Design and Development of a Gamified Mobile Application for Nakhon Pathom Community Ecotourism

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ABSTRACT

Gamification and mobile applications have been widely utilized across various sectors to enhance engagement, influence behavior, and improve outcomes. In the tourism industry, gamification and mobile applications have similarly been adopted to advance tourism marketing efforts. This study aimed to develop a gamified mobile application for community ecotourism and evaluate its appearance, functionality, usability, and user satisfaction. A mixed-methods approach was employed in the research. The sample comprised 30 ecotourism entrepreneurs and 400 tourists in Nakhon Pathom, Thailand. Data was collected through non-participant observation, in-depth interviews, and software evaluation questionnaires. Qualitative data were analyzed using triangulation, while quantitative data were analyzed using descriptive statistics. The gamified mobile application was designed by a user interface (UI) designer and developed using a visual programming language with a non-relational cloud database. The application featured three main components, with user roles categorized into two groups: game masters (representing ecotourism entrepreneurs) and players (representing tourists). The game elements included points, badges, leaderboards, and feedback mechanisms. Technologies integrated into the application included QR codes, GPS, Google Maps API, and geo-fencing. The application's core functionality was centered on Google Maps' place markers, with each place marker containing gamified activities. Ecotourism entrepreneurs managed the game content and supported players, while tourists participated in the game by visiting locations, engaging in gamified activities, and providing feedback. The application underwent testing and evaluation by developers and users. The overall user evaluation results indicated high levels of satisfaction, with scores for appearance, functionality, usability, and overall user satisfaction averaging at a high level ($\overline{X}$ = 4.17, SD = 0.54). The findings suggest that the proposed gamified mobile application represents a viable solution to promote community ecotourism in Nakhon Pathom, effectively meeting the needs and expectations of tourists.

Keywords : Application Design and Development, Community Ecotourism, Gamification

Introduction

The Ministry of Tourism and Sports discussed how the Thai tourism industry generated revenues of up to 1,068 million baht. Thai government focuses on and supports community ecotourism which involves the sustainability of the environment and cultural attractions in the local area. [1]. In general, the people in the community set a direction, manage tourist attractions, and accommodate visitors. The community must respond to the effect of tourism on natural

resources, cultures, and local traditions. [2],[3],[4],[5] Community ecotourism can be characterized as a type of tourism that attracts a distinct demographic of tourists. General tourists may require initial motivation and a well-defined purpose to participate in community ecotourism. The problem is that community ecotourism entrepreneurs must determine appropriate methods and tools to motivate tourists, create an impressive experience in community ecotourism, and attract more tourists [5]

According to the Household Information and Communication Technology Survey by the National Statistical Office, there were approximately 17.9 million computer users (28.3%), 36.0 million Internet users (56.8%), and 56.7 million (89.6%) mobile phone users. [6] The information indicated that information technology plays a crucial role in everyone's daily life. In general, the appropriate technology should be easily accessible to everyone. It must be online, small, portable, and perform tasks like searching data, communicating, using social media, and playing games. In Thailand, the top favorite mobile phone usage is playing online games. For these reasons, community ecotourism entrepreneurs need to understand the potential behaviors and practices of people in the digital age. The impressive feature of the game is that the mechanics used can entice players to spend their time paying attention and willingly doing the game's objectives and get the fun infiltrating with unawareness.

Gamification is the application of game mechanics to drive more engagement and enjoyment for non-game activities [7] Moreover, gamification adjusts user behavior to meet preferences. [8] Merchandising, education, and personnel management have utilized this approach. The tourism industry also applied gamification to motivate tourists and create a more enjoyable tourism experience. There were some applications of gamification in the tourism industry. However, they were not known or referred to as the concept of gamification, such as having a membership card, earning miles from a flight, and accumulating points to redeem rewards. [9] In Thailand, gamification has been adopted across various sectors, including tourism. However, the suitable gamification application for community ecotourism still needs to be clarified.

Gamification in community ecotourism remains challenging, primarily due to the limited number of relevant research studies [10] A research study by Harfield (2015) designed an interactive puzzle game for tourists in Phitsanulok, Sukhothai, and Phetchabun provinces in Thailand, applied the gamification concept to create a mobile application to capture the attention of tourists and provide tourists with access to places and fun with puzzle games [11] A research study by Chen [12] designed a mobile application prototype using game elements such as missions and point collecting to challenge foreign tourists to learn and understand Chinese culture and history [12] A research study by Signoretti et al. [13] developed Trip 4 All, an application that works on georeferenced maps as a gamified virtual assistant to the elderly during a walking tourist visit. The proposed application intends to work as a companion that provides self-confidence, support, and social integration to elderly tourists [13] A research study by Mihaela et al. [14] applied gamification techniques to develop a mobile application for tourism to create more challenges for users. The key technique in the research was the combination of area data that tourists have not yet

explored with game techniques, such as point-collecting, which indicate the travel progress of tourists [14]

Considering the points raised earlier, a gamified mobile application for Nakhon Pathom community ecotourism needed to be designed, developed, and evaluated. Community ecotourism entrepreneurs and tourism organizations used the gamified application to manage tourist attractions and activities. Moreover, the gamified mobile application was used to enhance tourist motivation and create more fun community ecotourism experiences that increased the number of potential tourists and the growth of the community ecotourism economy.

1. Research objectives

1.1 To design and develop a gamified mobile application for community ecotourism.

1.2 To evaluate the application's appearance, functionality, usability, and user satisfaction.

2. Literature Reviews

2.1 Gamification

Human beings possess an inherent inclination to interact with activities that mirror the structured nature of games, which makes them naturally inclined to engage in gaming. Gamification refers to the use of game mechanics to motivate the user to stay focused on a specific object or non-game activity and to change their behaviors to meet the desired outcome. [15] All games contain various game mechanics such as scoring, challenge, leaderboard, rules, and other stimuli that make the game more fun. [8] Therefore, gamification is the mechanism that stimulates the user to be more mindful of their actions.

In work and daily life, gamification uses game concepts and mechanics to help users concentrate on various problem-solving. [16] Gamification is also used in projects and processes to improve engagement, profitability, data quality, timeline management, and learning. [17] Thus, gamification is a leading feature of the game that people love to put in their daily activities to make ordinary activities more enjoyable. For example, earning rewards, points, or discounts when responding to specific tasks. [18]

From a technical perspective, gamification integrates game mechanics into existing features. For example, to motivate participation, enthusiasm, and fidelity in websites, applications, and online communities. In gamification, game designers usually apply data-driven techniques to stimulate players. These techniques are also used in non-game activities to drive actions that increase the business value. [19]

In conclusion, gamification is the technique of applying game concepts, mechanics, and essential elements to any non-game activity to enhance engagement, enjoyment, behavior changes, or skills improvement as expected.

2.2 Elements of Gamification

To apply game concepts in business, developers utilize game design styles and mechanisms with different complex elements. The MDA framework is a conceptual framework with simple ideas. The developers consider a game design with three key components. Starting from

a game designer's point of view, then choosing design tools (mechanics) to create a flow process (dynamics) that will give the desired experience (aesthetics) that fulfills the needs and accommodates the ability of the player. [20]

The mechanics describe the specific components of the game at the level of rendering information and algorithms. These elements are points, levels, scoreboards, leaderboards, challenges, trophies, badges, achievements, virtual goods, and virtual gifts.

The dynamics describe the behavior of the mechanics that respond to input. Then, display the results to the players at different times. In some cases, they represent human desires arising from the mechanics. These elements could be rewards, achievements, status, reputation, altruism, self-expression, and competitiveness.

The aesthetics describe the emotional responses that arise with the player while interacting with the game system and explain what makes the game fun. These elements can be the pleasure of sensation, fantasy, narration, challenge, fellowship, competition, discovery, exploration, expression, and abnegation.

From an alternative perspective, the MDA framework encompasses two primary stakeholders: game designers and players. Figure 1 illustrates the relationships between the fundamental elements and stakeholders within the MDA framework.

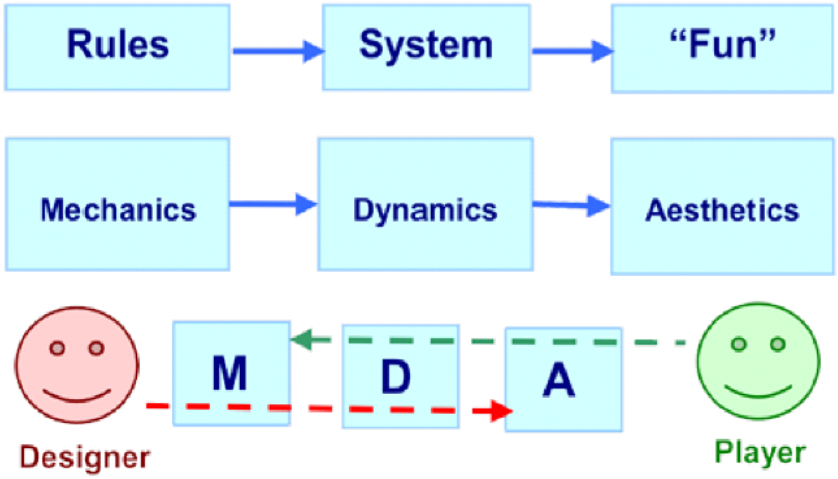

Figure 1 The MDA framework [20]

2.3 Ecotourism

Ecotourism comes from a combination of ecology and tourism. There are different names, including nature tourism, bio tourism, and green tourism. However, the name of such tourism implies the same tourism characteristics. The International Centre for Ecotourism Research defined ecotourism as conservative tourism that relies on natural products, sustainable management, and educational elements. [2] The International Ecotourism Society defined ecotourism as responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education. [3] Global Ecotourism Network defined ecotourism as responsible travel to natural areas that conserves the environment,

sustains the well-being of the local people, and creates knowledge and understanding through interpretation and education of all involved staff and visitors. [4] According to the definitions, the key concept of ecotourism focuses on the responsibility of natural and cultural attractions and the community participation that affects sustainability.

2.4 Components of Ecotourism

The International Union for Conservation of Nature proposes the components of ecotourism and relationships among infrastructure, tangible goods, and services in the delivery of ecotourism. The physical or actual goods and human resources create ecotourism activities or services for tourist experiences. Ecotourism comprises attractions, activities, facilities and equipment, services, infrastructure, branding and promotion, and pricing. [5] The description of the ecotourism components is as follows.

• Attractions are natural and cultural components of ecotourism such as a river, a lake, and a building.

• Activities take place in the attractions. In the natural attractions, there are activities such as swimming, kayaking, and fishing. The cultural attractions are sightseeing, visiting a museum, and making handmade products.

• Facilities and equipment can be a restaurant, a hotel, and a bus.

• Services take place in the facilities and equipment. Some examples are dining at a restaurant, accommodation in a hotel, and transportation by bus.

• Infrastructures are communications, roads, electricity, and airports that underpin and facilitate the development and execution of any tourism business.

• Branding and promotion must contribute to conservation while benefiting local communities, essential to positioning and differentiating it in the market.

• Pricing the ecotourism product should determine value in the market, the pricing of similar offerings, and the total delivery cost.

In conclusion, the components of ecotourism are the combination of attractions and facilities with the human resources to deliver services and facilitate activities. This process entirely creates and gives an experience that fulfills the needs and expectations of tourists.

2.5 Gamification in Tourism

Tourism is a service business that provides a memorable experience for tourists and tourism entrepreneurs. [21] Tourist engagement depends on tourism administration and management, which affects how the tourist participates in that tourism. According to related research [11], [12], [13], [14], [31], it shows that gamification helps improve the engagement and experience of tourists and increases the performance of tourism entrepreneurs. In the tourism service system, gamification will motivate tourists to interact with tourism to create a more fun experience. [10] In general, there are two purposes for gamified tourism. Firstly, gamification increases the incentives for tourists and tourism entrepreneurs to change behaviors such as making purchases or working more efficiently. Secondly, gamification is used to bring tourists and tourism entrepreneurs together to create a great travel experience by stimulating the intrinsic motivation to participate in tourism activities. [22]

Research Methodology

1. Research Design

The design of this research was mixed methods. In qualitative research, books, journals, proceedings, and websites related to gamification, ecotourism, and mobile application development were collected and studied. The requirements and relevant data from community ecotourism entrepreneurs and tourists in Nakhon Pathom were gathered through non-participant observation and in-depth interviews. In the quantitative research phase, a gamified mobile application was designed and developed using the Software Development Life Cycle (SDLC) model, tested through functional and non-functional testing methods, and evaluated using software evaluation questionnaires.

2. Sample and Data Collection

Two groups of the population in this research consisted of 247 community ecotourism entrepreneurs and 425,478 tourists in Nakhon Pathom, Thailand.

In the qualitative research, the gamified mobile application requirements were collected from ten ecotourism entrepreneurs derived from the purposive sampling method and 30 tourists using the convenient sampling method.

In the quantitative research, testing, and evaluation of the gamified mobile application were conducted with 30 ecotourism entrepreneurs, identified through purposive sampling, and 400 tourists, identified through convenient sampling.

3. Research Instruments

Non-participant observation and in-depth interview methods were utilized in the qualitative research to identify and capture all relevant requirements. The forms consisted of open-ended questions based on a preliminary study created by the researcher and validated by information technology and tourism experts. The qualitative data collected through the forms encompassed all relevant requirements, including ecotourism entrepreneurs, locations, activities, and tourists in Nakhon Pathom, Thailand.

In quantitative research, the software evaluation questionnaires were used to measure the quality of the gamified mobile application. The questionnaires consisted of the Likert scale and open-ended questions based on a preliminary study created by the researcher and validated by information technology and tourism experts. The data collected in the questionnaires consisted of mobile application evaluation items related to appearance, functionality, usability, and user satisfaction.

4. Data Analysis

The qualitative data from the non-participant observation and in-depth interviews were analyzed by triangulation. The approach verified that the obtained data were credible and valid by examining various sources of information, times, places, and people. Then, the qualitative data were coded and thematically analyzed based on the research objectives.

The quantitative data from the evaluation questionnaires were analyzed using descriptive statistics, including percentage, mean, and standard deviation. Then, the results of this research were presented, discussed, and concluded.

Results

1. Qualitative Results

According to non-participant observation and in-depth interviews, the results indicated that gamification could improve former ecotourism. Therefore, the researchers proposed a gamified mobile application for promoting community ecotourism attractions, activities, services, and products. The proposed gamification techniques involved collecting points, ranking on leaderboards, and giving feedback. The application development mainly involved Google Maps, QR codes, and geo-fencing. The application must be accessible and easy to use by everyone with general information technology skills. Besides, the application must be protected against damage or unauthorized use. The information displayed in the application should be attractive, accurate, complete, quick, and illustrated by meaningful graphics with short captions. The developer analyzed and synthesized a conceptual framework for developing a gamified mobile application for Nakhon Pathom community ecotourism. Figure 2 shows the gamified mobile application design framework.

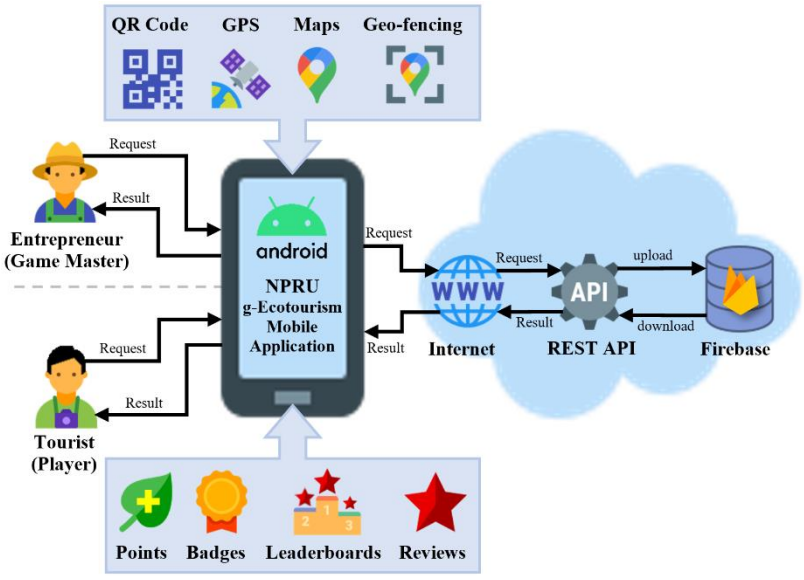

Figure 2 The gamified mobile application design framework

The gamified mobile application was designed by creating a use case diagram describing all system functions based on the different roles of users. The ecotourism entrepreneurs (game masters) manage application content and support tourists (players). The tourists visit places and attend community ecotourism activities. Figure 3 shows the use case diagram of the gamified mobile application.

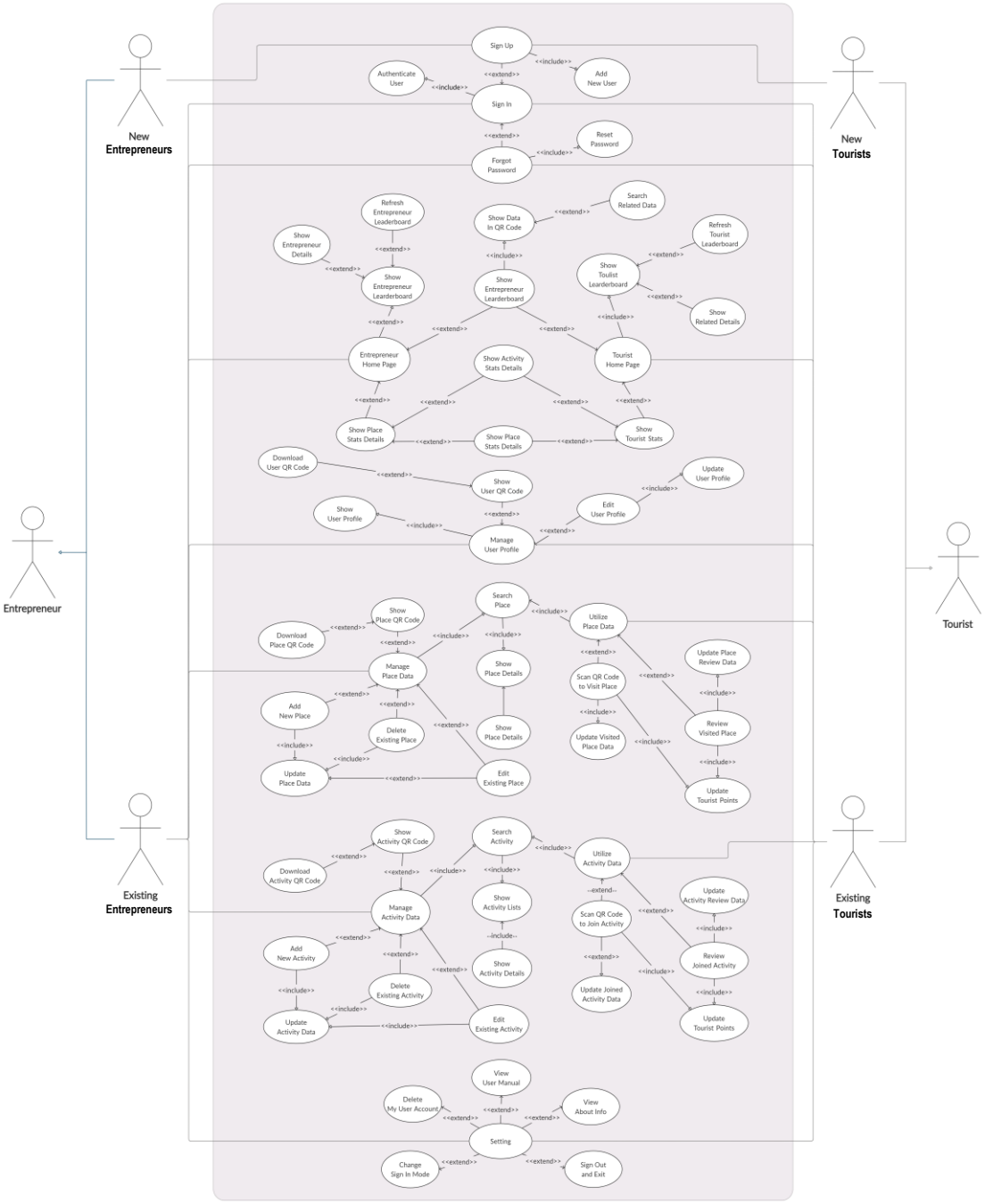

Figure 3 The use case diagram: Interacting with the gamified mobile application

In Figure 3, there are two groups of users and 12 main functions in the application. The descriptions of all use cases are listed as follows:

Use Case 01: The Sign Up is the membership registration function for new ecotourism entrepreneurs or new tourists. The users must enter a valid email address, set and confirm a password, and select the user type.

Use Case 02: The Sign In is the authentication function for registered users. In this process, the users fill out the correct email and password. When sign-in is successful, the system will automatically lead the user to a different home page, depending on the type of user.

Use Case 03: The Forgot Password is the recovery function for registered users who cannot access the system because they forgot or filled out an incorrect password. The users enter the registered email address and press the button. The system will send an email with instructions on changing the new password to the user's email address. After that, the user checks the new email, clicks the link, and follows the instructions on the screen.

Use Case 04: The Entrepreneur Home page is the first screen for community ecotourism entrepreneurs, including a leaderboard, statistic information, a QR code generator (for creating user ID cards, place tags, and activity tags), and a QR code scanner (for searching user, place, activity, and other information).

Use Case 05: The Tourist Home page is the first screen for tourists, including a leaderboard, statistic information, a QR code generator (for creating user ID cards), and a QR scanner (for visiting places, attending activities, or searching user, place, activity, and other information).

Use Case 06: The Entrepreneur Profile Management is the function that displays the entrepreneur's information, including photo, name, surname, user type, rating, gender, and phone number. Entrepreneurs can edit some editable information. In addition, entrepreneurs can display and download the entrepreneur ID card with the QR code.

Use Case 07: The Tourist Profile Management is the function that displays the tourist's information, including photo, name, surname, user type, points, gender, and phone number. Tourists can edit some editable information. In addition, tourists can display and download the tourist ID card with the QR code.

Use Case 08: The Place Data Management is the function for entrepreneurs to operate and manage ecotourism place contents, including searching and displaying ecotourism places on Google Maps, adding, editing, and deleting place information.

Use Case 09: The Place Data Utilization is the function for tourists to play the game, including searching and displaying ecotourism places on Google Maps, scanning QR codes to visit places, and rating with comments on the visited places. The tourists will get points for performing various actions in this section.

Use Case 10: The Activity Data Management is the function for entrepreneurs to operate and manage ecotourism activity contents, including searching and displaying ecotourism activities on Google Maps, adding, editing, and deleting activity information.

Use Case 11: The Activity Data Utilization is the function for tourists to play the game, including searching and displaying ecotourism activities on Google Maps, scanning QR codes to attend activities, and rating with comments on the attended activities. The tourists will get points for performing various actions in this section.

Use Case 12: The System Settings is the last function for users to customize system defaults, including switching login mode, deleting user accounts, displaying information about the system, displaying the user manual, and logging out.

To design the flow of each activity in the gamified mobile application, the developer created activity diagrams describing the flow and condition of all activities. Figure 4 shows the samples of activity diagrams of the gamified mobile application.

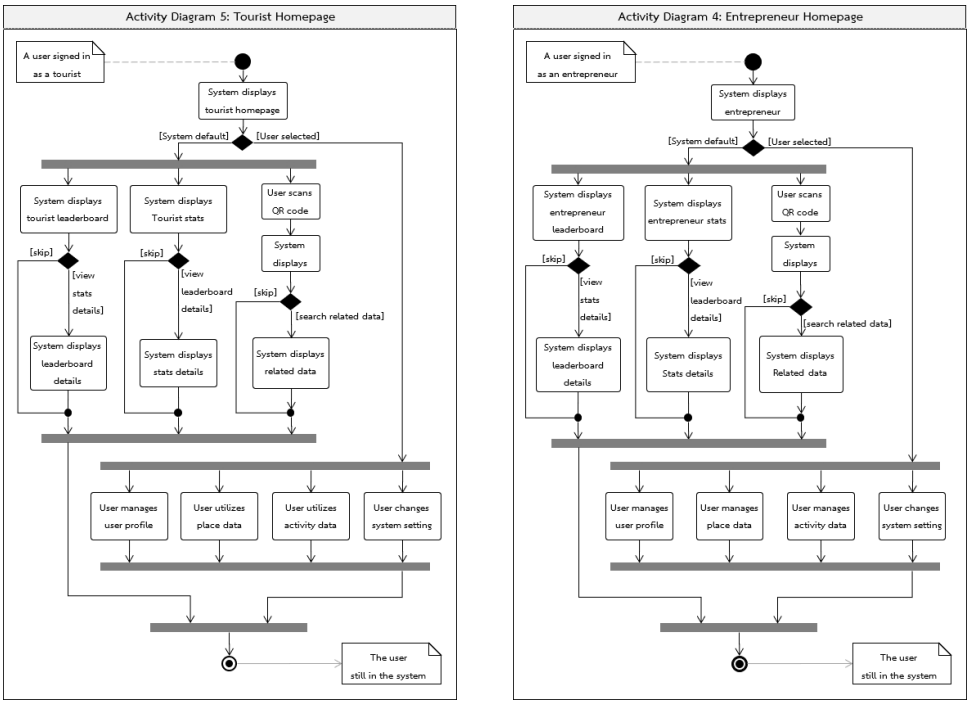

Figure 4 The samples of activity diagrams of the gamified mobile application

To design the point system of the gamification application, the developer created point system diagrams to describe the conditions for gaining and spending points. Figure 5 shows the samples of the point system diagrams of the gamified mobile application.

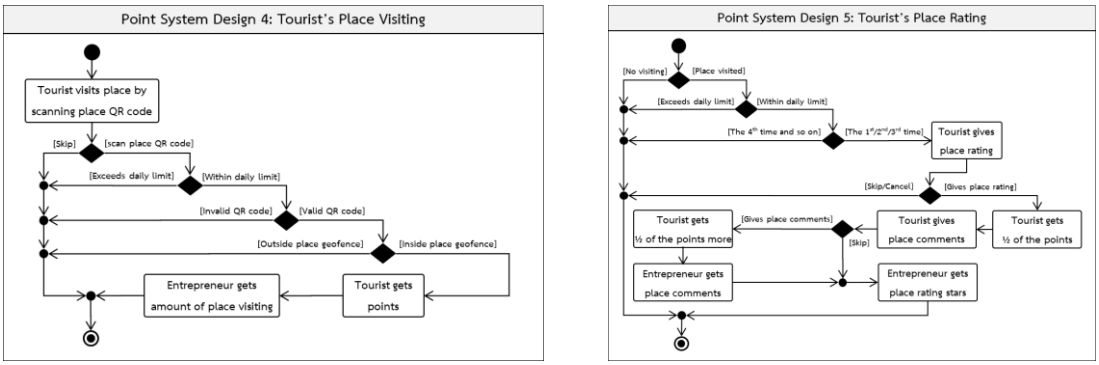

Figure 5 The samples of point system diagrams of gamified mobile application

To design the database system of the gamification application, the developer created the database diagram describing the data structures and relationships. Figure 5 shows the database diagram of the gamified mobile application.

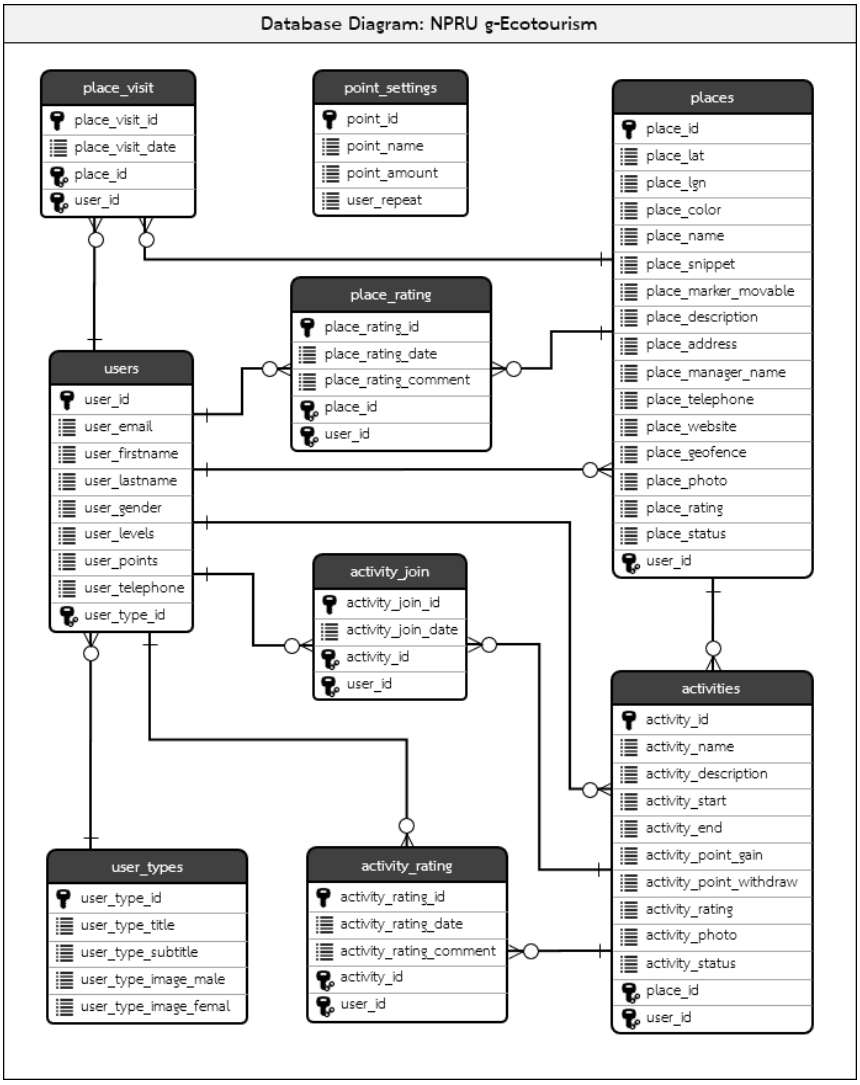

Figure 5 The database diagrams of the gamified mobile application

To design the user interfaces (UI) of the gamified mobile application, the screen layouts were created using an UI designer. The UI design focused on simplicity, attractiveness, and meaningful graphics with captions. Figure 6 shows the samples of the user interface design of the gamified mobile application.

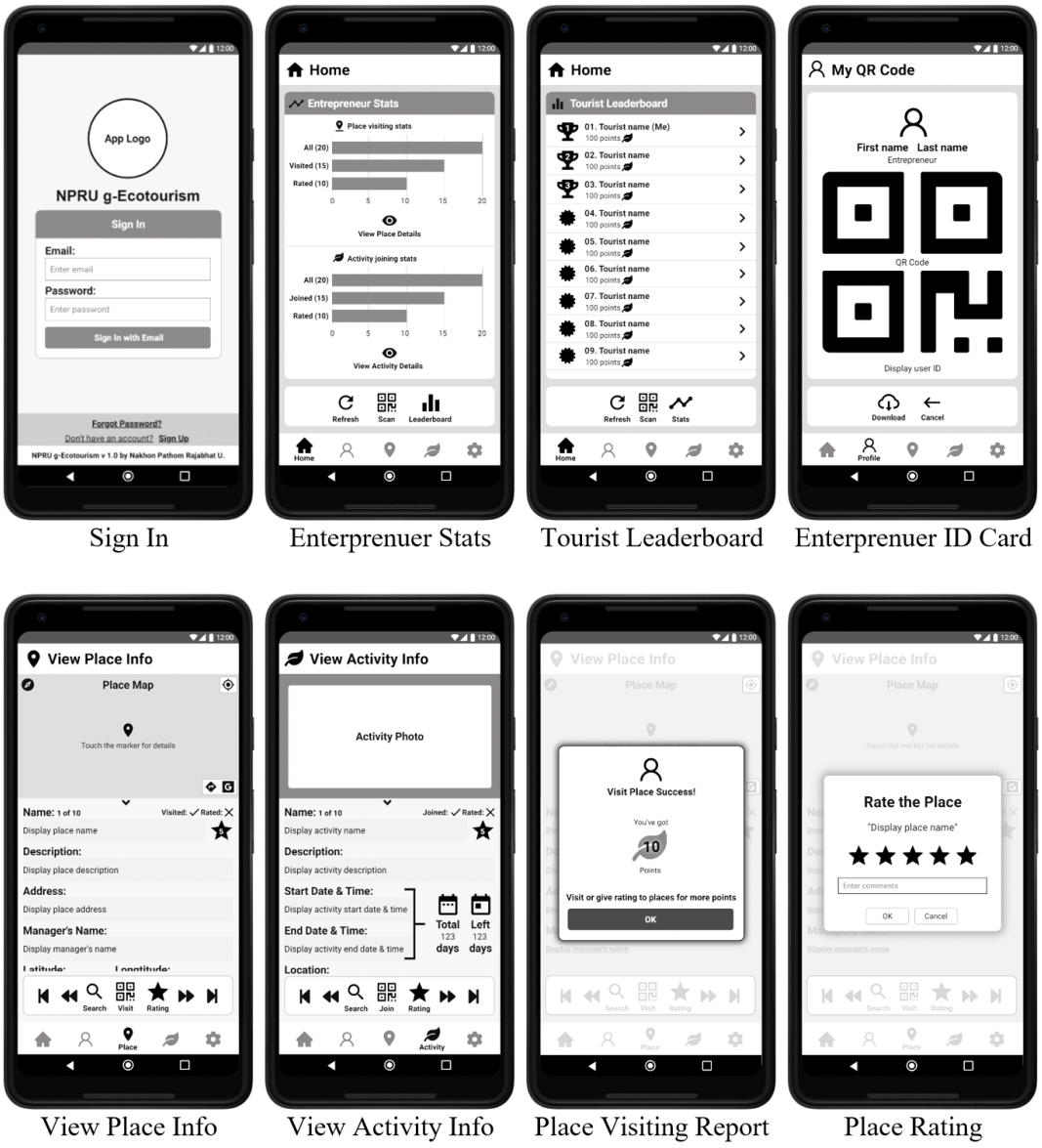

Figure 6 The samples of the UI designs of the gamified mobile application

To implement the UI design, a prototype of the gamified mobile application was created based on a mobile platform using Google Maps, Web, QR code, and related UI components in a visual programming IDE with a non-relational cloud database. Figure 7 shows the samples of the gamified mobile application screenshots.

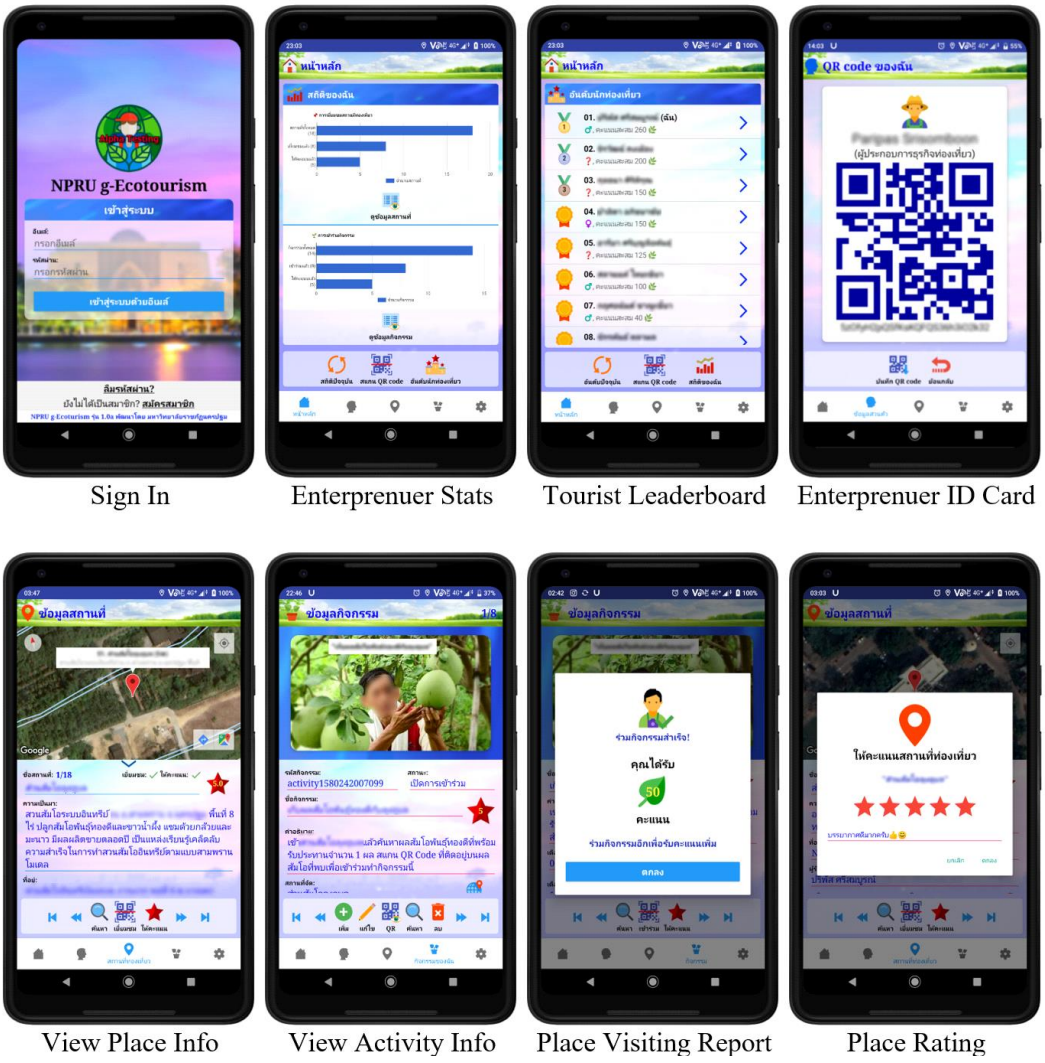

Figure 7 The samples of the gamified mobile application screenshots

2. Quantitative Results

According to the research design, the ecotourism entrepreneurs and tourists tested and evaluated the design and development of the gamified mobile application's appearance, functionality, usability, and user satisfaction. Tables 1 – 6 show the quantitative results of this study.

Table 1 Genders of the ecotourism entrepreneurs

Genders	Frequency (N)	Percentage (%)
Male	24	80.00
Female	6	20.00
Total	**30**	**100**

Table 2 Ages of the ecotourism entrepreneurs

Ages	Frequency (N)	Percentage (%)
<20	0	0.00
40 – 21	6	20.00
60 – 41	22	73.33
> 60	2	6.67
Total	**30**	**100**

The first respondent group was the entrepreneurs. Based on Table 1, most entrepreneurs are male (80%). In addition, Table 2 indicates that the predominant age group of entrepreneurs is between 41-60 years, comprising 73.33%, while those aged 21-40 account for 20%, and individuals over 60 represent 6.67%.

Table 3 The results of gamified mobile application evaluation by ecotourism entrepreneurs

Items	Results		
	$\bar{X}$	SD.	Interpretation
1. Appearance	4.11	0.48	High
2. Functionality	4.08	0.50	High
3. Usability	4.10	0.48	High
4. User satisfaction	3.96	0.52	High
Overall	**4.06**	**0.50**	**High**

As shown in Table 3, the overall results of the gamified mobile application evaluated by ecotourism entrepreneurs were high ($\bar{X}$ = 4.06, SD. = 0.50). The majority of the results were appearance ($\bar{X}$ = 4.11, SD. = 0.48) followed by usability ($\bar{X}$ = 4.10, SD. = 0.48), functionality ($\bar{X}$ = 4.08, SD. = 0.50), and user satisfaction ($\bar{X}$ = 3.96, SD. = 0.52).

Table 4 Gender of tourists

Genders	Frequency (N)	Percentage (%)
Male	95	23.75
Female	305	76.25
Total	**400**	**100**

Table 5 Age of tourists

Ages	Frequency (N)	Percentage (%)
<20	39	9.75
40 – 21	162	40.50
60 – 41	157	39.25
> 60	42	10.50
Total	**400**	**100**

The second respondent group was the tourists. Based on Table 4, most tourists are female (76.25%). In addition, Table 5 shows that the majority of age's tourists are between 21-40 (40.50%), and the rest are between the age of 41-60 (39.25%), above 60 (10.50%), and below 20 (9.75%).

Table 6 The results of gamified mobile application evaluation by tourists

Items	Results		
	$\bar{X}$	SD.	Interpretation
1. Appearance	4.45	0.62	High
2. Functionality	4.10	0.51	High
3. Usability	4.13	0.61	High
4. User satisfaction	4.45	0.62	High
Overall	**4.28**	**0.59**	**High**

As shown in Table 6, the overall results of the gamification application evaluated by tourists were high ($\bar{X}$ = 4.28, SD. 0.59). The majority of the results were appearance ($\bar{X}$ = 4.45, SD. = 0.62) and user satisfaction ($\bar{X}$ = 4.45, SD. = 0.62), and the rest are usability ($\bar{X}$ = 4.13, SD. = 0.61), functionality ($\bar{X}$ = 4.10, SD. = 0.51).

Discussion

According to the qualitative results, the gamified mobile application design and development in this research were consistent with a study by Chen [12] that designed a mobile application prototype using the gamification concept to promote the Chinese cultural tourism experience for foreign tourists. The game elements were missions and point collecting to challenge tourists to learn and understand Chinese culture and history in a local context. [12] Moreover, this study was also consistent with a research study by Mihaela et al. [14] that applied gamification techniques to develop a mobile application for tourism to create more challenges for users. The key technique in the research was the combination of concealed area data with game techniques, such as point collecting, which indicated the travel progress of tourists. [14]

The overall quantitative results of the gamified mobile application evaluated by ecotourism entrepreneurs and tourists were high. The results indicated that the appearance, usability, functionality, and user satisfaction positively affected the potential success of community ecotourism. The results were consistent with a research study by Chen [12] that evaluated a gamified mobile application for promoting Chinese cultural tourism. The results showed that tourists were more interested in Chinese culture and history. The mobile application provided an enjoyable method for foreign tourists to learn Chinese culture and history. [12] Moreover, this study was also consistent with a research study by Sigala [23] that used the design of TripAdvisor's Funware to investigate the use and the impacts of gamification in a specific tourism context. The study confirmed that gamification design affected meaningful experiential values and motivational affordances. [23]

Conclusion

This research aimed to design, develop, and evaluate a gamified mobile application for Nakhon Pathom ecotourism. The application helped improve marketing and attract more tourists. The technology elements in the mobile application consisted of the mobile platform, Google Maps, QR code, and geo-fencing. The game elements applied in the mobile application consisted of points, badges, leaderboards, and feedback. The users who tested and evaluated the gamified mobile application were ecotourism entrepreneurs and tourists in Nakhon Pathom, Thailand. The results indicate that the gamified mobile application could be the potential solution that positively affected community ecotourism and fulfilled tourist needs and expectations.

Recommendation and Further Study

Based on the limitations and findings of the study, the following recommendations and directions for further research are proposed.

1) Optimizing the suitable and influential game elements for tourism.

2) Designing and developing a gamified application on other platforms.

3) Applying the IoT, artificial intelligence, augmented reality, and virtual reality.

4) Studying perception, attitude, and adoption of technology toward gamified application for tourism

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