine the category of Implementation of the Internet of Things (IoT) in Monitoring and Controlling Engineering Equipment (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. 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. The data collection of these participants came from various villages or jorongs adjacent to UIN Mahmud Yunus Batusangkar. This research has obtained permission from the lecturer who teaches language courses. This study used several principles of research ethics. First, there was 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 was done to ensure that the participants understood 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 a google form format made by researchers, 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 language lecturers, and also IT links, online questionnaires were distributed to students of various majors. The distribution of this questionnaire was carried out on March 1, 2024 to March 30, 2024. The process of processing data that has been collected from respondents in the research field. The questionnaire data was then downloaded into an Excel file and then transferred to SPSS. 20 questions to review, 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 also diagrams that can calculate the scores obtained from students. The way the data is analyzed is by comparing each answer given by each student with previous studies. Data is presented in the form of average scores and percentages. Then the data is tested using the oneway anova test. Which compares the acquisition score of each group that fills in each statement related to the questionnaire made by the researcher. Researchers also really take into account the scores obtained by each student who fills out the questionnaire previously made by the

researcher. And will never leave the slightest answer given by students from the beginning of filling out the questionnaire until the last student fills out this questionnaire. Furthermore, researchers will also summarize in an accurate conclusion.

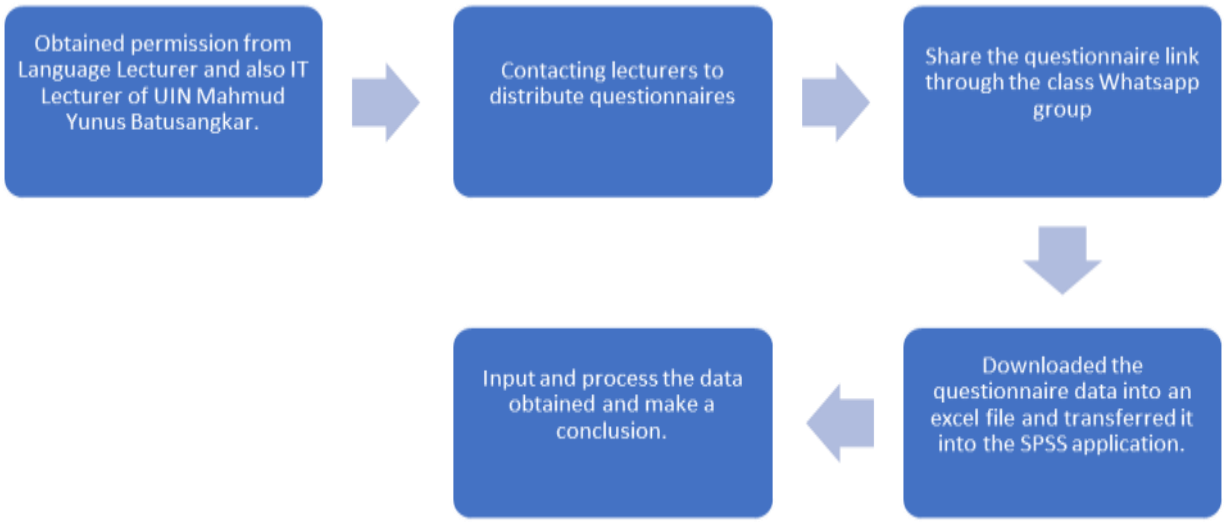
Table 1. 1
Categories of Acquisition of Exploring the Potential of Renewable Energy in Today's Engineering Development

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 Internet of Things (IoT) Application in Monitoring and Controlling Engineering Equipment

No	Statement	SS	S	KS	SKS
1	The application of IoT in engineering equipment monitoring enables real-time data collection from connected sensors, resulting in accurate and up-to-date information on equipment conditions.	50%	40%	10%	0%
2	With IoT, control of engineering equipment can be automated based on the data obtained, reducing dependence on human intervention and improving operational efficiency.	60%	40%	0%	0%
3	The integration of IoT in the monitoring and control of engineering equipment enables early identification of potential equipment damage or failure, enabling proactive repairs and reduced downtime.	65%	35%	0%	0%
4	IoT technology enables remote monitoring of engineering equipment, allowing management and supervision of systems from separate locations via the internet.	65%	30%	5%	0%
5	By leveraging IoT, engineering equipment can be integrated into a smart energy management system, enabling energy use optimization and operational cost reduction.	60%	40%	0%	0%
6	The use of IoT sensors in the monitoring of engineering equipment enables the collection of more extensive and in-depth data on system performance, enabling better analysis for system repairs and upgrades.	80%	20%	0%	0%
7	IoT can improve the reliability of engineering equipment by enabling continuous monitoring of equipment conditions, allowing timely preventive maintenance to avoid unexpected failures.	60%	40%	0%	0%

8	The application of IoT in engineering equipment control can enable the construction of adaptive and responsive systems, capable of automatically adjusting equipment operation to various environmental conditions.	75%	20%	5%	0%
9	The integration of IoT technology with traditional engineering equipment can improve overall system effectiveness, bringing benefits in terms of productivity, safety, and efficiency.	65%	30%	5%	0%
10	With the continued development of IoT technology, the future expectation is the further adoption of intelligent solutions in the monitoring and control of engineering equipment, bringing greater advances in system efficiency and performance.	60%	40%	0%	0%

Table 1.4
Acquisition of Internet of Things (IoT) Application in Monitoring and Controlling Engineering Equipment Tested for Feasibility with 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			

The application of the Internet of Things (IoT) in the monitoring and control of engineering equipment has become an innovative and effective solution in optimizing the overall performance of engineering systems. Through the continuous connection between equipment and the internet network, IoT enables real-time data collection on equipment conditions. The information obtained from these connected sensors provides a more accurate picture of equipment performance, allowing users to identify problems or potential failures more quickly and precisely. As such, users can proactively take the necessary actions to prevent further damage or unexpected downtime.

In addition, the application of IoT also brings advancements in the control of engineering equipment. By utilizing data obtained from IoT sensors, systems can respond automatically to environmental conditions or changes in operational needs. This automatic control reduces reliance on human intervention and improves overall operational efficiency. For example, in the manufacturing industry, IoT-based automated controls can optimize production processes by adjusting machines based on changing demand and operational conditions.

One of the main advantages of applying IoT in the monitoring and control of engineering equipment is its ability to enable remote monitoring. This allows management of systems from separate locations, even from very long distances, via an internet connection. This brings great flexibility in equipment operation, especially in complex or remote environments. For example, in the energy industry, IoT enables monitoring and control of power plants or distribution networks from a remote control center.

However, the implementation of IoT also presents certain challenges that need to be overcome. One of these is the issue of data security and privacy. With so much data being collected and exchanged between devices, data protection becomes crucial. Strong data protection measures are needed to prevent cyber attacks and misuse of sensitive information.

In addition, the implementation and infrastructure costs required for IoT deployment also need to be considered. A significant initial investment may be required to integrate the necessary IoT sensors, network infrastructure, and data management systems. However, with the development of technology and the increasing adoption of IoT, implementation costs can be expected to decrease over time.

Overall, the application of the Internet of Things in monitoring and controlling engineering equipment has brought great benefits in improving system efficiency, reliability, and responsiveness. By continuing to innovate and overcome existing challenges, IoT has great potential to revolutionize the way we manage and monitor engineering equipment in the future.

CONCLUSION

The takeaway from the application of the Internet of Things (IoT) in monitoring and controlling engineering equipment is that this approach enables the use of sensors and internet connectivity to collect real-time data from engineering equipment. By utilizing IoT, users can accurately and efficiently monitor equipment operational conditions, quickly detect potential damage or failures, and even remotely control equipment. This not only improves operational efficiency and minimizes downtime, but also opens up opportunities to implement more proactive and predictive maintenance strategies, extend equipment life, and improve overall safety.

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