

Immersive Culinary Simulation With FSM-Based NPCs in a 3D Game for Promoting Sundanese Restaurants

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Abstract— The development of a 3D interactive game entitled “Sapiring Rasa” aims to promote traditional Sundanese restaurants while supporting the preservation of Indonesia’s culinary heritage through digital media. The game is designed for desktop platforms with a top-down perspective, allowing players to manage a traditional eatery, serve customers, and address various resource management challenges. The development process employed the Unity3D Engine and applied the Multimedia Development Life Cycle (MDLC), which includes the stages of Concept, Design, Material Collecting, Assembly, Testing, and Distribution. The main contribution of this study lies in the practical implementation of artificial intelligence-based non-player characters (NPCs) using a Finite State Machine (FSM) approach to create dynamic and responsive customer interactions, thereby improving gameplay immersion and user experience. System functionality was validated through alpha testing using black-box methods, while usability evaluation was conducted through beta testing using the System Usability Scale (SUS) involving 30 participants. The results showed an average SUS score of 73.5, classified as “Good” and “Acceptable.” These findings indicate that the proposed game is usable and well received by users. Overall, the integration of local cultural elements into interactive gameplay demonstrates the potential of digital games as effective media for cultural promotion and educational purposes.

Index Terms— Artificial Intelligence (FSM); Cultural Game; Interactive 3D Game; Multimedia Development Life Cycle (MDLC); Sundanese Restaurant Simulation.

I. INTRODUCTION

Traditional Sundanese restaurants represent an important part of Indonesia’s cultural heritage that continues to endure today. Their uniqueness is reflected in the use of natural materials such as bamboo and wood in architectural design, as well as floor-seating (lesehan) arrangements that embody the communal values of Sundanese society. Signature dishes, including nasi liwet, pepes ikan, karedok, and lalapan, are not merely served as meals but also represent cultural values and local wisdom passed down through generations [1][2]. Despite the pressures of modernization and changing lifestyles, traditional

Sundanese restaurants strive to preserve the authenticity of their flavors, presentation, and atmosphere. Beyond functioning as dining places, these restaurants also serve as cultural spaces that introduce and transmit traditions to younger generations [3][4]. Therefore, factors such as service quality, pricing, taste, and comfort play a crucial role in attracting customers, while innovative promotional strategies are increasingly needed to remain relevant in a rapidly evolving era [5][6].

Along with technological advancements, cultural promotion no longer relies solely on conventional media but increasingly adopts interactive media, particularly digital games. Such media are widely used because they can engage younger audiences through more enjoyable and participatory approaches. Digital games have evolved from simple entertainment into effective educational media for conveying cultural messages [7]. Several studies indicate that digital games can enhance cognitive and socio-emotional abilities, making them a promising alternative for introducing cultural values to younger generations [8].

Previous studies have employed digital games and interactive media to promote local culture using structured development methods such as the Multimedia Development Life Cycle (MDLC). Research findings show that this approach is effective in increasing user interest in traditional cultural and culinary content [9][10]. In addition, the application of artificial intelligence techniques, such as Finite State Machines (FSM), has been proven to create more dynamic character behavior and enhance gameplay experience in interactive 3D games[11][12]. Usability evaluation methods, such as the System Usability Scale (SUS), are also widely applied to assess user experience and system acceptance in educational and cultural applications[13] [14].

Three-dimensional game development using Unity has been widely applied in educational and culture-based media. Unity supports graphics, audio, scripting, animation, and artificial intelligence features such as NavMesh and NavMeshAgent for NPC movement [13][14]. Previous studies have also combined FSM with pathfinding methods to improve NPC behavior in

Unity-based simulations [17]. In addition, Behavior Trees have been widely discussed as an alternative NPC behavior architecture because they provide more modular and extensible behavioral control for complex agents [18].

Based on the identified gap, this study develops an immersive 3D culinary simulation game focused on Sundanese traditional restaurants, integrating cultural elements, restaurant simulation, and FSM-based NPC behavior. The novelty of this study does not lie in proposing a new FSM algorithm, because FSM is already a well-established approach in game AI. Instead, the novelty lies in addressing the limited explanation of structured NPC service behavior in culturally themed restaurant simulations and in integrating FSM-based NPC behavior with Sundanese culinary representation as a promotional medium for traditional restaurants. The scientific contribution of this study is the design, implementation, and evaluation of structured NPC service behavior in a culturally themed 3D culinary simulation environment. This study aims to provide a promotional medium that is not only visually rich but also interactive, participatory, and relevant for introducing Sundanese culinary culture in the digital era.

I. METHODS

The development of the proposed 3D Sundanese restaurant simulation game follows the Multimedia Development Life Cycle (MDLC), which consists of concept, design, material collecting, assembly, testing, and distribution stages. In the concept stage, the main idea, target users, cultural content, and gameplay objectives were defined. The game was designed as an interactive promotional medium that introduces Sundanese restaurant atmosphere, traditional dishes, and restaurant service activities through a 3D simulation environment [19][20]. The overall workflow is illustrated in the Work Breakdown Structure (WBS) shown in Figure 1.

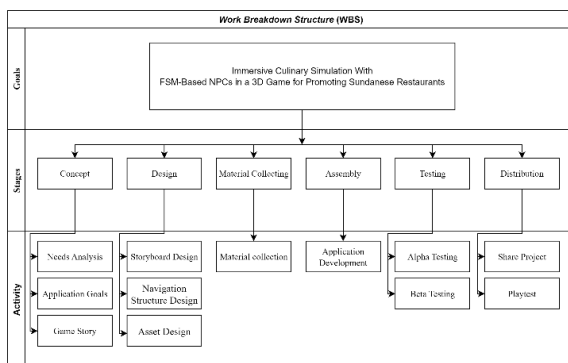


Fig. 1. Work Breakdown Structure

A. Concept

This initial phase focuses on analyzing user needs, defining development goals, and drafting the game narrative [19]. Key activities include identifying user requirements, setting development objectives,

determining the target users, and formulating a storyline that serves as the foundation for development. In this study, the concept phase also determined the main cultural elements to be represented in the game, including Sundanese restaurant atmosphere, traditional dishes, and restaurant service activities.

B. Design

In this stage, the visual elements, navigation system, and overall game structure are designed [19]. Activities include creating a storyboard, designing the navigation flow, and planning the visual assets. The outputs guide the development of the game's UI/UX and user interaction flow. The Finite State Machine (FSM) was also designed in this stage to define the behavior of NPCs in the restaurant service process. The FSM design includes the definition of NPC states, transition conditions, and event triggers that determine how NPCs move from one behavior to another. In this study, FSM was applied to service-related NPC behavior, such as entering the restaurant, moving to a table, viewing the menu, ordering food, waiting, eating, paying, and leaving the restaurant.

C. Material Collecting

This phase involves gathering all necessary assets and resources to support game development [19]. These materials include visual assets such as 3D models and illustrations, audio components like background music and sound effects, and cultural references to enhance the authenticity of local cultural elements featured in the game. References related to Sundanese restaurant interiors, traditional dishes, and restaurant atmosphere were also collected to support the cultural representation in the simulation.

D. Assembly

At this stage, all previously prepared components are integrated into the game application [19]. Activities involve developing the game using Unity3D, importing 3D assets, adding animations, and implementing game logic through C# scripting. The FSM logic was implemented at this stage to control NPC behavior according to predefined states and transitions. Each NPC behavior was represented as a state, and the transition between states occurred when specific user actions or in-game events were triggered. The output of this stage is a playable game prototype ready for testing.

E. Testing

The testing phase aims to ensure the functionality, NPC behavior, and usability of the game [19]. It was carried out in two stages: alpha testing and beta testing. Alpha testing was conducted internally to identify technical issues, validate gameplay functions, and examine whether FSM-based NPC behavior worked according to the designed scenario. The FSM behavior was evaluated by observing whether each NPC state

and transition was executed correctly based on predefined triggers. The observed aspects included state transition accuracy, NPC response to events, and completion of the restaurant service flow. Beta testing was conducted after the prototype had passed functional testing. At this stage, users were asked to play the game, interact with the restaurant environment, observe NPC behavior, and complete the System Usability Scale (SUS) questionnaire. Therefore, SUS data collection was conducted during the beta testing stage after users interacted with the playable prototype.

F. Distribution

The final phase focuses on delivering the game to end users [19]. This includes distributing the game via digital platforms such as itch.io. This step plays a crucial role in introducing the game as a medium for promoting Sundanese culinary culture to a broader audience.

G. FSM-Based NPC Behavior Implementation

The FSM was implemented to control NPC behavior in the restaurant service simulation. Each NPC behavior was represented as a state, and the transition between states occurred when specific conditions or events were triggered. The customer NPC behavior consists of several sequential states, namely Idle, Enter Restaurant, Move to Table, View Menu, Place Order, Wait for Food, Eat, Pay, and Exit. The NPC initially stays in the Idle state before entering the restaurant. When the game scenario starts, the NPC enters the restaurant and moves to an available table. After reaching the table, the NPC views the menu and places an order based on user interaction. The NPC then waits for the food, performs the eating activity after the food is served, continues to the payment process, and finally leaves the restaurant. This FSM structure was used because the restaurant service process follows a clear and predictable sequence, making it suitable for deterministic NPC behavior in the proposed simulation game.

II. RESULT AND DISCUSSION

A. Concept

1) Needs Analysis

The needs analysis was carried out through literature review and interviews. The literature review aimed to gather references related to educational game development, game technologies, and effective game design principles. References were sourced from academic journals, books, and previous research. In addition, interviews with the Garut Department of Tourism and Culture (Disparbud) were conducted to collect information on traditional Sundanese cuisine and interior design of traditional restaurants. This information ensured the visual and content elements in the game were culturally appropriate and reflective of Sundanese identity.

2) Application Goals

This game is designed to introduce Sundanese culinary traditions in an engaging and interactive way through a restaurant management simulation. Users are expected to become familiar with various traditional dishes while also learning basic management skills.

3) Game Story

The core concept of the game is managing a traditional Sundanese restaurant, where players serve customers, deliver food, hire cleaning staff, and expand the dining area. The game emphasizes traditional Sundanese atmosphere through visuals and interior design. Table I presents a detailed breakdown of the game concept.

TABLE I. GAME CONCEPT

No	Element	Description
1	Title	<i>Sapiring Rasa</i> , A top-down 3D simulation game themed on a traditional Sundanese restaurant.
2	Target Users	General audience, with no specific age restrictions.
3	Features	Open and manage the restaurant, serve customers, hire cleaners, expand dining area, rating and finance system.
4	2D and 3D Assets	3D characters, 3D top-down layout of the restaurant, 3D interior and exterior assets, and 2D game UI.
5	Audio	Traditional Sundanese background music and sound effects.

B. Design

1) Storyboard Design

The storyboard outlines the scenes and interaction flow within the game, helping visualize the player experience. Table II describes the storyboard in detail.

TABLE II. GAME STORYBOARD

No	Scene	Content	Description
1	Scene 1	Splash Screen Page	Displays the game logo as an opening screen.
2	Scene 2	Main Menu Page	Includes options such as Start, Settings, Info, and Exit.
3	Scene 3	Info Page	Shows information about the game developer.
4	Scene 4	Gameplay Page	The main scene where players manage the restaurant and interact with customers.
5	Scene 5	Gameplay Food Menu Page	Displays traditional Sundanese dishes with short descriptions.
6	Scene 6	Gameplay Menu Shop Page	Allows players to purchase staff (NPCs) and upgrade dining areas.
7	Scene 7	Gameplay Settings Page	Offers options to adjust audio, effects, and screen display.
8	Scene 8	Gameplay Results Page	Shows earnings and customer satisfaction ratings after gameplay ends.

2) Navigation Structure Design

This step involves designing the game's menu navigation system. The structure is illustrated in Figure 2.

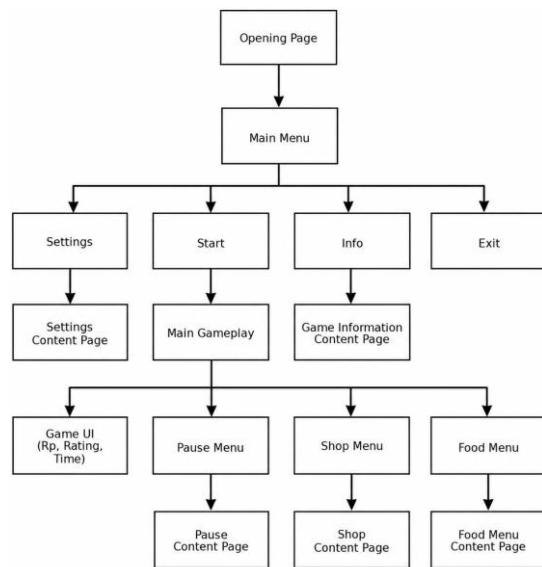


Fig. 2. Navigation Structure

Fig. 2 shows the main menu interface of the game. This interface provides access to the main features, including starting the simulation, viewing information, and exiting the game

3) Asset Design

The visual assets such as characters, restaurant layout, interior and exterior design, and UI elements were created with a Sundanese cultural theme as show as Figure 3 and Figure 4.



Fig. 3. UI asset designing

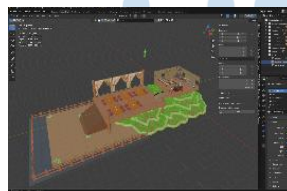


Fig. 4. Asset design Sundanese restaurant layout

Fig. 3 shows the exterior or initial environment of the restaurant simulation, while Fig. 4 shows the interior area where user interaction and restaurant service simulation take place. Therefore, these figures are not identical because they represent different spatial contexts in the game.

C. Material Collecting

In the Material Collecting phase, various assets were prepared to support game development. 3D models were created using Blender in .fbx format with designs reflecting traditional Sundanese restaurant themes. 2D assets, including UI elements, icons, logos, and illustrations, were produced in Adobe Illustrator to match the game's cultural aesthetic, along with a storyboard as a visual reference. Audio components

were sourced from royalty-free libraries and converted to .wav format for use in Unity. Additionally, all text elements were formatted using the Beach Lombok font to enhance the traditional atmosphere of the game.

D. Assembly

In this stage, all assets and design components were integrated into Unity3D to implement game mechanics, interaction systems, animations, user interfaces, and NPC behavior. Core features, including the main menu, settings, information page, gameplay interface, shop, food menu, and game result summary, were developed with a strong emphasis on Sundanese cultural elements.

Figs. 5–11 show the main interface and interaction features implemented in the game. Fig. 5 presents the main menu, which features background music and visual elements to create the ambiance of a traditional Sundanese restaurant. Fig. 6 shows the settings menu, which allows players to adjust audio and display preferences stored locally using Unity's PlayerPrefs system. Fig. 7 presents the information page, which introduces the game content. Fig. 8 shows the main gameplay interface with information such as money, rating, and time. Fig. 9 presents the shop system, which enables players to hire cleaners and expand the dining area. Fig. 10 shows the food menu, which presents authentic Sundanese dishes through images and descriptions. Fig. 11 presents the game result summary, which displays total earnings and customer satisfaction scores.

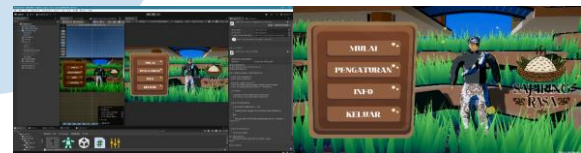


Fig. 5. Main Menu Implementation in Unity and In-Game Display

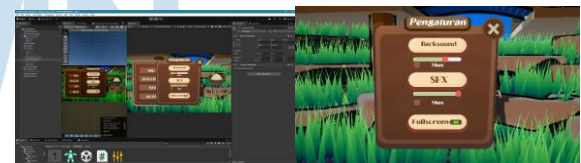


Fig. 6. Settings Menu Implementation in Unity and In-Game Display

Customer and cleaner NPCs were also implemented during this stage. Customer NPCs were programmed using Finite State Machine (FSM) logic to simulate structured restaurant service behavior, such as entering the restaurant, moving to a seat, ordering food, eating, providing ratings, and exiting the restaurant. Cleaner NPCs were implemented to support restaurant maintenance activities, such as moving around the restaurant area, detecting stains or trash, cleaning the area, and returning to patrol behavior. Fig. 12 presents the FSM state transition diagram used to describe the behavior flow of the NPC in the restaurant service scenario. This diagram shows how the NPC changes from one state to another based on specific triggers, such as entering the restaurant, moving to the table, viewing the menu, ordering food, waiting, eating,

paying, and leaving the restaurant. Fig. 13 presents the game flow diagram, which describes the overall interaction flow between the user, game system, and restaurant simulation environment.

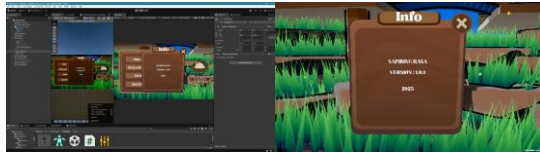


Fig. 7. Information Page Implementation in Unity and In-Game Display



Fig. 8. Gameplay Implementation in Unity and Display in Game



Fig. 9. Shop System Implementation in Unity and In-Game Display



Fig. 10. Food Menu Information Implementation in Unity and In-Game Display



Fig. 11. Game Result Summary Implementation in Unity and In-Game Display

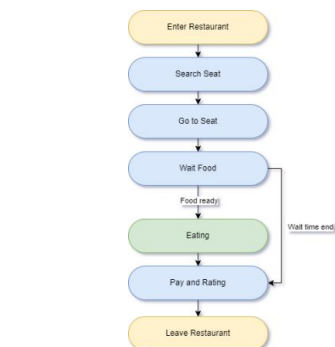


Fig. 12. Customer NPC Behavior Flow and In-Game Implementation

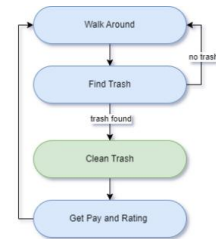


Fig. 13. Cleaner NPC Behavior Flow and In-Game Implementation

E. Testing

The testing phase aimed to ensure that the Sapiring Rasa game functioned properly, was free from critical bugs, and provided a smooth user experience. This phase consisted of alpha testing and beta testing. Alpha testing was carried out by the development team using the Black Box Testing method to evaluate whether each feature responded correctly to user inputs without assessing the internal code [21][22][23]. In addition to testing interface functions, alpha testing was also used to examine FSM-based NPC behavior. The observed aspects included whether customer NPCs could enter the restaurant, move to a seat, order food, eat, provide ratings, and exit according to the designed service flow.

TABLE III. SYSTEM USABILITY SCALE (SUS) QUESTIONS

No	Code	Question
1	P1	I think that I would like to use this system frequently
2	P2	I found the system unnecessarily complex.
3	P3	I thought the system was easy to use.
4	P4	I think that I would need the support of a technical person to be able to use this system.
5	P5	I found the various functions in this system were well-integrated.
6	P6	I thought there was too much inconsistency in this system.
7	P7	I would imagine that most people would learn to use this system very quickly.
8	P8	I found the system very cumbersome to use.
9	P9	I felt very confident using the system.
10	P10	I needed to learn a lot of things before I could get going with this system.

After the main features and NPC behavior had been functionally validated, beta testing was conducted to evaluate usability using the System Usability Scale (SUS) [24][25]. A total of 30 purposively selected respondents participated in the beta testing. The

respondents were selected based on their familiarity with digital games, computer use, or interactive applications. Participants were asked to play the game, interact with the restaurant environment, observe the NPC behavior, and answer ten SUS questionnaire statements. These statements consist of positively and negatively worded items used to assess perceived usability [26]. The statements are listed in Table III.

After completing the SUS questionnaire, participants also rated the game using a 5-point Likert scale to evaluate aspects such as interface comfort, ease of interaction, and gameplay flow. This provided additional insight into user satisfaction. Data were then processed using the SUS scoring method, where unanswered questions were assigned a neutral score of 3. Scores for positive (odd-numbered) items were calculated as (response – 1), while negative (even-numbered) items used (5 – response); the total was multiplied by 2.5 to yield a final SUS score ranging from 0 to 100. This process was applied to each respondent individually before calculating the average score [26]-[29]. The formula used is illustrated in Formula 1.

$$\bar{x} = \frac{\sum x}{n} \quad (1)$$

Description :

$\bar{x}$: Average score

$\sum x$: Total SUS score

n : Number of respondents

The final SUS score represents the overall usability of the game, where scores above 70 are considered good and acceptable, while those below 60 indicate the need for improvement [25][31]. Beta Testing was conducted on 30 participants aged 18–30 years with backgrounds in design, IT, or game development, chosen for their familiarity with games and computer use. The SUS results ranged from 45.0 to 100.0, with an average score of 73.5, placing *Sapiring Rasa* in the “Good” and “Acceptable” categories. However, the low minimum score indicates that some users faced issues, particularly related to functionality or interface comfort, highlighting areas for further refinement in future development.. Details of the questionnaire scores can be seen in table IV.

F. Distribution

The game *Sapiring Rasa* was distributed digitally through the Itch.io platform in a compressed .rar format. This package includes the executable file and all required assets, allowing users to easily download, extract, and play the game on desktop devices without needing installation. This method ensures simple and accessible gameplay for users.

TABLE IV. SUS TEST SCORES

R	Score Calculation Results										T o t a l	S U S S c o r e
	P 1	P 2	P 3	P 4	P5	P6	P7	P 8	P 9	P 1 0		
1	4	2	4	4		4	3	3	4	4	35	87.5
2	4	4	4	4		4	4	4	4	4	40	100.0
3	4	4	4	2		4	4	3	3	4	36	90.0
4	2	3	3	3		2	2	4	2	3	27	67.5
5	4	2	4	3		3	2	3	3	3	29	72.5
6	4	0	4	1		4	2	4	4	4	29	72.5
7	4	3	4	4		4	3	3	3	3	34	85.0
8	4	0	4	1		4	4	4	4	3	32	80.0
9	2	1	2	2		3	1	2	2	3	19	47.5
10	4	3	4	1		4	3	4	3	4	33	82.5
11	4	4	4	4		4	4	4	4	2	38	95.0
12	4	2	3	1		3	2	3	2	4	25	62.5
13	4	0	3	0		4	0	4	0	4	19	47.5
14	4	2	2	1		4	2	3	4	4	26	65.0
15	3	1	4	0		3	1	3	1	3	20	50.0
16	3	4	4	2		4	4	4	4	4	33	82.5
17	4	4	4	3		4	4	4	4	4	39	97.5
18	3	2	2	1		4	2	3	2	4	24	60.0
19	4	1	3	2		2	1	3	0	2	18	45.0
20	3	4	4	3		4	3	4	4	3	34	85.0
21	3	3	3	2		3	2	3	3	3	27	67.5
22	3	2	3	3		3	1	3	3	3	25	62.5
23	4	0	4	0		4	0	4	0	4	20	50.0
24	4	2	2	2		3	2	2	2	2	23	57.5
25	4	4	4	3		4	2	4	4	4	35	87.5
26	2	3	2	1		2	2	3	2	2	20	50.0
27	3	3	3	3		3	3	3	3	3	30	75.0
28	4	4	4	4		3	4	3	4	4	38	95.0
29	3	4	4	3		4	3	4	4	4	36	90.0
30	4	4	4	3		4	3	4	4	4	38	95.0
Average SUS Score											73.5	

III. CONCLUSION

This study led to the development of Sapiring Rasa, a 3D restaurant simulation game designed to promote traditional Sundanese restaurants, developed using the MDLC method and Unity3D. The game implemented key features such as restaurant management, ordering systems, food menu information, customer interaction, and NPC behavior controlled using FSM-based AI. The FSM implementation enabled customer NPCs to follow a structured service flow, including entering the restaurant, being seated, ordering food, eating, rating the experience, and leaving.

Usability testing with 30 participants produced an average SUS score of 73.5, placing the game in the Good and Acceptable range. This result indicates that the game is generally usable and has potential as a digital medium for promoting Sundanese culinary culture. However, the variation in user scores shows that some participants still experienced difficulties. These shortcomings may be related to limited user guidance, interface comfort, interaction consistency, and limited variation in NPC behavior. Future improvements should focus on providing clearer instructions, refining UI/UX consistency, expanding NPC behavior variation, and comparing FSM with other NPC behavior architectures such as Behavior Trees. Further development may also include broader platform compatibility and more diverse user testing to strengthen the evaluation results and improve the game's effectiveness as a cultural promotion medium.

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