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Promoting Hydroponics Learning with Gamification Approach

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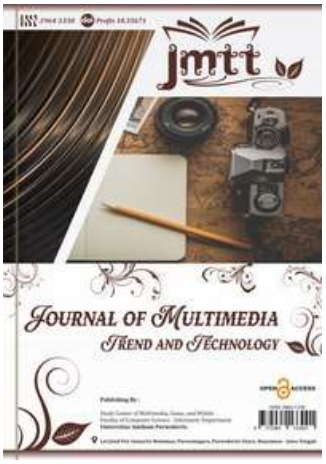

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ABSTRACT

Hydroponics is a farming technique without using soil media instead of water, it has many advantages compared to conventional general techniques in terms of resource efficiency. The use of hydroponics has gained wide popularity due to space optimization. Due to its simplicity, hydroponics method has attracted many new entrepreneurs especially from youngsters. Although it is quite popular nowadays, the hydroponics adoption for Indonesian farmers is quite limited due to lack of training exposure and access. The current training is still conducted in traditional classrooms with high costs and limited participants. The article proposes a new learning method using gamification method to empower new hydroponics entrepreneurs. The gamification method enables to deliver material in a more convenient way and reach a wider audience through mobile application. The article uses a common MDA framework to provide systematic material design and links to objectives. The outcome is expected to be used as a reference for hydroponics entrepreneurs to educate a larger audience.

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INTRODUCTION

Indonesia is an agricultural country where the agricultural sector plays an important role in the Indonesian economy, which causes most of population or workforce to depend on life or work on agricultural sector [1]. National statistics shows increasing population has caused the availability of agricultural lands to become increasingly limited. Major lands have transformed into housing and urban expansion [2]. Therefore, farming lands become more expensive and has allocated more on remote sites. To address this issue, the hydroponics method has become an effective solution for new farmers in city areas to increase agricultural products [3]. Hydroponics is a farming method without using soil media instead of water. Hydroponics enables to optimize space utilization with advanced farming methods so it can be conducted by people with limited farming land [4]. The hydroponic methods have created many new entrepreneurs in agricultural products. With recent technology, more and more agricultural products can be cultivated with hydroponic methods [5]. Hydroponics maintenance is also very easy because it easily to replace the plants and better pest control program.

Recently hydroponic methods are getting popular for new business startups. It has become a promising business due to better people awareness on pesticide-free agricultural products [6]. Hydroponics products enable to provide higher selling price with better quality. Modern grocery stores have installed more greenery agricultural products on their shelves, and the demands of the products increase dramatically. The greenery demands have exceeded the supplies, so it makes suppliers experience many difficulties fulfilling the agricultural products. To anticipate huge demand, hydroponics entrepreneurs has provided intensive trainings to recruit more business partners and establish strategic collaboration with them. More and more hydroponic trainings are provided to public [7]. Although it has become more common, the trainings may take higher costs and limited participants, since the trainings usually are conducted to remote sites [8]. Many participants also reported they easily get bored with training materials or unable to attend the trainings. Modern participants expect the training site should close to their residents or closest reachable area.

The article proposes the use gamification method in Koperasi (credit union) RMT as a case study. The RMT is located in West Java and has mission to create new hydroponics entrepreneurship. To support its mission, RMT has developed mobile application to enhance user learning more interactive and enjoyable [8]. With mobile application, entrepreneurs enable to reach a wider audience to become business partners of RMT.

Hydroponic is a method of cultivating plants without using soil media instead of using water that provides nutrients [1]. The planting media uses common materials that are easy to find such as rock wool or similar things such as sponges. The hydroponic method has existed since ancient times around 2600 years ago, however, hydroponic equipment with automation became popular worldwide in 1980. In Indonesia, hydroponic methods have started since 1980 and has gained wide popularity. Initially, hydroponics was introduced only around Jabodetabek area, however, over time, hydroponics has spread to all Indonesia areas [11]. The development of the hydroponic industry in Indonesia is also quite prospective due to the increasing demands for greenery vegetables, free-pesticide, limited farming lands, and soil degradation issues [12].

Hydroponic cultivation is usually carried out in an isolated glass house or known as greenhouse, which aims to make plants grow more optimally and protect them from uncertain natural factors such as weather and climate [4]. The provision of nutrients to hydroponic plants is made by dissolving fertilizer into the water according to the plant's needs. Then the water flows throughout the system to continuously hit the plant roots. Plant cultivation using hydroponic methods has many advantages compared to traditional methods in general, especially on land utilization, because hydroponic cultivation can be carried out on narrow or less fertile land. This is due to the hydroponic media being

water, not soil [13]. The yields from this hydroponic technique are relatively faster and are of very good quality, which makes the selling price higher in the market [5].

Gamification is a system used in a non-game context, using the same concept as a game [14]. This concept is often used for marketing strategies in a company. It can be played for major users' age. Besides being interesting, gamification motivates or encourages users to achieve a target [10]. Where the target is often the reason, the maker implements the gamification itself. Gamification is the application of game elements into a non-game context that aims to be more interesting and motivating to achieve better results [9]. The use of gamification application in hydroponic training allows novice learners to easily explore materials that suits to their interests.

The article utilizes MDA framework to provide systematic learning that enables students to switch from one topic to another topics that suits with their background knowledge [10]. They can participate teamwork to solve common problems. The concept of gamification itself is not a full game application, but several functions that usually exist in games are loaded in a certain context. Because human psychology enjoys challenges or encouragement in achieving something and is dissatisfied with what has been accomplished [15], with these traits, humans will be willing to do their best to achieve the targets they want, which is why gamification was created.

Examples of game elements that can be applied to gamification are levels, coins, badges, leaderboards, quests, and rewards [16]. These are things commonly used in gamification that excite the user. Currently, gamification application can easily be found in several industries such as education, banking and finance, agriculture, et.al. [9] The user interface (UI) is the component of an information system that necessitates user contact to generate input and output. In designing a website's interface, there are many factors to consider, including layout and composition, colours, textures, typography, and imagery, because an effective and user-friendly interface is crucial for those who are not experts in the field in which the system is applied [17]. In contrast, User Experience (UX) must guarantee that a product is responsive enough to please the user before, during, and after utilizing the service. User experience focuses on how people feel about interacting with a service and related to each other

Web Hosting is a rental service as a place to store data on the internet that is needed by a website. Web Hosting is definitely needed for all websites, so, that the website can be accessed online by anyone and anytime. Web hosting provides different price for any capacity and bandwidth, so, the greater number of visitors that means the more capacity and bandwidth needed for the website. Also, there is two different type of web hosting [18], there are Infrastructure as a Service (IaaS) and Platform as a Service (PaaS). IasS in web hosting provide customers accessing server's storage and the network itself according to needs of the user. For the PaaS, its Provide the customer a platform to deploy customer's web application. The services that are available for web hosting there are, Amazon Web Services, Google Cloud Platform, Microsoft Azure, etc.

METHOD

In the process of analyzing and building the game in this article, the author uses the following stages: (1) Idea Gathering; (2) Target Audience; (3) Gamification elements and design; (4) Describe Application; and (5) Prototyping. We apply gamification design for hydroponic materials into several stages to accomplish (see Figure 1):

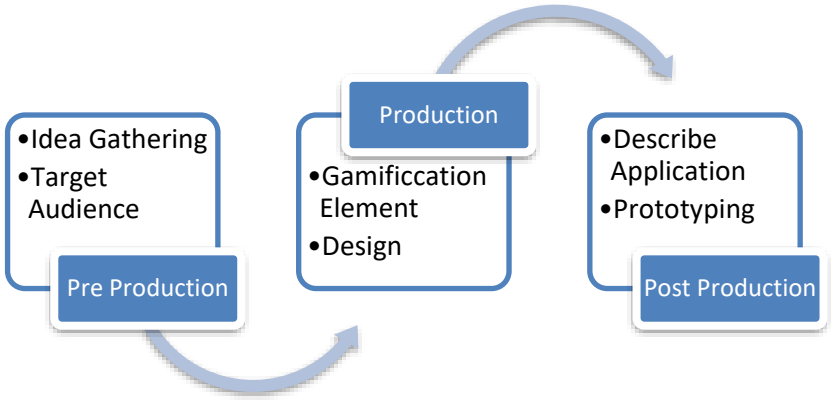

Figure 1. Game development stages flow.

1. Pre-Production

This stage is the foundation of the entire project. Its purpose is to plan, define, and prove the game concept before significant resources are allocated to full development. Failure to plan well here can lead to major problems later in the game. The team generates the game's basic idea, genre, target audience, and unique selling proposition (USP). Game Design Document (GDD): This is a detailed "blueprint." The GDD includes the storyline, gameplay mechanics, characters, levels, user interface (UI), visuals, and technical requirements. Market and technology research is conducted.

The team creates a small prototype focused only on the core mechanics to test whether the idea is enjoyable and technically feasible. Establishes an estimated budget, required resources (staff, equipment), and overall development timeline. Decides on a game engine (e.g., Unity, Unreal Engine), tools, and target platforms.

2. Production

This is the longest "development" phase, where most of the actual work takes place. The team grows to full size, and the plans created in pre-production are implemented. Programmers build the engine, gameplay mechanics, AI, physics, and other systems. Artists create 3D models, textures, animations, 2D assets, UI designs, and visual effects. Composers create music, sound designers create sound effects, and actors record dialogue (if applicable). Level designers build and populate environments (maps, dungeons, etc.) with engaging gameplay based on the GDD. All assets (code, art, sound) are integrated into the game engine.

Work is divided into milestones (important stages) often followed by internal testing. This process is iterative, meaning the team will repeatedly build, test, and refine features. Additional milestones are necessary when all core features are in place and playable from start to finish, but are still buggy and in need of polish. The next phase occurs when the game has all the features, major bugs have been fixed, and the focus shifts to polish and extensive testing.

3. Post-Production

This stage begins after the game reaches Gold Master (the final, release-ready version) and encompasses everything that happens after launch.

a. Key Activities Before Release:

Certification/Submission: submitting the game to platform holders (e.g., Sony, Microsoft, Steam) for verification and approval. Marketing and marketing campaigns, launch trailers, and ensuring the game is ready for purchase.

b. Key Activities After Release:
Maintenance and Patching: This is the most common post-production activity. The team monitors player feedback, identifies any undetected bugs or balance issues, and releases patches or updates to fix them. Community Support: The team serves players, answers questions, and collects data for future improvements.

c. Post-Launch Content:
DLC (Downloadable Content), which is additional content sold separately (story expansions, cosmetic items). For live service games, the team periodically releases seasonal content, special events, or major updates. The team conducts a post-mortem to evaluate what worked well and what can be improved in the next project.

RESULT

A. Ideas gathering.

We gather ideas from several stakeholders that affiliates with Koperasi RMT, such farmers, entrepreneurs, course designers and learners, through oberservation and discussion method.

B. Target audience.

Identify target audience of learning. Target learners normally range from 15-65 years. Common learners are recorded come from: students, housewives, and elderly (or retirements), and entrepreneurs. Each type of learner is studied carefully before putting in module design.

C. Consumer Behavior Change (CBC) to Consumer Engagement (CE).

We develop the learner's characteristics into game elements and design. It shows Table 1 game elements.

Table 1. Game Element.

Elements	Description
Onboarding/ Tutorials	This tutorial guides learners in a game so they do not need to read manuals. The tutorial is accustomed based on learner type.
Progress/ Feedback	All learner types need some degree of progress or feedback to provide a concise overview of the user's accomplishments. Progress might be static, offering just a graphical indication of how far the learner has progressed.
Theme	The theme is the unseen adhesive that binds all parts of the experience together. A theme establishes the framework within which actions and choices make meaning [19].
Narrative/ story	Storytelling is one of the most effective methods of retaining information because if the story connects with the learner, it gives a cognitive link to the subject and an emotional connection, which aids in knowledge retention and transfer.
Time pressure	Timer elements are often used in gamification design. It builds tension and might help them concentrate on the issue at hand.
Challenges	Putting their knowledge to the test and enabling them to apply challenges help to maintain participants' attention. People will feel they have achieved success when they overcome obstacles.
Certificates	It is formal marks of accomplishment. They can take the form of meaning, status and are useful appreciation. The module personalizes the achievements of the learner by including his/her name, date, and grades. Certificate comprises of achievement levels and badges to encourage for further higher levels.

D. Competency design.

Competency design is created to measure the achievements of the learners. Special notes can be embedded in competency design to assist faster achieving the objectives. We develop competency level into several stages as follows: (see Table 2).

Table 2. Competency Level.

Level	Explanation
Preparation (Pre-Modul)	In this module, the learner will be given an understanding and real-life case examples regarding the factors that influence farming using a hydroponic system, such as water, rainfall, and temperature.
Wick System (Level 1)	The Wick system is the simplest hydroponic method. In principle, the wick system only uses an axis connecting nutrients to the growing media. The user learns about seeding techniques and the wick system at level one. After completing this level, the user is expected to understand the basic concepts of hydroponic farming and be able to make their wick system at home.
Floating raft system (Level 2)	Floating raft system It is a hydroponic cultivation method in which the plants are stored in Styrofoam holes that float above the nutrient solution provided. At this level, the user is given the choice of whether to learn the seeding technique. The steps to make it are not easy at the floating raft level because it uses more items than the wick system. After completing this level, the user is expected to understand the process of making a floating raft (starting with the function of the tools to the process) and try it yourself at home.
Nutrient film technique (Level 3)	In this system, the nutrients will rotate continuously through a pipe assisted by a pump for the iteration process. The iterative process aims so that the nutrients provided can pass through all the plant roots. After completing this level, the user is expected to try it himself and try farming on a larger scale than the previous level.

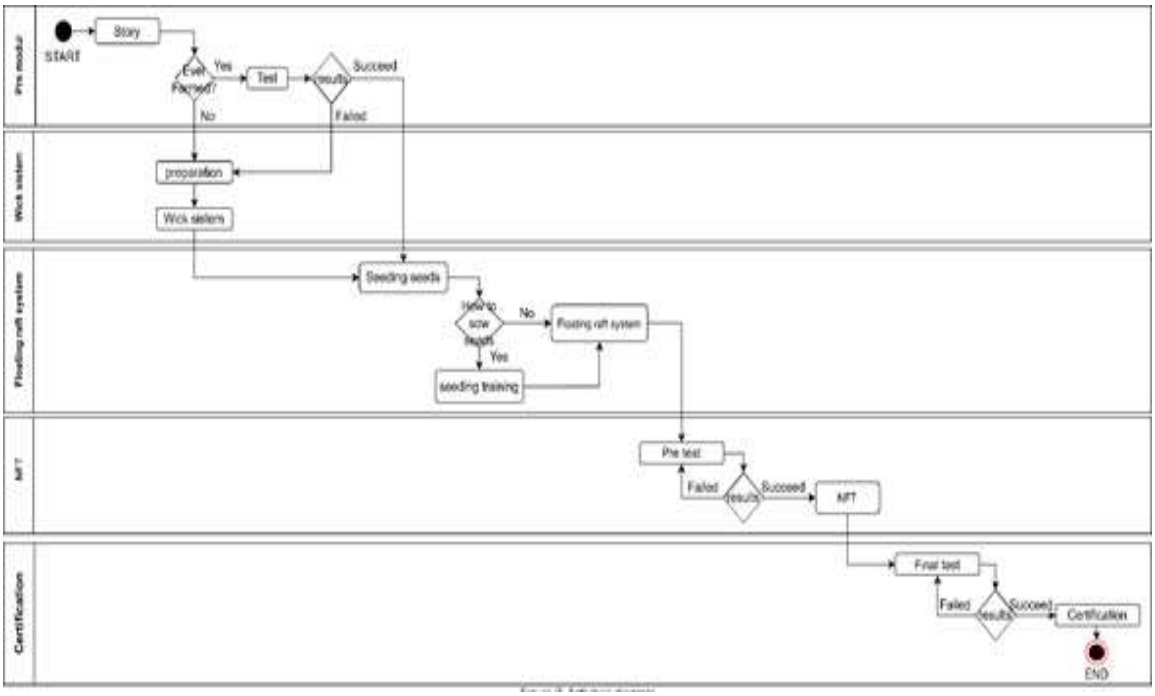

Figure 2. Activity Diagram.

E. Application flow describes the journey of learning within the game modules.

After compiling the material that has been obtained, the next stage is to create an application prototype. We use an activity diagram to describe the application flow. The application flow describes the activities of a system (see Figure 2).

1. At the beginning of the game, the learner will be asked whether he/she has been involved in previous farming activities.
2. If the answer is yes, a simple farming test will appear. The test directs the learner to the module that suits his/her achievements. If the answer is no then proceed with the regular learning track.
3. If the learner passes the test, it will be directed to the floating rift system without going through the preparation module and the wick. However, when starting the floating rift system module, the learner will be offered the chance to learn how to sow seeds, but it is optional, unlike in the wick system, which must be done.
4. Suppose the learner fails the test or answers never. He/she will be directed to the preparation module, where some features are mandatory to learn and then proceed to the wick system module.
5. After completing the two modules, there will be a pre-test to pass to the next level, namely the Nutrient film Technique.
6. At the end of the game, learner will get a passing certificate, but before that, the learner must complete the final test first.

F. Prototyping of game applications is developed and testing.

We use several development tools such as: (1). Draw.io, for drawing diagram (2). PHP and Visual Studio for development tools; (3). MySQL as database; (4). XAMPP as Web Server; (5). Figma as I/O system design; (6). SQL database; and third-party service such as Google AdSense. The game module design is illustrated as follows:

Figure 3. Interacive, and story page.

Figure 3 shows a prototype model built according to the scenarios previously presented in tables 1 and 2. Figure 3 shows the initial screen when the user opens the application. Figure 4 shows the game's process flow, designed similarly to that in Figure 3. In the Pre-Production phase, testing aims to validate the game's basic ideas and technical aspects. Prototypes are typically very simple (often called Vertical Slices or Proof of Concept) and focus on only one or two key features. The goal is to ensure that the game's core rules and interactions (the core loop) feel enjoyable and function as expected. Then, to prove that the chosen technology can support the game's core features (for example, whether physics controls work smoothly). Finally, risk identification aims to uncover design or technical challenges as early as possible before significant time and money are invested.

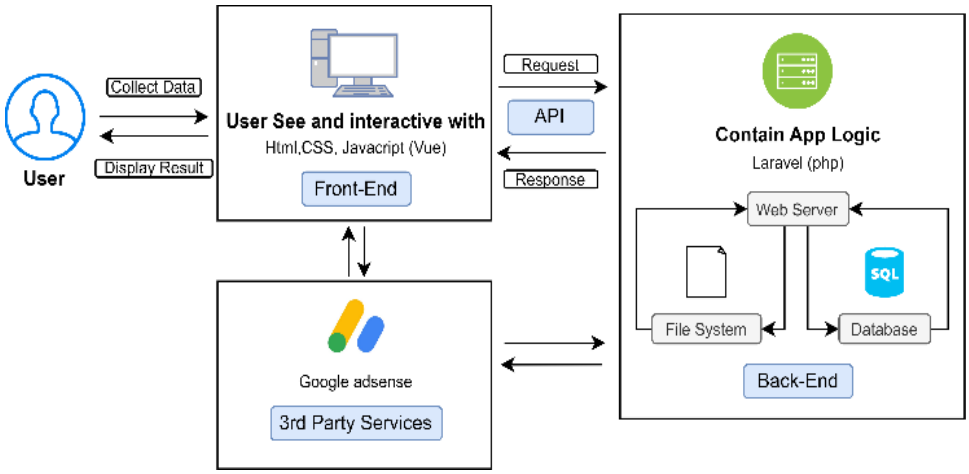

Figure 4. Application Architecture

Figure 4 shows that learner (user) can interact with game modules application as front-end. The application is linked with third party services such as Google AdSense:

1. Learner (user) accesses an application via a URL in a browser; it will simultaneously send a data request to the destination server via the API.
2. Data requests sent to the destination server will be processed with third-party services such as Google AdSense.
3. Data will be returned to the front end via the API, and the browser will translate the data processing result for learner (users) to see.
4. Ads will pop up at the start of the training and the end of the training.
5. The front-end and back-end application that is built will be placed on web hosting to be accessed in real-time.

CONCLUTIONS

Hydroponics have become efficient farming for people that experience lands scarcity. Hydroponics have emerged as greenery products that avoid the use of pesticides and soils instead of using water and other additional supporting forms. The market demands of hydroponic products have grown significantly where producers have difficulty supplying the market. Many hydroponic startups have offered onsite training to new potential farmers in rural areas. They come from several backgrounds such as students, retirees, housewives, and entrepreneurs. The training is usually conducted onsite in a traditional classroom where it requires special efforts to go onsite and is quite costly. Based on the experience, many learners, especially students and youngsters are easily getting bored with training materials. For this purpose, the article examines the use of MDA gamification framework to assist learners in convenient learning. The game modules are designed to suit learners background and can be accessed through mobile app. The game prototype has been tested and will be deployed on mobile app for Koperasi RMT for further mass training.

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Author Contributions

G.W, Review and editing, Methodology, Formal analysis. A.D.S, Writing -original draft, Investigation, Funding acquisition, Data curation.

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REFERENCE

[1]. S. Jan et al., "Hydroponics – A Review," Int J Curr Microbiol Appl Sci, vol. 9, no. 8, 2020, doi: 10.20546/ijcmas.2020.908.206.
[2]. R. Rosliani and N. Sumarni, "Budidaya Tanaman Sayuran dengan Sistem Hidroponik," Monografi, no. 27, 2005.
[3]. D. P. Diwanti, "Pemanfaatan Pertanian Rumah Tangga (Pekarangan Rumah) Dengan Teknik Budidaya Tanaman Sayuran Secara Vertikultur," Martabe : Jurnal Pengabdian Kepada Masyarakat, vol. 1, no. 3, 2018, doi: 10.31604/jpm.v1i3.101-107.
[4]. V. Mamatha and J. C. Kavitha, "Machine learning based crop growth management in greenhouse environment using hydroponics farming techniques," Measurement: Sensors, vol. 25, 2023, doi: 10.1016/j.measen.2023.100665.
[5]. R. S. Velazquez-Gonzalez, A. L. Garcia-Garcia, E. Ventura- Zapata, J.D.O. Barceinas-Sanchez, and J. C. Sosa-Savedra, "A Review on Hydroponics and the Technologies Associated for Medium-and Small-Scale Operations," Agriculture (Switzerland), vol. 12, no. 5. 2022. doi: 10.3390/agriculture12050646.
[6]. D. I. Pomoni, M. K. Koukou, M. G. Vrachopoulos, and L. Vasiliadis, "A Review of Hydroponics and Conventional Agriculture Based on Energy and Water Consumption, Environmental Impact, and Land Use," Energies, vol. 16, no. 4. 2023. doi: 10.3390/en16041690.
[7]. R. Zulfarosda and R. Tri Purnamasari, "Article Review: The Potential of Hydroponics as a Tourist and Educational Object," International Social Sciences and Humanities, vol. 1, no. 2, 2022, doi: 10.32528/issh.v1i2.173.
[8]. T. Pavlenko et al., "96. Increasing adoption of precision agriculture via gamification: the farming simulator case," 2021. doi: 10.3920/978-90-8686-916-9_96.
[9]. M. Sailer and L. Homner, "The Gamification of Learning: a Meta-analysis," Educ Psychol Rev, vol. 32, no. 1, 2020, doi: 10.1007/s10648-019-09498-w.
[10]. S. Dwi Putra and V. Yasin, "MDA Framework Approach for Gamification-Based Elementary Mathematics Learning Design," International Journal of Engineering, Science and Information Technology, vol. 1, no. 3, 2021, doi: 10.52088/ijesty.v1i3.83.
[11]. N. Marbun, F. Anisa Mayari, S. Novani, and M. Nina Adlini, "Hidroponik Dan Aquaponik Sederhana: Solusi Budidaya Sayur Di Lahan Terbatas Dalam Skala Rumah Tangga," MARTABE, vol. 5, no. 8, 2022.
[12]. V. G. Smelova, "Hydroponics - life without soil": convergent education program," School and Industry, no. 1, 2022, doi: 10.47639/0037-4024_2022_1_40.
[13]. D. Dutta et al., "Optimizing Plant Growth and Crop Productivity through Hydroponics Technique for Sustainable Agriculture: A Review," International Journal of Environment and Climate Change, vol. 13, no. 9, 2023, doi: 10.9734/ijecc/2023/v13i92315.
[14]. Wenny and G. Wang, "ANALYSIS OF GAMIFICATION FOR TRAINER PERFORMANCE USING MDA FRAMEWORK AND ARCS MODEL," J Theor Appl Inf Technol, vol. 100, no. 5, 2022.
[15]. M. Rizki, R. Dwi, F. Rahman, and G. Wang, "Architecture of social media marketing using gamification," International Journal of Advanced Trends in Computer Science and Engineering, vol. 8, no. 6, 2019, doi: 10.30534/ijatcse/2019/22862019.

[16]. S. Hinton, L. Wood, H. Singh, and T. Reiners, "Enterprise gamification systems and employment legislation: a systematic literature review," Australasian Journal of Information Systems, vol. 23, 2019, doi: 10.3127/ajis.v23i0.2037.

[17]. V. Handayani, F. Lukman Budiono, D. Rosyada, R. Nisa Sofia Amriza, Zulkifli, and S. Ummi Masruroh, "Gamified Learning Platform Analysis for Designing a Gamification-Based UI / UX of E-learning Applications: A Systematic Literature Review," in 2020 8th International Conference on Cyber and IT Service Management, CITSM 2020, 2020. doi: 10.1109/CITSM50537.2020.9268791.

[18]. N. Thakur, A. Singh, and A. L. Sangal, "Cloud services selection: A systematic review and future research directions," Computer Science Review, vol. 46. 2022. doi: 10.1016/j.cosrev.2022.100514.