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An Automatic Scenario Control In Serious Game To Visualize Tourism Destinations Recommendation

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ABSTRACT In the field of tourism, serious games are a pedagogical media application that helps players develop travel knowledge and expertise based on game content. A tourism serious game requires a scenario control system to visualize an attractive travel scenario. This paper proposes an Automatic Scenario Control in the serious game to visualize travel recommendation scenarios choice according to the player's expectations of potential tourism destinations criteria. There are two stages in system development, namely scenario design and scenario selection. In the scenario design stage, we use the Hierarchical Finite State Machine to translate challenge-based stories according to the type of attraction. While at the scenario selection stage, Dynamic Weight Topsis is a method for selecting one of the player's recommended scenarios. This study uses tourism destinations recommendations as to alternative variables, characteristics of tourism destinations as criteria, and players' expectations of tourism destinations' characteristics as weight criteria. In the implementation phase, the tourism serious game uses the content of tourism destinations in Mojokerto Indonesia. The test results show that Automatic Scenario Control generates a preference value for each alternative as a reference for choosing tourism destination scenarios for the player. Three things affect the scenario choice results, including the choice of month of tourist visits, player expectations of tourist destinations, and alternative input from the recommender system.

INDEX TERMS Automatic Scenario Control, serious game, tourism destinations, Hierarchical Finite State Machine, Dynamic Weight Topsis.

I. INTRODUCTION

In a country with a diversity of natural and cultural landscapes, such as Indonesia, tourism is one of the leading sectors that support the economy. Therefore the government is trying to introduce tourism to potential tourists through various promotional media. One of the promotional media that has not been implemented and discussed in various studies is games. Game is one of the new media in digital marketing technology. Developers can benefit from games for promotional media, including awareness of player needs, knowledge, and interest in brand content [1]. Games also can motivate players and involve the learning process contained in the content of games [2]. Games can promote tourism, and the costs incurred are more efficient than using posters, flyers, or advertisements. Games also have a wider spread because almost all tourists can play games on their smartphones. Tourists can use tourism games to enhance their travel experience. They can also be used as an innovative before-trip marketing tool, and encourage repeat visits after trip games can promote tourism.

One game genre with the characteristics and ability to visualize information and knowledge about tourism activities in detail is a serious game [3]. In advertising and services, serious games can provide information about products to consumers without their knowledge. These games tend to have a function for promotion, training, education, science, or other purposes that are more specific but still fun[4][5][6]. The serious benefit of implementing the game for tour operators is that they can use it as a promotional medium for tourism destinations. As for

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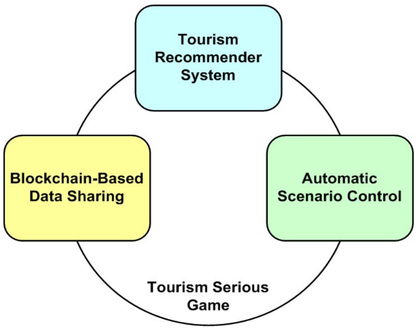

FIGURE 1. The research part of TSG.

tourists, this genre can increase knowledge about tourism destinations to prepare for a tour [7]. This statement is very reasonable because the serious game is a multimedia pedagogic product that helps players to develop knowledge and expertise on the game's theme [8].

Besides good visualization, a game also requires an attractive scenario design [9]. In this study, the game scenario's purpose was to visualize tourism activities in each tourism destination. Furthermore, we built Automatic Scenario Control (ASC) for the Tourism Serious Game (TSG) to reference these activities. This system provides the possibility of changing the scenario carried out [10] users based on environmental conditions and the characteristics of their desires. ASC is part of our research in building a tourism serious game (TSG) with a blockchain-based recommendation engine for potential tourists. Figure 1 shows this research's position, where some of the other parts we have discussed in the previous study [11] and [12]. The first research discusses blockchain-based data sharing to support data circulation used by other research sections. The second research on tourism recommender systems discusses how to generate recommendations for selecting tourist destinations for players. We use these recommendations as a reference for scenario selection in this study on automatic scenario control.

There are two processes in building a scenario control system, namely scenario design and scenario selection. Scenario planning is designing a storyline about the activities that players do in the game. The system requires logic and intelligence to regulate the game system's interaction with the player to ensure that a scenario can run. Several studies have used the Finite State Machine (FSM) to design game scenarios, including Artificial Intelligence (AI) [13], agent strategy [14], menu system to overall game activity rule [10]. FSM has developed into several other types: Hierarchical FSM (HFSM), which can handle more complex tactical scenario designs with many lowest level scenarios that are part of the main scenario [15]. In this study, we tried to take advantage of HFSM to design game scenario rules. The goal is to make it easier to translate scenarios in detail to provide players with an overview of traveling activities in each tourism destination. Scenarios are made based on many tourism destinations to accommodate a description of activities in all destinations. However, as we know, when playing a game, players can only run one scenario, so a process of selecting the most suitable scenario is needed.

In the scenario selection process, a game requires a method with a faster computational process. The reason is that players certainly want real-time interaction when running games. So we tried to use the Decision Support System (DSS) to handle the selection. One of the methods in DSS is Multi-Criteria Decision Making (MCDM). Among several techniques in MCDM, the Technique for Order Preference by Similarly to Ideal Solution (TOPSIS) is one of the techniques with simple computation [16]. Topsis is a technique that chooses alternatives based on the closest distance vector from the positive ideal solution and the furthest from the negative ideal solution [17]. When dealing with multiple alternatives, this technique performs better than other techniques [18]. Thus, this paper proposes using Topsis to handle the automatic selection of scenarios based on user preferences for environmental conditions of tourism destinations. To adapt to dynamic user desires, we use Dynamic Weight Topsis (DWT). This method is one of the Topsis method developments to assign appropriate weights to each attribute dynamically [19]. Topsis in the study obtained the appropriate attribute weights based on dynamic expectation data input from the user as a TSG player.

The collaboration between the HFSM and DWT methods can manage serious game scenarios, from design to selection. With this collaborative method, TSG can describe tourism destinations' activities through game scenarios and choose them according to the environment's user expectations. From the recommendations of tourism destinations discussed in previous studies, one is selected as the most suitable option for the user. We use the Unity game engine to build TSG and use tourism destinations in the Mojokerto area of East Java, Indonesia, as trial content. Unity is one of the most popular game engines and strongly supports 3D game visualizations with three programming language options: C #, UnityScript, and Boo [20][21].

A. RELATED WORK

There are several conceptual references in designing and developing game scenarios to convey knowledge to players, as shown in Table 1. In 2019, Luo et al. proposed a framework for designing scenarios suitable for individual players that use a database to generate scenarios and implement them in game-based learning. The authors create a scenario using a fitness evaluation methodology to integrate the player's intelligence modeling, simulation, and training process using an Artificial Neural Network (ANN)[22]. In another study, Pierre Laforcade and Youness Laghouaouta proposed a technique, namely Model-Driven Engineering (MDE), to design game-based learning scenarios. MDE has a special ability to handle dynamic scenarios [23]. In 2019 they offered a concept in building adaptive scenarios for learning games. Their research built scenarios by considering the scenario function as a transformation model from the student's profile as a player and a game description model. The authors apply the

TABLE 1. Related work for scenario design and scenario control.

References	Topic	Method	Object
[22]	Scenario design	ANN	Game-based learning
[23]	Scenario design	MDE	Game-based learning
[24]	Adaptif scenario design	Considering the scenario function as a transformation model	Autistic learning games
[25]	Adaptif scenario design	Considering the player profile as a series of activities	Serious game
[26]	Scenario design	ATTAC-L and XML	Educational serious game
[27]	Scenario design tool	ProDec	SPM game
[14]	Scenario design	HFSM base on pareto optima	Serious game for soil tilage
[28]	Scenario control	Multi-agent system	Serious game
[29]	Interactif scenario control	Interactive Scene Control Environment	Virtual environment game
[30]	Dynamic scenario	Agents controlling content and behavior	Museum serious game

scenario design concept to autistic children to learn visual performance skills [24]. In another study, Hussaan et al. introduced a scenario design concept adaptive to the serious game. The design scenarios considering the player profile as a series of activities to achieve learning objectives. A scenario design concept adaptive defines three knowledge to produce adaptive serious game scenarios, including the concept domain, learning resources, and serious game resources [25]. Several studies on game scenarios have become a knowledge reference for developing adaptive game scenarios to visualize recommendations for selecting tourism destinations in this study.

In 2014, Janssens et al. conducted research that discussed the stages of scenario creation for educational serious games. The scenario creation process has two stages, including the using scenario writing stage ATTAC-L followed by translating the scenario into a game engine using XML. Both of these tools make it easy to build scenarios [26]. In another study, Calderón et al. discussed a tool to design game scenarios about Software Project Management (SPM). They introduce an administration tool called ProDec, which allows a trainer to design game scenarios through this tool [27]. In 2020, a study on a serious game for soil tillage using HFSM in the scenario design. Through HFSM, game scenarios can visualize player game strategies [14]. In general, several previous studies that discussed scenario building tools have the advantage of simplifying the implementation of complex scenario designs in games, making it possible to use them in other similar studies. However, it is necessary to know that producing a good scenario requires an appropriate and interesting story idea design in visualizing game content. Therefore, in this proposed study, we offer increased suitability and attractiveness of scenario design through challenge-based story idea design according to tourism destinations' attraction types and characteristics.

Pons et al. introduce scenario control for the serious game using a multi-agent system in a scenario-setting. The system dynamically controls the game scenario to match the player's behavior. In building a serious game scenario, the challenge must adaptively adjust the developing players' skills [28]. Furthermore, in another study, Mihajlovic et al. propose a platform for interactive scenario control. The platform, called the Interactive Scene Control Environment (SCE), has two supervision parts, namely trainers and trainees. The trainer section can interactively control objects' placement and behavior and incorporate them into the scene [29]. The study about SCE becomes an essential reference for similar research in planning scenarios, especially for designing character behavior and placing objects in games. In a study, Mondou et al. introduce a dynamic scenario for a serious game with museum content with agents controlling content and behavior. They divide the scenario-building steps into two, namely, defining the behavior in grouping patterns and applying them [30]. Besides the scenario design system, the serious game also requires a system to control the scenario. Several kinds of research about game content ideas and scenario control become a reference to plan story ideas and design serious game scenarios. But apart from these two things, a game is better if it has more capabilities by adding a scenario selection system to make the game scenario suitable. Therefore, we offer the ASC concept with scenario design and scenario selection sections in the tourism serious game to visualize tourism destinations selection.

Several studies have offered various systems in providing knowledge to users about the selection of tourist destinations. Moussa et al., in a study, introduced a personalization-based system to help users determine their travel itineraries. The personalized system utilizes the ELECTRE method as a decision support system to find the optimal itinerary for the user [31]. Furthermore, Tenemaza et al. offer a mobile recommender system application for selecting tourism destinations base on tourist trip design problems. They designed a mobile recommendation system that can adapt to changing tourist destination environments and user interests [32]. In another study, Hasnat introduced a machine learning-based framework to overview the choice of tourist destinations for tourists. Machine learning performs location-based classification of tourist social media data from Twitter. Furthermore, the system predicts the next destination through the conditional random field model estimation [33].

Previous studies have implemented methods and frameworks to handle destination selection recommendations through web-based, online-based, and social media-based applications. However, to increase user interest, a system needs to consider the fun factor of using the application and visualizing interesting content. These two things can certainly affect the transfer of knowledge to

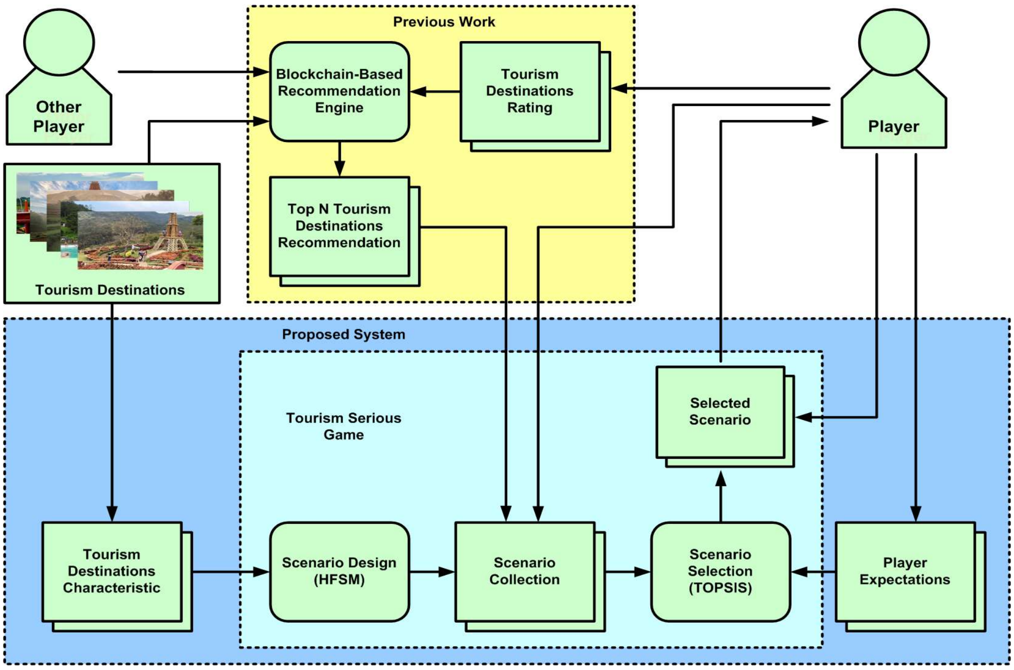

FIGURE 2. **The proposed system.**

users. Therefore, this study seeks to improve several previous studies' performance by visualizing a serious game that is interesting and fun. On the other hand, we also try to use the player's expectations of destinations as a reference criterion to improve their travel choices' accuracy.

B. CONTRIBUTIONS AND ORGANIZATION OF PAPER

Research on serious game scenarios, especially those focusing on tourism destination content, is interesting because few studies discuss it. One of the studies that address this topic is by Swacha and Ittermann [34]. They discuss how to produce an attractive tourism serious game scenario based on challenges. Attractive tourism serious game can increase the player's curiosity and interest, but an attractive tourism scenario design needs to consider the types and characteristics of tourist attractions. The suitability of the scenario and attraction is an essential factor in increasing the player's interest, knowledge, and experience. Because each attraction has different characteristics, it is necessary to have a different scenario idea in visualizing it.

In this study, we have an essential motive in developing a system that can control scenarios in choosing a serious game storyline by designing story ideas, scenarios, and their selection, especially to visualize tourism destinations recommended by players. Some of the points of contribution from this research are as follows. First, to produce exciting and challenging scenarios, this paper offers a collection of challenge-based story ideas tailored to tourist attraction types. We can use a collection of story ideas to plan a serious play scenario that introduces a tourist destination. Second, we offer a serious game scenario control system called Automatic Scenario Control (ASC) with two main parts: scenario design and scenario selection. Therefore, this paper describes designing and selecting a travel scenario following the player's expectations of the criteria for the tourism destination that tourists want to visit.

Furthermore, to explain each part of the research, this paper has several parts. Section 2 describes the design steps and methods used in this study. This section has several sub-sections, including TSG scenario flow, HFSM for designing TSG scenario, and scenario selection using Topsis. Section 3 discusses data acquisition. While section 4 discusses the results of game implementation and the discussion of testing. Finally, the discussion of the conclusions of this study occupies section 5.

II. DESIGN AND METHOD

In general, the ASC built in this study has two stages in the completion process: the scenario design stage and the scenario selection stage. Designing the scenario in question is designing a sequence of virtual tours offered to game users. The number of scenarios designed is the same as the number of tourism destination recommendations obtained from the process results in the previous recommendation engine section.

The recommendation engine in the previous research resulted in recommendations for selecting tourism destinations based on the user's personal characteristic (PC) and the user rating for tourism destinations. For first-time users, recommendations are generated based on their PC compared with the PC data classification results and tourist destinations from the previous tourist collection data. We classify PC training data and destination choices using an Artificial Neural Network (ANN). For users who have visited one of the tourist destinations that are the system's content, recommendations are generated based on the similarity of the destination assessment ratings against the

TABLE 2. Story ideas with attraction types based challenges.

Attractions	Challenge	Story Idea	Problem	Inducement
Natural Landscape (NL)	What	Inviting players to visit the NL attraction	Have never been to the NL attraction	Reward points at every visit to NL attraction
	When-where	Provides an overview of weather conditions each season in tourism destinations	The rainy season makes the visit not optimal	Reward points for choosing the right visit time
	How	Inviting players to use adventure vehicles	Natural landscapes need adventure vehicles	Reward points for using the correct choice of vehicle
	Why	Invites players to find objects as the NL attraction icon	Not knowing the NL attraction icon	Reward points for object discovery as an NL attraction icon
Artificial (AR)	What	Inviting players to visit each AR attraction	Never been to the AR attraction	Reward points in each AR attraction visit
	When-where	Provide an overview of the tourist visiting season	In certain seasons the visit is very crowded	Reward points for choosing the correct visit time
	How	Invite players to use public transportation	The tourist parking lot is often full	Reward points for the correct use of vehicles
	Why	Inviting players to find objects as the AR attraction icon	Not knowing the AR attraction icon	Reward points for object discovery as AR attraction icon
Cultural Heritage (CH)	What	Inviting players to visit each CH attraction	Have never visited the CH attraction	Reward points at each visit CH attraction
	When-where	Inviting players to visit the CH attraction when there is a special event	Inviting players to visit the CH attraction when there is a special event	Reward points for visits during special events
	How	Invite players to try using traditional vehicles and costumes	Introducing traditional vehicles and costumes	Reward points for proper use of traditional vehicles and costumes
	Why	Inviting players to find objects as the CH attraction icon	Not knowing the CH attraction icon	Reward points for object discovery as CH attraction icon

previous tourist rating data collection using the Multi-Criteria Recommender System (MCRS) method. PC data and tourism destinations rating can continue to grow with a data-sharing system between players using a blockchain network. In this study, the blockchain is a decentralized technology used to overcome the circulation of tourism destination rating data between players [11]. The combination of ANN and MCRS on the recommendation engine produces the highest to lowest recommendation rank called Top N Tourism Destinations Recommendations [12].

Each scenario is designed based on a tourism destination's characteristics, resulting in a different travel storyline. These various scenarios have the potential for increased complexity and challenges to solve them. In this scenario design phase, we use HFSM to describe the travel adventure storyline in each destination. In the scenario selection stage, the system selects one of several scenario design results for the user. We use Topsis as one of the Multi-Criteria Decision Making (MCDM) techniques to select the scenario.

Figure 2 shows the position of the proposed ASC and its connection to our previous work. Some of the yellow box sections are our previous work that focuses on building a blockchain-based recommendation engine. In this study, the blockchain is a decentralized technology used to overcome the circulation of tourism destination rating data between players. To visualize the recommendations, we designed a proposed system in the form of a serious game discussed in this paper. Implementing a serious game aims to increase players' understanding of knowledge about selecting tourism destinations in the initial phase of tourism activity. With a virtual environment, simulations, and game rules, the serious game can increase players' knowledge of content in the learning process [35].

We create two main parts in the proposed system, namely the scenario design and the scenario selection. The scenario design section is where we design scenarios for each tourism destination in the proposed serious game. The reference in scenario design is based on each tourism destination's characteristics, for example, the type and sequence of attractions. The number of scenarios and variations in each scenario's flow increases the complexity of the overall scenario. To solve this problem, we use HFSM in Scenario Design. Of all the scenarios designed, the system reduces them to several scenarios influenced by the Top N tourism destinations recommendation results. The purpose of the scenario design in this serious game is to visualize all scenarios for each tourism destination in the city, which are the game's content. However, to improve the recommendation results' suitability and increase player interaction with the game, they can evaluate the Top N recommendations for tourism destinations from the recommender system. If these recommendations are not suitable, players can directly update via in-game menu options before the scenario selection works.

The previous process results serve as a reference for determining the choice and number of scenarios in the Scenario Collection as input for the next process, namely the Scenario Selection. This section has the task of choosing a scenario that playing by the player using Topsis. Data on players' expectations of potential tourism destinations is a reference in determining these scenarios' choices. We determine the tourism destinations criteria as a reference for determining choices based on research [36]. There are weather, number of visitors, tourist spots, entrance tickets, and public facilities. In Scenario Selection, each criterion value from the expected data is used to weigh the criteria required by Topsis. In this section, we designed this system to automatically select a touring scenario in a tourist destination that is suitable for the player. However, suppose the player already has the desired tourist destination in some instances. In that case, the system allows the player to update the scenario selection results via the available menu and run it directly. All of that goes with the assumption that the player's chosen tourist destination is in the list of tourist destination scenarios designed in this game.

A. SCENARIO FLOW OF TSG

One of the benefits of implementing a serious game in tourism is increasing the experience and knowledge of traveling through a virtual environment [3]. Therefore, the serious game in this study takes the theme of travel in the selected tourism destinations. The goal is to provide virtual experiences to players to increase their knowledge of tourism destinations' in-game content. The TSG invites players to tour selected tourism destinations according to the player's recommendations and wishes through the game flow.

TSG in this study was built to be played by players as potential tourists in the before-trip phase. Games implemented in the initial phase of a tour should have four special challenges: what, when-where, how, and why [34]. What-challenge is a special challenge for players to make visits and activities in virtual tourism destinations. The aim is to introduce what become icons and activities in tourism destinations. When-where-challenge is a challenge that considers place or time, intending to attract players to visit certain places and times. The how-challenges in the before-trip phase illustrate how a player can reach each attraction in tourism destinations. This challenge can be in the form of invitations to use specific means of transportation. Meanwhile, the why challenge is a unique challenge for players to find their interest in tourism destinations.

This study tried to integrate the four special challenges in the game scenario and adjust them to the types of attractions that the selected tourism destinations have. There are several types of attractions with a fixed operating schedule in tourism destinations, including natural landscape (NL), artificial (AR), and cultural - heritage (CH) [37], [38]. Table 2. shows a collection of story ideas that contain special challenges in the tourism serious game scenario based on three types of attraction. Scenario planning based on story ideas based on specific challenges aims to increase the player's interest, knowledge, and experience of each attraction wrapped in curiosity and fun playing games.

B. HIERARCHICAL FINITE STATE MACHINE (HFSM) FOR DESIGNING TSG SCENARIO

A finite state machine (FSM) is a control system design methodology that describes the system's behavior or working principle using state, events, and actions [13]. At one point in a significant time, the system will be in one of the active states. The system can switch to another state if it gets specific input or events, either from external devices or components in the system itself (e.g., timer interrupt). This state transition is also accompanied by the system's actions when responding to the input that occurs. The actions taken can be simple actions to involve a series of relatively complex processes [39]. This FSM method is suitable for designing reactive and real-time control software such as games based on its nature. Therefore, this study uses FSM to design rule game scenarios, especially to describe the game flow based on story ideas in each virtual tourism destination in a serious game frame.

One of the obvious advantages of using FSM is its ability to decompose relatively large applications using only a small number of state items. Game researchers use this method to handle the game agent's AI implementation, the menu system, and the general game flow/rule [10]. A game programmer can easily translate scenario flow and rules into FSM's game engine programming language. In the development of research on FSM, researchers often combine these methods with other concepts or methods to improve their performance, for example, Hierarchical FSM (HFSM)[15][40]. HFSM implements a hierarchy to describe each FSM state. In particular, researchers usually use HFSM to simplify FSM's large complex form into several other FSMs in a hierarchically smaller scope. When a practical system has a large number of states and transitions, representation and analysis become difficult. In HFSM, the state has increased by using other FSM forms, namely slave FSM and master FSM in composition [41]. The HFSM method's ability is suitable for designing a complex tourism serious game scenario with various sub scenarios. We started the implementation of HFSM in this study with a hierarchical scenario design shown in Figure 3.

In the hierarchical scenario of TSG, the main scenario has 5 alternative sub scenarios, namely alternative 1 scenario (SA1), alternative 2 scenarios (SA2), alternative 3 scenarios (SA3), alternative 4 scenarios (SA4), and alternative 5 scenarios (SA5). Alternative scenarios consisting of SA1 to SA5 are a choice of game scenarios that visualize tourist trips in each alternative tourism destination 1 to 5. Each of these sub scenarios is a representation of the choice of tourism destinations from the recommendation system. SA1 to SA5 each have an attraction sub-scenario with a storyline according to the type of attraction of the selected tourism destinations, namely the natural landscape attraction scenario (SNL), artificial attraction scenario (SAR), and cultural - heritage attraction scenario (SCH). The rule scenario in each attraction sub-scenario describes the story idea with a challenge according to the type of attraction, as shown in Table 2. The designed hierarchy is further explained in detail through FSM, starting from the main scenario of TSG.

The main scenario is a part that describes the rules for the course of the game in general, starting from the beginning of the game, collecting data through questions to the player, selecting the Topsis-based scenario, running the scenario

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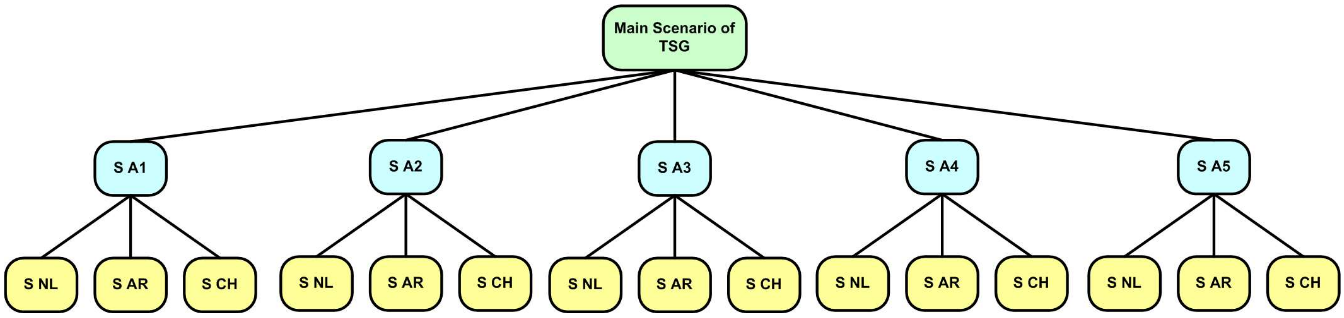

FIGURE 3. The hierarchical scenario of TSG.

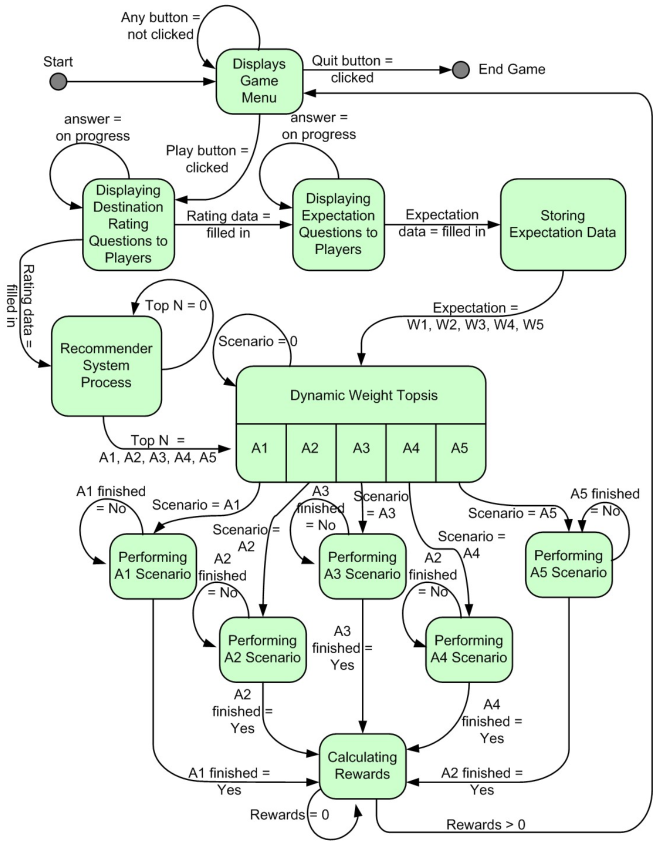

FIGURE 4. Master FSM of TSG.

from the chosen alternative to calculating the reward. Figure 4 shows the FSM master model of the main scenario of TSG. The FSM master in TSG scenario design has several states, including displaying game menu, displaying destinations rating questions, displaying expectations, storing data expectations, recommender system processes, and choosing alternatives (A1 - A5) based on topsis, performing *A1 - A5* scenario, and calculating reward.

In the proposed TSG, displays the game menu is the initial phase when the player runs the game for the first time. Futhermore the system runs the state displaying destinations rating questions to collect information about the characteristics of user ratings of tourism destinations as input for the state recommender system process. The recommender system produces the top five

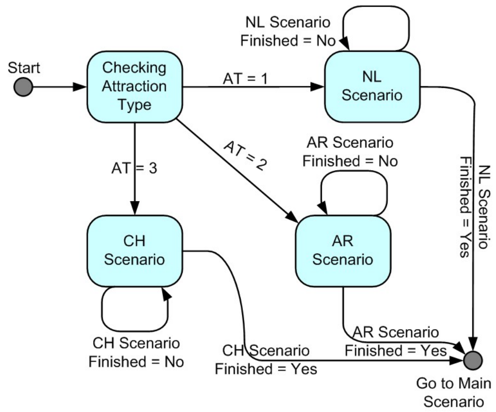

FIGURE 5. Slave FSM for performing alternative scenarios.

recommendations as to alternative tourism destinations *A1 - A5*. These recommendations are the five highest ratings of tourism destinations in a city that are game content. The five highest recommendations are also considered the most suitable players based on the previous process's recommendation system computation results, which consider the similarity of user preferences and the assessment of tourist destinations with previous user data. At the same time, the recommended top 5 ranking is to narrow down the most suitable choices for the player.

The system also runs the state displaying expectations questions, attempting to get player expectations data on a tourism destination's conditions. Then, the state of storing expectation player generates the expectation weight, where weather expectation = w_1, visitor number expectation = w_2, tourism spot number expectation = w_3, entrance ticket expectation = w_4, public facility expectation = w_5. Expectation weight data and alternative tourism destinations are input for states Dynamic Weight Topsis that determine an alternative of tourism destination as a choice of scenarios according to user expectations. After selecting one of the alternative scenarios, the system runs one of the selected scenarios. After the selected scenario runs and the mission is complete, the state calculating rewards is work. The final part of the scenario where the game system rewards the player after completing the selected alternative scenario's mission.

Figure 5 shows the performing state for each alternative scenario SA1 - SA5 in more detail via the FSM slave. Three

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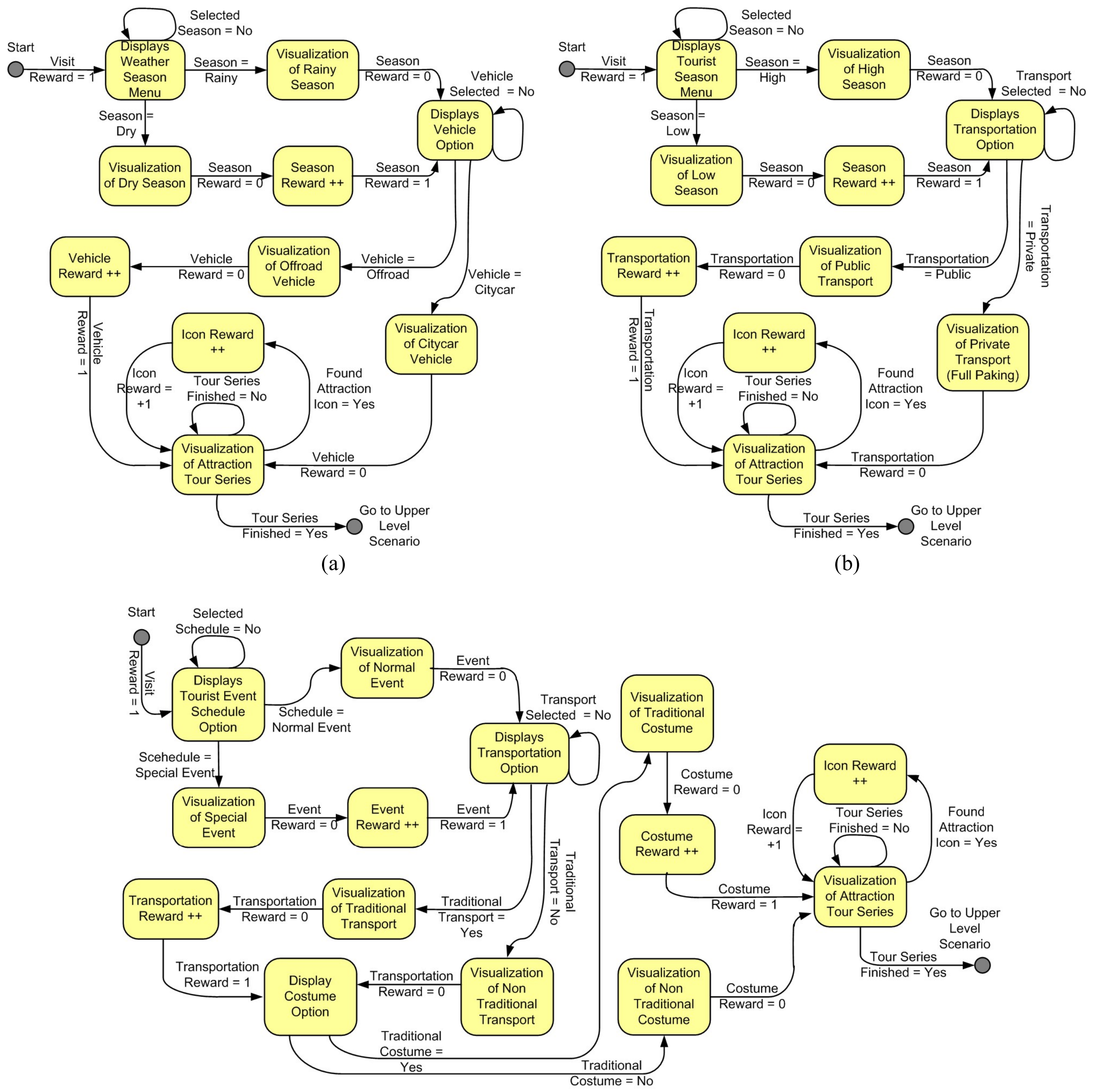

FIGURE 6. **Slave FSM of each attraction scenario. (a) NL scenario. (b) AR scenario. (c) CH scenario.**

states become sub scenarios in the FSM, namely the SNL scenario, SAR scenario, and SCH scenario. The three sub-scenarios have a design following the story idea with a challenge table based on attraction type.

Figure 6a shows the FSM slave design of the SNL scenario. According to the player's choice, the FSM slave has a state weather visualization, including visualization of the rainy season and visualization of the dry season, depicting Indonesia's weather season. Tourist visits to natural attractions during the rainy season have more obstacles than during the dry season. SNL scenario also has a state vehicle visualization, including visualization of offroad vehicles and city car vehicles. The suitability of weather and vehicle choices affects the addition of rewards for players. In addition, players who manage to get the attraction icon while running the game also get additional rewards.

Figure 6b shows the slave design of the FSM of the SAR scenario. The FSM started the process with a state of the display tourist season menu. If the player chooses to make a tourist visit during the high season, then that choice triggers the visualization of the high season state. Tourist visits during the high season have difficulties due to the density of visits to tourist attractions. If the players choose season = normal conditions, they trigger the state visualization of the normal season and add rewards for them. Players can also get additional rewards if they get an attraction icon during the game in the state visualization of the attraction tour series in the SAR scenario.

Figure 6c shows the design of the FSM slave to illustrate the flow of the SCH scenario. Slave FSM starts the storyline description with the state of displays event schedule option, which allows visit schedules when there are special events and no special events (normal events). In addition to visualizing the tourist event schedule, the scenario design also runs several types of state series, including transportation visualization, visualization of player costumes, and visualization of attraction tour series. In the SCH scenario, players have the opportunity to get rewards through four schemes, namely when choosing a special event schedule, choosing traditional transport, choosing traditional costumes, and when they get an attraction icon.

C. SCENARIO SELECTION USING TOPSIS

Topsis is one technique in the Multi-Criteria Decision Making (MCDM) method used by ASC to handle the scenario selection process. Topsis uses the principle that the chosen alternative is the best alternative with the shortest distance from the positive ideal solution. The longest distance from the negative ideal solution using the euclidean distance or the distance between two points relative proximity an alternative to the optimal solution. This technique has several advantages, so that it is one of the favorite techniques among several other techniques in MCDM. The advantages of Topsis include the concept of sensible decision making, easy-to-understand working principles, a simple computing procedure, and a lighter computation application [42] [43]. Until now, Topsis is still an interesting MCDM technique to be researched and developed [44].

In this study, we use Dynamic Weight Topsis (DWT) to carry out a decision-making process by considering several things: alternatives, criteria, and criteria weights. The alternatives are the top 5 choices of tourism destinations that have been determined by the tourism destinations recommendation system, namely *A1, A2, A3, A4*, and *A5*. The criteria are the characteristics of tourism destinations, including weather *C1*, visitor numbers *C2*, tourism spot *C3*, ticket price *C4*, and public facilities *C5*. For *C1* data relating to the weather every month in tourism destinations, in this research, we took the data available at www.bmkg.go.id. Furthermore, we get *C2* data directly from a collection of monthly visitor data in each tourism destinations from the Office of Mojokerto Tourism, Youth and Sports. Meanwhile, data for *C3, C4*, and *C5* were obtained from information available at www.disparpora.mojokertokab.go.id and each tourism destination's websites.

As a form of DWT implementation, the system determines the weights of the criteria w_1, w_2, w_3, w_4, and w_5 based on input from player expectations of the tourism destinations they want to visit. The weights can change dynamically at the beginning of the game and use a scale of 1 to 5 representing expectations of interest, where 1 = not important to 5 = very important.

The Topsis procedure, as part of the scenario selection in the ASC system, starts by calculating the normalized decision matrix with the formula shown in (1). Where r_{ij} is the normalized matrix element and x_{ij} is the decision matrix element x. Whereas i is the number of alternatives, $i = (1, 2, \dots, m)$ where m is 5, the number of tourism destinations selected from the previous process's recommendation system. Furthermore, j is an attribute that has been adjusted to the alternative, where $j = (1,2, \dots, n)$.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{1}$$

The second is calculating the weighted normalized decision matrix to produce a y_{ij} matrix, as shown in (2). Where w_i is the weighted value that shows the relative importance level as the player's expectations for each criterion.

$$y_{ij} = w_i \, r_{ij} \tag{2}$$

The third is to determine the positive ideal solution $A^+$and the ideal negative solution A^- which is determined based on the normalized weighted branch y_{ij}. Then y_i^+ is the element of the positive ideal solution and y_i^- is the element of the negative ideal solution.

$$A^+ = (y_1^+, y_2^+, \dots, y_n^+) \tag{3}$$

$$A^- = (y_1^-, y_2^-, \dots, y_n^-) \tag{4}$$

Where :

$$y_j^+ = \begin{cases} max\ y_{ij} : if\ j\ is\ the\ benefit\ attribute \\ min\, y_{ij} : if\ j\ is\ the\ cost\ attribute \end{cases}$$

$$y_j^- = \begin{cases} max\ y_{ij} : if\ j\ is\ the\ benefit\ attribute \\ min\, y_{ij} : if\ j\ is\ the\ cost\ attribute \end{cases}$$

In this study, the determination of the benefits or costs of the criteria is as follows. $C1$ is the only criterion that can cost or benefit depending on the player's desire for weather conditions in tourism destinations. This criterion becomes the expected cost of weather entered by game players, which is not the same as the weather in the month they enter and becomes a benefit if the opposite is true. For example, in January, which has rainy weather, but the player enters data on sunny or free weather expectations, the weather criteria become costly. $C2$ is the benefit criterion, where the more visitors, the more attractive a tourism destination is, so the better the value of these criteria. $C3$ and $C5$ are also benefited criteria because when a tourism destination has many tourist spots or complete public facilities, this can increase tourists' attractiveness to the place. In contrast, $C4$ is the cost criterion, where players as potential tourists are looking for tourism destinations with cheaper ticket rates.

Furthermore, the fourth determines the distance between each alternative's value with the ideal positive and negative solutions. Where $C4$ is the distance of the ith alternative with a positive ideal solution and D_i^+ is the distance of the ith alternative with a positive ideal solution and D_i^- is the distance of the ith alternative with a negative ideal solution.

$$D_i^+ = \sqrt{\sum_{j=1}^{n} (y_i^+ - y_{ij})^2} \tag{5}$$

$$D_i^- = \sqrt{\sum_{j=1}^{n} (y_{ij} - y_i^-)^2} \tag{6}$$

The last part is determining each alternative's preference value, where V_i is the proximity of each alternative to the ideal solution. The greater the value of V_i indicates that alternative A_i is preferred. Equation (7) shows the equation for getting the value V_i.

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \tag{7}$$

D. DETERMINATION OF CRITERIA

At this stage, we share these criteria to make it easier for players to describe their desired tourist destinations' conditions and characteristics. First, players get a choice of three *C1* criteria values to describe the desired weather conditions when visiting tourism destinations, namely free, sunny, and rainy, as shown in Table 3. Weather criteria can be cost or benefits depending on the player's choice of weather conditions. If they choose free or rainy, then the weather criteria will be a benefit for Topsis calculation. But if they choose sunny, then the weather criteria become the cost.

For the criteria for the number of visitors *C2*, players are also given five ranges of values, as shown in Table 4. The number of visits per month is the basis for determining the range of values. This criterion is a benefit in calculating Topsis. The assumption is that the more attractive tourist destinations are, the more visitors they come. Table 5 shows the choice of *C3* value, which represents the number of tourist spots in each tourism destination. The logic is that the more the number of tourist spots, the greater the value of *C3*. In this study, the number of tourism spots is a benefit in calculating Topsis.

Through the *C4* ticket price criteria, the system tries to explore data on player choices for tourism destinations based on the nominal value of the ticket price. The system provides five ticket price criteria options to simplify this choice, as shown in Table 6. As for the number of public facilities criteria, the system provides four players based on the number of available facilities in tourist destinations, as shown in Table 7. Types of facilities include rest areas, places of worship, places to eat, shopping places, toilets, and parking lots. The table also shows that the more complete the players desire the types of facilities available, the greater the value of *C5*. In this study, the ticket price criteria became the cost, while the number of public facilities criteria became a benefit in calculating the Topsis. The reason is that tourist orientation generally chooses cheap ticket prices with complete facilities.

TABLE 3. The weight of weather criteria.

w_1	Weather Options	Benefit/Cost
1	Free	Benefit
2	Sunny	Cost
2	Rainy	Benefit

TABLE 4. The weight of visitor numbers criteria.

w_2	Crowd Level	Visitor Numbers	Benefit/Cost
1	Deserted	< 10.000	Benefit
2	Rather deserted	10.000 – 25.000	Benefit
3	Medium	26.000 – 30.000	Benefit
4	Rather crowded	31.000 – 40.000	Benefit
5	Crowded	> 40.000	Benefit

TABLE 5. The weight of tourism spot criteria.

w_3	Tourism Spot Level	Number of Tourism Spots	Benefit/Cost
1	Little	1	Benefit
2	A little bit	2 – 4	Benefit
3	Medium	5 – 7	Benefit
4	Quite a lot	8 – 10	Benefit
5	Lots	> 10	Benefit

TABLE 6. The weight of ticket price criteria.

w_4	Expensive Value	Ticket Price (IDR)	Benefit/Cost
1	Cheap	<= 5.000	Cost
2	Rather Cheap	5.001 – 10.000	Cost
3	Medium	10.001 – 15.000	Cost
4	Rathet Expensive	15.001 – 20.000	Cost
5	Expensive	> 20.000	Cost

TABLE 7. The weight of public facilities criteria.

w_5	Completeness	Number of Public Facilities	Benefit/Cost
1	Incomplete	1	Benefit
2	Rather Complete	2 – 3	Benefit
3	Towards Complete	4 – 5	Benefit
4	Complete	6	Benefit

III. DATA ACQUISITION

To implement the ASC design on TSG, we took tourism destinations in Mojokerto, East Java, Indonesia. Mojokerto is a tourist city that has a tourism destination with a relatively complete type of attraction. This area has some mountainous areas with an attractive natural landscape. Tourists also find several types of artificial attractions that are suitable for children and families to visit. Besides, Mojokerto is an area that has many Javanese royal sites, which have now turned

TABLE 8. The example of tourism destinations data.

Alternative			Criteria				
Code	**Tourism Destination**	**Attraction Type**	*C1*	*C2*	*C3*	*C4*	*C5*
TD 1	Wana Wisata Padusan Pacet	NL	1	35066	11	12500	6
TD 2	Air Terjun Dlundung	NL	1	3278	2	10000	5
TD 3	Petirtaan Jolotundo	CH	1	6337	1	10000	5
TD 4	Makam Troloyo	CH	1	45012	1	5000	6
TD 5	Pemandian Air Panas	AR	1	29857	1	10000	6
TD 6	Museum Trowulan	CH	1	6969	1	3000	6
TD 7	Ekowisata Tanjungan	NL	1	10122	6	5000	5
TD 8	Siti Inggil	CH	1	62	1	3000	3
TD 9	Coban Canggu	NL	1	2328	2	7000	5
TD 10	Pemandian Ubalan Pacet	AR	1	10122	3	30000	6
TD 11	Candi Bajangratu	CH	1	2170	1	5000	3
TD 12	Candi Brahu	CH	1	2303	1	3000	4
TD 13	Candi Tikus	CH	1	2609	1	3000	3

FIGURE 7. The example of virtual environment visualization.

into tourism destinations with excellent cultural and heritage attractions.

We observe and collect data on the physical form of objects, buildings, and the environment in each tourism destinations. The goal is to get a visual image as a material for building virtual objects and environments in the game to be similar to the real thing. Next is to collect data on the characteristics of the criteria that each alternative has. Not all criteria have fixed data. Some change dynamically following changes in the month, such as weather criteria *C1* and number of visitors *C2*. There are two values for *C1*, namely 1 for rainy weather and 2 for sunny weather, which refers to tropical weather types. Every month the number of visitors changes, which causes a variation in the value of *C2* criteria. *C3* criteria data shows the number of tourist spots in each tourism destinations.

Meanwhile, *C4* is the ticket price value for each destination in Rupiah. The *C5* criterion shows the number of public facilities in tourism destinations, where the more the number, the more complete the tourism destinations are. As test materials, we used the criteria data for each tourist destination in Mojokerto from January to June 2019. Table 7 shows an example of the criteria data in March.

IV. RESULT AND DISCUSSION

A. TSG IMPLEMENTATION

The beginning of the TSG visual form development process was designing the menu display, user interface, characters, objects, maps, and virtual game environments to visualize each tourism destination scenario. Figure 7 shows an example of a virtual game environment display complete with objects, maps, and reward views. TSG's visual display provides players with some important information. The first is a map that provides information on the player's position when traveling in a virtual tourism destination environment. Next are the account information and reward points in the upper left corner of the screen. The system also provides mission-related information and content via the information box in the screen's lower-left corner.

As shown in Table 8, the 13 tourism destinations are the content of the scenario development for TSG. Therefore, TSG also has a game scenario design for each tourism destination, even though the recommendation system only selects 5 tourism destinations before finally determining one through Topsis.

B. DWT RESULTS AND ANALYSIS

This section describes the results of the initial testing and analysis of the DWT to ensure that this method works following the design objectives. We used 13 tourism destinations TD1 to TD13 with data criteria that varied from January to June. In this stage, we use 13 tourism destinations as alternatives in DWT *A1* to *A13*. The results of alternative selection using DWT on TSG are influenced by each criterion's weight value variation. Besides, changes in the criteria data every month also affect these results.

Table 9 shows the difference in each alternative's preference value every month, which results from the two sample criteria weights. The first sample has weight values w_1 = 2, w_2 = 1, w_3 = 1, w_4 = 4, and w_5 = 1. While the second sample has a weight value of w_1 = 2, w_2 = 2, w_3 = 2, w_4 = 5, and w_5 = 1. The two samples have different criteria configuration, where the first sample represents the sunny weather expectation where *C1* = cost, *C2* = benefite, *C3* = benefite, *C4* = cost and *C5* = benefite. While the second sample represents rainy weather using the configuration *C1* = benefite, *C2* = benefite, *C3* = benefite, *C4* = cost and *C5* = benefite. In the first sample, several alternatives change the preference value every month, even though the weight value and benefit configuration and cost are still constant. These changes affect the ownership of the highest preference value,

TABLE 9. Calculation results of proximity value of each alternative ideal solution based on the month of tourism arrival.

Samples	Criteria Weight					Preference Value for Each Alternative													Month
	w_1	w_2	w_3	w_4	w_5	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}	
1	2	1	1	4	1	0.66	0.59	0.60	0.72	0.64	0.70	**0.75**	0.68	0.65	0.11	0.67	0.69	0.69	January
						0.63	0.59	0.59	0.71	0.62	0.70	**0.72**	0.68	0.65	0.08	0.67	0.69	0.69	February
						0.63	0.59	0.59	**0.74**	0.63	0.70	0.72	0.68	0.65	0.08	0.67	0.69	0.69	March
						0.65	0.59	0.59	**0.76**	0.64	0.69	0.72	0.68	0.65	0.07	0.66	0.69	0.68	April
						0.65	0.60	0.60	**0.76**	0.63	0.70	0.74	0.69	0.66	0.10	0.67	0.69	0.69	May
						0.67	0.61	0.60	0.70	0.66	0.70	**0.73**	0.69	0.66	0.11	0.67	0.69	0.69	June
2	2	2	2	5	1	**0.71**	0.52	0.52	0.65	0.60	0.61	0.70	0.59	0.57	0.17	0.58	0.60	0.60	January
						0.64	0.52	0.52	0.63	0.56	0.61	**0.66**	0.59	0.56	0.13	0.58	0.59	0.60	February
						0.65	0.52	0.52	**0.68**	0.57	0.61	0.65	0.59	0.56	0.13	0.58	0.60	0.60	March
						0.69	0.52	0.52	**0.71**	0.59	0.60	0.65	0.59	0.56	0.12	0.58	0.59	0.60	April
						0.64	0.51	0.51	**0.68**	0.55	0.59	0.65	0.59	0.56	0.09	0.57	0.59	0.59	May
						0.70	0.52	0.51	0.60	0.60	0.59	0.63	0.59	0.56	0.11	0.57	0.59	0.59	June

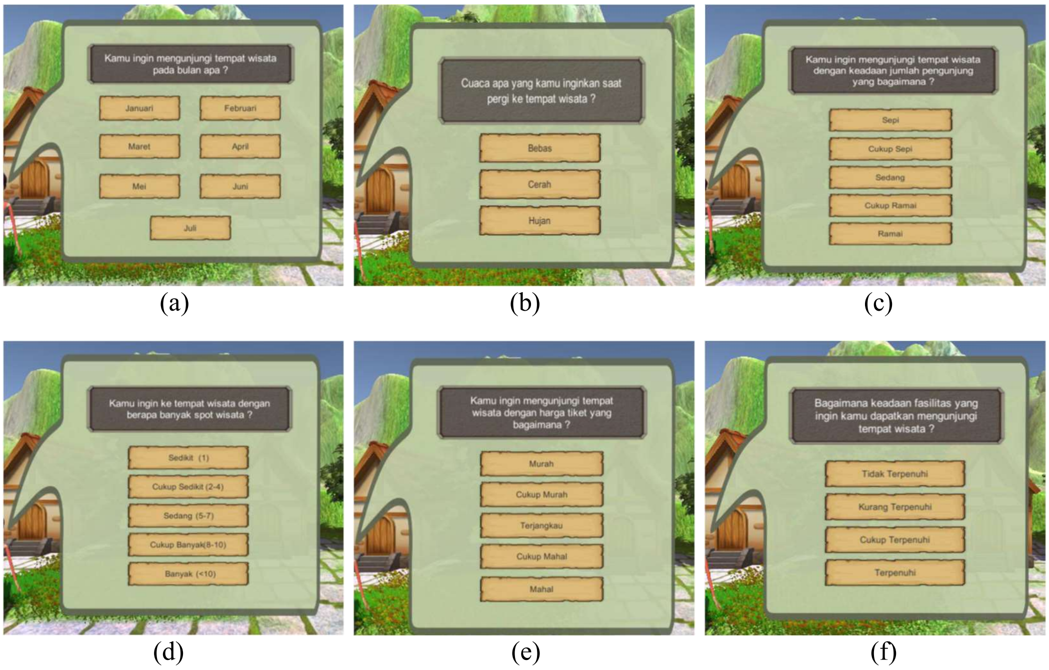

FIGURE 8. Expectation question to player. (a) The tour month question. (b) Weather question. (c) The number of visitors question. (d) The number of tourist spots question. (e) Ticket price question. (f) Tourism destination facilities question.

where in January the highest was *V7* = 0.75, February *V7* = 0.72, March *V4* = 0.74, April *V4* = 0.76, May *V4*= 0.76 and June *V7* = 0.73. In the second sample, the resulting preference values are different and more varied, where in January the highest preference was V1 = 0.71, February *V7* = 0.66, March *V4* = 0.68, April *V4* = 0.74, May *V4* = 0.68 and June *V1* = 0.70.

Based on this analysis, each criteria's weight value that changes based on user expectations and the choice of month of arrival by the user affects each tourist destination's preference value *V1* to *V13*. In this study, the weight value design for each criterion resulted in 1500 possible combinations of weights. This situation causes more variations in the preference value generated by the system.

C. RESULT OF SCENARIO SELECTION USING DWT BASED HFSM

Before Topsis worked to determine destination choice, the system interacted with the players through several questions related to each criterion's expectations. The system gets this information through player interaction with the question box, as shown in Figure 8. Figure 8a shows the question box about the planned months of arrival to tourism destinations. In comparison, Figures 8b to Figure 8f show the question box of players' expectations of $C1$, $C2$, $C3$, $C4$, and

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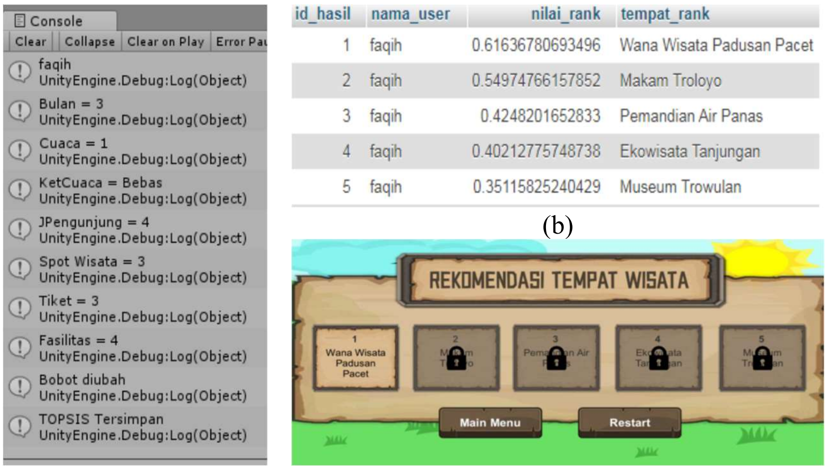

(a) (c)

FIGURE 9. Example result of HFSM based topsis. (a) Display of expectation input in the Unity console. (b) Display of topsis value ranking results for alternative tourism destinations. (c) Display of scenario selection results.

TABLE 10. Result of scenario selection trial based on alternative input from the recommender system and user expectations.

Sample	Alternative Options of the Recommender System					Player Expectations					Preference Value of Each Alternative					Selected Scenario
	A1	*A2*	*A3*	*A4*	*A5*	*C1*	*C2*	*C3*	*C4*	*C5*	V_1	V_2	V_3	V_4	V_5	
1	TD 1	TD 5	TD 7	TD 9	TD 10	Sunny	Rather deserted	Medium	Cheap	Towards Complete	0.70	0.28	0.39	0.19	0.18	TD 1
2	TD 3	TD 4	TD 6	TD 8	TD 11	Sunny	Rather crowded	Lots	Medium	Towards Complete	0.24	0.44	0.30	0.28	0.27	TD 4
3	TD 4	TD 6	TD 11	TD 12	TD 13	Free	Deserted	Quite a lot	Rather Expensive	Rather Complete	0.47	0.48	0.45	0.47	0.47	TD 6
4	TD 1	TD 2	TD 3	TD 5	TD 7	Sunny	Medium	Quite a lot	Medium	Complete	0.68	0.30	0.29	0.38	0.46	TD 1
5	TD 2	TD 3	TD 5	TD 7	TD 9	Rainy	Rather deserted	A little bit	Medium	Complete	0.42	0.42	0.50	0.55	0.45	TD 7
6	TD 6	TD 8	TD 11	TD 12	TD 13	Fee	Medium	Quite a lot	Medium	Complete	0.36	0.33	0.32	0.34	0.34	TD 6
7	TD 1	TD 5	TD 7	TD 9	TD 10	Rainy	Deserted	Little	Rather Expensive	Incomplete	0.65	0.65	0.74	0.67	0.15	TD 7
8	TD 4	TD 6	TD 8	TD 11	TD 12	Sunny	Crowded	Medium	Cheap	Complete	0.53	0.18	0.12	0.11	0.13	TD 6
9	TD 9	TD 10	TD 11	TD 12	TD 13	Rainy	Rather deserted	A little bit	Medium	Complete	0.48	0.24	0.48	0.51	0.50	TD 12
10	TD 3	TD 5	TD 7	TD 9	TD 10	Free	Rather crowded	Medium	Medium	Complete	0.28	0.43	0.40	0.31	0.19	TD 5

$C5$, which are then converted into weight data for the criteria w_1, w_2, w_3, w_4, and w_5.

After getting the player's criteria weight, the system calculates Topsis to determine one of the five tourism destinations that match the player. Figure 9a shows an example of the input from the player displayed by the game engine console. The Fakih account player plans a tour in month = 3 (March) with a value of $w_1 = 1, w_2 = 4, w_3 = 3, w_4 = 3$ $w_5 = 4$, and criteria configuration of *C1* = benefit, *C2* = benefit, *C3* = benefit, *C4* = cost, *C5* = benefit. The weight values and the criteria configuration represent the visit expectations as follows, wether = free, crowd level tourist = rather crowded, tourism spot level = medium, the expensive value of ticket price = medium, and completeness public facilities =complete. Figure 9b shows the Topsis calculation results of five consecutive alternatives stored in the ASC database system that worked well following the design scheme and succeeded in selecting alternative tourism destinations for players. The results indicate that the alternative Wana Wisata Padusan Pacet has the highest value, namely 0.6164, so it is the best choice for players visualized in the choice of game scenarios in Figure 9c. Furthermore, the system visualizes these choices' results to start their tour virtually according to the selected tourism destination scenario.

Next, we tested the TSG design with ASC on several potential tourists to see the various tourist destinations. Table 10 shows the test results based on 5 alternatives (*A1, A2, A3, A4, A5*) from the recommendation system and expectations against the 5 criteria (*C1, C2, C3, C4, C5*) from the player. The preference value of each alternative changes in each test sample due to differences in alternative input from the player's recommendation system and expectations. The

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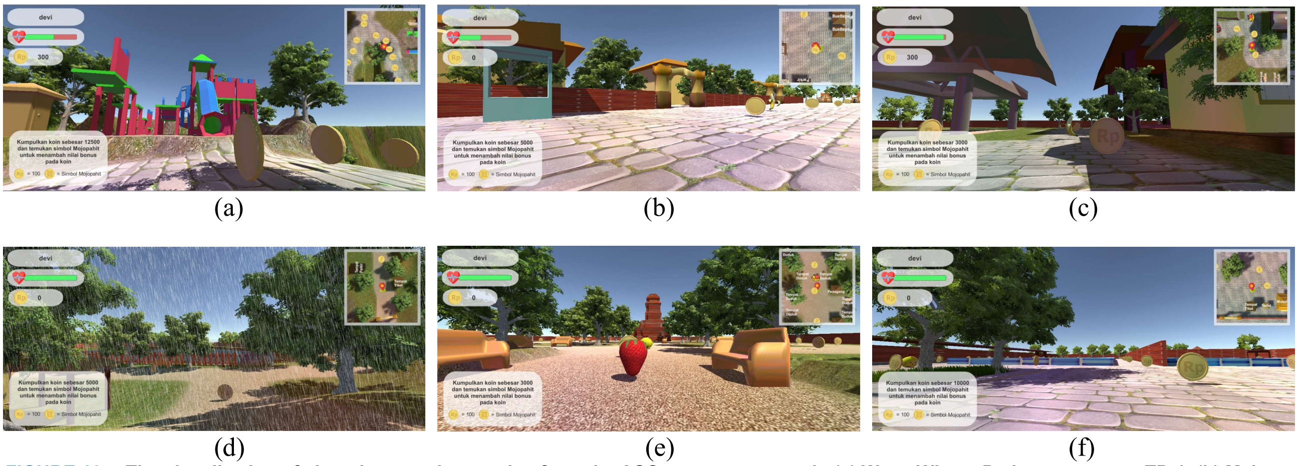

FIGURE 10. The visualization of changing travel scenarios from the ASC system test result. (a) Wana Wisata Padusan pacet as TD 1. (b) Makam Troloyo as TD 4. (c) Museum Trowulan as TD 6. (d) Eko Wisata Tanjungan as TD 7. (e) Candi Brahu as TD 12. (f) Pemandian Air Panas as TD 5.

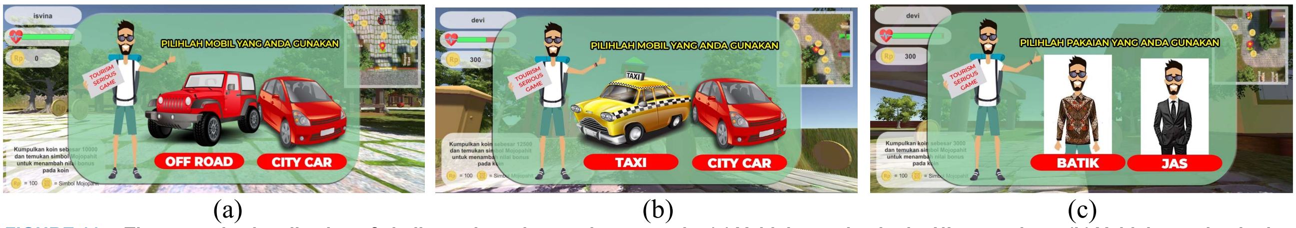

FIGURE 11. The example visualization of challenge-based attraction scenario. (a) Vehicles option in the NL attractions. (b) Vehicles option in the AR attractions. (c) Clothing option for tourist in the CH attraction.

change in preference value causes variations in scenario tourism destinations selected based on each sample's highest preference value. There are two special conditions in the test results table that relate to a combination of alternatives and player expectations. First, samples 1 and 2 have the same combination of alternative options generated from the recommendation system, but both have different player expectations input. This condition causes a difference in each alternative's preference value in samples 1 and 7, so the choice of tourism destinations scenario is also different, wherein sample 1, the scenario for Wana Wisata Padusan Pacet, was selected. In contrast, in sample 7, the Tanjungan Ecotourism scenario was selected. Second, although in samples 5 and 9 there are similarities in the conditions of players' expectations of tourism destinations criteria, both of them get a different combination of recommendations from the recommender system.

In this research, the ASC system can automatically select scenarios according to the input of tourist destination recommendations and player expectations data. According to challenge-based story ideas tailored to the type of attraction, ASC exclusively and completely visualizes each travel scenario. Figure 10 shows several visualizations of the results of different scenario choices based on the 10 ASC test samples. The different scenarios that visualize some of the attraction tour series show the change in ASC's scenario choices based on input recommendations and player expectation data. Figure 11 shows an example of the results of the visualization of the challenge-based attraction scenario with several forms of offering options for the use of vehicles and clothes for tourists in the game.

TABLE 11. The demographic of potential tourists as game players.

Variable	Category	Frequency	Percentage (%)
Gender	Male	5	15.6
	Female	27	84.4
Age	< 17	0	0
	18 – 22	4	12.5
	23 – 27	27	84.4
	28 – 32	1	3.1
	33 – 38	0	0
	> 39	0	0
Arrival experience	Ever come	17	53
	Not yet come	15	47
Hometown	In the city	17	53
	Out of town	15	47
Hobby	Traveling	32	100
	Non traveling	0	0
Education	High school	3	9.4
	Undergraduate	29	90.6

D. RESULTS OF GAME IMPLEMENTATION TO POTENTIAL TOURISTS

This section explains the results of the analysis of the ASC implementation in the game to potential tourists. We tested the system on 32 potential tourists as game players. They are potential tourists that we randomly selected and confirmed that they were planning to travel to tourist destinations in Mojokerto. Some of them plan to travel independently, and others plan to travel through a travel agency. In the game evaluation process, we allow them to play TSG and provide some feedback points to analyze test results. Table 11 shows the demographic of all these

TABLE 12. Comparison rate of accuracy, precision, recall, and f1 score.

Reference	Method	Application	Result			
			A	*P*	*R*	*F1*
[33]	Ada Boost	Social Media	0.77	0.78	0.78	0.77
[31]	ELECTRE	Web based Traveller's Information	-	0.67	0.71	0.68
[32]	K-mean + Genetic Algorithm	Mobile Recommen-dation system	-	0.84	0.50	0.63
Ours	HFSM + DWT	Tourism Serious Game	0.78	0.80	0.96	0.87

TABLE 13. The result of media and material aspects assesment.

Media Aspect				Material Aspect			
Ap	U	Q	Average	En	K	Ex	Average
8.4	7.7	7.3	7.8	7.5	8.2	8.0	7.9

potential tourists. In the first stage, we analyzed the accuracy (*A*), precision (*P*), recall (*R*), and F1 score (*F1*) using the confusion matrix method. Accuracy defines the level of closeness between the predicted value of the ASC and potential tourists' actual value. Precision is the accuracy between tourist destination desires from potential tourists and the ASC system's choice in the game. To complete the confusion matrix calculation data, we collect feedback data on tourism destinations' choices from each potential traveler and compare it with the selected results from the ASC. We use the following formula to get the values of *A, P, R,* and *F1*.

$$A = \frac{TP + TN}{TP + TN + FP + FN} \quad (8)$$

$$P = \frac{TP}{TP + FP} \quad (9)$$

$$R = \frac{TP}{TP + FN} \quad (10)$$

$$F1 = 2 \times \frac{P \times R}{P + R} \quad (11)$$

In this research, *TP* represents the number of conditions at which users select tourist destinations based on having similarities with the system selection results. *FP* represents unexpected results, for example, when the system has given the correct prediction, but the user's choice is wrong because they want a not available destination. Furthermore, *FN* is a condition where the system's prediction results are not following the wishes of the user's choice of tourist destinations. *TN* represents situations when the system and the user both have options outside of the available options. In this research, the system has value of $A = 0.78$, $P = 0.80$, $R = 0.96$, and $F1 = 0.87$. Table 12 shows the comparison of *A, P, R,* and *F1* values between our proposed system and other studies with different methods and applications. From this comparison, it can be concluded that the proposed system has a higher value in terms of accuracy, recall, and *F1* value. As for precision, this system still does not have the highest score, although it is not the lowest of all comparison references.

Next, we collect data on the response of potential tourists as players after playing this TSG. The assessment aspects of the response data include media and material aspects. The media aspect consists of the criteria of appearance (Ap), ease of use (U), and the quality of the game (Q). In contrast, the material aspect consists of the criteria of fun (En), knowledge (K), and experience (Ex) [45]. To get player response data, we asked them to evaluate each criterion with a value range of 1 to 10. Table 13 shows the average value of the assessment results of all potential tourists who have used TSG. Based on the assessment results table, the material aspects representing the content and the game scenario get an average of 7.9, slightly higher than the media aspects' assessment. The player's highest rating is on the Ap criteria in the media aspect, with a score of 8.4. However, in general, we need to improve the game's quality because we get a lower average rating of 7.3.

V. CONCLUSION

This paper discusses the proposed system known as ASC to handle scenario selection in TSG. We divided the design stages into two parts to produce ASC, namely the scenario design and scenario selection sections. This study uses HFSM to design a travel scenario flow for each destination based on a challenge-based story plan in the scenario design stage. In the scenario selection section, the technique used in scenario determination is DWT. This method selects one scenario from the five tourism destinations recommended by the previous system $A1$, $A2$, $A3$, $A4$, dan $A5$ based on the player's expectation input as weights w_1, w_2, w_3, w_4, and w_5 for the criteria for each tourism destination *C1, C2, C3, C4*, and *C5*.

Before testing, we implemented the ASC design for tourism destination content in Mojokerto. Furthermore, this system has 1500 possible combinations of criterion weights representing players' expectations of tourism destinations to produce variations in alternative preference value changes. The difference in traffic and weather data each month also causes changes in alternative preference values. The ASC implementation for TSG shows that ASC has received data input from players' expectations through the query box. In the testing phase, ASC succeeded in producing a choice of virtual travel scenarios in tourism destinations for players. Two things that affect the selection of tourism destination scenarios are the combination of input choices of tourist destinations from the recommendation system and the combination of tourist destination players' expectations represented in each tourist destination's criteria weight values. ASC in TSG has an accuracy value of 0.78, precision 0.80, recall of 0.96, and F1 score of 0.87. Meanwhile, based

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on potential tourists' assessment as test players, the system gets an average score for media aspects of 7.8 and material aspects of 7.9.

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