



Lilu's Village Chronicles Game Application in Sustainable Village Development with Implementation of Finite State Machine and GDLC

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ABSTRACT

Indonesia, as a developing nation, is characterised by its vast population, which is dispersed across a myriad of cities and rural areas. While several major urban centres in the country have seen remarkable progress and development, this stands in stark contrast to the many villages that continue to lag behind, particularly in terms of education, economic opportunities, and technological advancement. A significant factor contributing to this disparity is the insufficient public attention given to accelerating the development of rural areas. One potential avenue to address this issue is through the use of educational games, which can play a crucial role in raising awareness about the importance of sustainable development in these communities. Interactive games that incorporate educational elements could serve as a valuable tool in enhancing public understanding and fostering greater engagement with rural development initiatives. Among the computational models that can be employed in the creation of such games is the Finite State Machine (FSM), which offers a framework capable of providing a more immersive and realistic gaming experience that reflects the actual conditions of rural Indonesia. The educational game, Lilu's Village Chronicles, has been designed using the Game Development Life Cycle (GDLC), ensuring that its development process is systematic and thoroughly organised, thereby maximising its potential to educate and engage users effectively. The beta testing of the game was conducted through interviews with players. The results indicated that players found the game to be enjoyable and engaging, while also providing them with valuable insights into village life.

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1. INTRODUCTION

Sustainable development in rural areas has become a central focus within the broader global development agenda, particularly with the growing influence of digital technologies. In the contemporary digital age, technological advancements serve not only as a catalyst for accelerating progress in rural communities but also as a means of fostering more dynamic and inclusive participation from local populations (Barr, 2019). The integration of digital tools facilitates more efficient planning, enhances resource management, and promotes greater engagement among various stakeholders, particularly within sectors such as agriculture and community empowerment. The advent of digital technologies has created novel opportunities for rural communities to take a proactive role in shaping their own development, ultimately contributing to improved welfare outcomes and greater environmental sustainability (Diana & Sari, 2024).

In Indonesia, the integration of digital technology into the development of rural areas has led to substantial transformations. When applied to village development planning, technology not only expedites the implementation process but also enhances the involvement of both local communities and multiple stakeholders in the decision-making processes (Padilah, Fayuni, & Nurviyanti, 2023). Initiatives such as the National Program for Community Empowerment (PNPM) have demonstrated that community-based empowerment strategies can significantly bolster public participation and contribute to the long-term sustainability of rural development efforts (Nathanel, 2013). Nonetheless, a prominent challenge persists in the form of unequal access to technology. Many villages still lack the necessary technological infrastructure, creating a stark divide between those communities with access to advanced tools and those left without. This disparity is further compounded by the widespread issue of low digital literacy, which leads to a lack of awareness about technological advancements, the outside world, and the potential benefits that technology can offer to enhance daily life (Ilham & et al, 2023). This ignorance stands as a substantial impediment to the adoption of technologies that could otherwise play a pivotal role in fostering further development. To unlock the full potential of digital technology in rural areas, it is imperative that concerted efforts are made to improve digital literacy and expand access to technological resources across all villages.

An effective method for managing system responses in interactive games is the *Finite State Machine* (FSM). A *Finite State Machine* (FSM) is a model used to regulate system behaviour by moving from one state to another based on certain events or actions (Laksono & Susanto, 2020). In an FSM-based system, each object or character is only in one state at a time and will move to a new state when there is a relevant trigger, such as the approach of a player or a change in environmental conditions (Figat, Zielinski, & Hexel, 2017). In a game, FSM can manage the response of Non-Player Character (NPC) characters to player actions, so that NPCs can respond automatically and dynamically, such as interacting with the player when approached or taking certain actions according to changes in the game. This enhances a more immersive gaming experience and makes it easier for players to understand the concepts conveyed in the game, especially those related to sustainable village development. For this game, it will be applied to the *player main character* (MC) to manage the movement of the player.

One approach that can be used to educate the public about village development in the current era is through interactive learning media based on game simulations. This interactive

learning media not only provides an interesting learning experience, but also allows users to interact directly with the concepts of development in the village. In the development process, it will provide construction methods, physics concepts, and chemistry concepts. More than just entertainment, this game conveys messages about life in the village and teaches players to be sensitive to the reality of people who still have difficulties in living life in today's modern era.

The objective of this game is to design an interactive learning media based on a video game, to introduce the concept of village development in the age of digitalisation. The game aims to educate the public on resource management, waste management and infrastructure development through innovative solutions to advance underdeveloped villages, by conveying important messages about rural life and the need for quality education. The game was chosen because it has the potential to be an effective tool in facilitating learning to the community, while maintaining local values and village culture.

Based on the above background comes an innovative game, *Lilu's Village Chronicles*, a simulation adventure RPG video game, which invites players to enter the world of Lilu, a girl who returns to her hometown village after a long stay in the city. On her way home, Lilu is determined to improve her underdeveloped village before graduating from school during the semester holidays.

The game will teach various concepts, ranging from traditional farming techniques such as planting rice using a modern plough to the use of advanced technology such as harvesting machines, greening systems, which seasons are suitable for planting and so on. In addition, the game will also teach practical ways of growing crops using pipes, cooking healthy and nutritious food from farm produce, and even provide useful life values for the community. Not only that, the behaviours of the citizens in the game will also be taught by the player with a certain touch of interaction such as teaching waste management and disposing of garbage properly. Players will also build new houses for the villagers as well as school buildings for the villagers to study.

To address the challenges of village development and the importance of digital literacy, we chose an interactive educational game approach due to its appeal and high level of engagement, especially with the digital generation. Game media has been proven effective as a learning tool as it provides a hands-on and interactive experience for players. The ultimate goal is to create awareness and practical skills regarding sustainable village development through real scenario-based simulations in the game.

Thus, through the development of this interactive learning media, it is hoped that players can improve their skills in advancing their own village together with the village community in the game, by maintaining traditional values that are important in rural life.

2. METHODS

A *Finite State Machine* (FSM) is a computational model used to map the behaviour of a system that only has a certain number of states at a time. In an FSM, the system moves from one state to another based on events that act as triggers. This concept is simple but effective in managing systems that require automatic state changes. In the context of games, FSMs are widely used to govern the behaviour of characters, especially non-Player Characters (NPCs),

allowing them to provide relevant and adaptive responses to player actions. This creates more natural and dynamic interactions, providing a more realistic and immersive gaming experience (Dewi, Rachman, & Zahir, 2023). For example, research by Basrie et al. (2021) showed that FSMs enabled NPCs in the game "The Adventure of Pancasila Knight" to switch states from attacking to fleeing when the *Health Bar* was below a certain threshold, resulting in behaviour that felt more alive in the game.

FSM has several main components through which the transition between states in the system takes place. These components include *state*, *event*, and *action*. A *state* is a particular condition of the system that determines what actions can be performed at that time. For example, an NPC in a game may have several *states* such as "attack," "flee," or "stay". *Events* are triggers that cause a *state* change, such as a player approaching or an NPC's *Health Bar* dropping below a certain level. *Action* is the response or action the system takes when a transition from one *state* to another occurs. FSMs are effective because developers only need to define these states and the transition rules between them without having to create complex code for every possible behaviour (Basrie, Hasiholan, & Suteja, 2021).

The implementation of FSM is also proven to be effective in increasing the flexibility of game development because the design of character behaviour can be broken down into separate but interrelated small units. Hormansyah et al. (2018) elaborated that FSMs allow developers to easily model various scenarios and transitions between states in the game, such as when an NPC needs to move from "peaceful" to "alert" or from "walking" to "running" according to the context of the in-game environment. The modular structure of the FSM allows developers to make changes without affecting the entire system, making it more efficient and reducing the risk of implementation errors (Hormansyah, Ririd, & Pribadi, 2018).

3. RESULTS AND DISCUSSION

GDLC (Game Development Life Cycle) is an adaptation of SDLC (Software Development Life Cycle) to be applied in game development (Mustofa, Putra, & Kesuma, 2021), which can be seen in Figure 2.

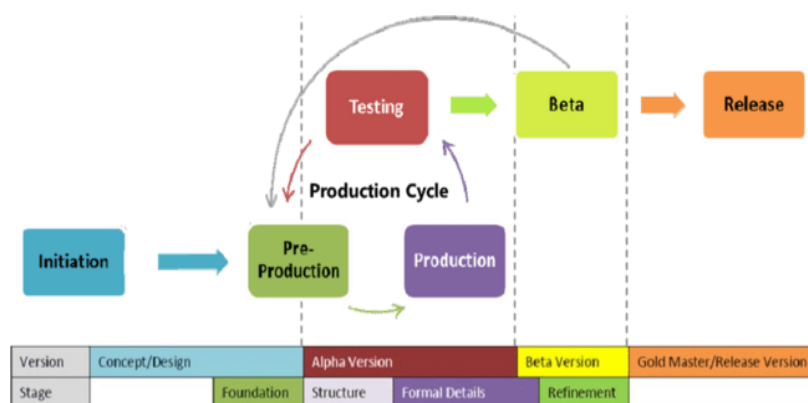


Figure 2. Game Development Life Cycle

In the process of developing this game, GDLC became the basic framework used to ensure a structured and efficient workflow. The GDLC methodology helps in defining the important

stages that must be passed, starting from the creation of the initial concept to the maintenance after the launch of the game.

3.1. Initiation Phase

At this early stage, the main idea of the game was designed with the aim of creating a unique experience for the player. Lilu's Village Chronicles is a game with the theme of sustainable village development. The game follows the journey of the main character, Lilu, a 15-year-old girl who returns to her home village after years of living in the city. Lilu's character is portrayed as a cheerful, passionate, visionary, and socially concerned girl, making her a natural leader who is determined to improve her village.

1. Theme and Background

Lilu's Village Chronicles is themed *Life on Land*, focusing on aspects of life on land and how rural communities can develop sustainably. The game also integrates several *Sustainable Development Goals* (SDGs) themes, including *Good Health and Well-being*, *Quality Education*, *Decent Work and Economic Growth*, and *Gender Equality*. Through this story, players are invited to understand and promote the values of rural life that emphasise equality, health, quality education, and fair economic growth.

2. Time and Place Setting

The game is set in 2015, when Lilu is on holiday in her hometown, which she hasn't visited since she was 4 years old. There, Lilu is welcomed by her grandmother who has a history as a warrior and village developer in the past. The game setting includes various seasons in each region of the village (east, west, north, and south), each with its own unique climatic characteristics and challenges for its people, such as rainy, subtropical, hot, and tropical seasons. These conditions will give players experience in dealing with environmental changes that affect agriculture, ecosystems, as well as daily village life.

3. Purpose and Genre of the Game

The game aims to be an interactive simulation with RPG (*Role-Playing Game*) genre combined with life simulation and adventure elements. Throughout the story, Lilu will learn from the village community, build infrastructure, manage resources, and develop the village with innovative approaches. The game focuses on developing the village through farming, building public facilities, and educating the villagers.

4. Target Audience

The target audience of Lilu's Village Chronicles is players who enjoy simulation, adventure, and RPG games with an interest in community development and management as well as rural life values and environmental exploration. All ages can play it but it leans more towards teenagers.

5. Game Look and Feel

The game has a third-person point of view and follows the main character's every move as he moves. The visuals of the game will depict a warm and friendly countryside atmosphere, with colourful and bright graphics that are *anime style*. Background sounds and music will bring out the natural and peaceful feel of the village environment. The player can also feel a sense of nostalgia for previous games, which can be seen in the style in Figure 3.



Figure 3. Game Display Style

3.2. Pre-Production Phase

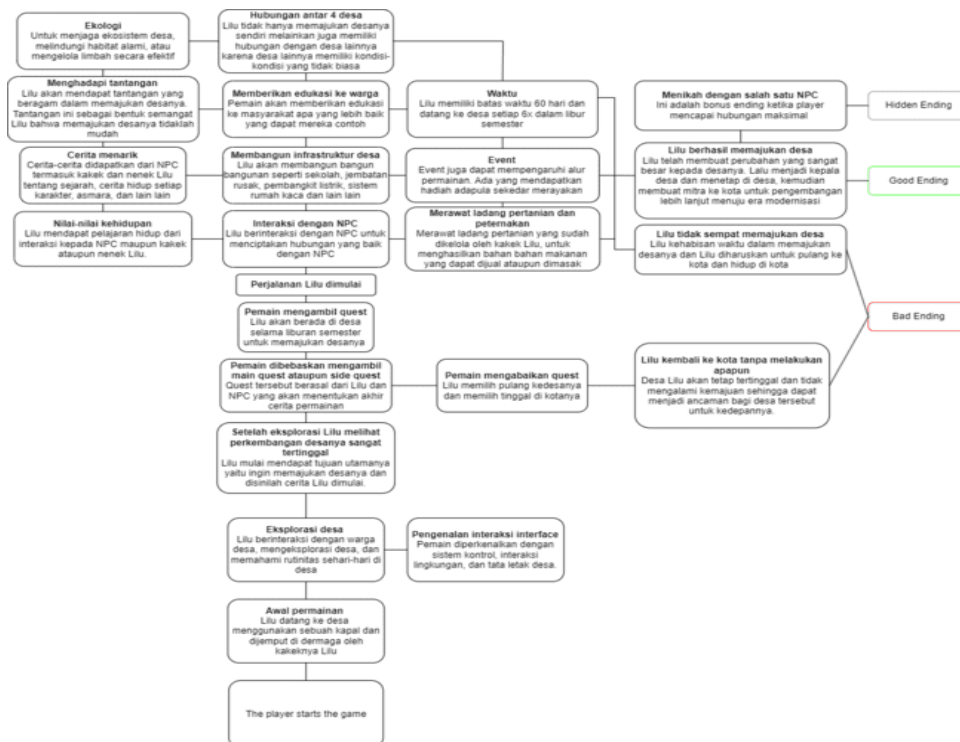
In the Pre-Production Phase, the previously designed game concept begins to be realised in a more concrete manner. The main focus of this phase is to ensure that all the basic elements of the game, from storyline to mechanics and visuals, are well planned out before entering full production. The pre-production stage involves several key components as follows:

1. Game Design Document (GDD) Preparation

The *Game Design Document* (GDD) is the main document that details all aspects of the game. It includes a description of the gameplay, story, characters, environment, and rules of the game in *Lilu's Village Chronicles*. The GDD will serve as a reference for the entire development team, ensuring everyone is working towards the same goal.

2. Gameplay Flow Timeline

To visualise the sequence of the game, a *Gameplay Flow Timeline* was created to show the sequence of main scenarios that the player will go through according to the storyline. Figure 4 is the storyline that leads to the end of the game in a *Lilu's Village Chronicles* game.

Figure 4. Timeline *Gameplay* Flow

3. Finite State Machine Movement Flowchart

FSM is used to organise the flow of character movement in the game. This movement is applied to the main character as well as the NPC. Figure 5 visualises the movement scheme based on the status that has been determined in the FSM mechanism.

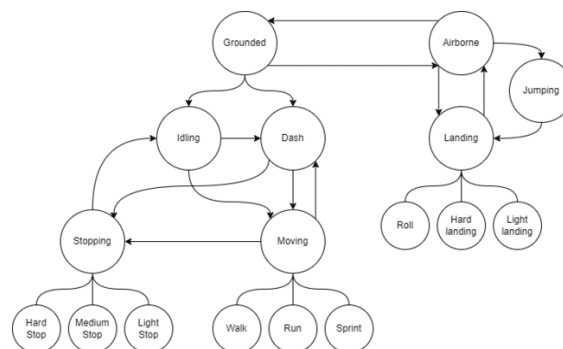


Figure 5. Flowchart of Limited State Machine Movement

4. Character Design

Character design in Lili's Village Chronicles includes both main characters and NPCs (*Non-Playable Characters*) that are part of the story experience. Figure 6a and 6b is the main characters that play an important role in the storyline. Lili is the main character in the game, a spirited young girl who goes on adventures to make her village more developed

and prosperous. She takes responsibility for her surroundings and inspires other villagers to care for their village.



Figure 6a. Main Character

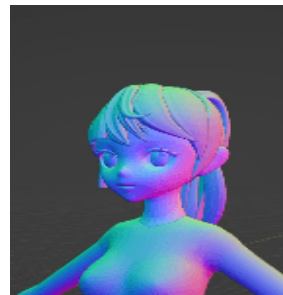


Figure 6b. Detail Character

3.3. Production Phase

The Production Phase is a refinement of pre-production in the core phase of *Lilu's Village Chronicles* development, where all game components are created and integrated. At this stage, the characters, environments, and game mechanics planned in the GDD and prototype begin to be realised. Each element that has been conceptualised in the previous stage is produced with detail and rigour to create a well-rounded gaming experience. The following are the results of the production stage:

1. Visual and Audio Content Development

At this stage, the 3D models for the main character, Lilu, and the NPCs in the village began to be developed in an *anime* visual style with the use of *toon shaders* specified in the *Style Guide*. Each character is equipped with basic animations appropriate to their role, such as walking, interacting with objects, and performing daily activities. The game environment was also developed to create an authentic rural feel, including traditional architectural elements and objects such as plants and interactive animals. In addition, sound effects that describe the character's activities, natural ambience, and background music that supports the rural theme were also added to enrich the atmosphere in the game. This visual and audio integration aims to provide an immersive and immersive gaming experience, so that players can feel the atmosphere of the village authentically in *Lilu's Village Chronicles*.

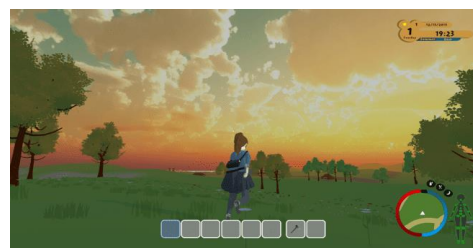


Figure 7. Visual Display of Character and Environment in the Morning and Afternoon



Figure 8. Visual Display of Characters and Environments during the Daytime



Figure 9. Visual Appearance of Characters and Environments at Night

2. Gameplay Mechanic Implementation

In this gameplay mechanic implementation stage, systems are developed to allow players to interact directly with the game environment, including object retrieval and usage, inventory management, crafting system, and building system. Each implemented mechanic has an important role in supporting a more realistic gaming experience. Table 1 for gameplay mechanics.

Table 1. Gameplay Mechanics Lilu's

No.	Screen Image	Description
1.		Object capture
2.		Player inventory
4.		Cutting down trees

5.		List of crafts
6.		Building the foundation
7.		Storage area
8.		Interaction to NPC

Furthermore, the movement of the character is organised through a *Finite State Machine*. Table 1 shows each movement condition experienced by the character.

3. Key Feature Development and Integration

The user interface (UI) design is intuitively designed to make it easy for players to access important information during play without distracting from the environment. Menus, HUD (*Head-Up-Display*) and icons were designed following the established *Style Guide* to maintain visual consistency. In this view, the menus will be displayed at the beginning of playing the game, namely the initial game menu, the display is shown in Figure 10.

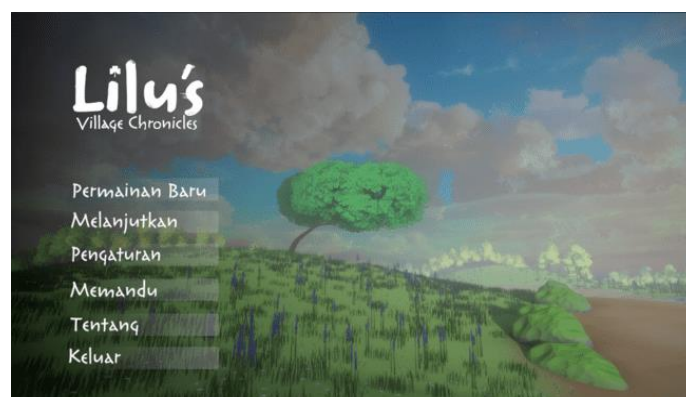


Figure 10. Main Menu UI



Figure 11. In-game HUD

Figure 11 shows the simple yet informative HUD interface, including the character's health status, item access, time and setting.

3.4. Testing and Refinement Phase

The testing and refinement stage is a step in ensuring the quality and stability of Lilu's Village Chronicles before it is launched to the public. At this stage, intensive testing is done to find and fix bugs, refine gameplay mechanics, and ensure that every feature in the game works as planned. Testing is done in two main stages, namely alpha testing and beta testing.

Alpha testing is conducted internally and involves the development team and testers. The purpose of this testing was to identify major bugs, fix discrepancies in features, and assess gameplay balance. Each major feature, such as the farming system, NPC interactions, as well as the mission system, was tested in depth based on planned test scenarios (see Table for a list of alpha testing scenarios). These tests covered all features implemented in the alpha version, ensuring that the core gameplay and game mechanics worked as expected.

Table 2. Alpha Testing

<i>Features</i>	<i>Expected results</i>	<i>Testing Results</i>
Object Capture	Can take any object that can be taken	Successful
Player Inventory	Can put retrieved objects into inventory, can be discarded, and put into quick access in inventory.	Successful
Crafts	Create crafts based on specific items	Successful
Building construction	Building construction	Successful
Cooking	Selecting raw materials for cooking	Successful
Interaction with NPCs	Select the task given by the NPC	Successful

Player Movement	Player can walk	Successful
NPC Movement	NPCs follow the player's direction	Successful

Beta testing was carried out by conducting structured interviews with players. The findings revealed that the game offered an enjoyable gameplay experience and effectively conveyed informative content about rural life.

3.5. Launch of

Once the game has completed the testing stage, the Lilu's Village Chronicles educational game is ready for launch. This stage ensures that the game has gone through a thorough vetting process.

4. CONCLUSION

Lilu's Village Chronicle educational game has been successfully built by implementing Finite State Machine (FSM) using unity game engine. In addition, the development of the Lilu's Village educational game has also successfully implemented 5 Game Development Live Cycle (GDLC) cycles. This educational game has provided learning features about village development, such as making crafts and building village construction, and recognising waste. In further development, it is expected to add more game features that provide education to increase public awareness in sustainable village development.

Future research on educational games is encouraged to explore improvements in interactivity and content personalization, aiming to better align with players' individual learning styles and needs. The incorporation of emerging technologies, such as artificial intelligence or adaptive learning systems, may further enhance the educational value of the game. Additionally, it is recommended to conduct more comprehensive evaluations, including quantitative analyses, to assess the game's effectiveness in improving learning outcomes

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