Development of mobile application to promote revisits to Kenrokuen using gamification theory

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Abstract

A mobile application was developed to promote revisits to Kenrokuen-garden (a famous Daimyo garden) using gamification theory in this study. The tourism industry was greatly affected by the movement restrictions during the Covid-19 pandemic. Micro-tourism, which means visiting local areas, gained attention during this period. Gamification design is incorporated into the app as a mechanism to maintain the motivation for the game. The tourists who have visited Kenrokuen, want to visit the place more than once due to the system (gamification theory). The tourists are also motivated to play the game at the same time. The garden is one of famous tourist destinations in Kanazawa City, Japan. In the developed app, a badge system was used to evaluate tourist behaviours based on the number of visits, number of steps taken, arrival rate of photo spots, and achievement rate in the four seasons. It was designed to motivate the repeat visits by giving badges as rewards. The design intent and the operational verification results of the developed app are reported in this paper.

Keywords

micro-tourism, gamification, app development, local tourism, Kenrokuen

1. Introduction

The number of tourists visiting each destination is increasing since the Covid-19 pandemic has calmed down considerably [Japan National Tourism Organization, 2024]. The number of foreign tourists to Japan in 2023 is approaching the pre-Covid-19 value, and new countermeasures for the tourism industry are required. The Japanese government is considering some measures to further promote the country as a tourism-oriented nation, but progress has not been made due to factors such as a lack of human resources. It has been reported that the level of the satisfaction of domestic and foreign tourists is highly dependent on the hospitality of the local area. It is essential to improve the hospitality ability of the region to increase the number of tourists [Tozaki, 2018]. Important factors are the human interaction with visitors and the use of information equipment to improve the satisfaction. The repeat rate will also improve when the satisfaction level improves. In order for the region to be recognized as a sustainable tourist destination, it must be economically stable and also the residents give importance to the history and culture. And the region is safe and secure. The hospitality towards visitors improves when the residents know and love the area where they live. As a result, the repeat rate increases.

Travel has been restricted and human interaction has decreased significantly due to the Covid-19 pandemic, and local areas have suffered large losses, for example the economic effect on the region and the decline in regional capability by the residents [Japan Tourism Agency, 2021]. In particular, most people refrained from using public transportation and traveling far away, which caused a huge blow to local economies and employment. On the other hand, many tourists engaged in micro-tourism, which involves visiting nearby areas multiple times, and this method of enjoying sightseeing in relatively nearby areas has attracted attention. Micro-tourism is also a good opportunity for the local and neighbouring residents to recognize the life and pride, and rediscover charm [Kobayashi, 2021]. It is believed that promoting micro-tourism will further foster local love and contribute to fostering hospitality for domestic and foreign visitors.

The use of gamification theory is proposed as a measure to promote micro-tourism in this study. Specifically, gamification theory was applied to develop an app that changes tourist behaviour to encourage visiting tourist spots multiple times. Kenrokuen-garden (Kanazawa City) was selected as the experimental site. Kenrokuen is a tourist spot that represents Kanazawa and there are many resources in the vicinity, for example Kanazawa Castle Park, 21st Century Museum and long-established restaurants. There are some elements to develop the system and increase the satisfaction level of various visitors in the future. It will also further improve the local residents' knowledge and pride for Kenrokuen. The app was developed and the operation was verified to achieve the above-mentioned objectives, and generally good evaluation was received.

2. Micro-tourism and Kenrokuen

Micro-tourism is a concept proposed by Yoshiharu Hoshino [2022]. It is a day-trip or overnight-trip that can be visited within 1 to 2 hours from where the tourist lives. The number of companions is also small, such as one person or a family unit in the tourism, and is characterized by being cheap in travel

cost, a close area, and a short distance. This form of travel has attracted attention as a form of travel that is possible even during a pandemic. Micro-tourism naturally targets the areas that people interact on a daily basis and have strong economic ties. Most forms of travel were short trips until around the 1970s, and they could be said to have been mostly micro-tourism. The annual income per person in each country was not very high and the economic situation was not good at that time. Later, expressways, bullet trains and air-flight services were expanded with economic development, and people could travel further more easily. The various customs of good hospitality from the previous era of micro-tourism are still retained in local tourism.

Kenrokuen, which is the target site of this study, is located in the center of Kanazawa City and is the tourism resource that attracts the most visitors. According to a report by the Kanazawa City Tourism Policy Division [2019], there were approximately 2.7 million visitors in 2019 (before Covid-19). There are many tourist facilities within 2 km from there including Kanazawa Castle Park and Higashichaya-gai. There are many dining facilities such as long-established restaurants for enjoying historical foods. It is also attractive as a tourist destination for enjoying the scenery of each season.

Kenrokuen is familiar to people in not only Kanazawa City but also Ishikawa Prefecture due to its abundance of surrounding facilities and its changing seasons, making it suitable as a micro-tourism destination. A simple questionnaire was carried out for twenty university students (from outside the prefecture) who attend universities in Kanazawa City. First, the subjects (students) were asked if they had ever visited Kenrokuen, and then the students who answered that they had visited were asked whether they had visited more than once. Questions on birthplace and gender were not asked at that time. As a result, there were no students who had visited Kenrokuen more than once, and most had visited for sightseeing purposes. Namely, most students were satisfied with their first visit and had no intention of visiting again. Although this is not the result of an official survey, it is thought that there are many cases in which tourists achieve their goals after visiting famous tourist destinations once and do not visit again. From these reasons, the target tourists of this study are citizens who live in the suburbs of Kanazawa City and have no desire to visit again. Citizens living in the surrounding area can easily visit Kenrokuen as many times as they wish. In this study, promoting micro-tourism was attempted by providing such tourists with an app that utilized the gamification design as a mechanism to make them want to visit again.

3. Gamification

Gamification is a method of incorporating the designs and elements of computer games that attract users into fields other than games. Tanaka and Kishimoto [2022] have written about a system that uses gamification design to stimulate and circulate user motivation. The overview is shown in Figure 1. First, play-
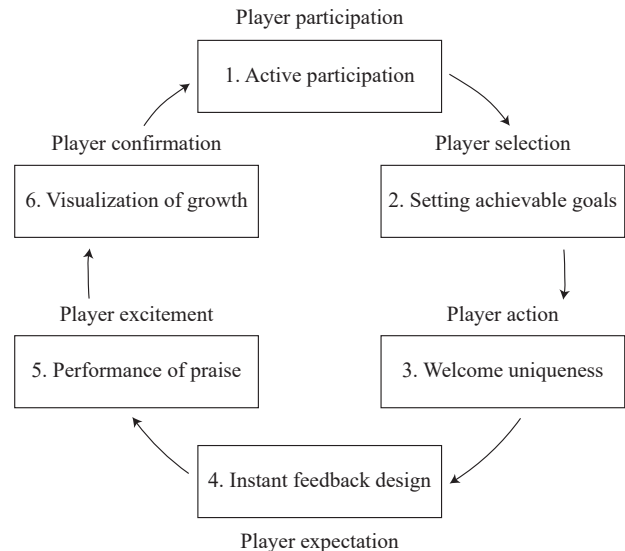

Figure 1: Cycle for maintaining motivation due to gamification

ers (users) become involved by using a design that encourages active participation. Then, let the players choose their own goals by setting achievable goals. Thirdly, it allows players to take free actions to achieve their goals as it welcomes uniqueness. And, the system is designed so that users receive immediate feedback on the actions they take with the expectation of success. The praise is given as a reward to increase the player's excitement and motivation, when the action is successful. Furthermore, the player's growth, as a result of rewards, is visualized so that the player can confirm and recognize growth. The participants will be able to maintain their willingness and motivation to participate in the next event by implementing these activities.

There have been some cases published where gamification has been used for education, customer retention, health maintenance, savings, etc., and successful user retention. The app 'iDenkimeter' which is a game where the users could understand whether or not they can achieve their energy-saving goals, attracted considerable attention at the time of the Great East Japan Earthquake in 2011 [Inoue, 2012]. This is an example that power saving was achieved while enjoying the game by making people aware of everyday events as in a game. Saving electricity is a disliked task in general but it is necessary to prevent global warming. '*Bikkura pon*' of Kura Sushi [2024], a conveyor-belt *sushi* chain, is another example of effective use of gamification. '*Bikkura pon*' is a service that allows customers to operate a slot machine once every five plates by placing the plate of *sushi* they have eaten into their collection pocket. The collection of dishes that had previously been collected by employees, became a self-service by utilizing a game design, and this is an example of reducing restaurant costs and increasing customer satisfaction by creating a game that customers can enjoy.

Bulencea and Egger [2015] wrote that the experiences tourists can gain by incorporating gamification design into tourism

can be a reward for tourism. As in the example of 'iDenkimeter,' the rewards in gamification do not necessarily have to be monetary rewards. Praise, titles, trophies, badges, etc. obtained in the game, serve as rewards that increase the user's motivation when a goal is achieved. One of the rewards is to give a feedback to the player's actions in the game, such as reactions. In other words, expression in luxurious words when a goal is achieved in the game is also a reward. Furthermore, players can visualize their own growth as a reward by recording actions and results in the game and displaying the play records in graphs.

4. Design and development of an application to promote revisits to Kenrokuen

The design and development of the app are explained in this section.

4.1 Design

The purpose of the developed app is to motivate tourists who have visited Kenrokuen (the target site) to visit the place again. Therefore, the gamification elements within this app, and the rewards obtained in the game, are designed as follows:

(1) Display sightseeing spots in Kenrokuen and the player's current position on the map, and visualize the objective spots.
(2) Arriving at tourist spots is one of the objectives in the game, and the spots visited are automatically recorded.
(3) Make it possible to view information about the tourist spot and the differences in scenery depending on the four seasons and the system gains knowledge of the spot and encourage the users to visit the area in other seasons as well.
(4) The system automatically measures the number of steps walked in Kenrokuen and provides a play history that contributes to the player's health.
(5) Praise and reward by giving an in-game badge as a reward for reaching a certain goal with the following data, namely the number of visits to Kenrokuen, percentage of sightseeing spots walked, number of steps walked in Kenrokuen, achievement rate of each season visited Kenrokuen (four seasons), etc.

The reward granting function is based on the Bartle test, which is used as a method to classify the characteristics of people who play games. The rewards are given based on the test according to the characteristics of the tourist [Bartle, 1996]. The test is a method that classifies the characteristics of game players into four types based on their interests (interest in the game itself) or (interest in other players) and actions (single) or (multiple). These are indicated using axes. The player who is highly interested in the game itself and enjoys playing the game independently, is named 'achiever.' The player who is highly interested in the game itself and enjoys interacting with people in the game and other players is named 'explorer.' A player who is highly interested in other players and enjoys interacting with each other is a 'socializer.' A player who enjoys the game alone for the purpose of interacting with other players (particularly competition) is named and classified as a 'killer.'

The primary goal of this study is to enable tourists to enjoy exploring the various tourist attractions of Kenrokuen, whether they are accompanied by a companion or not. Therefore, the rewards for 'achievers' are designed when classifying game players. The badge system shown in (5) was consequently designed.

It is intended to motivate tourists to aim for further achievement by visualizing the degree of achievement of tourism objectives through evaluation in the form of badges. The timing of reward provision is adjusted based on the balance design of achievement rewards by the game planner [Suemaru, 2019]. The game generally classifies the users into three grades such as 'light users,' 'middle users,' and 'core users' based on the average number of attempts per play. The system was designed to allow each user to derive the goal achievement rate and success rate for each trial. The tourists who visited a tourist destination for the first time, were regarded as light users in this study, and it was designed to achieve 60-80 % of the tourism objectives in one visit (number of trials). First, it gives a sense of satisfaction of tourism by achieving a success rate of 50 % or more on the first trial and the system motivates the tourists to come back by making them want to complete the remaining goals. This is the important intention for game participants. The badges that require the participants (tourists) to visit every four seasons are configured in the system, namely all objects cannot be achieved in one visit.

4.2 Application development

A smartphone app has been developed with the assumption that tourists will use it while at the visiting spot. The title of the app is 'Mawari-michi (detour) Kenrokuen.' The app is developed for Android OS because of the ease of handling equipment and the development environment. The environment is Android Studio (ver. Hedgehog) [Alphabet, 2023a]. Google Maps API is used to obtain the location and route information [Alphabet, 2023b]. The screen configuration of the app is indicated in Figure 2. There is a main screen (Home Fragment) that displays the current location of the participant and the photo spots on a map of Kenrokuen, and there is also a reward screen (Achieve Fragment) that displays the action history and badge acquisition status. These screens make up the app screen. The photo spots are displayed as pins on the map in the main screen. Some photos and information about that photo spot will be displayed by tapping the pin. Furthermore, it also has an information screen (Information Fragment) that displays other information while considering the extensibility of the app.

An example of the main screen transition is shown in Figure 3. On the displayed map, a participant can zoom in or out by using the +/− button or pinching in/out on the screen. The participant will be taken to a screen that displays the spot's photo
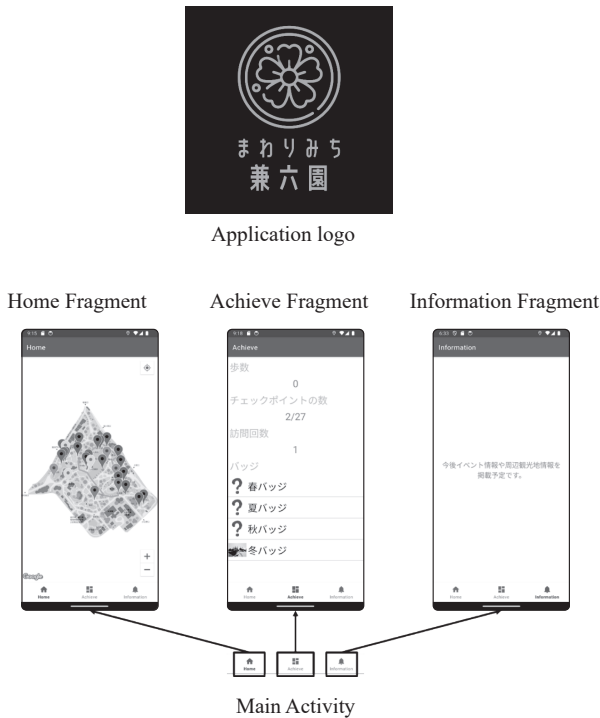
Application logo

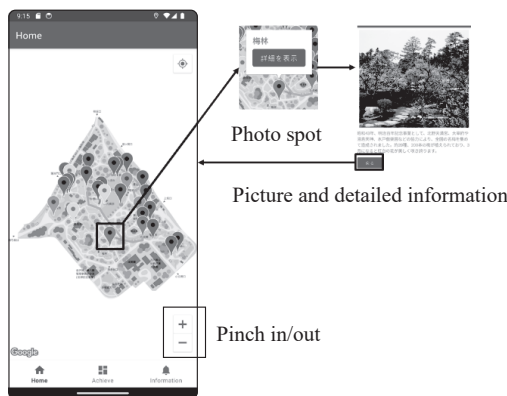Home Fragment   Achieve Fragment   Information Fragment

Main Activity

Figure 2: Screen configuration of app

Photo spot

Picture and detailed information

Pinch in/out

Figure 3: Example of main screen transition

Number of steps

Number of checkpoints

Number of visits

Badge system

Season badge
-spring, summer, fall, winter

Figure 4: Operation of the reward screen

and description by tapping the photo spot pin and tapping the 'display details' button. The participant can return to the main screen by tapping the 'return' button. The operation of the reward screen is explained in Figure 4. The number of steps, checkpoints, visits, and badges are displayed on the reward screen. The display updates when the participant moves the

screen to the reward screen.

The operation flow of the app is shown in Figure 5. The position is measured using GPS in the main unit measures while the app is running, and the current location is acquired and displayed through Google Maps API. The number of steps is acquired using the GPS sensor and the movement sensor in the participant smartphone, and the number is accumulated automatically after entering the Kenrokuen area. The distance between the current position and the photo spot is compared every second. When the participant reaches the vicinity of a photo spot, it is automatically determined that the parson has reached the photo spot and its arrival is recorded. The participant's history will be automatically measured while the user takes a walk, once the user launches the app at a tourist spot by automating the measurements. The reward screen is displayed when the user switches at any time. The number of steps, the achievement rate of photo spots and the achievement of badge condition are calculated when the user moves to the reward screen, and the current goal achievement status is displayed.

A smartphone equipped with Android OS is started in debug mode and the developed app is run during the development and operation verification. It will be published in the app store and users will be able to download it from QR codes posted on on-site posters when the service is actually provided.

4.3 Design policy regarding application extensibility

The game upgrades and additional content distribution is designed while considering scalability at developing the app. The following three points are focused on regarding scalability in particular:

(1) The rewards are designed by considering tourists as an 'achiever' (an element of gamification) in this app. The following three additional elements can also be made by setting new goals for the badge system, namely an element for a 'socializer' such as number of SNS posts, element for explorer such as solving puzzles and unlocking secret maps and element for killer such as goal achievement comparison system and ranking. In this app, one of the objectives of the game is to visit photo spots in Kenrokuen each season. For this reason, it is considered that the next expansion will be to add elements for socializers, such as sharing photos taken on SNS.

(2) Although this app targets Kenrokuen, it is also possible to change the data-set to another tourist destination while maintaining the basic structure. It is possible to develop apps for other tourist destinations at a very low cost.

(3) This app aims to increase the number of visitors to Kenrokuen. As the Covid-19 pandemic subsides and the number of tourists increases, over-tourism, in which more tourists visit than expected, is an important issue that must be resolved. This system also considers these issues. Therefore, information such as congestion predictions for tourist spots is displayed on the information screen, which is currently
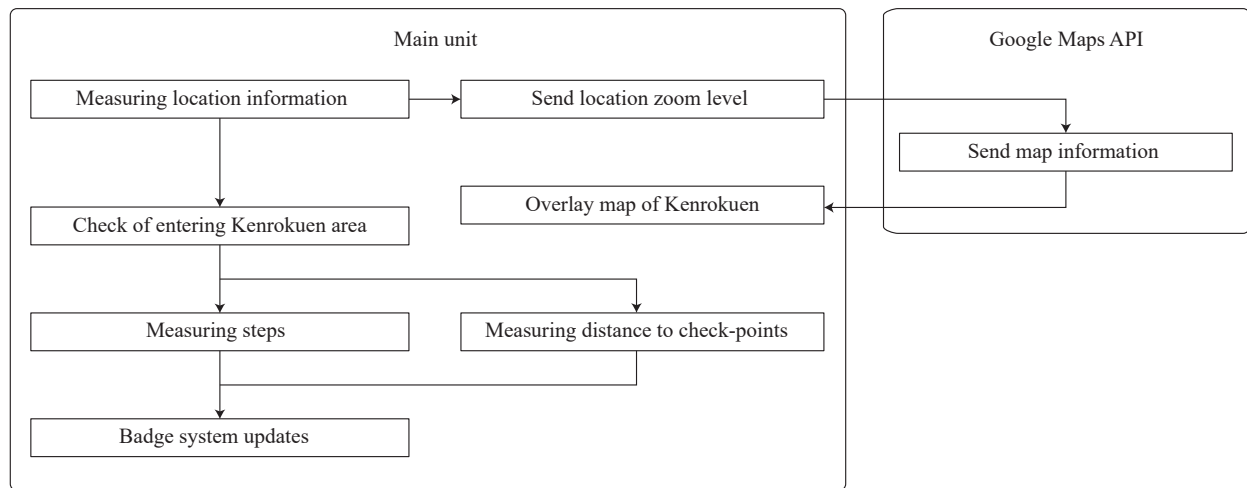
Figure 5: Application operation flow

not in use and it is provided to make it easier for nearby tourists to visit without crowding. The information screen can also be used as a link to information sites that the participants need, such as weather, traffic, and disaster information.

5. Verification and evaluation of application operation

The developed app was actually operated in Kenrokuen and its operation was verified in December 2023. The following items were verified in the operation experiment:

- Automatic recognition that the participant has entered Kenrokuen area
- Accuracy of step count measurement
- Automatic recognition when reaching a photo spot
- Automatic recognition of seasonal badge

The devices used for verification were Pixel 3 (Android 12, manufactured by Alphabet) and Galaxy S22 (Android 14, manufactured by Samsung). Testing was conducted on two males in their 20s and 40s.

Movement history was also recorded using another smartphone for comparative verification. While the participants were moving in the park, they visually confirmed and recorded their current positions at each spot. The above operation verification results are indicated in Table 1.

Table 1: Operation verification results

Verification items	Result
Automatic recognition of measurement area	Operated normally
Accuracy of step count measurement	Measure accurately (error within 50 steps)
Automatic recognition of arrival at a photo spot	Recognized normally (accuracy approximately 3 m)
Automatic recognition of seasonal badges	Operated normally

Regarding the automatic recognition of the measurement area, the number of visits is counted by entering Kenrokuen and it was also confirmed that it is not counted even if a participant enters and exits more than once in a day. It was determined that this item is 'operated normally' based on the result. An experiment to confirm the accuracy of the app's step counting was conducted. The participant went around the central route from Hanami-bashi (small bridge) in Kenrokuen for two times. The average number of steps was detected to be 1,500 steps. The error was within 50 steps compared to other smartphone pedometer apps. It was determined that the item on accuracy of step count measurement 'measure accurately' based on this result.

The automatic location recognition was verified when the experimenter reached a photo spot. The experiment was conducted by traveling along the central route from Hanami-bashi and stopping at eight photo spots along the route. When the experimenter came within 1.5 to 3 m from the center of the photo spot, the system recognized as having reached the photo spot. The system never mistakenly recognized the arrival at a photo spot when not visiting. The spot was relatively close (about 10 to 15 m). The standard error range for general GPS is within 20 m. The system could recognize that the participant has arrived at a photo spot when within 15 meters of that spot. The third item was judged as 'operated normally' based on the results of this experiment. The automatic recognition of seasonal badges was also investigated. It has been confirmed that the 'Winter Badge,' which is obtained when visiting Kenrokuen in winter, can be obtained correctly. The fourth item is also considered "operated normally" based on this result.

The operational verification confirmed that the developed application was implemented according to the expected specifications. The badge system implemented in the app that visualizes and rewards travelers' tourism behaviour is an important element that indicates the effectiveness of gamification. One of the useful results of this research is that the app for practical use was developed as designed. The following comments were

obtained from the participants who performed the operation verification:

- I want to visit photo spots that I have not yet visited by displaying the number of photo spots reached.
- I got the winter badge (one of the four-season badges in December when the experiment was conducted), but I wanted to get badges for other seasons as well.
- It's interesting to know how much I walked in Kenrokuen.

It is thought that it can be strongly expected to have an effect of arousing the desire to revisit although this is a minority opinion. This is the important purpose of the app's development.

6. Conclusion and future challenges

In this study, gamification theory and design are utilized to develop an app that encourages repeat visits to Kenrokuen. Visitors to Kenrokuen were considered as achievers in game design. The following tourist objectives are evaluated in the proposed badge system, namely number of visits, number of steps, photo spot arrival rate, four seasons completion rate etc. Various rewards are given based on the evaluation. The rewards are designed so that a participant does not feel a sense of accomplishment after just one visit and every reward cannot be achieved at once. In other words, it is designed to motivate revisits. In the operation verification of the developed app, it is confirmed that the automatic measurement of location, number of steps, and the operation of the badge system operate as expected.

The developed app will be used by tourists of different age-groups and living environments in the future, and the effectiveness of the app will be verified moreover. The appropriate experimental planning and statistical analysis to verify the effectiveness of the app will be conducted in a future verification experiment. It is necessary to analyze the psychology of tourists based on the results of verification experiments and make improvements regarding the gamification elements (functions) incorporated in this app. The motivation for repeat-visits will be further strengthen. In addition to free rewards such as praise given within the app, the collaboration with local tourism organizations is also considered to offer actual rewards (products, meal tickets, etc.). Free admission tickets and coupons that can be used at surrounding facilities are also considered. This system design can be applied to other tourist destinations by changing the data-set.

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