Edu Komputika 11 (2) (2024)

Edu Komputika Journal

http://journal.unnes.ac.id/sju/index.php/edukom

Utilisation of Analytic Hierarchy Process in Determining Natural Disaster Evacuation Points

Sandhy Fernandez[1], Muhamad Awiet Wiedanto Prasetyo[1]✉, Argiyan Dwi Pritama[2]

[1]Information Systems Study Program, Universitas Telkom

[2]Information Systems Study Program, Universitas Amikom Purwokerto

Info Artikel

Article History:

Received: 22 July 2024

Revised: 16 December 2024

Accepted: 31 December 2024

Keywords:

Analytic Hierachy Process, Evacuation Points, Natural Disasters

Abstract

The positive impact of the dry season in Indonesia is that the tourism sector, which prefers to travel to beaches, islands and other tourist attractions, becomes busier and activities such as surfing and diving are usually better during the dry season. Another negative impact is the natural disaster of forest fires and dry peatlands which are highly flammable and cause damage to the natural environment, reduce air quality and threaten wildlife habitats. The most frequent natural disasters in Indonesia are floods, which have a significant impact on health problems because polluted flood water can cause water diseases such as diarrhea, skin infections and even threaten people's lives. Determining the best evacuation point in the context of disaster mitigation is a complex and critical decision. The Analytic Hierarchy Process (AHP) method is a decision analysis method that makes it possible to compare several different criteria that are relevant in decision making, very helpful for determining the most effective alternative. The existing calculation results are added from each existing sub-criteria, the Supermarket alternative result is 0.27, the Hill alternative result is 0.45, the Health Center alternative result is 0.03, the Place of Worship alternative result is 0.30, the Government Building alternative result is 0.28. If the largest value is ranked to the smallest value, Alternative Bukit is the best evacuation place in the event of a natural disaster.

✉ Correspondence Address:
Jl. DI Panjaitan No.128, Karangreja, Purwokerto Kidul,
Kec. Purwokerto Sel., Kabupaten Banyumas, Jawa Tengah 53147
E-mail: awietmwp@telkomuniversity.ac.id

ISSN 2252-6811

E-ISSN 2599-297X

INTRODUCTION

Indonesia's geographical location has played an important role in its history as a colony of European countries. This is due to Indonesia's strategic position between two major sea trade routes, namely the spice trade route from Southeast Asia to Europe and the spice trade route from South Asia to East Asia (Dangu et al., 2022; Susanto et al., 2022). Another factor is its richness in spices such as cloves, palawija, pepper, and cinnamon. These spices had a very high economic value in previous centuries and became a very important trade commodity, this is because Indonesia is located on the Equator. This significantly impacts its flora, fauna, culture and climate.

When the rainy season arrives, it is very important for Indonesian farmers to produce fertile soil to support the growth of food crops such as rice, corn, and soybeans so that the ecosystem life of flora and fauna species becomes more vibrant with a large number of plants and wildlife that breed to support high biodiversity and the last impact makes electrical energy from hydropower plants by utilizing the flow of river water, lakes and reservoirs (Rizal et al., 2022; Suwarno & Fuadi, 2022). The positive impact of the dry season in Indonesia is the tourism sector, which prefers traveling to beaches, islands, and other tourist attractions to be more crowded, and activities such as surfing and diving are usually better during the dry season. The dry season tends to make it easier for land transport to cross roads that are usually waterlogged to be better and air transport can operate without weather disturbances (Annafilah et al., 2022; Sitorus, 2023; Suryaningsih, 2022). This dry season is also utilized by farmers of shot, cotton, and crops. Still, if the dry season is prolonged, it will have a big impact, such as crop failure of morning crops, corn, soybean, or very low production, thus losing their livelihood, and the country can face the problem of the food crisis and rise.

During the dry season, some provinces in Indonesia experience a clean water crisis as rivers and lakes often dry up or shrink drastically, resulting in a scarcity of clean water for people who depend on these water sources for their daily needs and triggering serious social and health conflicts (Anshori & Suswatiningsih, 2022; Rahim et al., 2023; Soleh et al., 2022; Wati et al., 2022). Another negative impact is the natural disaster of forest fires and dry peatlands, which are highly flammable and cause damage to the natural environment, reduce air quality, and threaten wildlife habitat. The most frequent natural disaster in Indonesia is flooding, which has a significant impact on health because polluted floodwater can cause waterborne diseases such as diarrhea and skin infections and even threaten the safety of people's lives. Indonesia's geography includes the Ring of Fire and most of the islands are filled with active volcanoes, the occurrence of storms or tornadoes due to high waves caused by tropical cyclones, abrasion natural disasters due to coastal erosion by sea waves and ocean currents that disrupt the natural balance around the coast, then there are earthquakes and tsunamis (Hargono et al., 2023; Nurdin et al., 2023; Oktaviana & Fithriasari, 2023; Protchky, 2022). Bengkulu Province is prone to earthquakes; according to the Head of Kepahiang Geophysical Station, Mr Anton Sugiharto, in 2022, there were 912 earthquakes with the lowest strength of 2.3 magnitude and the largest of 6.8 magnitude.

The greater the strength of an earthquake, the more likely it is that a tsunami will result, which can cause further damage to infrastructure that has already been affected by the earthquake and can result in injuries and even fatalities. The fatal event after an earthquake that causes a tsunami is that people still do not know the effective and efficient evacuation route by taking into account the location at the time of the disaster, understanding the topography and geography of the area, such as the slope of the land, rivers, and roads as access to the evacuation route so that we can estimate whether or not to use the mode of transportation when evacuating because there will be a population density that may have to be evacuated, another factor is the distance from the affected area to a safe place must be proportional to the time available to avoid unwanted events (Afandi et al., 2022; Hall et al., 2022; Lee et al., 2022; Sari et al., 2022). The development of information technology has played a key role in improving the efficiency, speed, and accuracy of tsunami evacuation efforts worldwide. Information technology has enabled innovations and tools to help identify, predict, and respond to tsunami threats better.

Advanced navigation and mapping technology allows emergency service providers and the general public to access digital maps that provide details of evacuation routes, evacuation points, and other important information. This helps in more accurate and efficient navigation during the evacuation process. The determination of the best evacuation point in the context of disaster mitigation is a complex and critical decision. To achieve an optimal solution, the Analytic Hierarchy Process (AHP) method has become a very effective tool. AHP is a decision analysis method that allows us to compare several different criteria that are relevant in decision-making. The decision-making system method is very helpful to determine the most effective alternative (Fernandez et al., 2021; Prasetyo et al., 2022; Prasetyo, Muhamad Awiet Wiedanto., Saputri, Devi Yunita, Riziana, Afilda Trisetya., 2022). Considering the complexity and importance of planning evacuation routes during an earthquake, AHP is highly beneficial. This method allows decision-makers to consider all relevant factors, weigh them according to their importance, and ensure that the most optimal and safe path is chosen. This method's ability to systematically evaluate multiple criteria and ensure consistency in decision-making makes it an invaluable tool in disaster management, where the consequences of poor decisions can be fatal. Thus, AHP is a highly effective, reliable, and robust decision-making tool that provides a systematic approach to evaluate and select the best evacuation route during an earthquake. The ability to handle complexity, integrate various types of data, and ensure consistency of decisions is the main justification for using this method in the highly critical field of disaster management.

Firstly, in determining the best evacuation point, it is necessary to identify and define the relevant key criteria (Muhtar et al., 2022; Wiguna et al., 2022). These criteria can include various aspects, such as vehicle type, road capacity, and road conditions. Each of these criteria has a different level of importance in the context of this decision. Possible alternative evacuation routes based on knowledge of the affected area and existing infrastructure. These alternatives may include land routes, sea routes, or a combination of both, depending on the geography and type of disaster that may occur. With the help of the AHP method, we can assign a relative weight to each criterion according to its importance (Arum et al., 2023; Syahputra & Asriyanik, 2023). For example, Vehicle type is more important than road capacity and more important than road condition, the next step is to perform pairwise comparisons between each evacuation route alternative in terms of criteria. This is done to determine how each alternative fulfills the criteria. This pairwise comparison can be done on a numerical scale, for example, from 1 to 9, with 1 indicating that two alternatives are equivalent in terms of a particular criterion and 9 indicating that one alternative is clearly better than the other. The pairwise comparison data is collated, calculating a relative priority score for each alternative. The alternative with the highest score is the evacuation route, which is considered the best in the context of the predefined criteria and weights. Applying the AHP method, we can combine very diverse information and evaluate each aspect systematically to determine the best evacuation route that suits the possible disaster situation. This is a very efficient and accurate approach to decision-making related to safety and disaster risk mitigation.

The earthquake that occurred in the West Sulawesi area, especially in the Mamuju district on January 15, 2021, and several earthquakes after it could trigger a lot of shaking that could push the generation of tsunami waves(Tanra et al., 2023). So, Mamuju district is an area that is very vulnerable to tsunami disasters. These disasters can be minimized with TES and route placement planning announced a tsunami. However, there is a lack of information about this problem in Mamuju Regency, so it is very important to analyze the TES and the closest paths to the TES. The aim of this research is to analyze TES and evacuation routes so that it is easy for people to evacuate themselves. On Determination of TES using spatial analysis methods in ArcGIS (Geographic Information System) and for exit route analysis using the Network Analysis method. Using spatial analysis in ArcGIS because it refers to the position or TES and the exit route, ArcGIS can make things easier by combining information from several existing data and analysis for refugee routes using methods of network analysis to find the fastest path to TES. Freezing point determination analysis results Meanwhile, 21 points were found spread across the Mamuju sub-district, and 11 points were unsuitable for use to become a TES. Planning assistance routes using network analysis using the shortest path to TES was produced taking into consideration areas prone to Tsunami disasters and in densely populated areas where they occur 54 exit lanes. With 21 TES points, it makes it easier for the public to communicate the results Network Analysis speeds up people to evacuate themselves.

Previous research defined main criteria such as road capacity, not crossing rivers, population density and road conditions in determining the best evacuation point. The selection of alternative evacuation routes previously focused on land and sea routes, then more attention was paid to social dynamics and infrastructure when selecting disaster evacuation routes. Current research adds the types of vehicles that will be used during earthquake natural disaster evacuation, the evacuation route focuses more on land routes.

RESEARCH METHODS

Before collecting field data, it is important to conduct a literature study and literature review regarding relevant previous research. This stage involves collecting information from various sources, such as scientific journals, etc., to gain insight into the methods, criteria, and variables used in similar research. The initial step in data collection is identifying specific data needs in accordance with the research objectives. In the context of determining evacuation routes for natural disasters, the data required includes geographic information, demographic data, road infrastructure, and environmental conditions. Identification of data needs aims to ensure that all aspects relevant to evacuation routes have been taken into account.

The first step in problem identification is understanding the geographic context to be studied, which is very important to identify the main problems that must be addressed in planning evacuation routes. After understanding the context, researchers need to collect initial information regarding potential disasters and existing infrastructure. This includes data regarding the history of disasters in the region, the frequency and intensity of disasters, and the impacts that have occurred previously. Situation analysis is carried out to identify the extent of community and infrastructure preparedness in facing disasters, as well as any weaknesses that may exist in the current evacuation system. Based on initial information and situation analysis, researchers must determine the focus of the problem to be studied. In the context of determining evacuation routes, the focus of problems can include the lack of adequate evacuation routes, the lack of safe evacuation points, or the public's ignorance of effective evacuation procedures. This stage involves identifying criteria that influence the determination of evacuation routes. These criteria may include factors such as road capacity, infrastructure condition, distance to evacuation points, and accessibility for vulnerable communities. Identify important criteria to ensure that the proposed evacuation route is able to accommodate all aspects of public safety and comfort.

AHP is used to identify and determine the most optimal evacuation route based on a number of predetermined criteria. The following is a long and detailed description of the stages of the AHP method process in research on determining evacuation routes for natural disasters. The first step in the AHP process is to establish a clear objective for this research, namely, to determine the most effective evacuation route in dealing with natural disasters. Setting specific goals is very important because it will be the main reference in the entire AHP process. In addition, the scope of the research must also be clearly defined, including the study area, the type of disaster anticipated, and other relevant parameters. Once the objectives are set, the next step is to identify the criteria that will be used to evaluate evacuation routes. These criteria usually include factors such as road conditions, which refer to the physical condition of the road, including road width, road surface, and availability of lighting.

Road capacity measures the extent to which the road can accommodate the number of refugees in a short time. The type of vehicle used is the most likely way that people will use the mode of transportation used when a natural disaster occurs. After the criteria are set, the next step is to form the AHP hierarchical structure. This structure usually consists of three levels. Level 1 Determine the best evacuation route. Level 2 Criteria that have been previously identified. Level 3 Alternative evacuation routes evaluated based on these criteria. This hierarchy helps map the relationships between goals, criteria, and alternatives, and provides a clear framework for subsequent analysis.

Each criterion that has been identified will be given a weight according to its level of importance in the context of determining evacuation routes. This assessment is carried out through pairwise comparisons between each criterion. For example, researchers will compare whether road condition is more important than road capacity, or vice versa. Each comparison is assigned a value on a scale of 1 to 9, where 1 means both criteria are equally important, and 9 means one of the criteria is much more important than the other. The results of this comparison are then calculated to obtain the relative weight of each criterion. This weight reflects the importance of each criterion in achieving research objectives. Once the criteria weights are determined, it is important to check the consistency of the assessments that have been carried out. Consistency in AHP is measured using the Consistency Index (CI) and Consistency Ratio (CR). The Consistency Index is calculated to determine the extent to which pairwise comparisons are logically consistent. The Consistency Ratio is then compared with the reference value to determine whether the assessment is acceptable. If CR is less than or equal to 0.1, then the assessment is considered consistent. However, if the CR value is greater than 0.1, researchers need to review the pairwise comparisons and make improvements if necessary.

After the criteria have been assessed and their weights determined, the next step is to assess each alternative evacuation route based on the established criteria. Each alternative is evaluated through pairwise comparisons, just as is done for the criteria. The results of this evaluation are then used to calculate the relative weight of each alternative in the context of each criterion. For example, if there are three evacuation routes being considered, researchers will rate each route based on how well it meets each criterion, such as road condition, capacity, etc. This comparison is carried out for all combinations of alternatives and criteria. After all alternative weights and criteria have been calculated, the next step is to combine these weights to calculate an overall priority score for each alternative evacuation route. This score reflects how well each alternative meets all predetermined criteria. The priority score is calculated by multiplying the weight of a criterion by the weight of the alternative for that criterion, then adding up the results for all criteria. The alternative with the highest score is considered the most optimal evacuation route. Once the priority scores are calculated, the results are analyzed and interpreted to provide clear recommendations regarding the most effective evacuation routes. Researchers will look at how each alternative evacuation route compares based on established criteria and provide an explanation of why certain routes are preferred over others. In addition, researchers can also conduct sensitivity analysis to see how changes in criteria weights can affect the final results. This is important to ensure that the recommendations provided are reliable and do not depend on unstable assumptions. At the conclusion stage, it must reflect the entire research process, answer the research questions that have been formulated, and provide a logical explanation of the results obtained. The conclusions also aim to provide practical and theoretical contributions that can be used by other researchers, practitioners, or policymakers in the future.

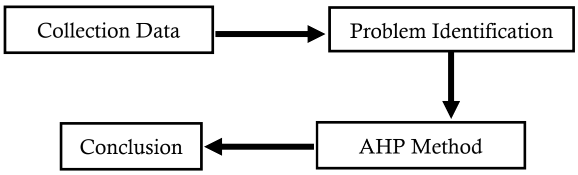

Figure 1. Research flow

RESULT AND DISCUSSION

The determination indicators used are road capacity (alley, regional road, national road), road conditions (labor, medium, up), vehicle types (R2 vehicles, R4 vehicles, heavy vehicles), and a hierarchy to determine the best evacuation site during a natural disaster around Bengkulu Province as shown in Figure 2. AHP Method Hierarchy.

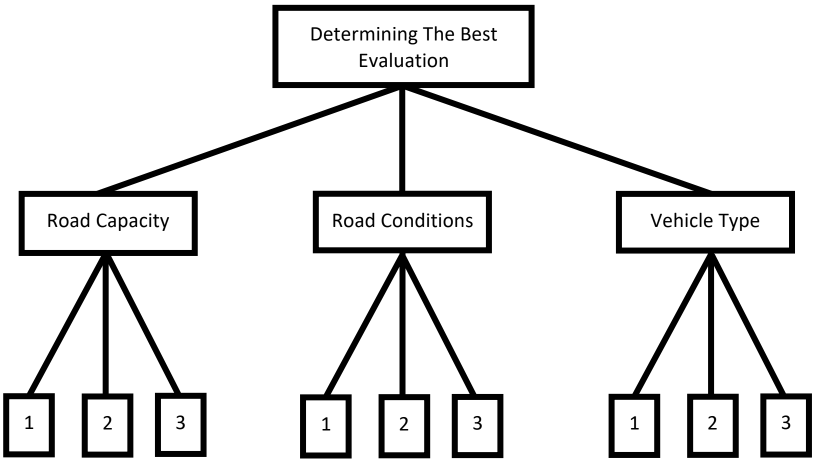

Figure 2. AHP method hierarchy

Stages of determining the priority of elements by making a pairwise comparison matrix filled with numbers to represent the relative importance between elements of the comparison scale matrix, the vertical result of the criterion value is obtained if the two criteria are equally important worth 1, the two criteria are slightly more important worth 3, the two criteria are more important worth 5, the two criteria are very important worth 7, the two criteria are absolutely important worth 9 and the two criteria are close to each other worth 2, 4, 6, 8. The horizontal result of the criterion value is obtained from the value of one divided by the vertical value in Table 1. Comparison Matrix of All Criteria.

Table 1. All Criteria Comparison Matrix

Criteria	C1	C2	C3
C1	1.00	0.33	0.20
C2	3.00	1.00	0.33
C3	5.00	3.00	1.00

The normalization matrix is an important step in the calculation process to obtain the relative weight of the evaluated criteria, each column in the pairwise comparison matrix with the formula equation 1.

$$n = \sum_{i=0}^{z} x_{ij} \quad (1)$$

Description:
N = the sum of each column
Z= many alternatives
i = 1,2,3, z
X the value of each cell or the combination of columns and rows

The calculation of the sum of the initial column to the last and the C1 criteria gets 9.00, the C2 criteria get 4.33, and the C3 criteria get 1.53. Each column value with the total column is concerned with obtaining matrix normalization using the formula equation 2.

$$m = \frac{x_{ij}}{n} \quad (2)$$

Description:
M = normalisation result
X= the value of each cell or the combination of rows and columns
N = the sum of each column

$$n = \begin{pmatrix} 1 & a/b & a/c \\ b/a & 1 & b/c \\ c/a & c/b & 1 \end{pmatrix} \quad (3)$$

In the matrix, a/b is the comparison between criteria a and b, a/c is the comparison between criteria a and c, and so on. The goal is to change the values in the matrix so that the sum of each row is equal to 1 or the sum of the columns.

Table 2. Normalisation Matrix of All Criteria

Criteria	C1	C2	C3
C1	0.11	0.08	0.13
C2	0.33	0.23	0.22
C3	0.56	0.69	0.65

The results of the normalization calculation can be seen in Table 2. Normalisation Matrix, then determines the priority weight to measure the level of importance or preference between the elements evaluated in the decision hierarchy. The results of priority weights use the formula equation 4.

$$BP = \frac{x}{n} \quad (4)$$

Description:
BP = priority weight
X = total criteria results
N = number of criteria

Before calculating the priority weights, we need to add the normalization matrix results from the row one value, which is 0.32; row two is 0.78, and row three is 1.90. The calculation is the total result of C1 / n = 0.32 / 3 = 0.11. Complete the calculation until the third row, and the results are seen in Table 3. Prioritization of All Criteria.

Table 3. Prioritisation of All Criteria

Criteria	Priority
C1	0.11
C2	0.26
C3	0.63

In the decision-making process, it is important to know how good the consistency is because it is not expected that decisions are based on considerations with low consistency. Calculating the eigenvalue needs to use the formula equation 5.

$$\lambda = BP * \Sigma p \quad (5)$$

Description:
E = eigenvalue
BP = Weight priority
∑p = result of the number of criteria

For example, the calculation is 0.11 * 9 = 0.96; complete the calculation until the third row, and the results can be seen in Table 4. Eigen Value of All Criteria.

Tab Table 4. Eigen Value of All Criteria

Criteria	Eigen
C1	0.96
C2	1.13
C3	0.97

Calculating the Consistency Index value is a measure used in the Analytic Hierarchy Process method to evaluate the extent to which pairwise comparisons made by decision-makers are consistent with the formula equation 6.

$$CI = \frac{\lambda\, max^{-n}}{n-1} \quad (6)$$

Description:
λ maks = maximum eigenvalue
n = many criteria

The calculation result is (3.06 - 3) / (3 -1) = 0.03. Calculating Consistency Ratio is a measure used in the AHP (Analytic Hierarchy Process) method to assess the level of consistency of pairwise comparisons made by decision makers with the formula equation 7.

$$CR = \frac{CI}{RI} \tag{7}$$

Description:
RI = index ratio
CR = consistency ratio

The index ratio value is obtained based on a random index value of 0.58, the calculation result is 0.03 / 0.58 = 0.05, and the results of the consistency hierarchy are declared consistent and can be used for the calculation of all existing criteria and alternatives because they have a value less than equal to 0.1. Priority value Table 3. Priority of All Criteria, and the results of calculating the priority value of each criterion are used to calculate alternative values. The priority value of Road Capacity Criteria with Gang Sub Criteria is 0.11, Regional Road Sub Criteria is 0.26, and National Road Sub Criteria is 0.63. The priority value of Road Criteria with Bad Sub Criteria is 0.11, Medium Sub Criteria is 0.26, and Good Sub Criteria is 0.64. The priority value of Vehicle Type Criteria with Heavy Vehicle Sub Criteria is 0.07, R4 Vehicle Sub Criteria is 0.28, and R2 Vehicle Sub Criteria is 0.64.

Table 5. Eigen Value of All Criteria

Alternative	Road Capacity	Road Condition	Vehicle Type
Supermarket	Local Road	Medium	R4 Vehicle
The Hill	Alley	Bad	R2 Vehicle
Health Centre	National Road	Medium	R4 Vehicle
Places of Worship	Alley	Good	R2 Vehicle
Government Building	National Road	Good	Heavy Vehicle

The calculation of alternative value results is the final value or score given to each alternative evaluated in a decision hierarchy. These values reflect the relative preferences of these alternatives based on comparisons with predetermined criteria with the formula equation 8.

$$A = BP * BPc \tag{8}$$

Description:
A = Alternative
BP = Criteria Priority Weight
BPc = Sub Criteria Priority Weight

The results of the existing calculations are added from each existing sub-criteria: the result of the Supermarket alternative is 0.27, the result of The Hill alternative is 0.45, the result of The Health Centre alternative is 0.03, the result of The Place of Worship alternative is 0.30, the result of The Government Building alternative is 0.28. When ranking the largest value to the smallest value, The Bukit Alternative becomes the best evacuation site in the event of a natural disaster.

CONCLUSION

This research aims to determine the optimal evacuation point based on the type of vehicle used, road conditions and the capacity of the road being used. The main focus is on two-wheeled vehicles such as motorbikes or bicycles, with the selection of road conditions categorized as good or fair, as well as road capacity, which includes national roads and local roads. Through an analysis process using the Analytical Hierarchy Process (AHP) method, several alternative evacuation points were evaluated based on these criteria. From the results of the calculations carried out, Bukit was identified as the best alternative evacuation site with the highest priority value, namely 0.45. This value shows that Bukit has the best combination of road conditions, road capacity, and suitability of two-wheeled vehicle types compared to other alternatives.

This research makes an important contribution to disaster evacuation planning, especially in the context of selecting evacuation locations that consider the infrastructure and characteristics of vehicles used by local communities. For further research, it is recommended to combine the method used with measuring the distance from disaster-prone points to evacuation points, using various methods for determining the shortest distance. This aims to optimize evacuation routes further and ensure that the selected evacuation points not only meet infrastructure criteria but also consider time efficiency and travel distance in emergency situations.

REFERENCES

Afandi, N., Yosmar, S., & Mayasari, Z. M. (2022). Penentuan Jalur Evakuasi Tsunami Bagi Pengara di Kota Bengkulu Menggunakan ALgoritma Fuzzy Dijkstra. *Jurnal Teori Dan Riset Matematika*, *7*(1).

Annafilah, A. A., Hasanah, N., Kurniawati, I., Diniyahm Afidah, Isnaini, S., & Azizah, L. N. (2022). Analisis Faktor Penyebab Terjadinya Bencana Banjir DI Daerah Pesalakan Kabupaten Bangkalan. *Science Education National Conference 2022*.

Anshori, A., & Suswatiningsih, T. E. (2022). Irigasi Air Tanah Mendukung Pertanaman Kacang Tanah, Jagung dan Kedelai di Lahan Kering pada Musim Kemarau. *Journal of Agri-Food, Nutrition and Public Health*, *3*(2).

Arum, R. P. S., Prayogo, T. B., & Prasetyorini, L. (2023). Evaluasi Kinerja Pada Daerah Irigasi Way Lo Kecamatan Waelata Kabupaten Buru. *Jurnal Teknologi Dan Rekayasa Sumber Daya Air*, *3*(2).

Dangu, A. S., Sumarjiana, I. K. L., & Anto, R. (2022). Sejarah Pendidikan Indonesia Awal Kemerdekaan Tahun 1945 - 1950. *Jurnal Inovasi Penelitian*, *3*(2).

Fernandez, S., Prihantoro, C., & Hidayah, A. K. (2021). Implementasi Wieghted Product pada Pemilihan Dosen terbaik di Universitas Muhammadiyah Bengkulu. *Jurnal Pseudocode*, *8*(2).

Hall, S., Sloan-Aagard, C., Harris, R., Emmett, C., Prasetyadi, C., Petterson, J., Cope, A., & Cox, M. H. (2022). Perceptions of Tsunami Susceptibility and Self-Efficacy Among Adolescents in Indonesia: The Influence of Gender, Religion, Location, Age, Hazard Information Source and Past Experience. *International Journal of Disaster Risk Reduction*, *79*.

Hargono, A., Artanti, K. D., Astutik, E., Widodo, P. P., Trisnawati, A. N., Wardano, D. K., & Lioni, E. (2023). Relationship Between Disaster Awareness and Disaster Preparedness: ONline Survey of The Community in Indonesia. *The Journal of Public Health in Africa*.

Lee, H. S., Sambuaga, R. D., & Flores, C. (2022). Effects of Tsunami Shelters in Pandeglang, Banten, Indonesia, Based on Agent-Based Modelling: A Case Study of the 2018 Anak Krakatoa Volcanic Tsunami. *Journal of Marine Science and Engineering*, *10*(8).

Muhtar, T., Amar, & Akbar. (2022). Penentuan Jalur Evakuasi Menuju Bandar Udara Melalui Pendekatan Analytic Hierarchy Process (AHP). *Jurnal Linears*, *5*(1).

Nurdin, N., Kluza, K., Fitria, M., Saddami, K., & Utami, Ri. S. (2023). Analysis of Social Media Data Using Deep Learning and NLP Method for potential use as Natural Disaster Management in Indonesia. *2023 2nd International Conference on Computer System, Information Technology, and Electrical Engineering (COSITE)*.

Oktaviana, P. P., & Fithriasari, K. (2023). Implementation of Bayesian Simulation for Earthquake Disaster Risk Analysis in Indonesia based on Gutenberg Richter Model and Copula Method. *Pakistan Journal of Statistics and Operation Research*, *19*(2).

Prasetyo, M. A. W., Setyaningsih, Gustin., Bachtiar, R. B., & Saputri, D. Y. (2022). Tuan Desa Application Menggunakan Metode Topsis Sebagai Penentuan Rencana Kerja Pembangunan Desa. *JST (Jurnal Sains Dan Teknologi)*, *11*(1).

Prasetyo, Muhamad Awiet Wiedanto., Saputri, Devi Yunita, Riziana, Afilda Trisetya. (2022). Penentuan Penerima Bantuan Sosial Dana Desa Dengan Sistem Pendukung Keputusan Menggunakan Simple Additive Weighting Method. *Jurnal Komputer Terapan*, *8*(2).

Protchky, S. (2022). Disaster in Indonesia: Along the Fault Line toward New Approaches. *Indonesia*, *113*.

Rahim, A., Rifai, A., Soleha, A., Fauziah, H. J., & Syain, M. (2023). Peran Pemerintah Daerah dalam Penaggulangan Bencana Banjir Menurut Peraturan Daerah Kabupaten Indramayu No. 3 Tahun 2016. *Jurnal Ilmiah Ilmu Pendidikan*, *6*(4).

Rizal, A., Astuti, Y. P., & Setiawan, A. (2022). Tingkat Kesulitan Adaptif pada Android Game bertema Flora Fauna Endemik Indonesia dengan Fuzzy Logic. *Jurnal Buana Informatika*, *13*(1).

Sari, R. M., Fahriani, M., Ningsih, D. A., Oklaini, S. T., Fitriani, D., & Neni, R. (2022). Edukasi Kesiapsiagaan dalam Mengahadapi Bencana Gempa Bumi dan Tsunami di Wilayah Kerja Puskesmas Pasar Ikan Kota Bengkulu. *Jurnal Pendidikan Tambusai*, *6*(2).

Sitorus, P. S. (2023). Penanggulangan Bencana Banjir dalam Perspektif Antropologi. *Jurnal Penelitian Ilmu-Ilmu Sosial*, *1*(1).

Soleh, A. W., Hasanah, M., Hasanah, M., Ihsan, Z. A., Sriwahyuni, I., Nisa, Y. A. M., & Rakhmawan, A. (2022). Analisis Potensi Bencana Kekeringan dan Upaya Mitigasinya di Desa Kampek Bangkalan. *Science Education National Conference 2022*.

Suryaningsih, Y. (2022). Penerapan Teknologi Silase Untuk Mengatasi Keterbatasan Hijauan Pakan Ternak Pada Musim Kemarau di Desa Arjasa Kecamatan Arjasa Kabupaten Situbondo. *Jurnal Pengabdian MIMBAR INTEGRITAS*, *1*(2).

Susanto, H., Fatmawati, S., & Fathurrahman. (2022). Analisis Pola Narasi Sejarah dalam Buku Teks Lintas Kurikulum di Indonesia. *Jurnal Ilmu Sejarah Dan Pendidikan*, *6*(2).

Suwarno, J., & Fuadi, A. L. (2022). Perancangan Aplikasi Pengenalan Flora dan Fauna Indonesia berbasis Android dengan Metode Library Research. *Jurnal Ilmu Kommputer*, *5*(2).

Syahputra, M. R., & Asriyanik. (2023). Pencarian Rute Terdekat Lokasi Evakuasi Tsunami Dengan Metode Pencarian Dijkstra Dan Pendekatan MADM. *Jurnal MEANS*, *7*(2).

Tanra, A. A. Y., Mulyadi, R., & Sir, M. M. (2023). Analisis Perencanaan Tempat Evakuasi Sementara dan Jalur Evakuasi Tsunami di Area kurang Sistem Informasi Geografi studi kasus: Kabupaten Mamuju. *Jurnal LINEARS*, *6*(2).

Wati, E., Arman, Y., & Adriat, R. (2022). Prediksi Awal Musim Hujan dan Awal Musim Kemarau di Ketapang Bagian Selatan Menggunakan Metode Autoregressive Integrated Moving Average (ARIMA). *Jurnal Prisma Fisika*, *10*(3).

Wiguna, I. K. A. G., Semadi, K. N., Sudipa, I. G. I., & Setiawan, I. K. J. (2022). Analisis Sensitivitas Prioritas Kriteria pada Metode Analytical Hierarchy Process (Kasus Penemuan Pemberian Kredit). *Jurnal Sains Komputer Dan Informatika*, *6*(1).