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CONTRIBUTION OF SDGS IN TSUNAMI DISASTER PREPAREDNESS EDUCATION IN INDONESIA

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ABSTRACT
Indonesia is an area with three different volcanic arcs. Almost every year, there are disasters in Indonesia, particularly tsunamis. On the other side, Indonesia has SDGs 2030 focused on disaster management or risk reduction. Based on Structural Equation Modelling (SEM) analysis, this study will look at the part that SDGs education plays in disaster readiness. To attain the research orientation, the researchers developed a tsunami education program and assessed its validity and reliability to find a suitable model. The research approach included a cross-sectional survey to gather quantitative data on the students' replies. The data are valid and expected based on the normal tests. Two of the five indicators from the model influence analysis have been verified, making the model just partially acceptable. However, it is known that only a small number of factors have an impact on other variables based on total effect, direct effect, and indirect effect analyses. Five variables were identified as not significant in the final analysis. Therefore, not all of the model's hypothetical variables can be accepted entirely. The scope of research can be expanded in the future by using more focused variables, a larger sample size, and more respondents.

Keywords: *Disaster, Education, Indonesia, Preparedness, SDGS, Tsunami.*

1. INTRODUCTION

Because of the volcanic paths in Indonesia, which extend from Sumatera to Papua, Indonesia is ranked as the 35th largest country that is often hit by tsunamis (Prahani et al., 2021; Rahsetyo et al., 2021). Indonesia is where the Indo-Australian, Pacific, and Eurasian plates converge (Hariyono et al., 2016; Suryadi et al., 2021; Prasetyo and Sriutami, 2022). Terrible earthquakes and tsunamis may result from this plate. Almost every year, there is a higher chance that Indonesia will experience a tsunami disaster (Li et al., 2016; Hariyono and Liliasari, 2018; Deta et al., 2020; Anggrayni et al., 2020). Tsunami disasters have negative impacts on humans, disruption of life, damage to housing, and loss (Ophiyandri et al., 2020; Al-Habsi et al., 2022). Along with earthquakes, less frequent events like the impacts of falling asteroids, enormous coastal and submarine landslides, and volcanic activity can all result in tsunami waves with a high amplitude (Aksa, 2020; Toulkeridis et al., 2022).

Indonesia has experienced numerous tsunamis over the past ten years, including those in Aceh, Mentawai, and Yogyakarta. Several tsunami disasters have occurred; the biggest disaster is Tsunami generated by a powerful underwater earthquake off the coast of Aceh (Kartika and Madlazim, 2022; Suprapto et al., 2022). The worst tsunami disaster even struck Aceh, a national disaster that led to the collapse of the nation's government, economy, and public infrastructure (Amri and Giyarsih, 2022). However, the tsunami disaster can be anticipated rather than prevented, so the effects were minimal. One factor that causes many disaster victims is knowledge of preparedness for disaster. However, the tsunami warning system that has Indonesia was still traditional and unable to share warnings to communities. Not only equipment warning systems but also evacuation times and community understanding about mitigation was still down (Kim et al., 2022; Suprapto et al., 2022).

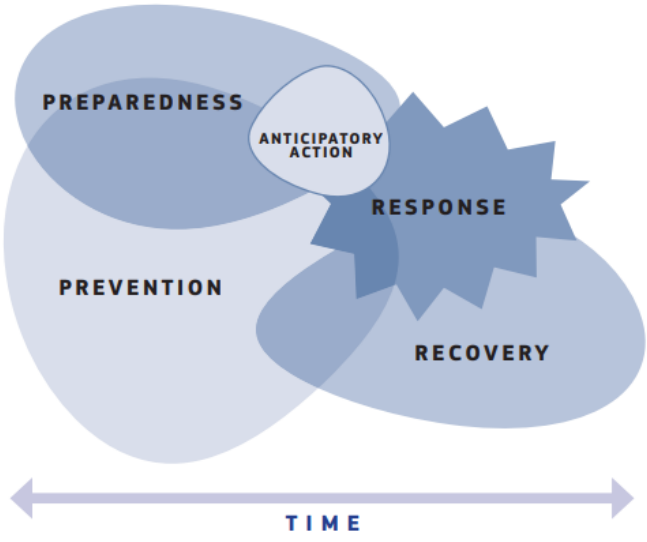

Figure 1. Risk Management Strands (Civil Protection and Humanitarian Aid, 2021)

There are many important lessons to be learned from the various disasters in Indonesia, especially for the scientific community and society to improve their disaster preparedness.

In terms of disaster management, disaster preparedness is a crucial aspect that all spheres of society must address (Suryadi et al., 2022). Their level of disaster preparedness will directly impact one's attitude toward responding to disasters. The community, as a stakeholder, is crucial in lessening the effects of disasters. Their level of preparedness will affect people's ability to deal with disasters. As a result, the community must be able to raise awareness of disaster preparedness as a risk factor and a direct influence on community behaviour (Suryadi et al., 2021). The goal of disaster preparedness is to increase resilience to unforeseen disasters. Moreover, Indonesia has SDGs 2030 objectives related to four notions of disaster management. First, education for Sustainable Development (ESD) believes in ensuring all people obtain knowledge for a better life to build community resilience in the face of disaster (Hariyono et al., 2018; Jauhariyah et al., 2019; Pradipta et al., 2021). As a crucial national policy framework, disaster management must encompass all facets of prevention, mitigation, emergency preparedness, and reconstruction.

2. RESEARCH OBJECTIVE

This research will examine SDG education's role in disaster preparedness based on SEM analysis. The researchers created a tsunami education program and evaluated its validity and reliability to identify a fit model to achieve the research orientation. According to the justification given above, the hypothetical model proposed by researchers is shown in figure 1. This model will be investigated.

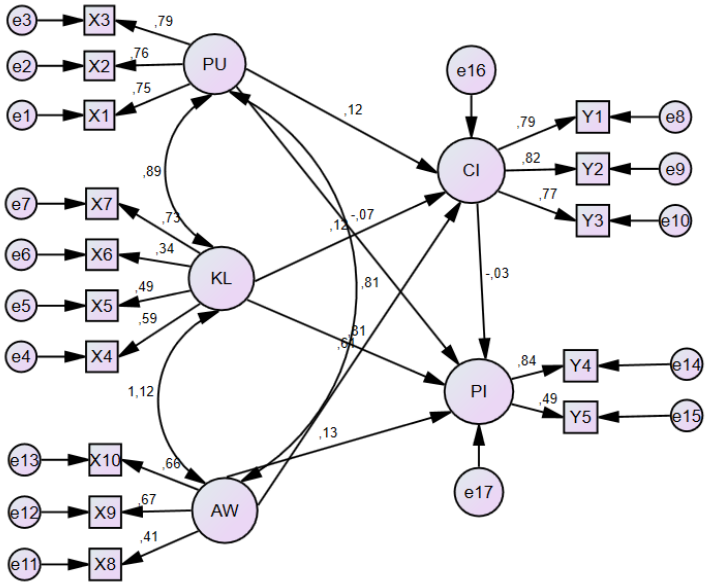

Figure 1. Hypothetical model

Note variable:

- PU : Perceived Usefulness
- KL : Knowledge
- AW : Awareness
- CI : Community Interest
- PI : Program Importance

Note model:

- All PU indicators can explain PU
- There are two KL indicators that can explain KL: X4 and X7
- There are two AW indicators that can explain AW: X9 and X10
- All CI indicators can explain CI
- There is one PI indicator that can explain PI: Y4

(Indicator is said to be able to explain the constructed variable if it has a loading factor value of more than 0.5)

Researchers then conducted empirical research with the following research questions in order to determine the fit model in relation to tsunami disaster preparedness:

a. What is the validity and reliability of tsunami disaster preparedness?
b. How does the fit model for tsunami disaster preparedness?

3. METHODS

A cross-sectional survey was used in the research design to collect quantitative data on the student's responses. The popularity of survey design stems from the strength of the Indonesian demographic (Suprapto, 2018). Then, a survey or questionnaire is a research tool that is adaptable and simple to use. The survey contains a number of concise and well-structured statements that prevent participants from providing another response. The initial data was gathered in August 2022.

The research subjects were chosen at random from a group of participants. The study concentrated on students in Indonesia because the country has many population centres there and is seismically active. The respondents' criteria included active students and alumni from Indonesian universities with a focus on the social and natural sciences. Then, Indonesia is located directly across from the Indian Ocean, where the Eurasian and Indo-Australian plates converge (Fauzi et al., 2022).

The research tool used to gather the quantitative data on educational readiness for tsunami disasters was called a questionnaire. The data was gathered by the researchers. Ten statements about disaster education, society knowledge, curricula, tsunami disasters, disaster awareness, and disaster preparedness were presented to the respondents with the option of agreeing or disagreeing. The statements offered four levels of disagreement: strongly disagree, disagree, agree, and strongly agree. They were written in straightforward language. Following the gathering of data, the student's responses were graded. The student's response was evaluated using a Likert scale with four levels. It provides their responses to queries.

Questionnaire items explored participants' views regarding general preparedness (e.g., how important disaster education is, especially Tsunami) and their perspective and knowledge relating to the tsunami disaster and its effects, regarding how useful the strategies were in preparing them for tsunami disaster and implementing disaster education curriculum. Then a questionnaire was a form of Google Forms and distributed via WhatsApp.

Participants' answers to closed questions were exported to SPSS and AMOS for data cleaning and analysis. Participant's answered multiple questions and indicated their level of

agreement with a range of statements on a scale of 1 (strongly disagree) to 4 (strongly agree). "Agree" and "strongly agree" responses were combined for each item and considered agreement when reporting the findings.

The author conducted a quantitative treatment of items selected through CFA (Confirmatory Factor Analysis). CFA was used to check the validity and reliability of the questionnaire. CFA can show the trend in participants' responses and check the relationship between two variables using AMOS program (Abraham and Barker, 2015; Brown, 2015; Eaton and Willoughby, 2018). There are several indicators such as CMIN/DF (Chi-Square Fit Statistics/Degree of Freedom), RMR (Root Mean Square Residual), GFI (Goodness of Fit Index), AGFI (Adjusted Goodness of Fit Index), NFI (Normed Fit Index), RFI (Relative Fit Index), IFI (Incremental Fit Index), TLI (Tucker-Lewis Index), CFI (Comparative Fix Index), RMSEA (Root Mean Square Error of Approximation), PGFI (Parsimonious Goodness Fit Index), and PNFI (Parsimonious Normed Fit Index) (Jöreskog and Sörbom, 1996; Hair et al., 2010; Ogbeibu et al., 2021; Oktasari et al., 2019). The author followed moderate criteria shown in Table 1.

Table 1. Criteria of goodness fit indices

Parameter	Acceptable Fit Indices	Goodness Fit Indices
CMIN/DF	2-3	2
RMR	.05	
GFI	.85	
AGFI	.80	
NFI	.80	
RFI	.80	
IFI	.90	
TLI	.90	
CFI	.90	
RMSEA	.05	
PGFI		
PNFI		

(Byrne, 2016; Hu and Bentler, 1999; Hooperet al., 2008; Lee et al., 2021)

4. RESULTS AND DISCUSSION

4A. Validity and Reliability

Table 2. Residual Statistics

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	42.00	60.00	51,29	5.329	180
Std. Predicted Value	-1.773	1.663	.000	1.000	180
Standard Error of Predicted Value	.000	.000	.000	.000	180
Adjusted Predicted Value	42.00	60.00	51.29	5.239	180
Residual	.000	.000	.000	.000	180
Std. Residual	.000	.000	.000	.000	180
Stud. Residual	.000	.000	.000	.000	180
Deleted Residual	.000	.000	.000	.000	180

Stud. Deleted Residual	.000	.000	.000	.000	180
Mahal. Distance	3.479	37.378	14.917	8.851	180
Cook's Distance	.000	.000	.000	.000	180
Centered Leverage Value	.019	.209	.083	.049	180

In order to answer the research questions. There are outlier tests to check the validity of students' responses. Outlier test showed in AMOS output. Parametric analysis shows that the data is valid and not an outlier. It's shown from Mahalanobis distance. We know that $\chi(0,001;15)$ = 37,6973, then minimum and maximum scores smaller than $\chi(0,001;15)$ score. That means the data is valid without an outlier. The next step is the multivariate normality test shown in figure 2. More than 50% of the points form a straight line, meaning it has a multivariate normal distribution. The normality test results in this study show that the points are scattered around the diagonal line on the normal probability plot graph.

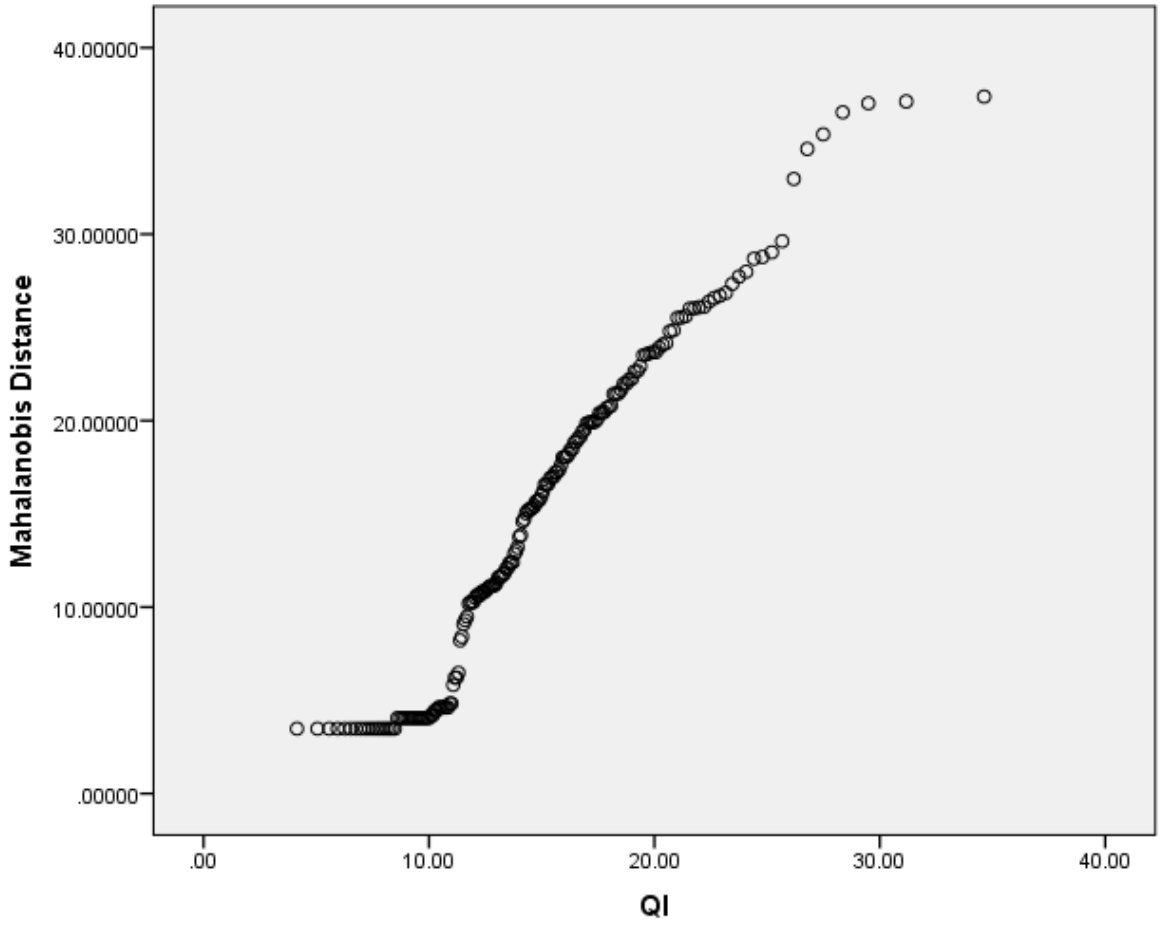

Figure 2. Multivariat normality data

Table 3. Correlations data

		Mahalanobis Distance	QI
Mahalanobis Distance	Pearson Correlation	1	.981**
	Sig. (2-tailed)		.000
	N	180	180
QI	Pearson Correlation	.981**	1
	Sig. (2-tailed)	.000	
	N	180	180
**. Correlation is significant at the 0.01 level (2-tailed)			

Table 3 shows the correlations test using a two-tailed test. Pearson correlation is 0,981 more than r table = 0,1463 (Johnson and Wichern, 2007). The results of the correlation coefficient obtained 0,981, which indicated a high correlation coefficient. The scatterplot and table 3 show that the data comes from a multivariate, normally distributed sample. After the normality test, CFA with SEM was processed, assisted by AMOS software.

The model chi-square, CMIN/DF, RMSEA, and CFI must report in SEM analysis (Kline, 2015). The chi-square represents a fundamental measure of overall fit. CMIN/DF shows a difference between the covariance matrix studied and the estimated one. RMSEA corrects if there is a chi-square tendency to reject models with large samples or measures the deviation of the parameter values of a model with its population covariance matrix.

Meanwhile, GFI shows a non-statistical measure by calculating a weighted comparison of the variances in the covariance matrix of the sample data and explained by the population covariance matrix. TLI (Tucker Lewis Index) is a measure that combines the size of parsimony into the index of comparison between the tested model and the baseline model. Accordingly, five out of all parameters indicated a non-goodness fit index. The five parameters are Chi-square, probability, AGFI, TLI, and CFI.

4B. Model Influence Analysis

Table 4. Model Fit Test

Criteria	Cut-Off	Result	Conclusion
Chi-square	Small (< = 37,6973)	148,820	Not Good
RMSEA	<0,08	0,069	Good
CMIN/DF	<2,00	1,860	Good
Probability	>0,05	0,000	Not Good
GFI	>0,90	0,903	Good
AGFI	>0,90	0,854	Not Good
TLI	>0,95	0,919	Not Good
CFI	>0,95	0,938	Not Good

Table 4 explains that 62,5% indicated not good, which means the suitability between the covariance matrix and the resulting population covariance matrix estimate. This is because the diversity in the sample is appropriate or representative of the diversity in the population.

The chi-square obtained is 148,820 or not good, so the model is not a good model. A high GFI value in this index indicates a better fit. RMSEA shows the model is acceptable. AGFI shows the hypothetical model can be accepted. TLI and CFI have values that are close to one. This shows that the model is an almost good fit with a value of less than 0,02.

According to Hooper et al. (2008), the model is good if at least one of the feasibility test methods is met, including Chi-Square, GFI, AGFI, RMSEA, and CFI. Some of these criteria were chosen because they are least sensitive to sample size, model specification errors, and parameter estimates (Boomsma, 2000). However, based on table 4, two of the five indicators have been met so the model is not fully acceptable.

Table 5. Total Effect Analysis

	AW	KL	PU	CI	PI
CI	,610	,121	,119	,000	,000
PI	,109	,803	-,069	-,028	,000

SEM analysis is used to describe the total effects among variables. The total effects between the two latent variables are the sum of the direct and indirect effects contained in the research model. The variables CI to CI, CI to PI, and PI to PI show a significant total effect. The Community Interest (CI) variable has relationship with PI (Program Importance) variable. While other variables do not show the total effect on the variables in the model. Further details are presented in Tables 6 and 7.

Table 6. Direct Effect Analysis

	AW	KL	PU	CI	PI
CI	,610	,121	,119	,000	,000
PI	,127	,806	-,066	-,028	,000

Direct effects between two variables occur when an arrow connects the two variables. The estimated value measures this effect among variables. For example, table 6 shows that only the CI to CI, CI to PI, and PI to PI show a significant direct effect. Other variables do not directly impact the variables in the model.

Table 7. Indirect Effect Analysis

	AW	KL	PU	CI	PI
CI	,000	,000	,000	,000	,000
PI	-,017	-,003	-,003	,000	,000

Indirect effects among variables can occur when a variable affects another variable by going through one or more latent variables according to the trajectory contained in the

research model. For example, table 7 shows that CI (Community Interest) has a significant indirect effect on AW (Awareness) variable. This also occurs between CI-KL, CI-PU, CI-CI, PI-CI, CI-PI, and PI-PI. So, Community Interest (CI) variable has a role important in Awareness (AW), Knowledge (KL), Perceived Usefulness (PU), and Program Important (PI).

Protection and respect from the community are integral to all education preparedness. Humanitarian Aid (BNPB) aims to support people in addressing their needs and managing the risks they face. The knowledge of society about Tsunamis can improve from their beliefs, social interaction, and local knowledge of disasters and the environment (Hariyono et al., 2020). So, knowledge (KL) is essential to understanding the occurrence of tsunami disasters (Hariyono et al., 2016; Suryani & Hariyono, 2021; Madlazim et al., 2022). The increase in the population of coastal communities around the coastal area (CI) and the lack of awareness (AW) create some problems in dealing with the Tsunami (Hariyono & Liliasari, 2017). One of the programs important to dealing with the tsunami disaster is preventing fatalities, protecting the community, and accelerating the resumption of normal operations. There is an indicator of perceived usefulness (PU).

Table 8. Hypothetical Analysis

			Estimate	S.E.	C.R.	P	Meaning
CI	<---	PU	,125	,205	,610	,542	Not Significant
CI	<---	KL	,180	,455	,395	,693	Not Significant
CI	<---	AW	,847	,360	2,356	,018	Significant
PI	<---	PU	-,073	,221	-,331	,740	Not Significant
PI	<---	KL	1,267	,549	2,305	,021	Significant
PI	<---	AW	,186	,492	,379	,705	Not Significant
PI	<---	CI	-,030	,226	-,132	,895	Not Significant

Further analysis showed that there were five variables indicated as not significant. There are CI-PU, CI-KL, PI-PU, PI-AW, and PI-CI. Therefore, variables AW (Awareness) to CI (Community Interest) and KL (Knowledge) to PI (Program Importance) got significant. So not all variables in the hypothetical model can not be accepted completely.

5. CONCLUSIONS

The data from the outlier test are reliable. The normality test results reveal that the points on the normal probability plot graph are dispersed all around the diagonal line. Two of the five indicators from the model influence analysis have been satisfied, making the model just partially acceptable. It is known that only a small number of factors have an impact on other variables based on total effect, direct effect, and indirect effect analyses. Five variables were identified as not significant in the final analysis. There are PI-PU, PI-AW, CI-PU, CI-KL, CI-CI, and PI-PU. Variables AW to CI and KL to PI become prominent as a result. Therefore, not all of the model's hypothetical variables can be accepted entirely.

There are still a lot of factors that have an impact on disaster education, but this research is still generic in nature. The authors advise future researchers to employ more focused variables in order to expand the depth of their research future. Additionally, researchers can expand their audience and recruit more participants. The study must include extensive, random surveys of multiethnic people throughout Indonesia.

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