Volume 10. No 2, May 2023
e-ISSN: 2527-9572 / ISSN: 2354-8924

Design of Gamification of Flood Early Warning Actions Using the "Cikeas – Cileungsi Overflow" Game in the KP2C Community

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***Abstract* – The role of the early warning system by the KP2C Community in providing information on flood disasters that often occur in the Cileungsi – Cikeas watershed really helps the community in reducing the impact of the unavoidable flood disaster. The creation of the game "Cikeas – Cileungsi Overflow" aims to introduce knowledge about actions related to flood early warning to the wider community more effectively and fun. By using the gamification method, real activities carried out by KP2C such as interacting with residents through social media, monitoring the condition of upstream rivers, and providing disaster warnings, can be displayed in a simpler form into an educational game. The process of creating a game is carried out by conducting research on various types of KP2C activities in becoming an early warning instrument and then converting the data into a game mechanic. Through the results of game testing, 93.4% of respondents said the gameplay displayed in the game "Cikeas – Cileungsi Overflow'' was quite interesting and 90% of respondents stated that their understanding of the concept of a flood early warning system had been conveyed well. There are still several aspects that need to be developed in the future from the "Cikeas Cileungsi Overflow '' game, especially the leaderboard mechanism which still has problems and continued development to the Android platform.**

Keywords: Early Warning, Flood, Game and Gamification

I. INTRODUCTION

Flood is one of several disasters that often occur in Indonesia, especially in areas adjacent to rivers or streams. Flood is a natural phenomenon in the form of stagnant water, which is detrimental to society caused of high rainfall and the failure of the drainage system to accommodate excess water [1].

Bojong Kulur Village, Gunung Putri District, Kab. Bogor, West Java, has a reasonably high flood intensity. One of the rivers, namely the Cileungsi River, is the cause of flooding in the surrounding settlements. Large-scale flooding in local settlements occurs when the intensity of the water brought from upstream exceeds the capacity of the river. The water condition upstream is the primary reference, along with warnings to determine whether or not the local river is flooding, so knowing the water condition upstream is crucial for residents who live around the river.

Referring to history, there are at least 3 aspects that can be studied in disaster management, namely warning, preparedness, and mitigation [2]. Unfortunately for the residents around the river basin, especially those living in the Cileungsi watershed, access to information on the condition of the river has not been a problem until now because it cannot be obtained quickly and easily, so that early warning aspects of disaster management cannot be properly implemented. Like the flood disaster that occurred in 2005, there was no warning sent to residents near the Cileungsi River that a flood was on the way, so residents were unprepared to deal with flooding.

The official establishment of Komunitas Peduli Sungai Cileungsi – Cikeas (KP2C) (KP2C) in 2016 became a bright spot in the problem of access to information on river conditions. The role of KP2C as an early warning instrument creates more significant opportunities to reduce the impact caused by flood disasters. With the KP2C, information about river water conditions can be easily accessed by residents until now, so that residents can be more quickly prepared if the river conditions have the potential to cause a flood disaster.

Gamification of KP2C activities is exciting, primarily to be used as an educational medium related to flood early warning actions, to increase awareness of residents living in areas adjacent to rivers and the broader community about the importance of knowledge of early warning actions. Gamification is solving a problem using techniques in a game [3]. Gamification is a method that allows something unrelated to games to have elements or

elements of game design techniques in it [4]. In its application, gamification does not always require users to create a game product. The primary use of the gamification concept is to utilize the way of thinking in play so that a goal can be achieved more fun and effectively [5]. The primary gamification method contains three essential elements: Points, Badges, and Leaderboards. However, it does not rule out the possibility that other elements can be added to gamification to support these three main elements. With PBL (Point, Badge, Leaderboard), a reward and competition mechanism in the game can encourage players to complete the primary goal of gamification [6]. In this case, with the application of gamification, actions regarding flood early warning, volcano eruption [7] which includes knowledge of emergency criteria and how the early warning system works, can be conveyed effectively and in fun in the form of educational games.

Liu, Mitsuhara and Shishibori have also created a similar work in 2020. Based on the journal they wrote, Liu, Mitsuhara and Shishibori created an earthquake disaster education application using the gamification method. The creation of these production works was based on concerns about the lack of awareness of visitors who come to Japan regarding knowledge of the frequent earthquake disasters in Japan. The application displays learning methods related to earthquake disasters, in the form of URL links, videos, texts and quizzes that utilize the application of gamification in the form of an achievement and reward mechanism for players who successfully carry out certain activities [6].

The gamification method will be applied to a disaster early warning system in creating this production work. Disaster early warning is conveying information in the form of warnings related to certain disasters carried out as soon as possible by authorized parties or institutions [8]. Several elements must be possessed by an early warning system, including Knowledge of Disaster Risk, Monitoring and Warning Services, Dissemination and Communication, and Response Capacity [8]. More specifically, the early warning system that will be the target of gamification in this production work is the Cileungsi Cikeas River Care Community (KP2C). KP2C is a community that becomes an information center regarding flood early warning and education on flood hazards for the benefit of residents around the river, to be precise on the Cileungsi and Cikeas rivers and the confluence of the two rivers, which is called P2C [9].

By providing accurate information at the right time, KP2C gives residents more time to prepare and carry out the evacuation process. Reporting to KP2C's website, as an early warning system, KP2C has several programs that are used in carrying out its role as an early warning system, which includes:

a. Information on rising water levels (Tinggi Muka Air or TMA) was obtained using CCTV monitoring devices and officers at several monitoring points.
b. Accurate and accountable information
c. Information distribution to the public (Early Warning) using KP2C's social media (Whatsapp, Twitter, Telegram, and others).
d. Coordinate with Bekasi Weir officers and government agencies related to the disaster.

II. METHOD AND DESIGN

The Game Development Life Cycle (GDLC), developed by Rido Ramadan and Yani Widyani [10], is a method that handles game development starting from the starting point to the very end. Starting from the stage of creating ideas and concepts regarding the game to be made, the final stage of game development is when the game is released. GDLC takes a stepwise or step-by-step approach to analyze and building games using specific and more complex cycles. The 6 phases can be grouped into three main processes, namely:

1. Initialization process consisting of concept and design,
2. The production process consists of Pre Production, Production, and Testing (Alpha and Beta)
3. Phase Release

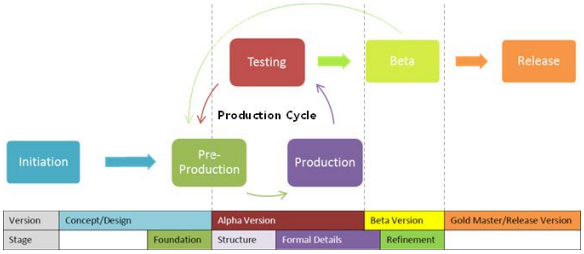

Figure 1: Phase and Process of GDLC [10]

1.Initation

The first step that must be taken in making a video game is to make a rough concept of what kind of game to make. The output of this first step is the game concept and description, which are explained.

2.Pre-Production

Pre-Production is one of the production cycle's primary and most essential phases. Pre-production involves the creation and revision of video game designs and the creation of video game prototypes. The focus on video game design defines the game genre, gameplay, mechanics, storyline, characters, challenge, fun factor, technical aspects, and the documentation of its elements in a game design document. After the game design document is created, a prototype form is created to assess the game design and the overall idea. The foundation and structure are prototyped in the first iteration of the production cycle. In contrast, in the next iteration, the related prototypes that will be perfected are formal details and improvements. The basis of the prototype is related to the quality criteria of pleasure. This base is used to demonstrate core gameplay mockups and game capabilities. Pleasure quality criteria are tested through questionnaires or discussions. The structure in fundamental improvement will be related to fun and functional quality criteria in video games. This

crucial structural feature can indicate the game's core gameplay and mechanics, such as arithmetic, logic, and game rules. Questionnaires and discussions are used to test the quality criteria of pleasure. Then the functional quality criteria are tested through play testing, where the examiner is given several tasks and objectives to be achieved according to scenario testing. Pre-production ends when revisions or changes to the game design have been approved and documented.

3.Production

Production is a core process that revolves around asset creation, programming, and integrating the two elements. Associated with the prototype in this phase are formal details and refinements. Formal Details is an enhanced structure with more mechanics and total assets. Production is an activity related to creating and refining proper detail balancing, adding new features, improving performance, and fixing bugs (related to functional and completion of internal quality criteria). Game balancing means adjustments related to the game's difficulty to make the game have suitable difficulty. Improvements are complete prototypes that are the subject of game polishing. The quality criteria at this stage regarding play should be fun and accessible. Activities during refinement are geared toward making the game more fun, challenging, and easier to understand. Only minor changes are allowed in this phase.

4.Testing

Testing in this context means internal tests conducted to test operational functionality and gaming capabilities—specific test methods for each prototype stage. Formal Detail Testing is carried out using a playtest to assess the features' functionality and the game's difficulty (related to balance). The method for testing functional quality criteria through the playtesting feature to test the complete quality internally can be done through playtesting simultaneously with functionality testing. When testers encounter bugs, loopholes, or deadlocks during playtesting, their causes and scenarios for reproducing the error as necessary are documented and analyzed. To test the balance of quality criteria, playtesting with several improvements is used to categorize whether an improvement needs to be simplified, too easy, or unnecessary. The Repair Test relates to the fun quality and accessibility quality criteria. In fix testing, the fun is tested through playtests and direct feedback from fellow developers, whether tedious, frustrating or challenging. Accessibility can be tested by observing the behavior of the testers. If testers find it difficult to play and understand the game, the game is not accessible enough yet. The outputs from testing are bug reports, change requests, and build decisions. The results will determine whether it is time to advance to the next phase (Beta) or repeat the production cycle.

5.Beta

Beta is the phase for testing by third parties or external parties called beta testing or beta testing. Beta testing still uses the same testing method as the previous one because the related prototype in beta testing is a formal detail and refinement. Tester selection methods come in two types: closed beta and open beta. The closed beta only allows invited individuals to participate, while the open beta allows anyone who registers to participate. The quality criteria in beta are closely related to the current prototype stage. In formal detail testing, testers are asked to find bugs (related to functional and internally complete quality criteria). In the improvement test, the tester is given more freedom to enjoy the game because the goal is more directed to get feedback (regarding the quality criteria of fun and accessibility). The output of beta testing is bug reports and user feedback. The beta session was closed mainly for two reasons, either the beta term ended, or the specified number of beta testers gave their test reports. From here, it can lead to another production cycle to refine the product or continue releasing games if the results are satisfactory.

6. Release

The release is the phase where video game development has reached its final stage and is ready to be released to the public. Release involves product launch, project documentation, knowledge sharing, post-mortem, and game maintenance and expansion planning. Game idea development is carried out by conducting research on KP2C activities in carrying out its role as an early warning system. The research was conducted by observing the activities carried out by KP2C daily, primarily through social media. The research was also carried out by examining documents published on the KP2C website, which explained in detail the profile and activities carried out by KP2C as an early warning system. Then as a form of validation, a procession of direct interviews was conducted with the founder of KP2C named, Mr. Puarman. From the results of this research, six activities were found that have the potential to be used as gamification materials, namely:

a. Social media interaction
b. Level of confidence in the early warning system
c. Monitoring and maintenance tools
d. Weather influences
e. The occurrence of floods
f. Dissemination of early warning
g. Coordination with other agencies

The results of this research were then developed into a game mechanic and documented in detail in the Game Design Document, along with visual concepts and other game elements. Then proceed with the testing process for a group of people to get feedback data or responses related to the playing experience that is implemented in the game. Furthermore, the data obtained is used as a reference for additional adjustments before the game is widely published. In distribution, this production work can be obtained via the Google Drive download link and played locally using a PC (Personal Computer) or through a game-sharing network site called Itch.io via the link christoffel.Itch.io/cco.

III. RESULTS AND DISCUSSION

A. Game Description

The Cikeas Cileungsi Overflow Game is a 2D Pixel Art Game (Figure2) with a management simulation genre which is a gamification of a simplified Cileungsi – Cikeas River Care Community (KP2C) flood early warning system. Like a flood early warning system, the Cikeas Cileungsi Overflow game features gameplay related to an early warning system that requires players to act as an early warning instrument responsible for providing information about rivers and floods to residents.

Figure 2: 2D Pixel Art Style

The target platform for the Cikeas Cileungsi Overflow game is a PC or personal computer that can be played locally or on the web. The controls used in the game are point and clicks, i.e., the player will depend on the mouse in-game navigation. The gameplay of the Cikeas Cileungsi Overflow game is the result of changes from actual activities carried out by early warning instruments; in the case of creating this game, the Cileungsi – Cikeas River Care Community (KP2C) was used as the reference target. The main mechanic in this game is that players must collect as many points as possible from interactions with residents; each point earned will help manage information and interactions that support the early warning system. The main objective of this game is that players must be able to maintain as many points as possible until the end of the game. The Cikeas Cileungsi Overflow Game is designed to have three levels, each representing a watershed in the area of West Java, to be precise in Bekasi City and Kab. Bogor, namely the Cileungsi river, the Cikeas river, and the confluence of the two rivers or commonly called P2C. each level is made to have characteristics that resemble the state of a river in the real world.

The main target of the Cikeas Cileungsi Overflow game is residents aged 12+ who live next to a river with the potential for flooding. The aim is that residents are more aware of the early warning system, which is expected to help residents to be more prepared for flood disasters.

B. Gamification Mechanic

Making the game "Cikeas Cileungsi Overflow" focused on applying gamification theory to design game mechanics. Based on the results of research conducted on KP2C activities as an early warning instrument, the following mechanics were successfully created based on the results of this research. The Matching Puzzle Mechanic (Social Media Interaction)

Figure 3: The Matching Puzzle Mechanic

The main mechanic of the Cikeas Cileungsi Overflow game is the Matching Puzzle mechanic, in which the player must match one social media logo with another in the dock at the bottom left of the screen to add points (Figure 3). This Matching Puzzle mechanic was created to symbolize one of KP2C's main activities: interacting with residents to exchange information related to rivers and floods through social media.

The Matching Puzzle mechanic requires players to Drag n Drop logo notifications that appear from residents. Notification logos will appear randomly from residents' houses which have a certain amount of time before they disappear. There are two types of logos in the game, namely those that must be interacted with and those that must be avoided; for each logo that is successfully equated, it will add Trust Points to the Trust Meter; otherwise, if it is left missing or charred, it will reduce the Trust Meter (Table *1*).

Table 1: Logo Notification

Notication Name	Icon	Type	Extra Attribute
Logo Twitter			Starting to appear from level 1
Logo Whatsapp			Starting to appear from level 1
Logo Facebook			Starting to appear from level 1
Logo Instagram			Starting to appear from level 2
Logo Telegram			Starting to appear from level 3
Logo Spam			It is a distraction and may be allowed to burn If it is already dragged, the trust meter will automatically decrease Starting to appear from level 1

Logo Hacker			The notification that appears first is another random notification logo, which will change after a while If the player has already dragged the hacker logo to another logo drop point, then the player will be subject to a temporary penalty and cannot drag and drop on other logos. If the player has already dragged the hacker logo, the player must throw the hacker logo into the trash logo Starting to appear from level 2 Appears during the Flood Period
Logo PLN			Must be matched using the help of an assistant Appears during the Flood Period
Logo BNPB			Must be matched using the help of an assistant

Information :

a. Red Block: Must be interacted with
b. Green Block: Must be avoided
c. Any logo that appears when the emergency button is activated will disappear
d. During the flood period, several unique logos (PLN logo and BNPB logo) appear and must be completed through an assistant; once completed, the flood period will change back to standard times.

Each notification logo in the game has its reason for being displayed. For social media logos, the five social media displayed in the game are used by KP2C as a medium for conveying information. The spam logo is motivated by the activities of social media users who often make repetitive interactions with KP2C accounts, which are usually questions that already have answers. The hacker logo is based on a hacking incident on the KP2C website, so the KP2C website cannot be appropriately accessed for some time. In contrast, the PLN and BNPB logos are based on the actions of the KP2C account, which often acts as an information bridge between residents and other agencies concerned (Coordination with other agencies).

Figure 4: Trust Meter Display

Being part of an automated early warning system is responsible for important information. The credibility of an agency or organization that is part of an early warning system will influence how the community responds to the information provided. The public will likely doubt any information conveyed if an early warning system organization has low credibility. Trust Meter is the mechanic behind this concept.

Table 2: Interaction Points

Interaction	Point Amount		
	Lv 1	Lv 2	Lv 3
Matching Notification	+3 pt	+3 pt	+3 pt
Miss Notification	-2 pt	-3 pt	-4 pt
Mismatching Notification (Termasuk Hacker dan Spam)	-2 pt	-3 pt	-4 pt
Special Matching Notification	+8 pt	+8 pt	+8 pt
Miss Special Notification	- 4 pt	- 4 pt	- 4 pt
Flood Warning	-25 pt	-25 pt	-25 pt
Flood Warning Succeed	+38 pt	+38 pt	+38 pt
Fix CCTV	-10 pt	-10 pt	-10 pt
Flood without Warning	Game Over	Game Over	Game Over

The Trust Meter mechanic is a bar point that determines the success or failure of each level played (Figure *4*). The Trust Meter mechanic is integrated into almost every activity performed during the game. In completing the game, the player must reach 50% Trust Points, and if the player has less than 50% Trust Points, then the player cannot continue to the next level. If the player touches 0% Trust Point during the game, then the level is declared failed, and the player must repeat the level. The Trust Meter information is in Table *2*.

Figure 5: CCTV Button

In carrying out TMA (Water Level) monitoring activities, KP2C uses CCTV as a monitoring tool so that the water level can be seen in real-time and the information obtained will be easier to share. The CCTV mechanic in the Cikeas Cileungsi Overflow game has the same function as its use in the real world. CCTV button (Figure *5*) is used to see the water level upstream of the river, which is then used to determine flood and whether or not residents inhabit the downstream areas or watersheds through specific calculations. The CCTV used to monitor the water level has a Health Condition like in the real world. In the real world, KP2C routinely performs maintenance on CCTV assets to maintain the quality of information related to high water levels. If the

Health Condition runs out, the CCTV will not be able to display the condition upstream of the river. Health Conditions can be added back using the Trust Point. The CCTV Health Condition recovery button (Figure *7*) can be accessed via the Arini Menu.

Figure 7: The Time Mechanic Display

Figure 8: CCTV Health Condition Recovery Mechanism

Flood mechanics is a simulation of flooding that begins with a high water discharge upstream that exceeds the capacity limit until the water travels from upstream to downstream and eventually overflows in residential areas. Flood mechanics are integrated with CCTV mechanics and time mechanics. The CCTV mechanic will show the water level upstream, and then if the water level exceeds the standard limit, the water will flow to residential areas according to the travel time in each river. River information can be seen in the Table

Table 3: Information of River Condition

	Cileungsi – Before P2C		Cikeas – Before P2C		Cileungsi - P2C	
Ready 1	TMA > 300 cm		TMA > 400 cm		TMA > 550 cm	
Ready 2	201 – 300 cm		301 – 400 cm		451 – 550 cm	
Ready 3	151 – 200 cm		201 – 300 cm		351 – 450 cm	
Ready 4	101 – 150 cm		-		-	
Normal	TMA < 100 cm		TMA < 200 cm		TMA < 350 cm	
Water Travel Time	In Game	Real	In Game	Real	In game	Real
	3 Hour	3 – 4 Hour	2 Hour	2 – 3 Hour	4 Hour	3 – 4 Hour

Information:

- TMA = Tinggi Muka Air
- So, if the TMA in the upper reaches of the Cileungsi River touches 320cm at 10.00, the water will arrive at residents' settlements and have the potential to flood at 13.00

The Weather Mechanic is a mechanic that displays how the weather changes as the game progresses. The game displays two kinds of weather: sunny weather and rainy weather (Figure *8*). When it rains in the game, the intensity of notifications will increase faster, as often happens in the real world. When it rains in the real world, residents who live around the river are usually more active in asking about the condition of the river to the KP2C account because they are worried about rising water levels. Weather information in the game can be seen through the logo next to the time information.

Figure 6: Weather Logo

The time mechanic is a mechanic that represents time in the game. The time system in the game is made by only displaying multiples of 1 hour, i.e., 09.00, 10.00, 11.00, and so on (Figure *6*). The time in the game will increase every 15 seconds.

Arini is an acronym for "Asisten Peringatan Dini." Arini is a game mechanic, a manifestation of the KP2C community. Arini's function is to display information related to rivers and some unique interactions that can be carried out in the game. Arini's function is to handle interactions with special notifications, PLN, and BNPB logos. Arini's assistant menu also handles in-game CCTV repairs. The primary function of Arini itself is to warn of impending flooding to residents, which must be done at the right time through a Flood Warning mechanic.

According to the results of an interview with Mr. Puarman, chairman of KP2C, frequent flood disasters often cannot be avoided if the government has yet to make significant changes to river conditions. Such as dredging the river, widening the river, and constructing permanent embankments along the river flow. Under these conditions, the most appropriate action to be taken is to minimize the impact of the flood disaster itself.

Through the KP2C early warning system, rising water levels can be monitored in real-time via CCTV; by knowing the condition of the river more quickly, notifications to residents about the potential for flooding are also much faster so that residents have more time to prepare.

In the Cikeas Cileungsi Overflow game, the flood warning mechanic is the gamification result of this action. After the player gets a notification about the rising water level via the CCTV mechanic, the player must determine when the overflow will appear in residential areas. The calculation is done by adding the time when the water rise notification appears with the Water Travel Time. The Water Travel Time for each river is different, so players must check it first at the beginning of each game through Arini (Assistant Menu). After knowing the time of the water overflow, 1 hour before, the player must press the Flood Warning button (Figure *9*) via Arini to sign that there will be an overflow within the next 1 hour. If the player sets the wrong time or forgets to press the flood warning button, the level is declared failed because the player failed to become an early warning system for residents.

Figure 9: Flood Warning Button in Arini Menu

As a form of appreciation to players for completing levels, each point collected from each level will be accumulated to be able to open badges for each level, with the following description:
For the leaderboard, the system uses the results of sharing screenshots which later can be seen by other players via social media. However, there are still obstacles for players to be able to share the points and badges that have been obtained directly. Players should be able to immediately press the share button at the end of a level or when players are in the badge menu (Table *4*).

Table 4: Player Achievement

Level	Badge	Total points required
Level 1 Cileungsi		200 Poin Level 1
Level 2 Cikeas		350 Poin Level 2
Level 3 P2C		500 Poin Level 3

C. The Game Validation

1. KP2C Response

After the game entered the production stage of a playable prototype, a visit was made to KP2C to validate the data used and related to the gamification actions used for KP2C activities. The visit was conducted to solicit comments along with criticisms and suggestions of KP2C regarding the game mechanics.

From the visit and interview conducted on April 27, 2022, with the founder and chairman of KP2C, Mr. Puarman, the Cikeas Cileungsi Overflow game has well illustrated how an early warning system works, especially the early warning system implemented by KP2C. Game mechanics resulting from gamification are also appropriate with the elements of KP2C activities. There is a slight improvement in the data, especially in the river information section, but the use of other data is accurate. From a visual perspective, Mr. Puarman suggested changing the color of the river from brown, representing cloudy water, to blue, like the color of water in general. In terms of gameplay, Mr. Puarman hopes that in the future, the Cikeas Cileungsi Overflow Game can be further developed so that simulations related to flood early warning can be displayed more accurately and closer to real-world situations.

2. Game Testing

Game testing was carried out on 30 respondents randomly, and the results were found as shown in the Table 5. The flood early warning system gamification mechanic that was tried to display also received positive reactions, with almost 93.4% of respondents stating that the gameplay shown was quite interesting. The game "Cikeas Cileungsi Overflow" as an educational medium for flood early warning measures was also achieved, with 96.6% of respondents stating that their understanding of the concept of early warning had been well conveyed through games. 90% of respondents also stated that after playing the game "Cikeas Cileungsi Overflow," they became more familiar with the concept of a flood early warning system and other related matters.

Table 5: Respondent Evaluation

Assessment Aspect	Respondent Scores				
	1	2	3	4	5
Gameplay	-	6,5%	29%	38,7%	25,8%
Implementation of Early Warning System Concept	-	3,2%	38,7%	32,3%	25,8%
Visual Display	-	3,2%	25,8%	25,8%	45,2%
Increased understanding of respondents	-	9,7%	32.3%	35,5%	22,6%
	Respondent Scores				
	1 - 5	6	7	8	9	10
Overall Value	-	3,2%	16,1%	41,9%	25, 8%	12, 9%

Value description:

Table 6: Value Description

Number		Information
Scale 1 - 5	Scale 1 - 10	
5	9 - 10	Excellent
4	7 - 8	Good
3	5 - 6	Enough
2	3 - 4	Less
1	1 - 2	Fail

IV. Conclusion

Based on the game's discussion and testing, the "Cikeas Cileungsi Overflow" game succeeded in presenting an exciting flood, the early warning-themed educational game with a visual appearance that is its main strength. The gamification mechanic for the flood early warning system that was tried to display also received positive reactions, with almost

93.4% of respondents stating that the gameplay shown was quite interesting. This statement was also confirmed by direct validation from KP2C and the average score given by respondents of 8.26/10. 96.6% of respondents stated that their understanding of the concept of early warning had been well conveyed through games. 90% of respondents also stated that after playing the game "Cikeas Cileungsi Overflow," they became more familiar with the concept of a flood early warning system.

REFERENCES

[1] A. R. R. A. Pamungkas, "Faktor-Faktor Kerentanan yang Berpengaruh terhadap Bencana Banjir di Kecamatan Manggala Kota Makassar," *J. Tek. ITS*, vol. 3, no. 2, pp. 178–183, 2014, [Online]. Available: http://ejurnal.its.ac.id/index.php/teknik/article/view/7263.

[2] A. Rosyidie, "Banjir: Fakta dan Dampaknya, Serta Pengaruh dari Perubahan Guna Lahan," *J. Reg. City Plan*, vol. 24, no. 3, p. 241, 2013, doi: 10.5614/jpwk.2013.24.3.1.

[3] I. A. Prasetyo, S. Destya, and R. Rizky, "Penerapan Konsep Gamifikasi Pada Perancangan Aplikasi Pembelajaran Al-Qur'an," *Semnasteknomedia Online*, vol. 4, no. 1, pp. 4–8, 2016, [Online]. Available: https://ojs.amikom.ac.id/index.php/semnasteknomedia/article/view/1157.

[4] M. B. Sitorus, "Studi Literatur mengenai Gamifikasi untuk Menarik dan Memotivasi," *Academ*, vol. 110, 2016.

[5] Q. Aini, U. Rahardja, A. Moeins, and D. M. Apriani, "Penerapan Gamifikasi Pada Sistem Informasi Penilaian Ujian Mahasiswa Untuk Meningkatkan Kinerja Dosen," *J. Inform. Upgris*, vol. 4, no. 1, pp. 46–55, 2018, [Online]. Available: http://103.98.176.9/index.php/JIU/article/view/2263.

[6] M. Liu, H. Mitsuhara, and M. Shishibori, "Make it fun: The application of gamification in earthquake education for foreigners," in *ICCE 2020 - 28th International Conference on Computers in Education, Proceedings*, 2020, vol. 2, pp. 240–245, [Online]. Available: https://apsce.net/icce/icce2020/proceedings/W1-13/W5/ICCE2020-Proceedings-Vol2-W5_4.pdf.

[7] F. N. Makrifah and E. Sudarmilah, "Game Edukasi Mitigasi Bencana Gunung Meletus 'Petualangan Guntur,'" *PROtek J. Ilm. Tek. Elektro*, vol. 6, no. 1, pp. 36–41, May 2019, doi: 10.33387/protk.v6i1.1034.

[8] B.N.P.B., "Pedoman Sistem Peringatan Dini Berbasis Masyarakat," *Jakarta Badan Nas. Penanggulangan Bencana*, Sep. 2012, [Online]. Available: https://bpbd.bantenprov.go.id/upload/deni/foto/Pedoman_EWS_Masyarakat.pdf.

[9] KP2C, "Profil KP2C," *Website Resmi KP2C*, vol. www.kp2c.com, 2022.

[10] R. Ramadan and Y. Widyani, "Game development life cycle guidelines," in *2013 International Conference on Advanced Computer Science and Information Systems, ICACSIS 2013*, 2013, pp. 95–100, doi: 10.1109/ICACSIS.2013.6761558.