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# Educational Game Design Sorting Waste Android Based

Nyoman Ayu Gita Gayatri
Universitas Bina Nusantara: Teknik Informatika, Jakarta, Indonesia
Nyoman.gayatri@binus.ac.id

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***Abstract*— Waste management in Indonesia is still quite far from good, this is still happening due to a lack of public awareness of the management and processing of waste around the community environment. Indonesia is estimated to produce 64 million tons of waste annually. Referring to data from Sustainable Waste Indonesia (SWI), only 7% of this figure is recycled, while 69% of it accumulates in landfills (TPA). With this situation, learning media that are educational are needed starting from Early Childhood (PAUD). Educational games are used as learning media which are very interesting to be developed as a learning tool for early childhood to introduce waste and sorting organic and non-organic waste. The educational game created is based on Android with the waterfall development method. The purpose of this research is that it can be used as an alternative learning medium in Children's Education (PAUD) in changing conventional learning methods into game simulation learning methods, so that it can educate children (PAUD) in the introduction of types of waste and waste management. Based on the results of functionality testing, the application game has run well and passed all test scenarios using the black box method and can run on smart phones with the Android operating system.**

***Index Terms*- Educational games, waste, Early Childhood Education.**

## I. INTRODUCTION

Environmental problems are issues that cannot be avoided. At present waste is a very serious environmental problem faced by Indonesian people in general. It can be said that housewives produce waste every day, both organic and inorganic waste. But what is worrying is the garbage that The products produced are instead disposed of carelessly in various places, and the effect will damage the surrounding environment. The amount of waste produced every year will increase in line with the increase in population. The current government has tried in various ways to overcome the waste problem. Especially the problem of inorganic waste. However, it has not yet reached the point of perfection. This is because the amount of waste in Indonesia is very high. So that the government has difficulty determining the right way to solve it.

Garbage is an object or material that is no longer used by humans so it is thrown away. The social stigma associated with waste is that all waste is disgusting, dirty, and so on, so it must be burned or disposed of properly. All community activities always generate waste. This is not only the responsibility of the local government but also of the whole community to process waste so that it does not have a negative impact on the environment. The waste problem includes 3 parts, namely downstream, process and upstream. On the downstream side, waste disposal continues to increase. In the process section, there are limited resources from both the community and the government. In the upstream section, it is in the form of a less optimal system that is applied to the final processing. Most people consider burning waste as part of waste management. however, such things can cause pollution to the environment and interfere with health. Attitudes like this are probably influenced by knowledge and age maturity. Building public awareness is not as easy as turning the palm of the hand. It needs cooperation from all parties, both the

community, government and third parties as supporters. It took quite a long time to build that awareness. Positive examples and role models as well as consistency from the policy makers in Indonesia are also needed a certain area. Direct outreach activities about waste management can encourage community participation in waste management. At this time and from day to day it is increasingly unavoidable that waste problems will occur, the problems that will be found will be more complex if this is allowed to continue without a solution then it will become a big problem. The problem that will occur is the amount of garbage that will be scattered and will disturb the view and can also block the flow of the river and eventually cause flooding. This problem can occur due to a lack of concern for waste and also a lack of education and awareness related to waste.

According to the definition of the World Health Organization (WHO) waste is something that is not used, not used, not liked or something that is thrown away that comes from human activities and does not happen by itself [3]. Waste Management Act No. 18 of 2008 states that waste is the residue of daily human activities and/or from natural processes in solid form. Garbage is now a serious threat to the survival of children, if waste is not managed properly and children do not get good educational resources about waste, then in the next few years around 250 million Indonesian people will live together with piles of garbage and will incur a lot of losses.

One alternative is to conduct education about knowledge in waste management which can be done by early childhood by sorting organic and inorganic waste, but sorting waste is a new behavior in children, therefore a study of children's knowledge and attitudes needs to be done. Knowledge studies can be carried out with learning media and children's attitudes can be carried out by instilling the behavior of sorting organic and inorganic waste from an early age in children so that later they will be carried over when they grow up.

The fact of handling the waste mentioned above also shows the behavior of children who do not care about their household waste, especially the environment. This is reflected in the culture of our children who are still very fond of littering. Therefore there must be efforts to prevent and instill a caring attitude towards the environment from an early age.

Meanwhile, what is currently happening is that the existing educational/knowledge media on waste management are lacking in number and unattractive. Materials and methods for implementing Environmental Education that have been used so far are felt to be inadequate so that the target group's understanding of environmental preservation is incomplete. In addition, materials and methods for implementing Environmental Education that are not applicable do not support the resolution of environmental problems faced in their respective regions. Given the rapid development of current technology, researchers are trying to solve this problem through software engineering that is considered cheap, popular and popular with children. As technology develops, smartphones have become children's daily needs, there are many applications that can help children carry out their activities more easily. Currently smartphones are also equipped with many new facilities that allow users to perform many activities. Smartphones are also late equipped with Operating Systems such as Android, IOS.

Mobile application comes from the word application and mobile. Application means application, application, use. In terms of application is a ready-to-use program that is designed to carry out a function for the user, while mobile can be interpreted as moving from one place to another. As reported by gs.statcounter.com, Android is the most widely used operating system in Indonesia, with a percentage of 75.27%. In second place is IOS with a percentage of 22.74%. Judging from the facts above, researchers are innovating to provide environmental learning features, especially in relation to the introduction and processing of waste for children. The application created will be packaged in the form of an Android-based interactive game made using Unity. This educational game hopes to provide knowledge and create

awareness to children of the importance of protecting the environment, especially regarding waste, as well as the ability to process waste so that it can be managed properly and efficiently.

## II. THEORETICAL BASIS

### A. Garbage

Waste is a material that is wasted or disposed of from sources resulting from human activities or natural processes that do not yet have economic value. Waste is classified into 2 categories, namely organic and inorganic waste. Organic waste is waste that is easily recycled such as dry leaves, vegetable scraps, food

scraps and others. While inorganic waste is waste that is not easily decomposed such as plastic, paper, bottles, glass, cans, electronic waste and others.

**B. Android**

Android is an operating system for mobile devices that is open and based on the Linux operating system. Android can be used by everyone who wants to use it on the device. Android provides an open platform for developers to create their own applications that will be used for various software [6].

**C. Mobile Application**

Mobile Applications are applications specifically designed for smartphone or cellular platforms such as iOS, Android, Harmony OS, or Windows Mobile. Then the advantages of the mobile application are that there is permanent storage space on the device and it is easy to use anytime and anywhere [10].

Mobile application is a type of software in the form of applications that are created and run on mobile devices such as smartphones and tablets. Generally, mobile applications aim to provide services that are almost the same as PC devices but with a smaller size [13].

**D. Waterfall**

Waterfall is a software development framework in which the development process is completed sequentially one by one. The phases in the waterfall are divided into analysis, design, implementation, testing, and maintenance. In the waterfall model, requirements must be defined in advance so that there can be no changes in the middle of the process [17].

- **Analysis**
  The Analysis phase is also known as the software requirement specifications (SRS) phase. which is the phase where all requirements in software development will be described and analyzed in detail. From the analysis carried out, it will produce functional and non-functional requirements. Functional requirements include objectives, scope, perspective, functions, software attributes, user characteristics, and database requirements. On the other hand, non-functional requirements include constraints, limitations, design and operating requirements of the software.

- **Design**
  The Design phase is a phase that includes planning and problem solving processes for software solutions. The planning process carried out in this phase is the design for software to solve the problems found in the previous phase, the design can be in the form of algorithm design, software architecture design, logical diagram scheme, and data structure definition.

- **Implementation**
  The Implementation phase is a phase that refers to business needs and design into an execution program, database, website through programming and deployment. This is where the original code is written and compiled into operational applications, where databases and text files are created. In short, this means the conversion process from the process phase to the production phase.

- **Testing**
  The Testing phase, which is commonly known as verification or validation, includes the process of checking that the expectations for the software meet the performance and specifications and the completion of the intended goals. Verification refers to the process of software evaluation carried out to determine whether the product at a certain phase meets the initial conditions. Validation refers to the process of evaluating software during and at the end of the development process with the aim of finding that the software meets specified requirements. Of course in this process bugs and system glitches are found and fixed, then redefined accordingly.

- **Maintenance**
  The Maintenance phase is the phase after the software has been developed, where in this phase there are several things, such as correcting errors encountered during use, improving the performance and quality of the software, and accommodating changes needed in the software [14].

**E. Unified Modeling Language (UML)**

Unified Modeling Language (UML) is a visual language for modeling and communicating about a system using diagrams and supporting texts [15]. In developing applications, the authors use several Unified Modeling Language (UML).

Use Case Diagram is a model for the behavior of the information system to be built. Use case diagrams describe an interaction between one or more actors with the information system to be built. Use case diagrams are used to find out what functions exist in an information system and who has the right to use these functions [16].

## III. METHOD

In this study using the waterfall method. The waterfall method is a structured system design process with a systematic approach. This method runs sequentially through several stages where the output from one stage will be used as input in the next stage. The following is an elaboration of the development stages adapted to the research. The main thing in using this paradigm is to determine the steps for making the right game in accordance with software engineering rules to get games that suit your needs, as shown in Figure 1.

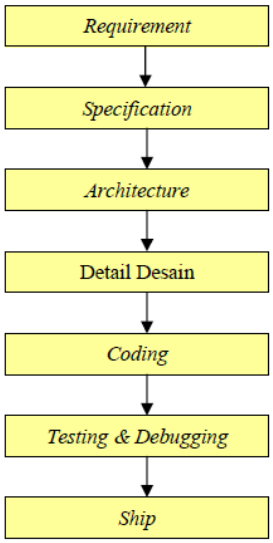


Figure 1 Research Methodology

**Analysis and Design**

Application analysis and design using UML diagrams which is a standard language for modeling applications built with an object-oriented methodology. The system overview is described by a Use Case Diagram.

### A. System Analysis

The system design that will be made requires several input data requirements, output data requirements and interface requirements. The purpose of the needs analysis is to determine the function specifications, capabilities and facilities of the program. Needs analysis is also useful as a basis for evaluation after the program has been compiled.

### B. System Design

The system design is described using a Use Case Diagram, which is intended to form an explanation of the main functions and application behaviors in an outline with the hope that the processes that occur in it can be easily understood. The following is a description of these functions as shown in Figure 2 below:

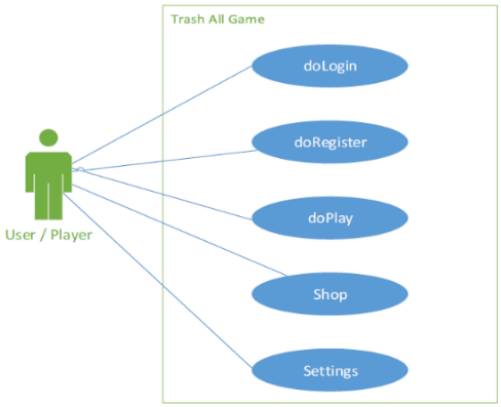


Figure 2 Use Case Diagram of an Educational Game to Sort Waste.

## IV. RESULT AND DISCUSSION

The results of the analysis of the materials that have been collected are then formulated game product specifications according to market needs (in this case PAUD children). The game's initial design emphasized:

### A. Game Description Design

The game that will be made is a learning game to get to know waste and good waste management. It is hoped that this research can help children (PAUD) to understand and know the types of waste and their processing, in this case changing conventional learning methods into simulation learning methods with mobile-based educational game media and helping children (PAUD) develop children's creativity, because in educational games has elements of challenge, accuracy, reasoning and ethics. This game contains learning for children (PAUD), where learning will be given through games which are one of the media for playing while learning, especially for PAUD children. We hope that the use of games as an educational medium can become a new technique that can make children enjoy learning more.

### B. Scenario Storyline

The game scenario is used to find out the flow of the game that will be made, as shown in Figure 2. Where

the Player who will play this game is Children (PAUD). There are 2 (two) games to choose from, namely waste recognition and waste management.

### C. Game Rules

The rules of each game are used to limit what players can do and what players cannot do when playing the game. Rules can be in the form of lives, points, stamina and so on for the main support of the game. The rules contained in this educational game Players at the beginning of playing this educational game get a point 0 (zero) and have to play in waste management to increase the points obtained. Players also won't die or run out of lives while playing, but the points they get will decrease due to mistakes in sorting and processing waste. There is a time in the game so that if the allotted time runs out, the player will be considered wrong in playing the game and return with the points that will be obtained reduced.

### D. System Implementation

The design of the application screen is a display design that will later be applied in the game application as an interface display. Screen design stages are very important in the development of application games in the application of making displays using Adobe XD in designing application game screens. The following is the display design of the garbage sorting educational game:

- **Game Main Menu**


Figure 3 Game Main Menu

The main menu in Figure 3 is the initial appearance of the game trash, in this view there is a start button to start the game and a settings button to change according to the existing functions. Users can start the game by taking action on the start button then the game will start.

- **Settings page**

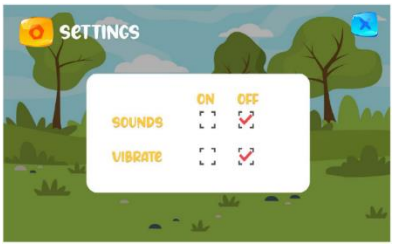


Figure 4 Settings page

The settings menu shown in Figure 4 has the function of selecting or setting defaults for display, sound, and vibration when playing Game Trash. Settings can be made by the user to determine the comfort level when playing the trash game.

- **Page Leveling Mode**


Figure 5 Page Leveling Mode

The display in Figure 5 from Game trash where the page can monitor the user's level, Game trash is a level/challenge based game where you have to get 3 stars on a challenge to open a new challenge, the higher the user level, the the more types of trash that will be played and known and the more scores that will be obtained.

- **Information page for types of waste**


Figure 6 Information Menu for Types of Trash

The information menu for the types of waste that is displayed in Figure 6 contains various types of waste and how it is processed. This view will open after clicking the Start button on the Main menu in Figure 3, then after that all types of garbage will be displayed accompanied by an explanation and also followed by a voice that will explain it. This voice function makes it easier for children (PAUD) to capture the information conveyed because at the age of PAUD children there are still those who cannot read information in the form of text.

- **Garbage Processing Mode page**


Figure 7. Waste Treatment Mode Menu

On the display of Figure 7 is the process of implementing the game. In the game process the user can sort waste according to its type, separate the types of waste based on the color of each available disposal site, if the player puts the wrong trash in the wrong place then points will be reduced so that if you do it continuously the stars on the challenge will reduced to 2 until it runs out so it can't continue to the next stage and can't go up to the next level.

### E. System Function Testing

Testing in this game is done by using black box testing. Black-Box Testing is a software testing method that only focuses on functional specifications without testing the code and software design sections. In Black-Box Testing, the tests carried out are only to find out whether the functions, inputs, and outputs of the software being tested comply with the specifications [17]. Black box testing is carried out to test the software in terms of functionality in applications developed with a given scenario. The results of functionality testing using the black box method show that all functions and features in the application for the community from the first time it is run to completion can run well according to what has been planned. There are 5 features that have been tested, **Table 1** shows the results of testing the game application.

**Table 1. Application Game Testing Results**

| No | Testing | Information | Status |
|---|---|---|---|
| 1 | Main Menu | Displays the main menu | Passed |
| 2 | Leveling Mode | Goes Well | Passed |
| 3 | Garbage Treatment Mode | Displays the Garbage Treatment Mode | Passed |
| 4 | Setting Page | Can do Settings | Passed |
| 5 | Waste Type Information | Displays information on the type of waste | Passed |

### F. Evaluate the 8 Golden Rules

In the process of developing Educational Games, refer to the principles of 8 (eight) golden rules. Following are the results of the evaluation of the application developed against the 8 (eight) golden rules:

- **Strive for consistency**
  The Educational Game developed has a consistent interface design in terms of color, uniform font type, consistent navigation, the use of images in the form of flat icons of the same size and type, the sequence of actions for similar functions has a consistent sequence.
- **Cater to universal usability**
  In educational games, the language used is English because it is a universal language and can be understood by many people.
- **Offer informative feedback**
  The Educational Game that has been developed has provided a response/feedback to the crucial actions taken by the user, such as when the user wants to close the game, the system will display a confirmation pop up to ensure that the user wants to close the game.

**Design dialogs to yield closure**
The Educational Game developed has provided the appropriate end function for each action.

**Offer simple error handling**
The Educational Game developed has provided informative and easy-to-understand error handling for every action, such as when the user selects a level that is not yet accessible, the game will display a message informing an error.

- **Permit easy reversal of actions**
  In the Educational Game developed there is a mechanism to cancel the actions taken by the user. For example, when the user wants to close the game, the system will display a confirmation pop up. And if the user wants to cancel the process, the user can press the cancel button to cancel the close game process.

- **Support internal locus of control**
  The Educational Game developed provides a simple and functional display, because this display is preferred by early childhood, which provides information in the form of easy-to-understand visualizations.

- **Reduced short-term memory load**
  The Educational Game developed has designed an interface that is easy to recognize and users have no difficulty in remembering the purpose of information.

### G. Multimedia Evaluation

The following is an evaluation of the application of multimedia elements to Game Trash.

- **Text**
  In Game Trash, text elements play a role in giving instructions to players so they can run game programs correctly. Apart from giving instructions, text also plays an important role throughout Game Trash where this educational game really needs text. With text, this game can be used correctly in terms of writing.

- **Picture**
  Image elements in Game Trash can be seen in the buttons, logos, and menu displays. Images play a role in making the game less boring and attracting player attention. This image element is also very important when playing different types of waste.
- **Voice**
  In the Trash game there is the use of sound which is an important element in the game where the use of sound can increase understanding of the information conveyed and increase children's interest in operating the Trash game.

- **Animation**
  Game Trash doesn't use any animation elements in its application to the game.

- **Videos**

  Apart from animation, the game Trash also doesn't use video elements

## V. Conclusion

The conclusion that can be drawn from the program that has been made is that this educational game can help children (PAUD) understand waste and how to sort waste according to its type, learning is provided by simulation with game media and makes it easier for children (PAUD) to learn to know how to understand waste , how to dispose of trash properly, and make habits to dispose of trash in its place. The developed Game Trash can meet the needs of garbage education, Game Trash is in great demand by users because of its attractive appearance, In terms of the user interface, the appearance of the game is designed in a clear, concise and orderly manner which makes users understand how to use the application properly. In the evaluation results, this game has been able to achieve the initial goal of being able to make Early Childhood Children (PAUD) aware of the importance of sorting waste. The application of gamification to Game Trash supports learning content to distinguish types of waste, which makes it more attractive to players. Children who play online games are proven to be able to socialize well in the gamers' environment and also expand their social networks through cyberspace. Children or gamers are proven to have the ability (skill) and knowledge (knowledge) in the use of internet technology.

Suggestions for development that can be carried out in this study are that the object of research can be made more varied and the discussion in Game Trash is more general as well as the environment the game is made in more detail and made with an even more attractive appearance so that users can use and increase knowledge about the types of waste and their management patterns

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