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The Analysis of Understanding in Seismic – Resilient Infrastructure Planning in Vocational Student's Civil Engineering

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Abstract: The analysis of understanding in Seismic-Resilient Infrastructure Planning among vocational students in civil engineering is indispensable for multifaceted reasons. This study employs a questionnaire validation test as a means of data collection, utilizing questionnaires to gather information. Simple random sampling was applied to select respondents from Medan State Polytechnic students in their 5th and 7th semesters. The questionnaire is designed to assess students' knowledge of earthquake-resistant infrastructure planning. The research is structured into three segments, focusing on the understanding of earthquake resistance management, structural earthquake resistance, and infrastructure earthquake resistance. The aspect of management seismic resilience understanding ranges from 3.22% to 9.65%. The highest understanding is observed in the awareness of quality control activities, the fifth assessment (9.65%). The lowest understanding is in reduce errors in the implementation of earthquake-resistant construction, the nineth assessment (3.22%). The aspect of structure seismic resilience understanding ranges from 2.78% to 9.48%. The highest understanding is observed in threaded reinforcement, the fourth assessment (9.48%). The lowest understanding is in earthquake-resistant house construction, the seventh assessment (2.78%). The aspect of infrastructure seismic resilience understanding ranges from 5.57% to 15.83%., The highest understanding is observed in earthquake-resistant foundations, the second assessment (15.83%). The lowest understanding is in post-disaster assessment approach, the fifth assessment (5.57%). These percentages likely represent the level of comprehension or proficiency of students in each respective aspect, with higher percentages indicating a better understanding. It is crucial to analyze these results collectively and over time to identify trends, strengths, and areas for improvement in the seismic resilience education provided to vocational civil engineering students.

Keywords: Seismic-Resilient Infrastructure Understanding, Earthquake Resistance Management Understanding, Structural Earthquake Resistance Understanding, Infrastructure Earthquake Resistance Understanding

1.Introduction

Infrastructure systems such as transportations, telecommunications, energy water, educational institutions, educational facilities, healthcare facilities, wastewater, and emergency services, are the essential continuous performance to grow up modern society and the economy in ordinary times even during emergencies [1]. Natural hazards such as earthquakes cause significant damage to infrastructure systems made the local knowledge in buildings and infrastructures that are constructed to endure seismic activity. [2] [3].The Liquefaction is a common form of damage caused by earthquakes [4]. The Indonesian Institute of Sciences (LIPI) and the United Nations Educational, Scientific, and Cultural Organization (UNESCO) state that five factors can influence disaster preparedness. They are knowledgeable and have attitudes toward disaster risk, policies, and guidelines, planning for disaster emergency conditions, warning systems, disasters, and resource mobilization capabilities. Weak preparedness can lead to more severe disaster impacts such as high death tolls, serious injuries, extensive infrastructure damage, and the emergence of diseases resulting from disasters[5].

The analysis of understanding in Seismic-Resilient Infrastructure Planning among vocational students in civil engineering is indispensable for multifaceted reasons. As a pivotal educational assessment tool, it evaluates the efficacy of the curriculum and instructional strategies in conveying knowledge about seismic-resilient infrastructure, enabling educators to refine teaching methodologies by identifying strengths and weaknesses in student comprehension. By pinpointing specific knowledge gaps, the analysis facilitates targeted enhancements in the curriculum, ensuring a comprehensive education in seismic resilience. The insights derived contribute to the ongoing enhancement of the civil engineering curriculum, empowering curriculum developers and educators to adapt approaches, introduce new topics, and emphasize critical aspects of seismic-resilient infrastructure planning. This process aids in continuous quality improvement, aligning education with the evolving needs of the field and preparing students to contribute to future seismic-resilient infrastructure projects [6].

Moreover, understanding students' comprehension levels is vital for their professional development, guiding the design of programs that bridge the gap between academic knowledge and practical application in real-world engineering projects. The analysis also ensures the alignment of vocational civil engineering students with current industry requirements, fostering graduates equipped to contribute to industry advancements. Ultimately, it plays a pivotal role in community safety by cultivating a generation of civil engineers well-versed in seismic-resilient infrastructure planning, ensuring the design and construction of infrastructure capable of withstanding seismic challenges[7]. Furthermore, the findings stimulate research and innovation, identifying areas that require new technologies, materials, or design approaches and fostering a culture of continuous improvement and creativity in the field of seismic resilience.

This study employs a questionnaire validation test as a means of data collection, utilizing questionnaires to gather information. Simple random sampling was applied to select respondents from Medan State Polytechnic students in their 5th and 7th semesters. The questionnaire is designed to assess students' knowledge of earthquake-resistant infrastructure planning. The research is structured into three segments, focusing on the understanding of earthquake resistance management, structural earthquake resistance, and infrastructure earthquake resistance.

2. Method

2.1. Approach Study

According to Arikunto, a method study is a method used by the researcher to collect research data. In this research, the writer uses a method of study descriptive with a quantitative approach [8]. Sugiyono explains that the method of quantitative study is based on the philosophy of positivism, used in research to sample and population study [9].

Method study descriptive is something method in group status research of human, an object, a condition, a thought, or an incident moment. Method descriptive is used to make a description or description in a systematic, factual, And accurate way about the existing phenomenon. Study descriptive quantitative is an illustrative research variable in a way that exists supported with data in the form of the resulting number from circumstances.

This research uses the technique of data retrieval via questionnaire. The type taking sample used is simple random sampling. Samples used 115 respondents were taken from students of Polytechnic Medan State (Students in the 5th and 7th semester).

2.2. Data Collection Technique

Research data is obtained from the data collection technique. The technique used in this research is deep data collection through a questionnaire.

A questionnaire is a method of data collection where a set of questions or statements is given to respondents to answer. Sugiyono stated that there are several principles to consider when writing a questionnaire, including: (a) Ensuring objective questions are filled in, (b) Using appropriate language, (c) Considering the type and format of the questions, (d) Avoiding ambiguous questions, (e) Avoiding questions that have already been asked or forgotten, (f) Avoiding leading questions, (g) Keeping questions concise and in a logical sequence, and (h) Paying attention to the physical appearance of the questionnaire [9].

2.3. Data Analysis Technique

This research analysis uses the calculated value from all answers in questionnaire from each student as respondents. The calculate value using Microsoft excel and using the formula below.

$$X_{tot} = \sum x_1 + x_2 + x_3 + \cdots + x_{25} \quad (1)$$

$$X_{mri\%} = \sum x_{r1}.10\% + x_{r2}.10\% + x_{r3}.10\% + \cdots + x_{r10}.10\% \quad (2)$$

$$X_{sri\%} = \sum x_{r11}.10\% + x_{r12}.10\% + x_{r13}.10\% + \cdots + x_{r20}.10\% \quad (3)$$

$$X_{iri\%} = \sum x_{21}.10\% + x_{r22}.10\% + x_{r23}.10\% + \cdots + x_{r25}.10\% \quad (4)$$

The symbolized X_{tot} is the total of the right answer from the respondents, after each respondent calculate with the formula (1) use $X_{mri\%}$, $X_{Sri\%}$, $X_{iri\%}$. The $X_{mri\%}$ is the value of total management resilience understanding seismic each respondent. The $X_{sri\%}$ is the value of total structure resilience understanding seismic each respondent. The $X_{iri\%}$ is the value of total infrastructure resilience understanding seismic each respondent.

3. Result and Discussion

This research is divided into three parts that is management seismic resilience understanding, structure seismic resilience understanding and infrastructure seismic resilience understanding. in part of management seismic resilience understanding have 10 questions which show the capability of students in recovering the damaging effect of an earthquake, mitigating the impact of earthquakes, the impact of earthquake made collapse infrastructure, and considering earthquake resistant infrastructure. the result of this part will show below:

Table 1. *The result of **m**anagement seismic resilience understanding*

Code	Aspect	Percentage
M1	the understanding of Mitigation activities for the most important earthquake disaster as civil engineering student	54.8%
M2	the concerned causes of casualties or injuries after the earthquake	96.5%
M3	the knowledge of the most important thing to consider in the face of the earthquake disaster	92.2%
M4	the knowledge of important activity considered before the implementation of construction in a disaster area	94.8%
M5	the awareness of quality control activities is carried out in project implementation that can be strong enough to withstand the existing load	95.7%
M6	the ability to consider factors that need in project quality control	47%
M7	the understanding student select factors of materials that do not comply with specified standards often occurs due to	88.7%
M8	the ability to analyze non-technical causes of infrastructure collapse	51.3%
M9	the understanding of efforts that can be made to reduce errors in the implementation of earthquake-resistant construction,	81.7%
M10	the ability to avoid the collapse due to an earthquake	32.2%

The table has a set of results related to various aspects of knowledge or understanding related to management seismic resilience that are labeled with code M1, M2, M3,..., M10, and the percentage indicates the level of understanding in that particular aspect. The high percentage shows a strong understanding of that topic among the respondents. the first aspect where the percentage is relatively high is M2 (96.5%) suggesting that civil engineering student polytechnics have a robust understanding of the factors that contribute to the casualties or injuries following an earthquake. The causes of casualties in earthquakes can be diverse including infrastructure collapse, landslides, tsunamis, and structural failures, the high percentages suggest abroad and comprehensive understanding across these different dimensions. The second aspect that have high percentage is M5 (95.7%), this aspect suggesting a strong awareness of quality control activities carried out in project implementation to ensure structures are strong enough to withstand loads. The student 95.7% understand the quality control is a systematic process that aims to ensure that a product service meets specified standards by systematically checking and verifying construction process and materials especially for now many systems and technologies that help to build construction such as Building Information Modelling that functions and features technologies for the construction of the project provides a lot to help quality protection [10] The third aspect has a high percentage is M4 (94.8%) indicating a strong understanding of important activities considered before construction in a disaster-prone area. Students high understand that a substantial seismic occurrence has the potential to inflict considerable harm on infrastructure systems, leading to substantial direct and indirect repercussions[11]. Achieving earthquake-resilient infrastructure demands a thorough risk-management strategy.

In other aspect, the aspect M10 (32.2%) which focuses on the ability to avoid the collapse due to an earthquake suggest to notable for improvement in the understanding of vocational civil engineering students regarding the measures and skills needed to prevent structural collapse in the event earthquake. Many nations have recognized the value of incorporating indigenous knowledge into hazard management. In Indonesia, the traditional response to natural hazards, particularly earthquakes, involves adapting house constructions based on the hazards present in the surrounding environment [12]. These practices have been tried and tested over many centuries. However, despite the longstanding existence of this indigenous knowledge, the process of learning goes beyond mere recollection; it necessitates translating this knowledge into actionable steps [12]. This is the one of reason and strategy to make students more understand the aspect M10.

In the face of increasing seismic activities globally, understanding the seismic resilience of structures has become paramount in ensuring the safety and sustainability of our built environment. As we navigate the intricate relationship between structural design and earthquake resilience, the findings presented herein shed light on the knowledge students within this critical domain. Our exploration encompasses a range of facets, including the comprehension of risk level by SNI 1726:2019, concept of earthquake resistant buildings awareness of quality control measures, and the ability to analyze non-technical causes of infrastructure collapse. By examining these aspects, we aim to contribute to the ongoing discourse on seismic resilience, informing both academic and practical considerations in the field of civil engineering. The results of structure seismic resilience understanding aspects describes below.

Table 2. *The result of structure seismic resilience understanding aspects*

Code	Aspect	Percentage
S11	In SNI 1726:2019 there is a division of risk categories for building structures starting from the lowest category 1 to the highest risk category level 4. Which includes buildings with risk category level 4	76.5%
S12	The concept of earthquake resistant buildings is inaccurate	51.3%
S13	Weaknesses of precast concrete structures against	64.3%

	earthquake loads	
S14	Threaded reinforcement is better used than plain reinforcement in reinforced concrete structures in terms of earthquake load resistance	94.8%
S15	Quality control activities on concrete by taking concrete samples that have been left for 7, 14, 21 and 28 days to get the FC' plan	93.9%
S16	The term Strong Column Weak Beam concept in earthquake resistant structures	79.1%
S17	The basic characteristics that need to be present in earthquake-resistant house construction, except	27.8%
S18	The earthquake hazard on bridges must be characterized using	51.3%
S19	True or false, stronger and more earthquake-resistant walls should be designed with plain concrete	80.0%
S20	True or false statements: a dam is exposed to a simpler system of forces during an earthquake compared to other structures	53.9%

The above table 2 has a set of results from various aspects of knowledge or understanding related to earthquake resistant structures which are coded S16, S17, S18,..., S25, and the percentage shows the level of understanding in that aspect. This high percentage shows the respondents' strong understanding of the topic. The first aspect with a relatively high percentage is S14 (94.8%), which shows that civil engineering polytechnic students have a strong understanding that threaded reinforcement is better to use than plain reinforcement in reinforced concrete structures in terms of earthquake load resistance. S14 describe comprehensive scientific investigations into significant earthquake hazards that can gather valuable insights for predicting and preventing the mitigation of earthquake disasters [13]. According to Wang [13],Examining the source physical processes, deep structures, and surface processes of seism genic structures during significant earthquakes is beneficial for gaining profound insights into the mechanisms and patterns of earthquake hazards. This study establishes a theoretical foundation for reducing the impact of earthquake disasters. The second high aspect in structure seismic resilience understanding is S15 (93,9%), Student high understand that Quality control activities on concrete by taking concrete samples have been left for 7, 14, 21 and 28 days to get the FC' plan. The aspect with a relatively low percentage is S22 (17.8%) regarding the basic characteristics that need to be present in earthquake-resistant house construction. This is because few respondents have studied earthquake engineering. The characterization of multi-hazard scenarios, especially earthquakes, follows a probabilistic approach. Nevertheless, evaluations based on specific scenarios can offer additional essential insights that are relevant for designing critical facilities [14]

The highway network is a vital factor in the growth and economic prosperity of urban areas. Numerous research efforts have emphasized the significance of expanding highway networks, considering economic, social, political, and military dimensions to gauge the urban development level. The planning of roadway network expansion and development primarily takes into consideration population growth and the physical environment, with minimal attention given to incident management[13]Transportation infrastructures yield diverse positive effects on economic well-being and fairness, contributing to the reduction of prices and the enhancement of investment, trade, and productivity. [15]However numerous regions across the globe are situated in crucial seismic zones. The third aspect that analyzed is infrastructure seismic resilience understanding aspect in Table 3 below,

Table 3. *The result of infrastructure seismic resilience understanding aspects*

Code	Aspect	Percentage
I21	Correct statement about earthquake mitigation	60.9%
I22	The correct statement regarding earthquake-resistant foundations	79.1%
I23	A series of activities carried out immediately after a disaster by government or non-government institutions	51.3%
I24	Steps and objectives in the assessment of post-disaster needs	70.4%
I25	Post-disaster assessment approach	27.8%

The table has a set of results related to various aspects of knowledge or understanding related to infrastructure seismic resilience that are labeled with code I1, I2, I3, I4, I5 and the percentage indicates the level of understanding in that aspect. The results from the five sample questions related to infrastructure seismic resilience could not provide significant answers to the student's knowledge. The first aspect where the percentage is relatively high is I2 (79.1%) suggesting that polytechnics' civil engineering student have a robust understanding of the statement regarding earthquake-resistant foundations. Students understand the correct type of foundation for infrastructure seismic resilience and know the type of soil that is good for determining the type of foundation. The last aspect where the percentage is relatively low is I5 (27.8%) about post-disaster assessment approach. It is because respondents have never studied disaster management.

The average understanding of Seismic-Resilient Infrastructure Planning in Vocational Student's Civil Engineering is an assessment or measurement of the overall comprehension level within this specific domain among students pursuing civil engineering in vocational education in Medan State Polytechnic. It signifies the collective grasp of concepts, principles, and practices related to designing and constructing infrastructure that can withstand seismic forces.

This result is often derived from analyzing the responses of vocational students to questions, assessments, or evaluations that gauge their knowledge, skills, and awareness in the field of Seismic-Resilient Infrastructure Planning. The result of average understanding of Seismic-Resilient Infrastructure in Medan State Polytechnic in below :

Table 4. *The result of average understanding Seismic – Resilient Infrastructure Planning in Vocational Student's Civil Engineering*

Code No. Question	Management seismic resilience understanding	Structure seismic resilience understanding	Infrastructure seismic resilience understanding
1	9,22%	5,13%	12,17%
2	5,48%	7,65%	15,83%
3	9,48%	6,43%	10,26%
4	9,57%	9,48%	14,09%

5	4,70%	9,39%	5,57%
6	8,87%	7,91%	
7	5,13%	2,78%	
8	8,17%	5,13%	
9	3,22%	8,00%	
10	9,65%	5,39%	

The provided data appears to represent percentages related to the understanding of seismic resilience in different aspects, specifically in management, structure, and infrastructure, possibly among vocational students in civil engineering. Each row appears to represent a separate assessment or measurement.

The aspect of management Seismic Resilience Understanding, Ranges from 3.22% to 9.65%. The highest understanding is observed in the fifth assessment (9.65%). The lowest understanding is in the ninth assessment (3.22%).

The aspect of Structure Seismic Resilience Understanding, Ranges from 2.78% to 9.48%. The highest understanding is observed in the fourth assessment (9.48%). The lowest understanding is in the seventh assessment (2.78%).

The aspect of Infrastructure Seismic Resilience Understanding, Ranges from 5.57% to 15.83%., The highest understanding is observed in the second assessment (15.83%). The lowest understanding is in the fifth assessment (5.57%).

These percentages likely represent the level of comprehension or proficiency of students in each respective aspect, with higher percentages indicating a better understanding. It is crucial to analyze these results collectively and over time to identify trends, strengths, and areas for improvement in the seismic resilience education provided to vocational civil engineering students. Additionally, it may be beneficial to investigate the factors influencing the variations in understanding across different assessments. The total from the average data describe the graphic below :

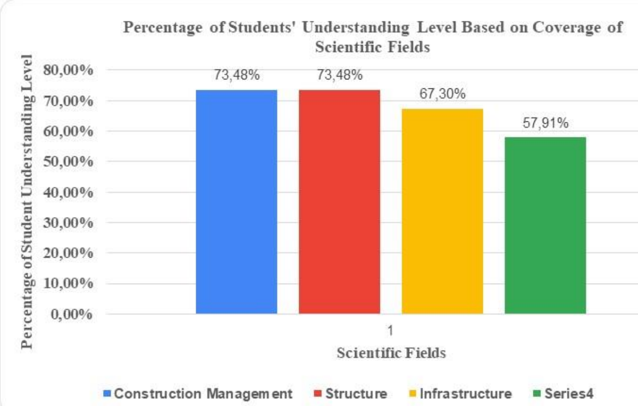

Figure 1. Percentage of student's understanding Seismic – Resilient Infrastructure Planning

4. Conclusion

The furnished data seems to depict percentages associated with the grasp of seismic resilience in various dimensions, specifically in management, structure, and infrastructure, potentially among vocational students in civil engineering. Each row is indicative of a distinct evaluation or measurement. Concerning the comprehension of management in seismic resilience, the aspect of management seismic resilience understanding ranges from 3.22% to 9.65%. The highest understanding is observed in the awareness of quality control activities, the fifth assessment (9.65%). The lowest understanding is in reduce errors in the implementation of earthquake-resistant construction, the nineth assessment (3.22%). The aspect of structure seismic resilience understanding ranges from 2.78% to 9.48%. The highest understanding is observed in threaded reinforcement, the fourth assessment (9.48%). The lowest understanding is in earthquake-resistant house construction, the seventh assessment (2.78%). The aspect of infrastructure seismic resilience understanding ranges from 5.57% to 15.83%., The highest understanding is observed in earthquake-resistant foundations, the second assessment (15.83%). The lowest understanding is in post-disaster assessment approach, the fifth assessment (5.57%).

These percentages likely signify the level of comprehension or proficiency among students in each respective area, with higher percentages indicating a more robust understanding. A comprehensive analysis of these results over time is essential to discern trends, strengths, and areas for improvement in the seismic resilience education offered to vocational civil engineering students. Additionally, investigating the factors influencing variations in understanding across different assessments would be beneficial.

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