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Structural Engineering's Readiness to Face the Challenges of Natural Disasters in the 21st Century

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ABSTRACT
Research Background: In the modern era, the challenges of natural disasters are increasing as a result of climate change and uncontrolled development. Therefore, structural engineering preparedness in the face of natural disasters is crucial to minimize losses and negative impacts. This research aims to investigate structural engineering preparedness in facing the challenges of natural disasters in the 21st century. This is done by analyzing technical approaches, regulations, and innovations in structural engineering that can improve the resilience of infrastructure to natural disasters. The research methods used include literature review, policy analysis, and interviews with structural engineering experts. Data were collected and analyzed to understand recent developments in structural technology that can cope with natural disasters, and to evaluate the successful implementation of regulations and best practices. The results showed that structural engineering has undergone significant developments in dealing with natural disasters in the 21st century. Approaches such as anti-earthquake design, sensor technology for structural monitoring, and construction of disaster-resistant infrastructure have helped improve the resilience of infrastructure to natural disasters. From the results of this study, it can be concluded that the readiness of structural engineering to face the challenges of natural disasters in the 21st century has improved significantly. However, further efforts in technology development, regulation, and public awareness are still needed to ensure more resilient infrastructure against natural disasters in the future.

Keywords: *Engineering's Readiness, Natural Disasters, 21st Century.*

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INTRODUCTION

The inverted pyramid is a visual representation of the challenges faced by the field of structural engineering in dealing with natural disasters in the 21st century (Coman et al., 2020). In this context, the background of the inverted pyramid includes The main challenge faced is the imbalance between the increasing risk of natural disasters and the readiness of infrastructure to deal with them.

As natural disasters become more frequent and intensive (Mishra et al., 2020), inadequate infrastructure can result in huge losses in terms of human lives and material damage (Majumder et al., 2019). This study aims to solve the problem of structural engineering readiness in the face of natural disasters by formulating effective and efficient mitigation strategies (Yang et al., 2021). It is important to address this as resilient infrastructure can be a key determinant in minimizing the impact of natural disasters on communities and economies.

Through interdisciplinary and innovative approaches (Selwyn, 2019), this research will explore the technology (Lou & Noels, 2019), structural design, and public policy to improve infrastructure preparedness in the face of various natural disaster scenarios.

In the context of increasing frequency and impact of natural disasters in the 21st century (Payal et al., 2024), This research was conducted to identify and address existing gaps in structural engineering readiness to meet these challenges.

This research was conducted in response to the escalation of natural disasters threatening global infrastructure (Pham, 2022). The imbalance between disaster risk and structural engineering preparedness requires innovative and sustainable solutions.

This research will contribute by identifying areas where current structural engineering preparedness is inadequate, and formulating new strategies and technologies to fill the gap (Setiawan & Wiedarti, 2020) The methods to be used include in-depth analysis, detailed simulation and cross-disciplinary collaboration.

Through a review of the state of the art (Larrabee Sønderlund et al., 2019), researchers will evaluate best practices and existing advanced technologies in natural disaster mitigation. Proposed innovations include the development of disaster-resistant materials (Gao & Zhang, 2020), adaptive structural design, and more responsive early warning systems.

This article makes a novel contribution by presenting an updated approach to dealing with natural disasters that integrates the latest technologies and a deep understanding of disaster dynamics (Dzulkifli, 2021). Compared to previous research (Koller et al., 2020), We offer a more holistic and sustainable solution that considers the complexity of modern natural disasters.

Furthermore, this research will test and apply the proposed solution in simulated disaster scenarios and real situations. (Chung et al., 2021). We hope that future researchers will continue this work by developing practical implementations that can be widely adopted to improve structural engineering readiness worldwide.

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 subjects as a reference to determine the readiness of structural engineering to face the challenges of natural disasters in the 21st century (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

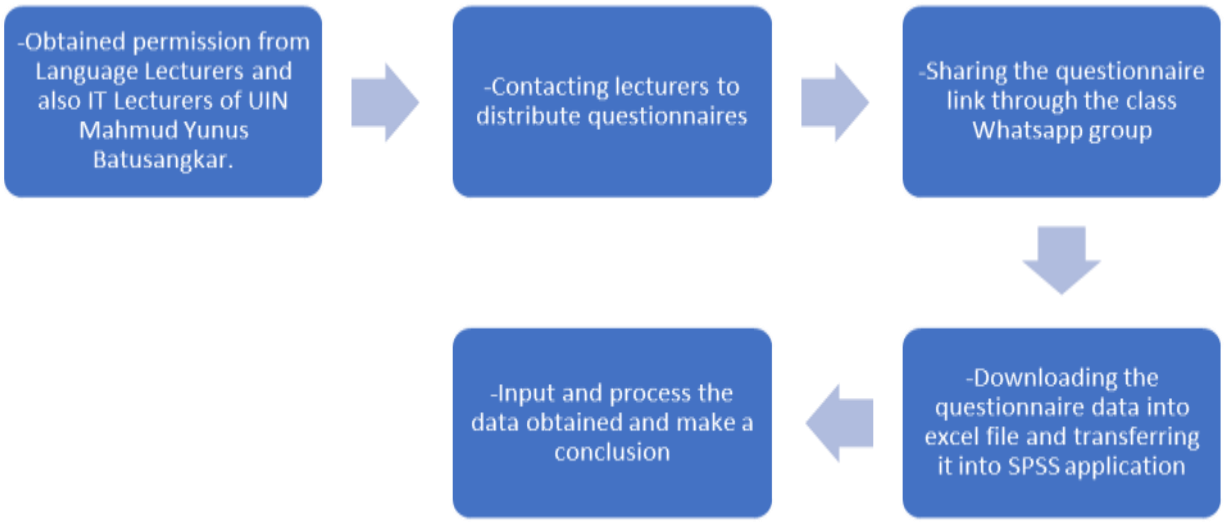
Readiness of Structural Engineering to Face the Challenges of Natural Disasters in the 21st Century

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 Readiness of Structural Engineering to Face the Challenges of Natural Disasters in the 21st Century

No	Statement	SS	S	KS	SKS
1	Resilient and disaster-resistant infrastructure is an important aspect of mitigating the impacts of natural disasters that are becoming more frequent in the 21st century.	75%	25%	0%	0%
2	Research and development of innovative structural engineering is needed to improve preparedness for various types of natural disasters, from earthquakes to floods and storms.	60%	40%	0%	0%
3	Structural engineering readiness should include the identification and evaluation of	70%	30%	0%	0%

	risks and the development of adaptive and sustainable solutions.				
4	Training and public awareness on safe and disaster-resistant building construction is also an important part of structural engineering readiness.	65%	30%	5%	0%
5	The integration of advanced technologies such as sensors and monitoring systems into structural design can improve the ability to detect and respond to natural disasters more quickly and appropriately.	60%	40%	0%	0%
6	Collaboration between structural engineers, environmental scientists and other stakeholders is needed to create a holistic approach to the challenges of natural disasters.	80%	20%	0%	0%
7	Adequate funding and investment in research and development of disaster-resistant infrastructure is key to improving structural engineering readiness.	60%	40%	0%	0%
8	Adaptation to climate change should also be a key focus in developing effective structural engineering readiness strategies.	75%	20%	5%	0%
9	Knowledge of local natural disaster patterns and experience from past disasters are valuable resources in designing appropriate and relevant solutions.	65%	30%	5%	0%
10	Structural engineering readiness is not just about strengthening physical buildings, but also involves smart urban planning, integrated risk management and sustainable post-disaster recovery.	70%	30%	0%	0%

Table 1.4
Results of Structural Engineering Readiness to Face the Challenges of Natural Disasters in the 21st Century 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			

The challenges of natural disasters in the 21st century are increasingly forcing the field of structural engineering to improve its readiness to deal with increasingly complex and diverse situations. Disasters such as earthquakes, floods, storms and tsunamis require a holistic and integrated approach to reduce human and material losses. Structural engineering readiness covers various aspects, from planning earthquake-resistant building designs to implementing advanced technologies for early detection and mitigation of disaster risks.

The importance of investing in research and development of the latest technologies is crucial in improving infrastructure readiness. This includes the development of new construction materials that are stronger and more disaster-resistant and the use of sensors and monitoring systems to detect disaster threats quickly.

In addition, community training and awareness on safe construction practices is also an integral part of structural engineering preparedness. Educating the public about the potential hazards of natural disasters and the steps that can be taken to protect themselves and their households is an important step in minimizing the impact of disasters.

Cross-sectoral and inter-agency cooperation is key in creating effective solutions to natural disasters. Structural engineers, environmental scientists, governments and communities must work together to develop comprehensive preparedness strategies.

Adaptation to climate change is also an important focus in structural engineering preparedness. As weather patterns become more extreme, infrastructure must be able to adapt to changing threats.

Through learning from past disasters and field experiences, we can gain valuable insights into what has worked and what needs to be improved in enhancing structural engineering readiness.

Structural engineering readiness does not stop at the planning and construction phase, but also includes rapid and sustainable post-disaster recovery efforts. Assisting communities in rebuilding destroyed homes and infrastructure and providing psychosocial support is an important part of this process.

Although the challenges faced are immense, technological advances and innovations continue to push the boundaries of possibility in improving the engineering preparedness of structures. With a sustainable and comprehensive approach, we can build a safer and more disaster-resistant future.

It is hoped that the concerted efforts of all parties, from governments to the general public, will result in stronger and more resilient infrastructure to meet the challenges of natural disasters in the 21st century, minimizing losses and increasing the overall resilience of the global community.

CONCLUSION

Young adulthood is defined as an age that is immature in terms of social relationships. An inferior attitude, likes to be alone, lack of concern for other people, and maladjustment often occur in young adults, especially those who have just completed formal education. Relationships with peers become increasingly strained after adolescence ends and a person moves on to an adult lifestyle, such as pursuing a career, working or getting married. Due to busy careers, involvement in activities outside the home is decreasing. As a result, young adult individuals will experience social isolation for the first time, this is known as a competitive crisis by Erickson. The socioemotional development of young adults consists of temperament, attachment, interest, and openness.

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