Roblox-based tsunami survival game: a tool to stimulate early childhood disaster preparedness skills

Adelia Maulida[1], *Hasnan* Hanif[2], *Maulana* Kamal[3], and *Rina* Suryani Oktari[4*]

[1]Department of Early Childhood Education, Faculty of Teacher Training and Education Universitas Syiah Kuala, Banda Aceh 23111, Indonesia

[2]Department of Geophysics Engineering, Faculty of Engineering Universitas Syiah Kuala, Banda Aceh 23111, Indonesia

[3]Department of Communication Science, Faculty of Social and Political Science Universitas Syiah Kuala, Banda Aceh 23111, Indonesia

[4]Graduate Program in Disaster Science, Tsunami and Disaster Mitigation Research Center, and Department of Family Medicine, Faculty of Medicine, Universitas Syiah Kuala, Indonesia

Abstract. Disaster education for early childhood is crucial, especially in Indonesia, which is located within the Ring of Fire, an area prone to various disasters, including tsunamis. Children are a vulnerable group in disaster situations, as they are susceptible to physical and psychological negative impacts. In this context, a game-based approach becomes an attractive alternative as it combines interactive and enjoyable learning experiences. The objective of this study is to explore the effectiveness of using this game as a means of teaching tsunami preparedness. The Tsunami Survival game has visually appealing, child-friendly graphics and easily understandable elements. This study was conducted at Darul Hikmah Kindergarten in Kajhu Village, Aceh Besar District, focusing on the utilization of a game-based approach, specifically the Roblox-based Tsunami Survival game, to educate and stimulate disaster preparedness skills among 20 children aged 4-6 years. The game has equipped children about the actions to be taken during a tsunami through engaging storytelling and gameplay. It incorporates age-appropriate content, interactive gameplay, and virtual scenarios to engage children in learning about evacuation, emergency response, and survival skills. Pre- and post-intervention assessments were conducted to evaluate the impact of the game-based approach on the children's disaster preparedness skills. At the same time, questionnaires and interviews gathered qualitative data on their engagement and perceived learning outcomes. The expected outcomes include improvement knowledge and awareness of tsunami preparedness, as well as insights into the practical implementation of game-based learning in early childhood education. This research contributes to the development of effective strategies for disaster education and resilience-building among young children, leveraging the popularity and accessibility of gaming platforms.

Keywords: Disaster education, Early childhood, Disaster preparedness, Disaster resilience, Roblox

1 Introduction

Aceh is one of the regions in Indonesia that is at high risk for disasters, particularly tsunamis. Since the Aceh tsunami tragedy in 2004, it is critical to keep enhancing the younger generation's capacity for disaster preparedness, particularly among children [1]. Disasters are becoming more likely in the modern day and cannot be prevented. Tsunamis, for example, can destroy a lot of infrastructure and represent a major threat to human safety.

Children are one of the vulnerable groups that need to be specially prepared in dealing with emergencies and disasters. Early childhood is vulnerable to the negative impacts of the disaster, both physically and psychologically. Children tend to be more vulnerable to physical injury during disasters such as earthquakes,

floods or tsunamis which can cause physical injuries to children, such as cuts and broken bones, from being buried under rubble, or exposure to hazardous materials. In addition, disasters can cause psychological and emotional disturbances in children, such as anxiety, stress, fear, or depression. They may be traumatized by the loss of a family member, home or familiar environment [3]. Therefore, it is important to improve disaster preparedness skills in early childhood in order to minimize risks and increase their level of safety.

The creation of gaming media has recently gained popularity as a viable alternative to teaching kids about catastrophe preparedness. There is a lot of promise for games to be engaging and effective teaching tools for children. Games have the potential to teach concepts in a fun, engaging, and interactive method for young learners. There are many game features that are not only for playing

---

* Corresponding author: okta@usk.ac.id

entertainment, but there are already many games to hone thinking and logic that can introduce material to make it more interesting to be accepted and understood, especially by children who are still at an early age [4].

In this regard, the Roblox engine, a popular game development platform, can be an effective vehicle for creating engaging learning experiences. The development of the Roblox engine-based Tsunami Survival game media can be an interesting solution in helping children learn disaster preparedness in an interactive and fun way. The Roblox engine-based Tsunami Survival media game is specially designed to give children a simulation experience of the disastrous situations they may encounter. Through the use of engaging and interactive technology, children can learn about steps to take in the event of a disaster, recognize warning signs, and develop critical survival skills in emergency situations [5]. Children must understand the early signs of an earthquake and tsunami, identify safe places around their homes or schools, practice evacuation drills, avoid dangerous objects during disasters, and understand the importance of staying calm during a disaster and helping others who may need help [6].

Despite the relevance of developing gaming media as a stimulant for disaster preparedness skills in early childhood, disaster preparedness research and development in this context is still limited [7]. As a result, the purpose of this study is to fill that gap by creating a Tsunami Survival media game based on the Roblox engine to stimulate disaster preparedness abilities in early childhood.

The development technique and pre-experimental research design will be applied in this study. This technique will allow the design, development, and implementation stages of the Roblox engine-based Tsunami Survival game media to be completed. Data will be gathered by observation, interviews, and the use of assessment tools such as questionnaires and knowledge tests [8]. The data will be evaluated descriptively and comparatively in order to determine the effectiveness of game media in increasing disaster preparedness abilities in early childhood.

The purpose of this study is to create a Tsunami Survival game media based on the Roblox engine to stimulate earthquake and tsunami disaster preparedness abilities in early childhood aged 5-6 years in Aceh and Indonesia. It is intended that by incorporating children as research subjects, this study would make a good contribution to strengthening children's knowledge, abilities, and understanding of the activities that must be taken in dealing with disasters in their area.

2 Research Method

2.1 Research Design

This study used a developmental research technique and through literature review to identify the needs of disaster education and innovative disaster education media for early childhood as well as to develop a tsunami survival game media. The strategy of develop the Tsunami Survival game media based on the Roblox engine was employed as a stimulant for disaster preparedness abilities in early infancy in this study. This

method includes a game development step that is specifically designed to promote understanding and disaster preparedness skills in early childhood [10].

The tsunami survival media was development used the type of research called "R&D", (which stands for research and development). In this research, we use a basic 4D (Four D) a development model which consists of 4 stages such as defining, designing, developing, and disseminating (Thiagarajan) [8,9]. Initial testing of tsunami survival media was conducted at Darul Hikmah Kindergarten located at tsunami-prone area. In the test, data was collected regarding children tsunami preparedness knowledge and skills before and after used tsunami survival media through assessment scale. The technique utilized for data analysis is quantitative descriptive analysis to present statistical data on increasing children tsunami preparedness knowledge and skills using tsunami survival media.

Research and development approaches of Thiagarajan (2019) were used in the process of developing Tsunami Survival Game Media [9]. This study involved only three (see Figure 1) of the total 10 steps proposed by Borg and Gall, namely: i) Preliminary study, ii) Model's development, and iii) Model's testing.
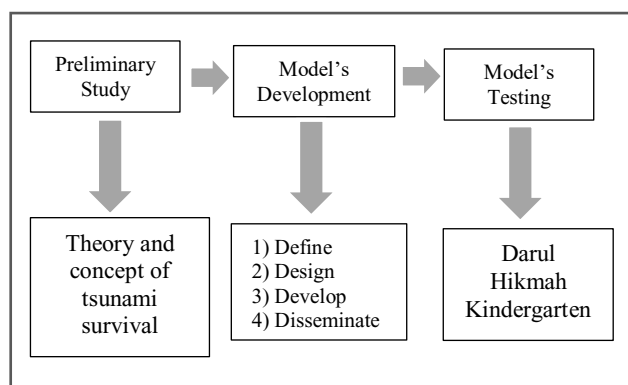

Figure 1. Process of Developing Tsunami Survival Game Media

3 Result and Discussion

In this section, the first we review some related studies on the needs of disaster education and innovative disaster education media for early childhood from scientific literature. The basic model of 4D development of tsunami survival game media then describe in the Section 3.2. Explanation of the result of development Tsunami Survival Game media in Section 3.3 and the last section in 3.4 we present of Tsunami Survival Model Test.

3.1 Theory and concept of tsunami survival game development

The development of tsunami survival media to improve disaster preparedness skills is basically based on the problems that there needs of disaster education and innovative disaster education media for early childhood. We have collected at least 8 articles written by authors have been published in reputed journals, described in table 1.

Table 1. Previous Studies on Disaster Education for

Early Childhood

Authors	Year	Key Message of Disaster Education
Hanif et al.	2023	The use of game in education has been shown to enhance children's engagement and retention of knowledge. Therefore, incorporating game is expected to increase the effectiveness of disaster education for children. [14].
Ghazi et al.	2022	The application of game based method is expected to increase the attractiveness and understanding of students about disasters. In addition, game based method also adds an element of knowledge and the role of several institutions directly involved in disasters. [40]
Ulfa et al.	2021	Disaster education can given to early childhood with take advantage of media use interesting in the learning process [31].
Agrestin et al.	2021	It is important for children to gain knowledge about flood disasters as a preventive effort that is important and fundamental for children's daily lives to reduce the risk of disasters faced by [42].
Imam et al.	2021	Building a social system is very important to ensure disaster awareness and to transmit on lessons to the future generation [41].
Yeon, Chung & Im	2020	Preparedness can reduce the damage caused by disasters and can encourage children to prepare themselves more carefully in the face of disasters.[43]
Proulx, Kerrie & Frances	2019	Disaster risk reduction (DRR) for pre-school children are still lacking. On DRR program the contribution of children can reduce the impact of natural disasters. DRR interventions carried out can be improve the quality of early childhood education and children's knowledge of DRR [21].
Sudarmillah et al.	2019	Use of video game in disaster management learning gladly done have a more significant impact towards children. One of them is a child able to receive knowledge and can practice directly [44]
Ma, Z., & Xu, Q	2020	That there is no creative learning media to help children understand disaster preparedness skills (25)

3.2 The basic model of 4D development Tsunami Survival

The results of research on the development of the Roblox engine-based tsunami survival game media is aim to stimulate tsunami disaster preparedness in early childhood. The development of tsunami survival game media was conducted through a basic model of 4D (Four D) which consists of 4 stages such as defining, designing, creating, and implementing. The result of 4D model to develop tsunami survival media is described below.

1) Defining Analysis Stage (Define)

In this stage, we are conducting an analysis and gathering information on the extent to which survival tsunami media needs to be developed. Based on the previous research, the "pendifinisian" stage consists of five activities (Thiagarajan).

a. Front End Analysis

The development of the tsunami survival game media was conducted based on the results of an analysis of the needs of disaster education and innovative disaster education media for early childhood. In our research, we analyzed the needs through literature study. From the results of the literature study (in table 1), it indicates a need for the development of disaster education and disaster education media for early childhood.

These results indicate that children's knowledge of disasters is still lacking, especially regarding children's readiness in facing disasters.[32]. This is based on the uneven distribution of the disaster education system, especially for early childhood and the lack of innovative learning media in disaster preparedness education.

b. Learner analysis

In this stage, targeting the use of the tsunami survival game media is carried out in accordance with the indicators and development objectives. As for the targets in developing this media, it is aimed at early childhood aged 5-6 years in terms of the level of achievement of child development in *Permendikbud* Number 137 of 2014 which states that problem-solving abilities and logical thinking in children aged 5-6 years consist of activities explorative learning

c. Task Analysis

In this stage, the concept of the task is developed with reference to STPPA No. 137 of 2014 concerning the cognitive development of children aged 5-6 years. The tasks that must be carried out by children in this tsunami survival game media, namely: children must observe carefully when a tsunami disaster will occur, children must look for evacuation routes that have been provided in the game, children must find safe evacuation places from tsunami disasters and children must paying attention to the impact of the tsunami disaster that occurred.

d. Concept Analysis

In this stage, the tsunami survival game media material developed is in the form of material regarding the process of occurrence of a disaster and steps for evacuating a disaster to a safe place. The assigned task is identified based on children's competencies according to the Standard of Achievement of Child Development (STPPA) regarding the cognitive development aspect in disaster education for children aged 5-6 years old.

e. Goal Analysis

The main purpose of develop tsunami survival game media is expected to stimulate disaster preparedness skills in early childhood aged 5-6 years. This analysis is conducted by researchers to determine the learning objectives to be achieved through the development of tsunami survival media. The objectives formulated based on the task analysis and the concept of tsunami survival game media are for children to understand the process and events of disasters depicted through an immersive gaming

experience and enhance children's understanding of performing self-evacuation and knowing safe locations during disasters.

2) Designing Stage

The research output is a learning media in the form of a tsunami survival game built with the Roblox engine to help children improve their tsunami disaster preparedness skills. The tsunami survival game media is designed in such a way as to attract children's interest in using game media as a disaster education media [12,13]. This tsunami survival game media is designed with an environment that mimics real-world conditions, including the presence of school buildings, markets, hospitals, beaches, and escape buildings. The experience during disasters is also designed to be highly realistic, with buildings being destroyed as a result of the tsunami disaster. This is intended as a representative form of real conditions so that children can understand the atmosphere displayed in the game [13-15].

3) Development Stage

In this stage, we got an idea to develop a tsunami survival game media begins with the stages of building maps through the Roblox Studio application. The development consists of the stages of building a city shape whose depiction is adjusted as closely as possible to the real world [33-35]. The city that was built consisted of escape buildings, houses, schools, hospitals, markets, bridges, beaches, public refuelling stations, mosques, fields and police stations. Besides that, it is also equipped with various other accessories such as evacuation route signs, street lights, trees, cars and other vehicles.

The tsunami survival game media was developed as attractively as possible to provide a fun experience and impression of learning about disaster and not difficult for children to understand.

4) Disseminate Stage'

The disseminate stage of Tsunami Survival game media was conducted through trial period of use to small group that consist of 19 children in 5-6 years in Darul Hikmah Kindergarten. The kindergarten is located in Kajhu village, Banda Aceh and it located at tsunami-prone area. The village also have a history of distraction in 2004 Pacific Ocean earthquake and tsunami.

3.3 Tsunami Survival Game Media Development Results

1) City maps

The city is built in an attractive shape and is appropriate for the child's age. Children can also explore cities, houses, schools and other buildings in the game. In addition, some of the vehicles provided in the game can also be driven by children. The city is depicted in realistic shape but uses striking colours and is liked by children who can also hone their imagination.

Figure 2. The shape of the city in the tsunami survival game

In addition, the city in the tsunami survival game is also equipped with evacuation directions and escape buildings that can be used as safe evacuation sites.

Figure 3(a). Escape Building

Figure 3(b). Evacuation Route

2) Tsunami waves

In this tsunami survival game media, tsunami waveforms are built through a script programming process to create tsunami waveforms that are similar to real conditions [37,38].
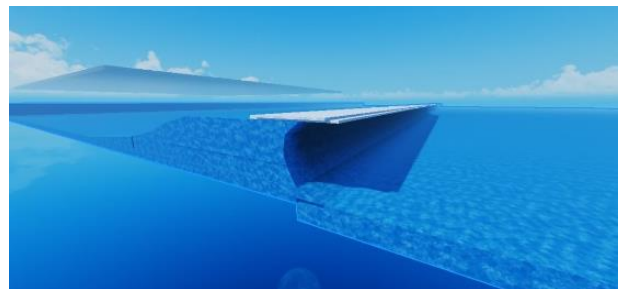

Figure 4(a). Tsunami wave

In this game, the tsunami disaster that occurred was also made in the form of running water submerging the city.

Figure 4(b). Tsunami wave submerged the city

The development of the tsunami survival game media has been carried out through several stages such as designing cities and tsunami waves. The next stage is to build a working system for the tsunami survival game using script programming to create a more real atmosphere and effects of disaster events [37].

3) How to use of tsunami survival game media

The Roblox Tsunami Survival game is a digital-based game that can be played with the Roblox application which can be installed on various devices, such as smartphones and laptops, for free. This game only requires internet access, and does not take up a large amount of memory, this is because the development of this game aims to increase the accessibility of this educational game, so that it can be applied in various schools, even in each student's home [39].

The Roblox Tsunami survival game can be played alone or in groups of up to 20 players at once. In this game, students will be faced with an interactive virtual world, with map models containing houses, school buildings, soccer fields, mosques, tall buildings, and building Tsunami Escape Building. Before the game starts, the teacher will provide education on mitigation measures when an earthquake and tsunami disaster occur, this is to prepare students to have knowledge and preparedness when simulating in a virtual world in a world built on the Roblox engine base.

This game has a duration of 5 minutes, where students will be taught how to 1) evacuate when an earthquake occurs, 2) know the gathering point when an earthquake occurs, 3) know the signs of a tsunami, and 4) know the location of the escape building which became the evacuation point from the tsunami disaster. This Tsunami Survival Roblox game has a virtual world that can give imagination to students when at any time an earthquake and tsunami disaster occurs in the real world [40].

The development of the Tsunami Survival digital game is carried out on the basis of the Roblox Engine so that it can be easily accessed by various students, teachers and instructors in Indonesia and abroad. This is because Roblox is a free game, which is lightweight, and has high accessibility, compared to physical games. This game is very easy to play anywhere and anytime, so it is very flexible in disaster education that is interactive and fun for children [41].

Table 2. Stages of the Tsunami Survival game

Stages	Description
Preparation	At this stage, the teacher will provide education on earthquake and tsunami evacuation through animated videos.
Exploration	At this stage, students will be given time to explore the maps in the Tsunami Survival Roblox game.
Earthquake Evacuation	At this stage an earthquake simulation will be given and students will be given in-game instructions to move outside the building and head to the assembly point by following the evacuation route.
Tsunami Evacuation	At this stage students will be given a simulation of the signs of a tsunami, and will be directed to find an evacuation route to a safe point from a tsunami, namely the Escape Building.

4) Roblox Tsunami Survival Model Test

In the final stages of developing tsunami survival game media, validation was carried out in terms of material and media to determine the validity of the tsunami survival game media that had been built and developed.

Quantitative data was obtained from a Likert scale assessment questionnaire, while qualitative data was obtained from feedback of teacher darul hikmah kindergarten.

Trials using the tsunami survival game were carried out using a pre-test and post-test. It aims to measure and determine the success of the development of this game. The trial was conducted on 19 children aged 5-6 years. The trial results can be seen below:

Table 3. The Result of Normality Test (pre-test and post-test)

No of respondent	Pre-test (x)%	Post-test (y)%	Gain (d) (y-x)%
1	42	64	22
2	28	60	32
3	32	68	36
4	36	68	32
5	32	62	30
6	34	64	30
7	36	68	32
8	28	54	26
9	36	62	26
10	36	62	26
11	32	60	28
12	34	68	34
13	34	54	20
14	34	62	28
15	30	58	28
16	46	66	20
17	34	64	30
18	32	56	24
19	30	60	30
	34%	62.1%	28.10%

The t test on the pre-test and post-test resulted in $t_{count} = 34.03$ and $t_{table} = 17.55$. The results of these calculations revealed that $t_{count} > t_{table}$, or $34.03 > 17.55$ or Ho is rejected, which means there is a significant difference for children in improving disaster preparedness using the tsunami survival game media based on the Roblox engine.

Based on the results of the t test, it shows that there is a difference in improving disaster preparedness skills in children aged 5-6 years consisting of 19 children between before and after using the tsunami survival game media in the form of knowing the disaster, the steps to be taken When a disaster occurs, how to evacuation and know a safe place to evacuate when a disaster occurs. This can be

seen in the post-test results, the average child is 62.10%, included in the good category. Based on the results of the post-test which showed a value greater than the pre-test, it can be concluded that the media game tsunami survival is effective in use and can improve disaster preparedness skills in children aged 5-6 years.

This was also corroborated by a comment from one of the teachers, Raudhatul Athfal Darul Hikmah, who said:

"This educational game provided is very innovative because it's easy to play anywhere, only requires a smartphone and internet, we can provide education to children in a fun way, so it's not boring for children because it has an interesting theme."

Figure 5. Test Game Tsunami Survival Roblox

The children were very enthusiastic in playing the Tsunami Survival Roblox Game in the trial, where it was seen that the students were enthusiastic in exploring the world that had been built in the game, then they also learned to recognize earthquake evacuation and signs of a tsunami in an imaginative way, not only that but even children became curious how to build digital games. Not only that, but the school also promotes digital game-based instructional activities, where this game teaches students in a novel and timely manner so that children can safely experience earthquake and tsunami circumstances through the Roblox virtual world. There are various stages in this game, which are explained in the table.

4 Conclusion

This study created an interesting and creative R&D product as a learning media for disaster preparedness education for children aged 5-6 years by developing the learning media for the tsunami survival game utilizing the Thiagarajan (4D) fundamental development model. This product intends to make it easier for youngsters to understand the notion of disaster preparedness in an easy-to-understand and realistic manner. As a result, parents and teachers may be able to employ tsunami survival media as a teaching medium for disaster preparedness for children as soon as possible.

The effectiveness of the tsunami survival game learning media as a stimulation of disaster preparedness skills aimed at children aged 5-6 years has gone through a trial process carried out with a t test with a pre-test result of 34% and a post-test score of 62.10, thus getting an increase of 28.10%.

References

1. R.S. Oktari, A. Nugroho, M. Fahmi, A. Suppasri, K. Munadi, R. Amra, IJDRR, **54**, 102052 (2021)

2. I. Mohiddin, R. W, ERPH, 33-47 (2019)

3. A.A. Pediatrics, 139 (2017)

4. D.L. Fitri, D.A Setiawan, TMEIK **8**, 225-230 (2017)

5. M. Ali, N. Iqbal, M. Awais, IEEE Access, **9**, 89048-89064 (2021)

6. E. A. Gao, IJDRS, 222-225 (2021)

7. S. Azwar, I. Prahardini, PSNPAUD, **1(1)**, 136-141 (2015)

8. L. Cohen, L. Manion, K. Morrison, Routledge (2017)

9. J. W. Creswvell, SP (2017)

10. E.L Deci, & R. M. Ryan, Intrinsic motivation and self-determination in human behavior, SSBM (2013)

11. Pusat Kurikulum dan Perbukuan. Buku Saku Pembelajaran Anak Usia Dini. Jakarta: Pusat Kurikulum dan Perbukuan, Kemdikbudristek (2017)

12. Y.Q. Wang, X. Liu, X. Lin, G. Xiang, 243-258 (2011)

13. A. Darvishpour, M. Rassouli, IJDRR, **45**, 101479 (2020)

14. H. Hanif, A. Maulida, M. Kamal, & O.S. Rina, JPKM **9(2)**, 71-73 (2023)

15. R. Effendy, N.K. Lestari, PKNSI, **5(1)**, 284-289 (2018)

16. J. P. Gee, CE, **1(1)**, 20-20 (2003)

17. D.J. Dewi, ACIECE , 16-18 (2022)

18. İ. Gökdaş, Z. Eğmen, JECR, **58(7)**, 1614-1638 (2020)

19. W. Gulo, H. Syarifuddin, JPTK, **26(3)**, 294-303 (2019)

20. R.P. Satorras, A. Vespignani, PRL, **86(14)**, 3200 (2001)

21. K. Proulx, F. Aboud, IJED, **66**, 1-7 (2019)

22. T. Mayes, S. de Freitas, JISC (2004)

23. M. Kearney, PC, 137-160 (2013)

24. R.K. Yin, SP, (2014).

25. Z. Ma, Q. Xu, IJDRR, **46**, 101504 (2020)

26. R.S. Oktari, I.D. Kumala, IJCE, **6(3)**, 195-202 (2020)

27. UNICEF Indonesia. Learning from Aceh: ` for the Next Big Earthquake and Tsunami 2009, (2023). Available on https://www.unicef.org/indonesia/reports/learning-aceh-preparing-next-big earthquake-and-tsunami

28. J. Piaget, The psychology of the child, (2008)

29. World Health Organization. (2018). Early Childhood Development 2018, (2023). Available on

https://www.who.int/topics/early-childhood-development/en/

30. D.P. Ningtyas, R.D. Fera, CPAUD, 179 (2018)

31. K.U. Ulfah, Bahrun, & Rahmi. JIMPGAUD, 12 (2021)

32. Y.S. Wijayanto, A. Pratomo, JIPD, **5(2)**, 167-180 (2019)

33. T. W. Malone, ACM, **11(3)**, 162-169 (1980)

34. D. S. Mileti, Disasters by design: A reassessment of natural hazards in the United States. JHP, (1999)

35. A. Rezvanfar, C. Chen, IEEE Access, **9**, 24408-24420 (2021)

36. M. Resnick, J. Maloney, A.M. Hernández, N.Rusk, E. Eastmond, K. Brennan, Y. Kafai, ACM, **52(11)**, 60-67 (2009)

37. Roblox Corporation. Developer Hub 2021. (2023) Available on https://developer.roblox.com/

38. Roblox Corporation. Roblox Studio 2021. (2023) Available on https://www.roblox.com/create

39. D. Yanuarita, A.N. Azizah, E. M. Ginting, ICIMTech, 1-6 (2019)

40. G. Maulana, U. Hasanah, H. Salwa, S. Urrahmi, T.A. Dzikri, R.S. Oktari, E3S Web of Conferences, 340, 03005 (2022)

41. I. Maulana, L. Raswita, S. Karlina, M. Mukarram, M, R.S. Oktari, IOP Conference Series: Earth and Environmental Science, **708(1)**, 012094 (2021)

42. I. Agrestin, E.C. Maulidiyah, JECIE, **5(2),** 93-95 (2021)

43. D.H. Yeon, J.B. Chung, & D.H. IJERPH, **17(15),** 5347 (2020)

44. E. Sudarmilah, I.H.A. Wahab, D.A.P. Putri, W.D. Pratisti, I. Yuliana, IJATCSE, **8(6),** (2019)

45. I. Maulana, L. Raswita, S. Karlina, M. Mukarram, M, R.S. Oktari, IOP Conference Series: Earth and Environmental Science, **708(1)**, 012094 (2021)

46. K. Satake, Y. Nishimura, P.S. Putra, A.R. Gusman, H. Sunendar, Y. Fujii, Y. Tanioka, H. Latief, E. Yulianto, PAG, **170**, 1567-1582 (2013)