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Natural Disaster Logistic Assistance Using A Star Method

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Abstract— Natural disasters in Indonesia have tremendously impacted the victims. This is because there has not been a solution/method that can be used immediately when a natural disaster occurs, so losses caused by natural disasters continue to increase and are difficult to recover. The research used a case study of the *Cianjur* area. The research provides immediate assistance when natural disasters occur, as a liaison between donors and disaster victims, and is easy to use anytime and anywhere—assisting using the A Star method, which is used in navigation systems to obtain the fastest and closest distance by calculating two points using Longitude and Latitude. The result is an app for mobile devices used by donors, couriers, and victims of natural disasters, where donors can give their donated items faster. Apps can help the community at large. Many people can use the application to share information at the disaster site. The application is also easy to use anytime and anywhere, obtained from a weight of 4.00 by the users.

Keywords— A Star Method; Mitigation Disaster; Mobile Apps; Natural Disaster Logistic.

I. INTRODUCTION

Life is inherently intertwined with unforeseen occurrences, including events like natural disasters. The frequency and magnitude of natural disasters such as floods, hurricanes, and earthquakes are increasing yearly [1], [2]. Indonesia is among the countries most vulnerable to natural disasters. Natural disasters in Indonesia, especially earthquakes, can cause many casualties and damage people's buildings [3], [4]. After all, earthquakes are one of the most devastating natural disasters that can cause human, infrastructure, economic, and social losses [5]. Earthquakes often occur in Indonesia because they are crossed by four plate lines: the Indo-Australian plate, the Eurasian plate, the Pacific plate, and the Philippine plate [6].

Since 2014 – 2023, it has been known that natural disasters in the form of tornadoes are the most frequent disasters in Indonesia, with a score of 4.653 cases. Landslides have occurred most frequently in the *Cianjur* area over the past five years, with a score of 59, compared to other natural disasters, such as earthquakes, with a score of 5. Earthquakes are among the third-fewest of all disasters that occurred in the Cianjur area [7].

On November 21, 2022, there was an earthquake with a magnitude of 5.6 and an average depth of 10 KM in Cianjur Regency, West Java Province [8]. The earthquake occurred due to a fault shift called the *Cugenang* fault. The fault affected nine villages in two sub-districts of *Cianjur* area. Six villages in the *Cugenang* District consisting of *Cibeureum* Village, *Nyalindung* Village, *Mangunkerta* Village, *Sarampad* Village, *Cibulakan* Village, and *Benjot* Village; 2 villages in *Pacet* District, namely *Ciherang* Village, *Ciputri* Village; In addition, there is also one other village at the end of the fault, namely Nagrak Village [9], [10]. The impact of the earthquake caused 327 deaths, and many buildings were completely damaged [11].

When a natural disaster occurs, various demands occur, and then there is damage to networks and facilities. It is estimated that there will be a shortage of resources, which will increase. [12]. By obtaining clear and high-quality data and information on the needs of the victims, the use of technology will be very helpful in the logistics sector. Therefore, the distribution of logistical aid has an important role in helping meet the needs of disaster victims. The delivery of appropriate logistical assistance to the victims can ease the burden on the victims [13]–[15]. Natural disaster relief is donated to areas affected by natural disasters through government organizations, NGOs, and disaster care volunteer posts [16]. These organizations have different owners and administrators but share the same goals [17].

Disaster victims tend to have low expectations of help from people they contact through social networks. The study of Yuzuka Kashiwagi and Yasuyuki Todo interprets these results as possible because general shocks affect members of society while victims have limited social networks [18].

One strategy that can be adopted for disaster management is to develop flexible technology solutions that create highly visible materials and improve responsiveness by improving the efficiency of people and processes [19]. The supply chain is needed to execute the strategy, and one of the most important components of the supply chain is logistics [20]. Today, one of the main logistics tasks is the effective movement of materials from producers to consumers [21]. The survival rate in disaster-affected areas depends on the available logistical support[22].

Social media contributes to the efficiency of information dissemination, so it is an important part of improving public information and warning during disasters [23]. Some things contributing to the speed of social media information dissemination are detecting socially disruptive events, facilitating crisis communication, and achieving situational awareness [24]. According to research data from the International Journal of Disaster Risk Reduction, disaster damage data is collected conventionally with field surveys, post-disaster satellite imagery, or Unmanned Aerial Vehicle

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(UAV) imagery. However, none of these sources of information can be accessed quickly after a disaster due to limited atmospheric or environmental conditions for the deployment of manpower and equipment for the victims [25].

The National Disaster Management Agency (BNPB) currently has several problems with the assistance process, from the assistance needed to the assistance that donors have distributed, so there is a backlog of donations that are not by the needs of victims of natural disasters. No complete or precise information media is one of the main factors in the current problems. So, there is no information on the actual needs of victims of natural disasters, and there is no information that conveys whether donations from donors have been distributed. BNPB currently only accommodates donations sent by donors and sorts the needs of the victims, causing some donations to be unable to be distributed, resulting in a buildup of donation items that BNPB cannot distribute.

This research will create an information system that can display what types of donations are needed by victims of natural disasters and can display information to donors that donations that donors have sent have been distributed or are still being transmitted. Donors will also be given volunteer post information aimed at simplifying or speeding up the process of sending donations to the nearest volunteer post using the A Star method.

II. Research Methodology

This study used the A Star method, published in 1986 by Peter Hart, Nils Nilsson, and Bertram Raphae [26]. A Star combines Dijkstra and Breadth First Search (BFS) algorithms. It is the best algorithm for efficient path search and evaluation of different extension points based on heuristic costs. The algorithm is described in Figure 1.

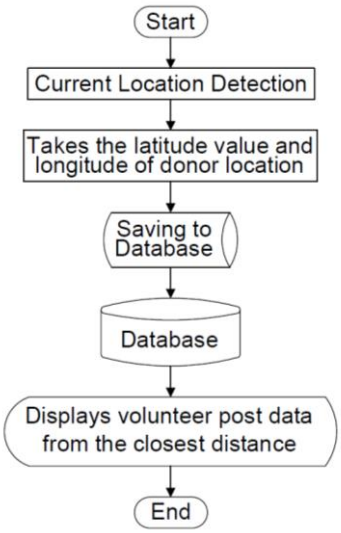

Figure 1. Flowchart Calculation Method A Star

The A Star formula can be used in Equation (1).

$$Fn = Gn + Hn \quad (1)$$

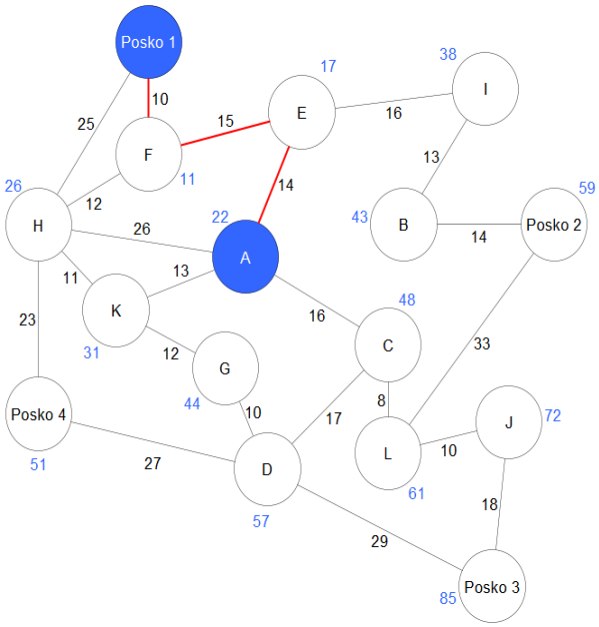

Figure 2. Mapping A Star Point A – Post 1

In the A Star formula, G and H values are needed, where G values are obtained from one node to another node to the destination point on the map, and H values are obtained from Heuristic values from the user's coordinate point to the specified post endpoint [27], [28]. Figures 2 to 5 show finding the fastest and shortest route from the initial coordinate point (A) to the coordinate point at each post (Post 1/Post 2/Post 3/Post 4).

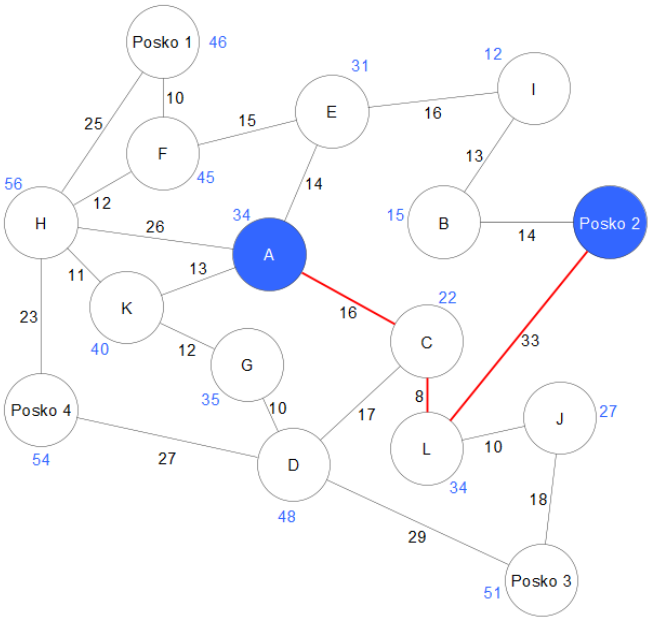

Figure 3. Mapping A Star Point, A – Post 2

The best route that needs to be taken from point A to Post 1 is A – E – F – Post 1, as shown in Figure 2, with a total (KM) taken of 39 KM. This is the fastest route that can be taken from several routes from point A to Post 1.

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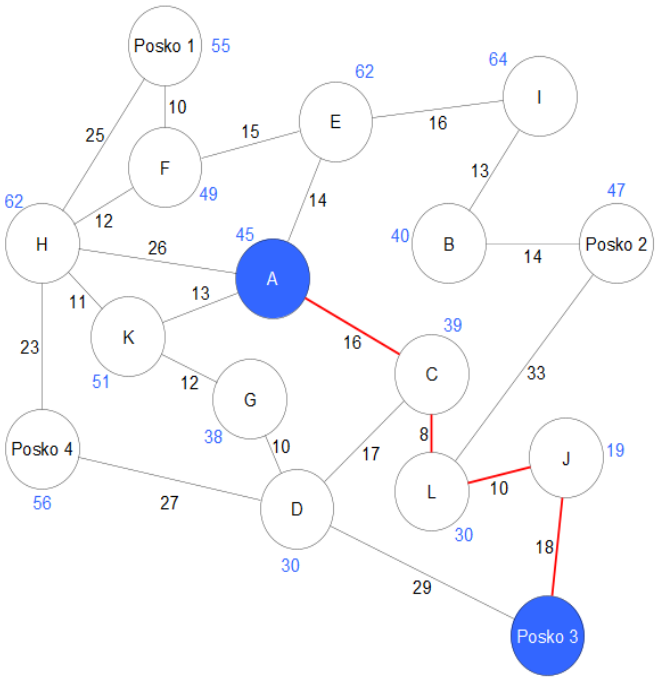

Figure 4. Mapping A Star Point, A – Post 3

Figure 3 calculates the distance from point A to Post 2,3 points can be passed to get to this post. The best route that needs to be taken from point A to Post 2 is obtained by A – C – L – Post 2, with a total (KM) taken of 57 KM.

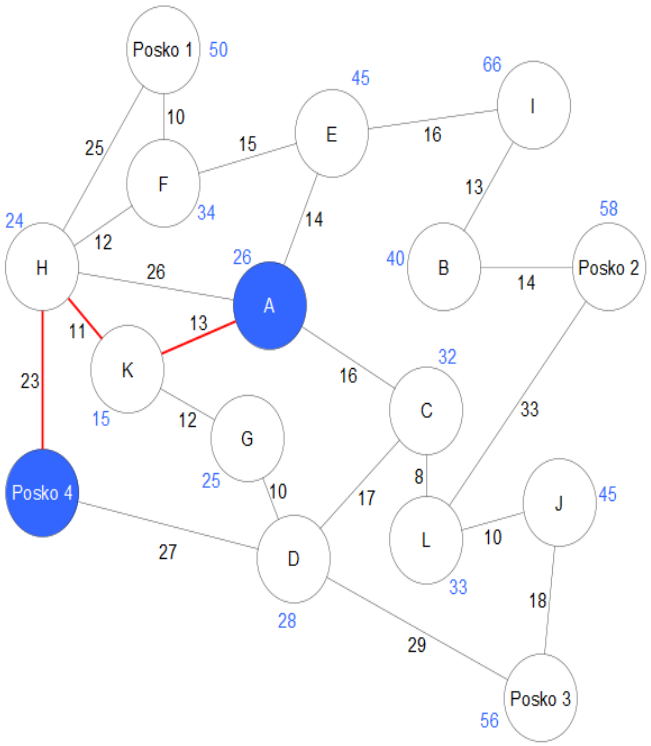

Figure 5. Mapping A Star Point, A – Post 4

The best route that needs to be taken from point A to Post 3 is obtained by A – C – L – J – Post 3, with a total (KM) of 52 KM, as explained in Figure 4. This route differs from other routes because it passes through 4 points to the designated post, but the total distance travelled is almost the same as route point A to Post 2.

The best route that needs to be taken from point A to Post 4 is obtained A – K – H – Post 4, as shown in Figure 5, with a total (KM) of 47 KM. The distance from point A to post 4 is quite far, even though it only needs to pass 3 points. Heuristic value is carried out using Equation (2).

$$Gn = \sqrt{(x^1 - x^2)^2 + (y^1 - y^2)^2} \quad (2)$$

The algorithm for the A Star method is explained,

$$A = \sqrt{(-4-16)^2 + (129-110.5609)^2} = 22$$
$$E = \sqrt{(-6-10)^2 + (128-111.477)^2} = 17$$
$$F = \sqrt{(-6-10)^2 + (100.1-109.9)^2} = 11$$
$$H = \sqrt{(8-14)^2 + (129-103.701)^2} = 26$$
$$K = \sqrt{(-8-15.1)^2 + (131.376-101.2)^2} = 31$$
$$C = \sqrt{(-2.365-8.737)^2 + (151.599-104)^2} = 48$$

Calculate the A Star method using the heuristic value that is obtained:

$$A - A => 22 + 0 = 22$$
$$A - E => 17 + 14 = 31$$
$$A - H => 26 + 26 = 52$$
$$A - K => 31 + 13 = 44$$
$$A - C => 48 + 16 = 64$$
$$A - E - I => 38 + 14 + 16 = 68$$
$$A - E - F => 11 + 14 + 15 = 40$$
$$A - E - F - \text{Post } 1 => 0 + 14 + 15 = 39$$

Take the shortest distance on each related path. For example, point A can pass through points E, H, K, or C to reach Post 1. The calculation on each line shows that lines A – E are the closest. Continuing from point E, you can use path I or F, obtaining points A – E – F. The results of determining the path were obtained A – E – F – Post 1 with a total distance of 39. Donors expect applying the A Star method to make it easier to send donations according to the nearest post—the logistics delivery process used in the *KitaPeduli* application.

a) Donors: Donors are users who provide donation assistance to disaster victims. The algorithm that occurs at the donor level is shown in Figure 6. After entering the application, donors can see data on logistical needs for disaster victims, and then donors can choose the items they want to donate. After choosing, donors will be given a choice of the nearest post to be able to send donated items.

b) Courier: Couriers are one of the actors who play an essential role in sending donated goods from the post, where donors give their goods to the victims. Figure 7 shows the algorithms and processes at the courier level.

The application is opened, and the courier will log in with his account first. Then, the courier will see a list of donated

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items that have been filled. After that, the courier will choose the donated item to be delivered. During delivery, the courier can update the item's delivery status along with the last location of the courier's whereabouts.

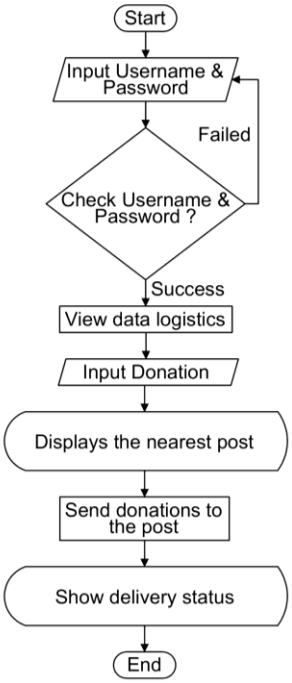

Figure 6. Donor Flowchart

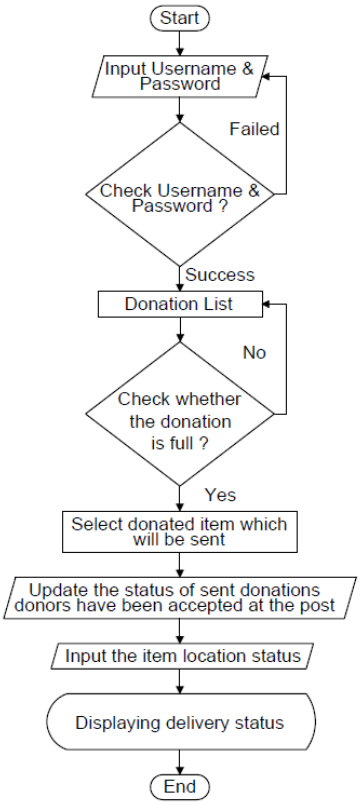

Figure 7. Courier Flowchart

Data collection using qualitative and quantitative methods in interviews, data analysis of literature studies, and official website data belonging to the Meteorology, Climatology and Geophysics Agency (BMKG) and BNPB, as shown in Figure 8. The results were obtained through interviews regarding the need for a medium for donors to help disaster victims. The flow created for collecting all information is designed according to the needs of this research, understanding relevant previous studies, and assisting the researcher in choosing the appropriate research method.

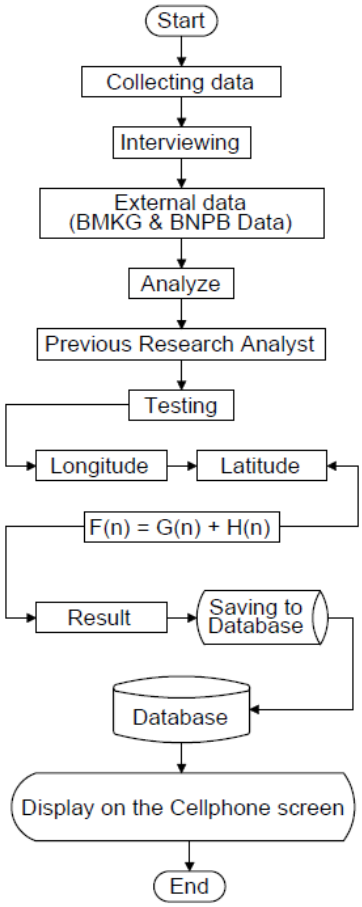

Figure 8. Research flowchart

The research process starts with data collection conducted by interviews and through external data (BMKG & BNPB Data). After the data is obtained, it will be analyzed by literature review analysis and proceed to the testing process. The system will detect the user's longitude and latitude values and then input them to be able to test using the A Star method. The A Star method will generate a value in distance, which will then be saved to the database and displayed to the user's mobile layer.

III. Result and Discussion

The *KitaPeduli* application has several features and pages, each with its function. In Figure 9 to Figure 26, you can see the page's appearance and function. *KitaPeduli* has been tested by several users, and the test results can be seen in Table I.

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TABLE I
USABILITY TEST RESULTS

Description	Point
KitaPeduli is easy to use	4.00
Apps can help donors and victims of natural disasters	5.00
KitaPeduli app performance	4.00
The menu and features in the application are complete	3.50
Bugs in *KitaPeduli* application	1.33

If the user already has an account, they will get access to login by inputting the username and password registered on the register page. After entering the login form, the user can click the Login button as shown on the side, and if the user does not have an account, then the user must click the Sign-Up button as shown in Figure 9.

Figure 9. Display of Login

This Register page, shown in Figure 10, is helpful for users who do not have an account. Then, users must input the user form name, gender (Dropdown), address, email, account level (Dropdown), password, and confirm password. Make sure the password form and confirmed password form are the same. After that, the user can click the register button. If successful, the user will be redirected to the login view. Suppose the user already has an account from the KitaPeduli application. In that case, the user does not need to register because there is a Sign In button at the bottom to move the display from register to login.

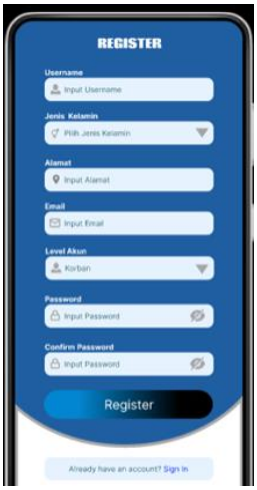

Figure 10. Display of Registration

In Figure 11, there is a feature to fill in the location where the information on the status of the victim and the status of the instructor is displayed by the user. When the user presses the Submit button, the program will send a request to the map package to be able to get geographical values in the form of latitude and longitude values and display them on the next page. Users can also switch to the menu view on the Menu button.

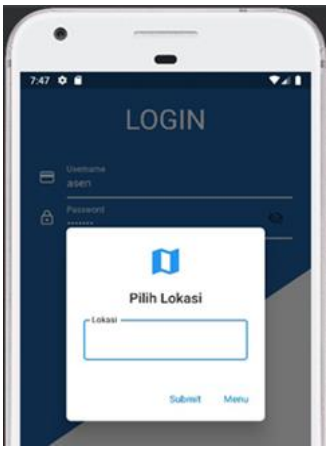

Figure 11. Display Of Select Region

Figure 12 is a feature that provides information on the status of victims and infrastructure status based on the area that has been selected. Then, the selected area will display all the information data. Users can also switch to the menu view at the very bottom of the Menu button.

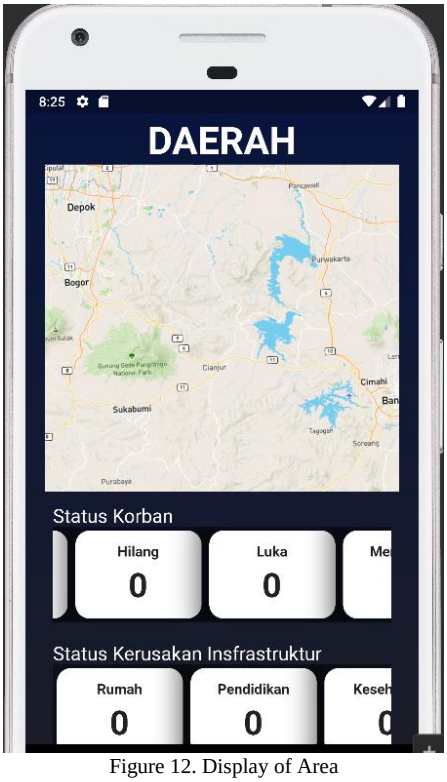

Figure 12. Display of Area

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In Figure 13, users can immediately see disaster information that is happening at a certain time, and there are several menus, such as disaster forms, logistics forms, victim status forms, infrastructure forms, disaster lists, logistics lists, delivery status, and certificates. The form menu is used by the user to input data into the program, while the list menu displays data that the user has input.

Figure 13. Display of Menu

In Figure 14, there is a Dashboard where users can see the number of disasters that have occurred since the application was released, the number of donors who joined the application, and the number of couriers who joined the application. Users can also see graphs of increases or decreases from disasters that occurred during the current year and graphs of increases or decreases in donors and couriers who joined the application. With this short dashboard, the admin level can conduct a brief analysis of the data owned, and it can also help in making decisions for actions that need to be done next.

The disaster form serves to input any disaster events that have occurred in an area. The form in Figure 15 that has been inputted will be stored in the database. Data can also be entered from information obtained through BMKG.

The logistics form in Figure 16 serves to fill the needs of the victims so that donors can know the items needed by the victims. PIC has a role on this logistics form page to input addresses and various needs of disaster victims, such as the type of goods, the name of the goods, the number of needs of the victims, and the number of victims in need.

Figure 14. Display of Dashboard

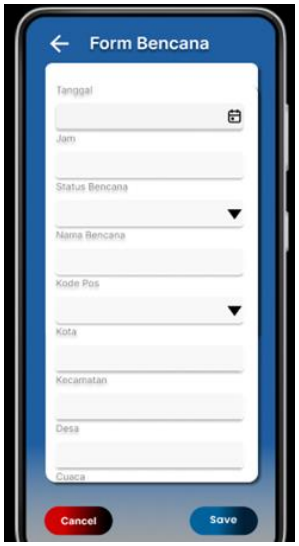

Figure 15. Display of Disaster Form

Figure 16. Display of Logistics Forms

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In Figure 17, there is a Victim Status Form page that PIC can fill out. This page is very important and must be filled in because the data that has been filled in will be information for donors related to the number of victims in an area after a disaster occurs. PIC can fill in the number of disaster victims, such as the number of deaths, the number of missing victims, the number of injured victims, and the number of victims who took refuge in evacuation posts. When the PIC presses the Save button, the data will be saved to the database and displayed on the Regions page.

Figure 17. Display of Victim Status Form

Figure 18 is a page to fill in damage data for all buildings in the area where the disaster occurred. All damage data for each building must be entered into this form to make conveying information easier and provide immediate assistance.

Figure 18. Display of Infrastructure damage status form

The Disaster History page serves to provide information on disaster events that have occurred or are happening, the data displayed in the form of the name of the disaster, the postal code where the disaster occurred, and the date of input of the disaster information. The data in Figure 19 is based on data that users have filled in on the disaster form.

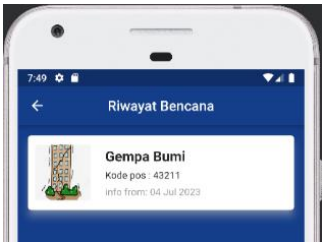

Figure 19. Display of Disaster History

The Logistics Table in Figure 20 provides information on the logistics disaster victims need in an area. The contents of the list in this table come from the logistics form that has been inputted by the user, such as the post name, postal code of the post, type of goods needed, number of needs, information related to the number of donations that have been given, the column for donation, and the status of the donated items have been sent or have not been sent or are in the process of being sent.

Figure 20. Display of Logistic Table

Donors can make donations in Figure 21 according to the desired amount in Figure 20. The table has a button for donations that will display a pop-up in the form of the donation the donor wants to make.

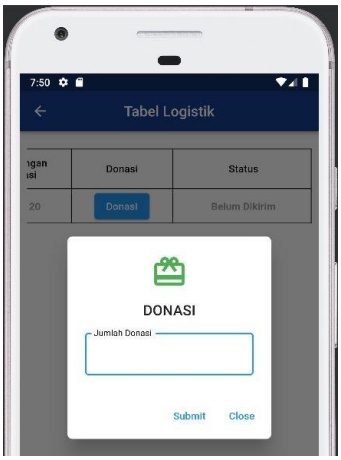

Figure 21. Display of Donation

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Figure 22 provides information on the status of goods and the location of goods that have been or are being sent by courier. On this page, couriers can add status related to the delivery of donated items, where the added status will be visible to donors in real time.

Figure 22. Display of Tracking Goods

Donors can track the logistics they have distributed; couriers can add the delivery status of goods on the button located on the Delivery Status page. In Figure 23, the courier must input at every logistics checkpoint on the delivery route to the distribution destination.

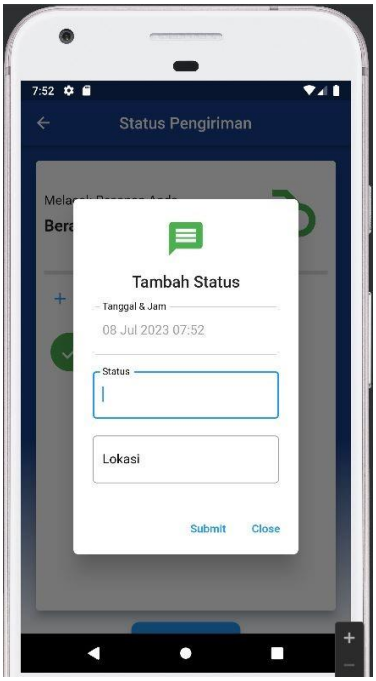

Figure 23. Display of Add Status

IV. Conclusion

The *KitaPeduli* application was created to help disaster victims get help from donors. The application can display the logistics requested by the victims, as well as the status and location related to the logistics so that donors can be sure that the victims of the disaster correctly receive the items they donate. With a value weight of 4.00, the *KitaPeduli* application is feasible and easy for the public to use. Future research can use other or several methods and compare the results of these methods.

References

[1] S. Iqbal, M. U. Sardar, F. K. Lodhi, and O. Hasan, "Statistical model checking of relief supply location and distribution in natural disaster management," International Journal of Disaster Risk Reduction, vol. 31, pp. 1043–1053, Oct. 2018.

[2] R. I. Ogie, S. James, A. Moore, M. Amirghasemi, and J. Whittaker, "Social media use in disaster recovery: A systematic literature review," International Journal of Disaster Risk Reduction, vol. 70, no. 102783, pp. 1–18, Feb. 2022.

[3] G. M. Warsito, M. P. Budiharsana, S. Burns, and B. Hartono, "Hazed targets of the silver bullets: Transformation of disaster risk reduction policy into measurable actions in Indonesia development agenda," International Journal of Disaster Risk Reduction, vol. 54, no. 102029, Feb. 2021.

[4] P. S. Mohan, "Disasters, disaster preparedness and post disaster recovery: Evidence from Caribbean firms," International Journal of Disaster Risk Reduction, vol. 92, no. 103731, Jun. 2023.

[5] P. Dang, J. Cui, W. Ma, and Y. Li, "Simulation of the 2022 Mw 6.6 Luding, China, earthquake by a stochastic finite-fault model with a nonstationary phase," Soil Dynamics and Earthquake Engineering, vol. 172, no. 108035, Sep. 2023.

[6] K. S. Pribadi, M. Abduh, R.D. Wirahadikusumah, N. R. Hanifa, M. irsyam, P. Kusumaningrum, and E. Puri, "Learning from past earthquake disasters: The need for knowledge management system to enhance infrastructure resilience in Indonesia," International Journal of Disaster Risk Reduction, vol. 64, no. 102424, Oct. 2021.

[7] National Board for Disaster Management, "Indonesian Disaster Information Data." Accessed: November 20, 2023. [Online]. Available: https://dibi.bnpb.go.id/

[8] X. Jinghai, A. Jiwen, L. Bo, and N. Gaozhong, "Study on recognizing method of earthquake heavy disaster area from location data of mobile phones," Journal of Natural Disasters, vol. 32, pp. 14–22, 2023.

[9] F. Fakhriati, D. Naseri, M. Mu'jizah, Y. M. Supriatin, A. Supriadi, M. Musfeptial, and K. Kustini, "Making peace with disaster: A study of earthquake disaster communication through manuscripts and oral traditions," Progress in Disaster Science, vol. 18, no. 100287, pp. 1–8, Apr. 2023.

[10] J. Qiu, L. Ji, L. Zhu, C. Liu, and J. Wang, "The June 2022 Khost earthquake in southeastern Afghanistan: A complicated shallow slip event revealed with InSAR," Geod Geodyn, vol. 14, no. 6, pp. 559–565, Nov. 2023.

[11] C. Coetzee, S. Khoza, L. D. Nemakonde, L. B. Shoroma, G. W. Wentink, M. Nyirenda, S. Chikuse, T. Kamanga, K. Maripe, M. J. Rankopo, L. Mwansa, and D. V. Niekerk, "Financing Disaster Risk Reduction: Exploring the Opportunities, Challenges, and Threats Within the Southern African Development Community Region," International Journal of Disaster Risk Science, vol. 14, pp. 398–412, Jun. 2023.

[12] M. F. N. Maghfiroh and S. Hanaoka, "Multi-modal relief distribution model for disaster response operations," Progress in Disaster Science, vol. 6, no. 100095, pp. 1–12, Apr. 2020.

[13] Y. S. Triana, M. A. Osman, A. Pratomo, M. F. Pasha, D. Stiawan, and R. Budiarto, "Neural network models selection scheme for health mobile app development," IAES International Journal of Artificial Intelligence, vol. 12, no. 3, pp. 1191–1203, Sep. 2023.

[14] Y. S. Triana and A. Retnowardhani, "Enhance interval width of crime forecasting with ARIMA model-fuzzy alpha cut," TELKOMNIKA, vol. 17, no. 3, pp. 1193–1201, Jun. 2019.

DOI : https://doi.org/10.25139/inform.v9i1.7104

[15] J. Shao, X. Wang, C. Liang, and J. Holguín-Veras, "Research progress on deprivation costs in humanitarian logistics," International Journal of Disaster Risk Reduction, vol. 42, no. 101343, Jan. 2020.
[16] Y. Chen, "Relief goods distribution problem: Considering donation strategies, fairness, and interventions," Progress in Disaster Science, vol. 12, no. 100198, pp. 1–9, Dec. 2021.
[17] Y. Chen and Q. Zhao, "Donation-based relief goods distribution problem," Comput Ind Eng, vol. 152, no. 106990, Feb. 2021.
[18] Y. Kashiwagi and Y. Todo, "How do disasters affect intergroup perceptions? Evidence from the 2018 Sulawesi Earthquake," International Journal of Disaster Risk Reduction, vol. 87, no. 103602, Mar. 2023.
[19] Rustian, Sumartono, Hermawan, and H. Wardhono, "Disharmonization of Logistic Management and Regulation of Natural Disaster in Indonesia: A Collaborative Governance Perspective," JOURNAL OF SOUTHWEST JIAOTONG UNIVERSITY, vol. 56, no. 3, pp. 347–360, Jun. 2021.
[20] D. Prajapati, S. Pratap, M. Zhang, Lakshay, and G. Q. Huang, "Sustainable forward-reverse logistics for multi-product delivery and pickup in B2C E-commerce towards the circular economy," Int J Prod Econ, vol. 253, no. 108606, Nov. 2022.
[21] A. Galkin, L. Obolentseva, I. Balandina, E. Kush, V. Karpenko, and P. Bajdor, "Last-Mile Delivery for Consumer Driven Logistics," Transportation Research Procedia, vol. 39, pp. 74–83, 2019.
[22] T. Kundu, J.-B. Sheu, and H.-T. Kuo, "Emergency logistics management—Review and propositions for future research," Transp Res E Logist Transp Rev, vol. 164, no. 102789, Aug. 2022.
[23] Y. Yang, C. Zhang, C. Fan, W. Yao, R. Huang, and A. Mostafavi, "Exploring the emergence of influential users on social media during natural disasters," International Journal of Disaster Risk Reduction, vol. 38, no. 101204, Aug. 2019.
[24] R. I. Ogie, R. J. Clarke, H. Forehead, and P. Perez, "Crowdsourced social media data for disaster management: Lessons from the PetaJakarta.org project," Comput Environ Urban Syst, vol. 73, pp. 108–117, Jan. 2019.
[25] H. Hao and Y. Wang, "Leveraging multimodal social media data for rapid disaster damage assessment," International Journal of Disaster Risk Reduction, vol. 51, no. 101760, Dec. 2020.
[26] J. Li, B. Zhao, and F. Xu, "Dynamic path planning of intelligent robot in power equipment maintenance environment," Energy Reports, vol. 9, pp. 784–791, Sep. 2023.
[27] D. Foead, A. Ghifari, M. B. Kusuma, N. Hanafiah, and E. Gunawan, "A Systematic Literature Review of A* Pathfinding," Procedia Comput Sci, vol. 179, pp. 507–514, 2021.
[28] X. Wang, J. Lu, F. Ke, X. Wang, and W. Wang, "Research on AGV task path planning based on improved A* algorithm," Virtual Reality & Intelligent Hardware, vol. 5, no. 3, pp. 249–265, Jun. 2023.

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