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Development of community tourism enhancement in emerging cities using gamification and adaptive tourism recommendation

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ABSTRACT

This research aims to develop community tourism in emerging cities by applying the gamification approach to improve the standard of products and services in tourism for offline and online operations. The mobile and web application development concentrates on promoting and advertising tourist attractions, accommodations, restaurants, hotels, and standardized local businesses. The established application also displays the recommended travel routes applied with the adaptive tourism recommendation algorithm for suggesting high-quality travel routes. This algorithm was developed based on the data collected by tourists, tourist attraction staff, and local entrepreneurs altogether. The selected local entrepreneurs, which met the application standards, were demonstrated by the pin reward icons shown in Google Maps. The pin reward icons representing the standardized businesses provide valuable information to tourists when they make decisions. The result shows that the sensitivity was 98.63%, and the accuracy was 97.06% of the recommended location for the tourists, entrepreneurs, and tourism development agencies while using the applications. Ultimately, this will directly benefit the emerging cities if the public sector encourages mobile application utilization training and practices.

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1. Introduction

Tourism is the key factor to drive and boost up the economy of many nations. This industrial sector connects various types of economic activities. Over the past few years, the tourism industry has become highly and intensely competitive. Therefore, high standards of products and services should be parts of its components. Especially emerging cities are another tourist destination that is becoming increasingly popular. Tourists are seeking new destinations and novel products to fulfill their desires. Thence, visiting an emerging city becomes an amazing alternative for tourists. As a result, there are more business opportunities for each nation to develop its tourism industry to distribute the national wealth and increase the national employment rate at the same time. Moreover, this tourism development is also an extra income source for the local people to gain more revenue. Nevertheless, there are some limitations in this tourism development for emerging cities, for example, lacking well knowledge in product and service enhancement. Sequentially, these cities may lose their competitiveness and recognition to their competitors. Hence, the public sector must strengthen the tourism sector by continuously tackling all the related problems regarding the standards of products and services. Especially during the a novel Coronavirus disease (COVID-19) pandemic, tourists' safety, social distancing, and individual care for individual tourists are some new traveling standards to attract the new tourists to travel. Considering a large number of tourists or quantity should be omitted inevitably. Tourists tend to pay more attention to several unknown emerging destinations to avoid crowded traveling sites and protect themselves from the virus infection. Unfortunately, many tourists are still uncertain about their destinations and require sophisticated technology to assure them while they travel.

Thereby, games have been integrated into the tourism industry to offer outstanding experiences for tourists. This new marketing paradigm is called gamification, which refers to applying elements in game design to non-game contexts (Deterding et al., 2011). Gamification is purposely developed to achieve motivational or behavioral effects to captivate more customers and to enhance their experience. Additionally, it can stimulate consumer retention in the business sector (Asquer and Krachkovskaya, 2015). It has

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been playing a huge role in the field of management, health care, education, and tourism (Xu et al., 2016). The foundation of contemporary gamification is mobile technologies, location-based services, cloud computing, web 2.0, and augmented reality. Thus, this research integrates offline and online activities using the gamification approach to develop a mobile application that enhances the business standards in emerging cities with a low budget for tourism development.

Furthermore, this work also conforms to the worldwide national policy regarding environmental-friendly tourism development. If entrepreneurs do not have sufficient knowledge, they would unconsciously destroy the environment and tourist attractions. Subsequentially, it causes a lot of serious side effects on the tourism industry. The public sector should support the tourism industry by inviting local entrepreneurs to train and improve their business standards. These strategies will maintain and balance its supply chain and turn it into sustainable tourism in the long run. Thus, gamification should be used for increasing competitiveness in community destinations for tourists. Moreover, the promotion of travel routes and travel packages must be considered to maximize the number of points of interest (POI) for tourists to visit while minimize the total cost of tourist operations by using a greedy algorithm method. Nevertheless, the problem of greedy algorithm is that it targets too many POI and the shortest routes with some tourists' limitations such as time and budget. Consequently, the ant colony algorithm is then applied to discover the shortest routes, selected as famous POI in the database. However, the ant colony algorithm sometimes has some negative impacts on tourist destinations, such as overcrowding.

Therefore, this research develops an algorithm using the quantitative data instantly collected from each POI and the qualitative data on the design and route suggestions. These data types are used to solve the overcrowding problem by suggesting the appropriate POI at a single point in time. Additionally, local entrepreneurs play a significant role in answering inquiries and recommending the next destination as point-by-point travel routes based on up-to-date information. The remainder of this paper is structured as follows. Some studies that related to gamification and tourism were explained in Section 2. The application design and development, including the adaptive tourism recommendation approach, were described in Section 3. The evaluation results in all aspects are presented in Section 4. In Section 5, the researcher concludes by discussing the results and further work.

2. Literature review

2.1. Gamification

Gamification is a new term coined in 2002 by Nick Pelling, a British-born computer programmer and game developer (Marczewski, 2013). The most cited definition of gamification refers to the utilization of game design elements like rewards, missions, rankings, and fun in non-game contexts (Deterding et al., 2011; Koivisto and Hamari, 2014; Werbach and Hunter, 2012). Over the past decade, gamification has improved individual's involvement, motivation and attitude by using games in non-game or business domains such as health care (Schoech et al., 2013), environment (Filsecker and Hickey, 2014), sports (Koivisto and Hamari, 2014), engineering (Huotari and Hamari, 2017), mathematics (Attali and Arieli-Attali, 2015), computer science (Domínguez et al., 2013), biology (Su and Cheng, 2015), communication (Hanus and Fox, 2015), and psychology (Landers and Landers, 2014). Nonetheless, scholars must continue providing new theoretical frameworks, broader goals and more consistent empirical practices on the matter as well as studying impacts of its application in different fields (Deterding et al., 2011; Zichermann and Cunningham, 2011). The purpose of gamification is to encourage and assist users to perform a given task (Deterding et al., 2011; Domínguez et al., 2013; Huotari and Hamari, 2012), engage them in activities (Csikszentmihalyi, 1990; Deci and Ryan, 1985; Deterding et al., 2011; Hamari, 2013; Ryan et al., 2006), and promote their enthusiasm in a particular area that may augment learning experiences and tourism industry simultaneously (Zichermann and Cunningham, 2011). This is relevant to the belief that individuals have an innate drive to pursue achievement, status, and competition. Therefore, gamification is a concept of designing or modifying the action of any activity to create a more game-like awareness and experience (Vesa et al., 2017). According to Huotari and Hamari (2017), they stated that the conceptualization of gamification consists of affordances, psychological outcomes, and behavioral outcomes as follows:

- Affordances refer to the system designed where users may decide to use the things provided by the system (Norman, 2013). However, affordances should be another option that allows players to make their own decisions. The affordances may be the payment of money or any act instead of accomplishing the objectives set out in the gamification concept.
- Psychological outcomes refer to the psychological impact and experience produced by the users while playing a game. These outcomes may take the form of emotions and feelings, such as happiness, enjoyment, entertainment, community relations, or even the expertise with creativity (Ryan et al., 2006). All of these things will be an intrinsic motivation and a trigger for the game (Deterding et al., 2011; Huotari and Hamari, 2017; McGonigal, 2011; Ryan and Deci, 2000).
- Behavioral outcomes refer to any action arising from gamification, which encourages various behaviors based on the game context (Deterding, 2015; Hamari et al., 2014; Huotari and Hamari, 2017). Especially if there is relevance to cultural, social, and demographic, the game must be carefully designed to make it more appropriate and motivating to play, which greatly affects the perception of the player (Koivisto and Hamari, 2014).

Following the above gamification concept, players are willing to take any action to engage in the game (Hamari, 2013).

2.2. Gamification in tourism

A wide variety of studies have been conducted on gamification in the context of tourism. Bulencea and Egger (2015) carried on a comprehensive literature review on gamification and suggested theoretical foundations and research directions for gamification applied to the tourism industry. This is in line with what Xu et al. (2016) stated that gamification is a new paradigm of mobile learning in tourism. They also highlighted some design elements of gamification, which can be used as a means to expand technological influences upon motivation and behavior. Sigala (2015) conducted an empirical study that justified gamification's positive impacts on motivational behavior and psychological effects by comparing behavioral perception toward gamified mobile applications between users and non-users in a virtual community platform. Yoo et al. (2017) examined the factors influencing the adoption of gamified applications within the context of tourism and discovered that the hedonic characteristics of gamified apps are positive. Besides, gamification encourages ecotourism (Lee, 2019) and helps maintain the tourist attractions' environment, especially for overcrowded tourism. For example, the WasteApp rewards tourists who support cleanliness by accessing and scanning the quick response (QR) code on the waste bins in some European countries. Aguiar-Castillo et al. (2019) confirmed that this

application anticipated the practicality and convenience of a new mobile application that integrated social games and location-based technology by measuring tourist satisfaction levels and recycling behavior.

Gamification has been successfully applied in the tourism industry. It promotes brand awareness (Xu et al., 2013; Xi and Hamari, 2020) and brand love (Hsu and Chen, 2018). For example, the Smile Land Thailand game improves brand awareness, focusing on the destinations that include tourist attractions, restaurants, and shops via Facebook (Xu et al., 2017). Foursquare brings many partnership brands to display during gameplay via check-in and allows players to share their experiences on social media (Wilken and Humphreys, 2019). Even TripAdvisor offers discounts for tourists sharing their experiences and information on participating accommodation in the application (Moro et al., 2019). Moreover, gamification plays a role in getting tourists to business locations and allows players to participate in different locations. In this way, it is the destination engagement (Koo et al., 2018). For example, the rewards might be hidden in a specific location until the player reaches that location where augmented reality technology is needed to find them, such as the Pokémon GO game. This gameplay applied the global positioning system (GPS) upon the concept of geocaching to located rare monsters or items. Pokémon GO has partnerships to provide support and set locations for access to rewards. This approach is the gamified trip which is derived from the gamification concept (Shen et al., 2020). It gives players a role to visit and engage the destinations through mobile devices (Rauschnabel et al., 2017). However, in various studies, most of them design games and applications that focus only on tourists as the primary players. There are hardly any applications that allow entrepreneurs or local businesses to played and engaged with tourist players.

Therefore, this research focuses on developing applications for both players, especially allowing local entrepreneurs to play a key role in updating information into systems for applied to adaptive tourism recommendations. This approach will not pass the burden on tourists to update information. On the other hand, tourists act as community tourism seekers and create the impetus for entrepreneurs to develop their enthusiasm and build the standard of products and services in emerging cities to be equivalent to the big city.

3. Methodology

The research process adopted in the development of the mobile application for raising standards of community tourism includes the following steps.

3.1. Data collection

All data were collected in Ranong province, where the tourist development agency supported its tourism industry in an emerging city. The data were divided into five groups: system design, system testing, system usage training, system effectiveness, and real-world application usage data.

- The system design data were derived from feedback of the forty-five volunteers who communicated via social media in the tourism community online for ninety days. They were divided into three groups comprising twenty tourists, twenty prospective entrepreneurs, and five government officials in tourism development. Each volunteer contacted the team by calling with instant messaging or social media applications such as LINE and Facebook. Full information about the survey was provided, and all inquiries were answered concerning community tourism.
- The system testing data was evaluated by five experts in the field of information technology or tourism development.
- The system usage training data were collected from the pre-test and post-test questionnaires. There were forty-five samples which were the same volunteers involved in collecting the system design data.
- The system effectiveness data were collected by assessing volunteers while being used the applications. These volunteers are forty-five samples during the training process.
- The real-world application usage data were collected while using the application for fourteen days by eighty-five tourists in Ranong province. This data was used to compare the locations in the recommended travel packages with the locations were visited by tourists.

All participants received the documents describing the protocols with ethical research conduct to sign and accepted the agreement and privacy in this experiment.

3.2. Gamification design

In this research, gamification mechanics were applied using the points and the level system to notice the progress while participating in online and offline game activities. This gamification purpose is to develop and support entrepreneurs to reach the provincial government's standards. Thus, the game did not focus on ranking or severe competition to avoid disharmony within the community. The game missions were designed for two types of players, including entrepreneurs and tourists. The tourism development agency was responsible for specifying the games or activities for entrepreneurs to enhance their standards by passing each level to reach the game missions. The entrepreneurs were assigned each mission, and the scores were gained from attendance activities, real business practices, business records in the system, governmental evaluation, and approving the visited locations. After the participants completed all five missions, they then received a hard copy of the certificate (or trophy) and the pin icon. These rewards had expiry dates, meaning the entrepreneurs need to restart the game and challenge all the missions again to maintain their status. If the entrepreneurs did not restart the game, the pin icon would disappear from the map. For tourists, they must apply for membership and choose a recommended travel package. Then they proceed to the activity by visiting the locations specified in the package. In this gamification design, tourists have to meet with entrepreneurs to confirm their actual visit to the locations. All players will receive various rewards and status with different colors when each mission is accomplished. The details of each mission design and reward mechanism of the game were explained in Table 1.

3.3. Adaptive tourism recommendation

The tourists meet the local entrepreneurs is a mission that they would be engaged in the game. At this stage, the local entrepreneurs had to scan the QR code from tourists and record their visited location. This activity allows them to talk and exchange information and experiences about their previous and next destinations. Thus, they could be recommended appropriate, up-to-date travel routes and potential destinations for the tourists on the applications. Hence, tourists could dynamically modify or create a new plan and trip for themselves based on the information obtained from completing the mission. This participation helps to increase tourist' confidence and safety because the local entrepreneurs are reliable and have passed the standards from the government sector. Therefore, meeting face-to-face communications is an excellent way for tourists to appropriately reach out to

Table 1
Mission design and rewards for each player.

Players	Missions	Status	Rewards
Entrepreneur	**Level 1** (offline): register and participate in all training and activities on specified dates and times.	Starter (orange)	None
	Level 2 (offline): apply the obtained knowledge to the real business practice.	Starter (orange)	None
	Level 3 (online): input and update the business information, contact channels, product and service information such as pictures.	Starter (green)	None
	Level 4 (offline): acquire and pass the inspection of the standards of products and services from the public sector or tourism development agencies.	Entrepreneur (blue)	Pin icon on the map, certificate (or trophy)
	Level 5 (offline + online): talk with tourists and scan their QR code for approving the real-world visited location, update the current situation in the system, then recommend the next destination to the tourist.	Keeper (violet)	Keep the pin icon and status as enable on the application
Tourist	**Level 1** (online): apply for a new member (in case of no account) and choose a recommended travel package provided on the application.	Beginner (green)	QR code (Tourist identification)
	Level 2 (offline): visit the location according to the recommended travel package, talk to the entrepreneur, then show a QR code to the entrepreneurs to scan and approve the visited location into the system.	Seeker (blue)	Coupons, or discounts, or products and services within a community or establishment
	Level 3 (offline): repeat the second level of the mission (level 2) until the player completes to visit all locations in the selected recommended travel package.	Traveler (gold)	Special discount price for other packages

communities and locations. In addition, this research focuses on using the gamification approach as a part of tourism promotion. Hence, it combines both offline and online activities to help tourists and entrepreneurs get a connection. The tourist attractions, accommodations, restaurants, and local stores that tourists visited were stored in the cloud database for improving the travel package accordingly. This would help the tourism development agency to improve and update the recommended travel packages later. Also, tourists can be a plan and set their destinations which are suitable in real-time.

In this research, all these places were called points or locations. Let L be the universal set. It is a set of all locations (l) within the Ranong province. Let P be a set of all recommended travel packages in the province. The package p_x represents any recommended travel package that consists of several locations. The package p_x may be defined as follow.

$$p_x = \{l \mid l \in L\} \tag{1}$$

where x refers to the sequence number of the recommended travel packages, and $1 \leqslant x \leqslant |P|$.

For example, let p_1, p_2, and p_3 be a first, second, and third package, respectively. All three of these packages may be redundant or not redundant of the locations. Suppose $p_1 = \{l_1, l_2, l_3, l_5\}, p_2 = \{l_1, l_4, l_6\}$, and $p_3 = \{l_7, l_8, l_9, l_{10}\}$. So, packages p_1 and p_2 have the locations l_1, while p_3 has not any locations as same as p_1 or p_2.

Let T_x denote a set of tourists in package p_x, where N refers to a total number of tourists in a package.

$$T_x = \{t_1, t_2, t_3, \ldots, t_{N-1}, t_N\} \tag{2}$$

Let t_i denote a set of locations were visited by tourist number i in T_x, as formulae.

$$t_i = \{l \mid l \in L\} \tag{3}$$

where i refers to the sequence number of the tourists in T_x, and $1 \leqslant i \leqslant |T_x|$.

According to (1)–(3), suppose t_1, t_2, and t_3 are the sets of locations that three tourists visited, respectively, in package p_1. Each tourist may have a different visit to the locations or aside from the package p_1, for example, $p_1 = \{l_1, l_2, l_3, l_5\}$, $t_1 = \{l_1, l_2, l_3, l_5\}$, $t_2 = \{l_1, l_2, l_3, l_5, l_7\}$, and $t_3 = \{l_1, l_2, l_6\}$. It found that the first tourist t_1 and second tourist t_2 have visited all the locations as specified in package p_1. The second tourist t_2 has a visit to location l_7 that excludes package p_1, while the third tourist t_3 did not complete to visit all locations specified in package p_1.

The comparison between the recommended travel packages and the actual travel routes tourists visited could be measured by the consistency of traveling, such as the matching point visited rate, the matching point-by-point rate, and the matching directed point-by-point rate.

First, the matching point visited rate was used for examining whether each tourist traveled to different points or locations according to the recommended travel packages or not. This rate was calculated by the total number of locations that each tourist has visited and is a tourist destination included in a recommended travel package divided by the total number of locations in the recommended travel package then average by a total number of tourists in a package. Regarding (1)–(3), the matching point visited rate of package p_x is denoted by $MAT_{points}(p_x)$, as follows.

$$MAT_{points}(p_x) = \frac{1}{|T_x|}\sum_{i=1}^{|T_x|}\left(\frac{|p_x \cap t_i|}{|p_x|}\right) \tag{4}$$

where

$|p_x \cap t_i|$ refers to the total number of locations which are visited by tourist t_i in package p_x;

$|p_x|$ refers to the total number of locations in package p_x;

$|T_x|$ refers to the total number of tourists in package p_x.

According to p_1, t_1, t_2, and t_3 in the previous example, the $MAT_{points}(p_1)$ could be calculated to $\frac{1}{3}(\frac{4}{4}+\frac{4}{4}+\frac{2}{4})$, it was 0.8333. Therefore, the matching point visited rate in (4) was the average

rate of the visited locations within a recommended travel package per tourist.

Second, the matching point-by-point rate was used to examining whether each tourist has traveled from one location u to the next location v, considering every ordered pair of locations that visit each other. Let $R(p_x)$ be the relation of the ordered pairs of locations from u to v or v to u in the recommended travel package p_x, as formula.

$$R(p_x) = \{(u, v) \in p_x \times p_x \,|\, (u = l_j \ \ and \ \ v = l_{j+1}) \ \text{or} \ \ (u = l_{j+1} \ \ and \ \ v = l_j)\} \tag{5}$$

where j refers to the sequence number of the location in packages p_x, and $1 \leqslant j \leqslant |p_x|$.

It can be defined the relation of the ordered pairs of locations that each tourist t_i has traveled from one location u to v or location v to u in actual as follows.

$$R(t_i) = \{(u, v) \in t_i \times t_i \,|\, (u = l_k \ \ and \ \ v = l_{k+1}) \ \text{or} \ \ (u = l_{k+1} \ \ and \ \ v = l_k)\} \tag{6}$$

where k refers to the sequence number of the location were visited by tourist t_i, and $1 \leqslant k \leqslant |t_i|$.

Based on (2), (5), and (6), when comparing the relation of $R(p_x)$ and $R(t_i)$ by ignoring the sequence in which each ordered pair, the matching point-by-point rate of package p_x is denoted by $MAT_{pairs}(p_x)$, as formulae.

$$MAT_{pairs}(p_x) = \frac{1}{|T_x|}\sum_{i=1}^{|T_x|}\left(\frac{|R(p_x) \cap R(t_i)|}{|R(p_x)|}\right) \tag{7}$$

where

$|R(p_x) \cap R(t_i)|$ refers to the total number of ordered pairs of locations were visited by tourist t_i in package p_x;

$|R(p_x)|$ refers to the total number of ordered pairs of locations in package p_x.

Third, the matching directed point-by-point rate was used for finding the ratio of the sequential of traveling from the first location to the last location with certain directions between each tourist traveling and the recommended travel package. Let $Rd(p_x)$ be the relation of the ordered pairs of locations from u to v in a one-way direction within the recommended travel package p_x.

$$Rd(p_x) = \{(u, v) \in p_x \times p_x \,|\, u = l_j \ \ and \ \ v = l_{j+1}\} \tag{8}$$

where j refers to the sequence number of the location in packages p_x, and $1 \leqslant j \leqslant |p_x|$.

Let $Rd(t_i)$ be the relation of the ordered pairs of locations from location u to v with the one-way direction for each tourist t_i in actually visited travel routes. This relation can be defined as follows.

$$Rd(t_i) = \{(u, v) \in t_i \times t_i \,|\, u = l_k \ \ and \ \ v = l_{k+1}\} \tag{9}$$

where k refers to the sequence number of the location were visited by tourist t_i, and $1 \leqslant k \leqslant |t_i|$.

According to (2), (8), and (9), the matching directed point-by-point rate of package p_x is denoted by $MAT_{directions}(p_x)$, in formulae.

$$MAT_{directions}(p_x) = \frac{1}{|T_x|}\sum_{i=1}^{|T_x|}\left(\frac{|Rd(p_x) \cap Rd(t_i)|}{|Rd(p_x)|}\right) \tag{10}$$

where

$|Rd(p_x) \cap Rd(t_i)|$ refers to the total number of ordered pairs of locations were visited by tourist t_i in package p_xx;

$|Rd(p_x)|$ refers to the total number of ordered pairs of locations in package p_x.

By combining (4), (7), and (10), the consistency of traveling of package p_x would be denoted by $C(p_x)$, formulated as follows.

$$C(p_x) = \frac{1}{3}\left(MAT_{points}(p_x) + MAT_{pairs}(p_x) + MAT_{directions}(p_x)\right) \tag{11}$$

The consistency of traveling of package p_x can be range from zero to one. The closer to one means the recommended traveling package, which has the sequence and ordered pair locations are consistent or close to most tourists' actual travel in the recommended travel package. Therefore, the travel consistency rate for all recommended travel packages was denoted by C_{all}. It could be calculated, as follows.

$$C_{all} = \frac{1}{N}\sum_{x=1}^{N} C(p_x) \tag{12}$$

where N refers to the total number of all recommended travel packages in the province.

Furthermore, there were also locations where the tourists visited, but they were not recommended in the recommended travel package. It can be considered from the over-location visited rate. This rate depends on each visited location, which is out of the recommended travel package. Let $O(p_x)$ be the set of all locations were visited by tourists T_x and excluded from the recommended travel package p_x. So, $O(p_x)$ could be found as follows.

$$O(p_x) = \bigcup_{i=1}^{|T_x|} t_i - p_x \tag{13}$$

Let j be the sequence number of the visited location i_j in $O(p_x)$. Thus, the average rate of each visited location l_j and excluded from the recommended travel package p_x, was calculated in (14).

$$Avg(O(p_x)_j) = \frac{1}{|T_x|}\sum_{i=1}^{|T_x|} |O(p_x)_j \cap t_i| \tag{14}$$

where j refers to the sequence number of the visited location l_j in $O(p_x)$, and $1 \leqslant j \leqslant |O(p_x)|$.

In contrast, some locations might be unvisited in the recommended travel package. These locations were unwanted or ignored by tourists. Hence, the tourism development agency could remove some of these locations from the packages or find the facts. Let $M(p_x)$ represents a set of locations unvisited in package p_x that could be found in (15), and the average rate of each unvisited location l_j in package p_x was formulated in (16).

$$M(p_x) = \bigcup_{i=1}^{|T_x|} p_x - t_i \tag{15}$$

$$Avg(M(p_x)_j) = \frac{1}{|T_x|}\sum_{i=1}^{|T_x|} |M(p_x)_j \cap t_i| \tag{16}$$

where j refers to the sequence number of the unvisited location l_j in $M(p_x)$, and $1 \leqslant j \leqslant |M(p_x)|$.

By applying algorithms for adaptive tourism recommendation, eighty-five tourist samples who usually used an application to find the tourist attractions and voluntarily took the efficiency testing were selected to explore the visited locations or places. There are fifty-one locations in this experiment; forty-six locations were recommended in seven recommended travel packages, and five locations were excluded from any recommended travel package. Thus, the accuracy and sensitivity analysis were used to measure the algorithm performance. Especially the sensitivity, if it is high, gives a low false-negative rate (FNR), which further supports the system's high reliability. On the other hand, if the sensitivity is low, the system has a high probability of making prediction errors. Therefore, these values are indicators of how suitable recommended travel packages meet the needs of tourists. The accuracy and sensitivity can be formulae in (17) (Nuanmeesri and Sriurai, 2021) and (18) (Powers, 2011), respectively.

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \quad (17)$$

$$Sensitivity = \frac{TP}{TP + FN} \quad (18)$$

where

TP refers to the recommended locations where tourists visited in the selected package;

TN refers to the locations in different packages or the unrecommended locations where tourists do not visit;

FP refers to the recommended locations where tourists do not visit in the selected package;

FN refers to the locations in different packages or the unrecommended locations where tourists visited.

3.4. Design of the mobile and web application

In this research, the mobile application was designed to supported Android and iOS operating systems. The web application was designed by applied responsive web design (RWD) technology, which compatible with all devices ranging from smartphones to computers. The RWD allowed available information displaying with high visibility on the big screen, supporting the government to use the data and resolve the limitations according to the needs of users. Furthermore, designed pin icons were evaluated and accepted by five experts in information technology or tourism development. The scoring for evaluation was based on the index of Item-Objective Congruence (IOC), as presented in (19) (Lynn, 1986).

$$IOC = \frac{\sum R}{N} \quad (19)$$

where

R refers to the score that the rated by experts;

N refers to the number of experts.

Each indicator was measured with the IOC value of 0.5 or higher (the highest IOC value was 1), which meant more than half of the experts answering that the questionnaire met the objective (Nuanmeesri, 2019; Nuanmeesri and Poomhiran, 2019; Rovinelli and Hambleton, 1977). It could also be implied that the pins met the objectives and possessed the contents suitable for the operation, showing that the pins worked effectively. In other words, if the IOC value of each indicator was 0.8, it meant the pins met the objective and were suitable for use in the application development. The five experts in tourism development evaluated the pins by applied the following assessment criteria in Table 2.

Fourteen pins passed the evaluation with an IOC value was greater than or equal to 0.8. These pin icons were designed by general graphic design software with a dimension of 68x60 as PNG files formatted. They are transparent background images and shown as colored icons on the map. All new pin icons were uploaded and replaced the general pins using Google Maps API with the proportionate ratio (1:1 or 3:2). These pins represented the locations, including public agencies, tourist attractions, and standardized local businesses such as hotels and accommodations, restaurants, local stores, and souvenir shops. The map area offers multiple interactive features for the users to explore the itinerary surroundings; for example, it will display its name in a pop-up label when mousing over a pin icon. There are two types of pins: entrepreneur reward pins and attraction and favorite pins. All pin icons are illustrated in Fig. 1.

Moreover, five experts in information technology or tourism development assessed the consistency of the contents on the applications. Correspondingly, the result was used for determining the content validity index (CVI) and the item content validity index

Table 2
Rating criteria for pins evaluation.

Rating criteria	Meaning
1	There is content consistency. Pin icon is suitable for display as standard on the application.
0	There is uncertainty in the content consistency. Pin icon is not suitable for use as a standard representative on the application.
−1	There is neither content consistency nor appropriateness for the pin icon as a standard representative on the application.

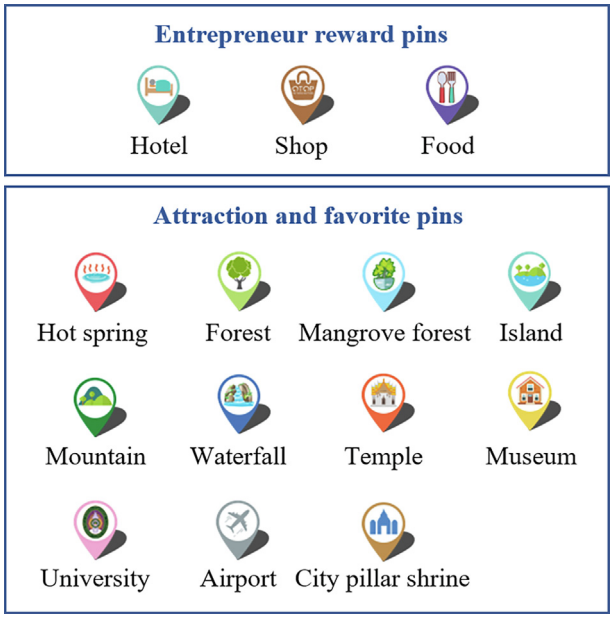

Fig. 1. The designed reward pins for display on the application.

(I-CVI) of each feature in the applications. Also, the content validity for scale (S-CVI) was used to evaluate the appropriateness of features (Lynn, 1986). In general, S-CVI/Ave value was the average proportion calculated by taking the I-CVI summations and then divided them by the total number of questions. For the CVI, only the items rated at 3 or 4 by the experts were considered content validity index. Therefore, the actual calculation was dichotomous by which 1 or 2 indicated inconsistency, and 3 or 4 indicated consistency (Polit and Beck, 2006) as follows.

$$I - CVI = \frac{N_c}{N} \quad (20)$$

where

$I - CVI$ indicates the content validity index by features;

N_c indicates the number of experts who rated the score at 3 and 4 levels;

N indicates the total number of experts.

$$S - CVI/Ave = \frac{\sum I - CVI}{P} \quad (21)$$

where

$S - CVI/Ave$ indicates the average content validity index of the entire application;

$\sum I - CVI$ indicates the total value of the content validity index by features;

P indicates the total number of features.

Furthermore, five experts specialized in information technology or tourism or development evaluated the features of the mobile and web applications. The I-CVI was applied to the evaluation to

Table 3
Rating criteria for the mobile and web application based on the content validity index.

Rating criteria	Meaning
1	Inconsistent and unsuitable as a feature in the developed application
2	Partially consistent and suitable as a feature in the developed application
3	Fairly consistent and suitable as a feature in the developed application
4	Highly consistent and suitable as a feature in the developed application

determine scores. An I-CVI above 0.78 was defined as having good content validity (Shi et al., 2012), and a scale with excellent content validity should be composed of I-CVI of 0.78 or higher and S-CVI/Ave of 0.8 and 0.9 or higher (the highest S-CVI value is 1) (Davis, 1992; Grant and Davis, 1997; Polit and Beck, 2004; Waltz et al., 2017). Rovinelli and Hambleton (1977) shown that the number of experts answering the questionnaire met the following objective made up higher than 50% of the total. This implied that the features met the objectives and possessed the contents suitable for the application and showing that the features worked effectively. For example, if each CVI indicator was 0.8 or higher, it means the features met the objective and suitable for application development. The experts provided a rating by using the assessment criteria, as illustrated in Table 3.

All features on the mobile and web applications that met the criteria above mention were illustrated in Fig. 2. The diagram of features shown the data inputs and outputs depicting the whole procedure in the mobile and web application.

3.5. Development of the mobile and web application

Both applications were developed to support running on smartphones and computers. There are the various technologies used to develop the applications as follows.

- **Backend database**: MySQL database is used to store data in the system, consisting of seventeen tables. This database collation was set to the UTF8 character set with case-insensitive and deployed on Google Cloud SQL for MySQL interconnection data. The entity-relationship diagram (ERD) of the backend database was shown in Fig. 3.
- **Web application development**: Bootstrap version 4, Hypertext Markup Language version 5 (HTLM5), and Cascading Style Sheets (CSS) were applied to design the user interface, beautiful display, and browser compatibility in the concept of RWD. For the programming, PHP version 5.6 is the primary language to control JavaScript (JS) and jQuery for operating with Google Maps API and webpages. The MySQL database was connected based on Extensible Markup Language (XML) and JavaScript Object Notation (JSON) string.
- **Mobile application development**: Ionic framework was applied to mobile application development that supported iOS and Android operating systems. It helps the developers who had adequate knowledge about HTML5 and CSS did not need to study any new computer programming language. The Ionic framework utilized the HTML5, TypeScript, Google Maps API. The data connection to the MySQL database is based on JSON string via PHP API.

Furthermore, the registered tourists have the QR code as a tourist identification code used in the missions. The creation of the QR code was generated by the ngx-qrcode2 library. Due to its tiny size, the QR code could display various information on the screen, reducing perception mistakes and allowing convenient scanning. There are samples of pseudo-code shown in Fig. 4, while the application user interfaces were shown in Fig. 5–10.

3.6. System testing

The developed applications were tested using the black box testing approach by five experts in information technology or

Fig. 2. Diagram of features operation for mobile and web application.

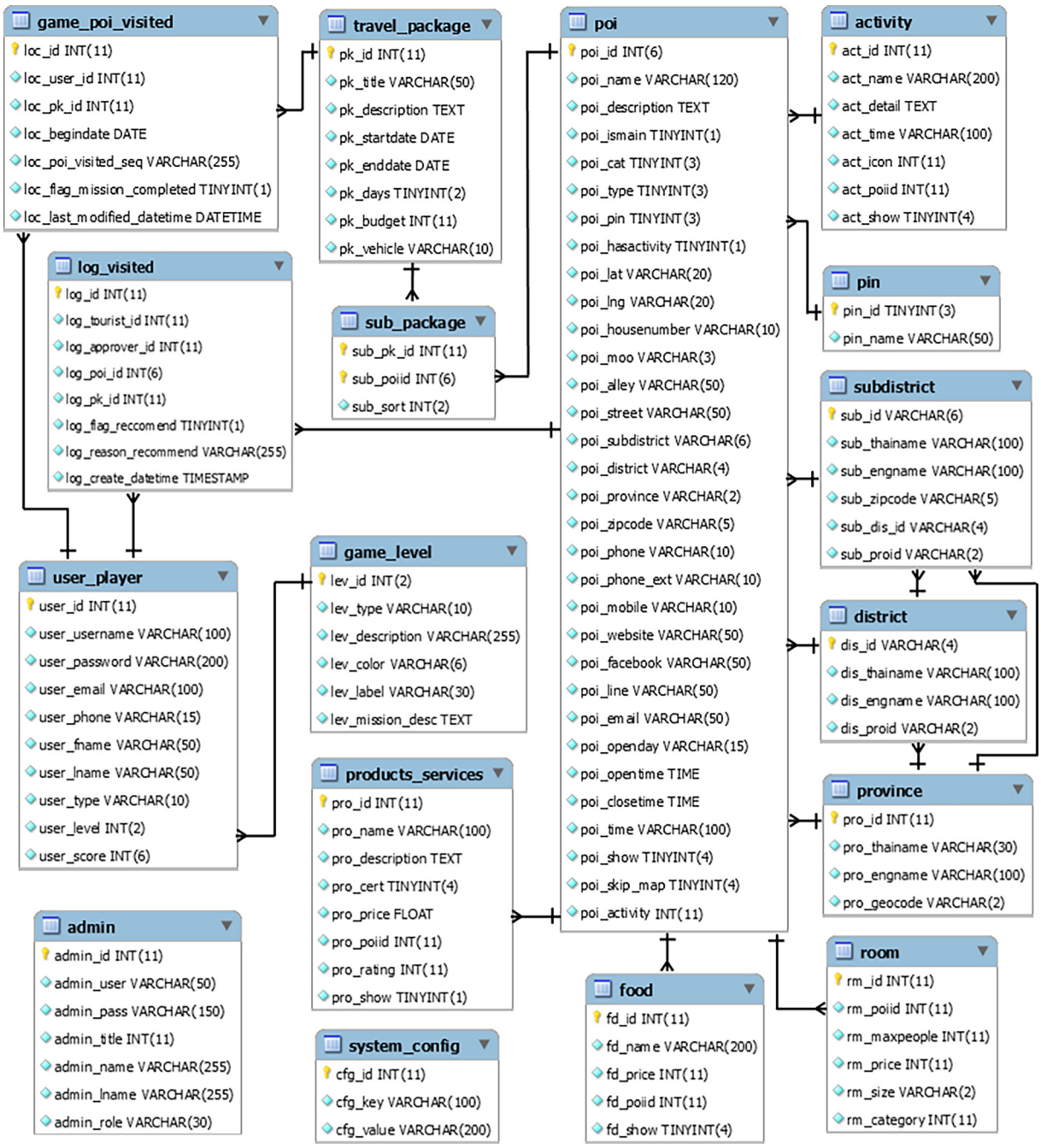

Fig. 3. The entity-relationship diagram of the backend database.

tourism development. Black box testing is a software testing technique that neglects the internal mechanisms of a system or a component, including the internal code structure, implementation details, and knowledge of internal paths of the software. In other words, this testing focuses on inputs and outputs of the software system without bothering about internal knowledge of the software program. In this study, there were five kinds of testing. First, the function requirement test focused on the application's operation, whether it is met the requirement or not. Second, the function test focused on the product behaved properly. Third, the usability test; the application was tested by the users and accepted in terms of convenient operation. Next, the performance test focused on responding to the inputs and outputs. Lastly, the security test focused on the application was carried out to ensure utilization and data storage safety. Thus, the results were analyzed to gain the mean value and the standard deviation (SD) value regarding the Likert-scale scoring criteria (Likert, 1932), as illustrated in Table 4.

3.7. System usage training

Both applications were deployed in a practical training session with forty-five volunteers, including tourists, prospective entrepreneurs, and government officials. In this training, there was a guest speaker who experts in web and mobile application development. Moreover, there are one-to-one teaching assistants who were

```
Function CalTravelCons(Args: (array) px, ay 2-dimension) tx)
Begin
    Set y = 0
    Set m1 = call CalMatchPoints(px, tx)
    Set m2 = call CalMatchPairs(px, tx)
    Set m3 = call CalMatchDirections(px, tx)
    Set y = (m1 + m2 + m3) divided by 3
    Return (y)
End
```

```
Function CalMatchPairs(Args: (array) px, (array 2-dimension) tx)
Begin
    Set npx = total members in array px
    Set ntx = total members in array tx
    Set y = 0
    Set sum = 0
    For i = 0 to ntx-1 Do
        Set array t = tx[i]
        Set n = total members in array t
        Set c = 0
        For j = 0 to n-2 Do
            Set tloc = t[j]
            Set tloc2 = t[j+1]
            For k = 0 to npx-2 Do
                Set ploc = px[k]
                Set ploc2 = px[k+1]
                If tloc == ploc and tloc2 == ploc2 or
                   tloc == ploc2 and tloc2 == ploc Then
                    Set c to increase by 1
                End If
            End For
        End For
        Set sum = sum + (c divided by npx)
    End For
    Set y = sum divided by ntx
    Return (y)
End
```

```
Function CalMatchPoints(Args: (array) px, (array 2-dimension) tx)
Begin
    Set npx = total members in array px
    Set ntx = total members in array tx
    Set y = 0
    Set sum = 0
    For i = 0 to ntx-1 Do
        Set array t = tx[i]
        Set n = total members in array t
        Set c = 0
        For j = 0 to n-1 Do
            Set tloc = t[j]
            For k = 0 to npx-1 Do
                Set ploc = px[k]
                If tloc == ploc Then
                    Set c to increase by 1
                End If
            End For
        End For
        Set sum = sum + (c divided by npx)
    End For
    Set y = sum divided by ntx
    Return (y)
End
```

```
Function CalMatchDirections(Args: (array) px, (array 2-dimension) tx)
Begin
    Set npx = total members in array px
    Set ntx = total members in array tx
    Set y = 0
    Set sum = 0
    For i = 0 to ntx-1 Do
        Set array t = tx[i]
        Set n = total members in array t
        Set c = 0
        For j = 0 to n-2 Do
            Set tloc = t[j]
            Set tloc2 = t[j+1]
            For k = 0 to npx-2 Do
                Set ploc = px[k]
                Set ploc2 = px[k+1]
                If tloc == ploc and tloc2 == ploc2 Then
                    Set c to increase by 1
                End If
            End For
        End For
        Set sum = sum + (c divided by npx)
    End For
    Set y = sum divided by ntx
    Return (y)
End
```

Fig. 4. The example of pseudo-code for adaptive tourism recommendation.

students in the information technology department to take care of volunteers during training. In the beginning, all participants must take the pre-test before the training, which is a multiple-choice question, answer only one option, amount ten questions which created in Google Forms. After completing the pre-test, then start the training process and learn to use the applications. It took three hours to train by explaining how to install and use the applications on both the web and mobile, showing usage examples, and giving participants practical training. All participants got the hard copy of the user manual while the guest speaker using the slide in PowerPoint file formatted. After learning processes are done, all volunteers take a post-test which is the same as the pre-test question but shuffled questions and answer options. At the end of the training, the guest speaker suggests the online material and where to download it.

4. Results

This section demonstrates the results of evaluations in all aspects as follows.

4.1. The evaluation of the application using black box testing

The evaluation results of the application using black box testing showed that, among the five indicators, the usability test criteria had the highest mean value at 4.80, together with the SD value at 0.45. The other indicators had almost the same mean value, which was 4.60. The mean in total was 4.64, and the standard deviation was 0.49. Regarding the quartiles (Q), all five assessment indicators have no more interquartile range (IQR) than one. Also, the quartile deviation (QD) no more than 0.5, shown in Table 5.

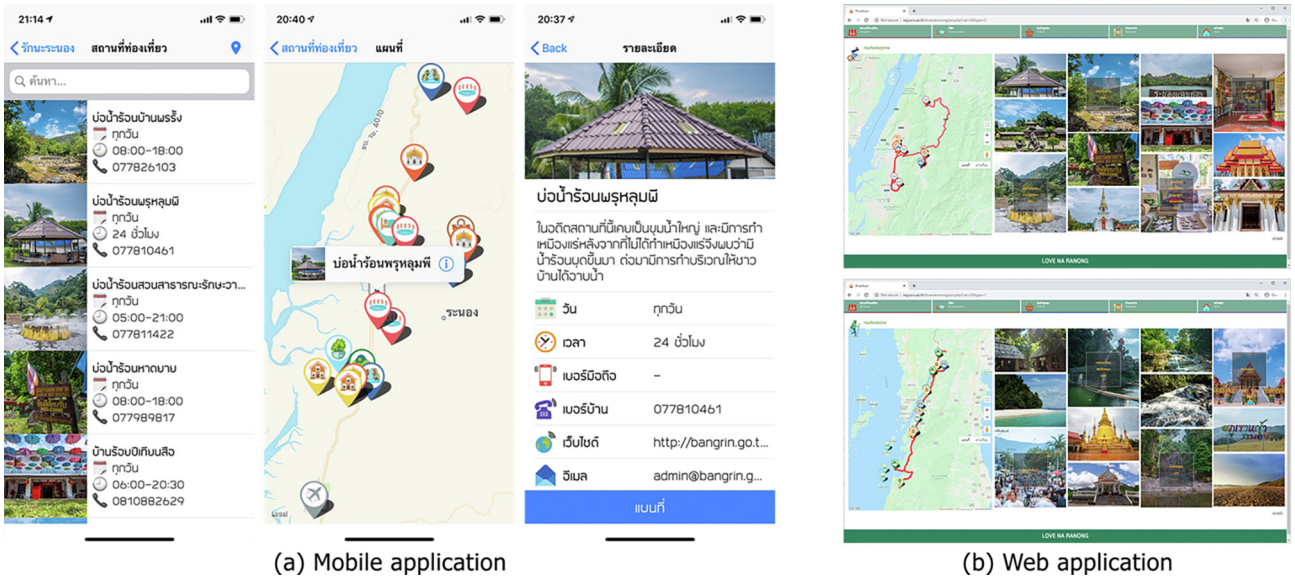

Fig. 5. The example of the user interface for tourist attractions.

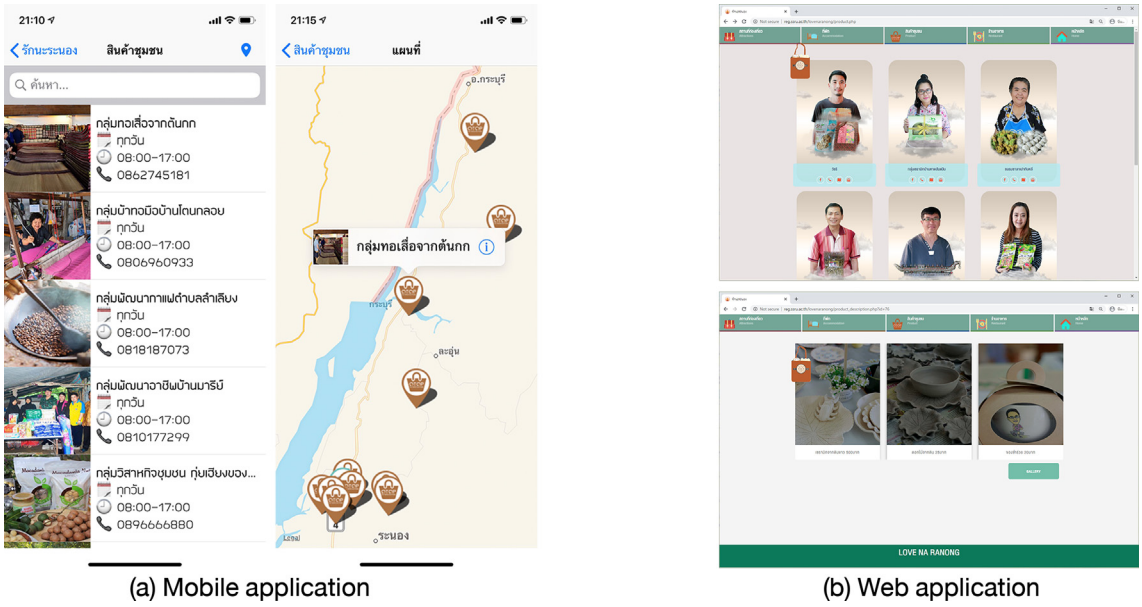

Fig. 6. The example of the user interface for local enterprises and shops.

The result suggests that the applications are suitable for use at the highest level with high consensus by five experts.

4.2. The evaluation of the learning outcomes by users

The effectiveness evaluation result was gained from pre-test and post-test by forty-five samples (N) in the training process. The learning results showed that the samples received more correct answers after the training. Afterward, the comparative test results collected before and after the training were used for the statistical test of the following hypotheses:

H_0: The learning results before and after using the applications are not different.

H_1: The learning results before and after using the applications are different.

Statistically tested by *t*-Test, the null hypothesis (H_0) was rejected because the probability value (*p*-value) was lower than the significant level (α); it was considered statistically significant. Therefore, in this study, the H_0 was rejected, while the alternative hypothesis H_1 was accepted where $\alpha = 0.05$. According to the paired sample *t*-Test results, it was found that the significance value was lower than the predetermined significance level. Therefore, the mean values of the two groups were different. According to the learning outcomes before and after the application usage training, there was a statistically significant difference between the learning outcomes (*p*-value < 0.001). There is the mean value at 5.95 with the SD at 0.74 for the pre-test. For post-test, the mean value at 9.41 with the SD value was 0.39, as shown in Table 6.

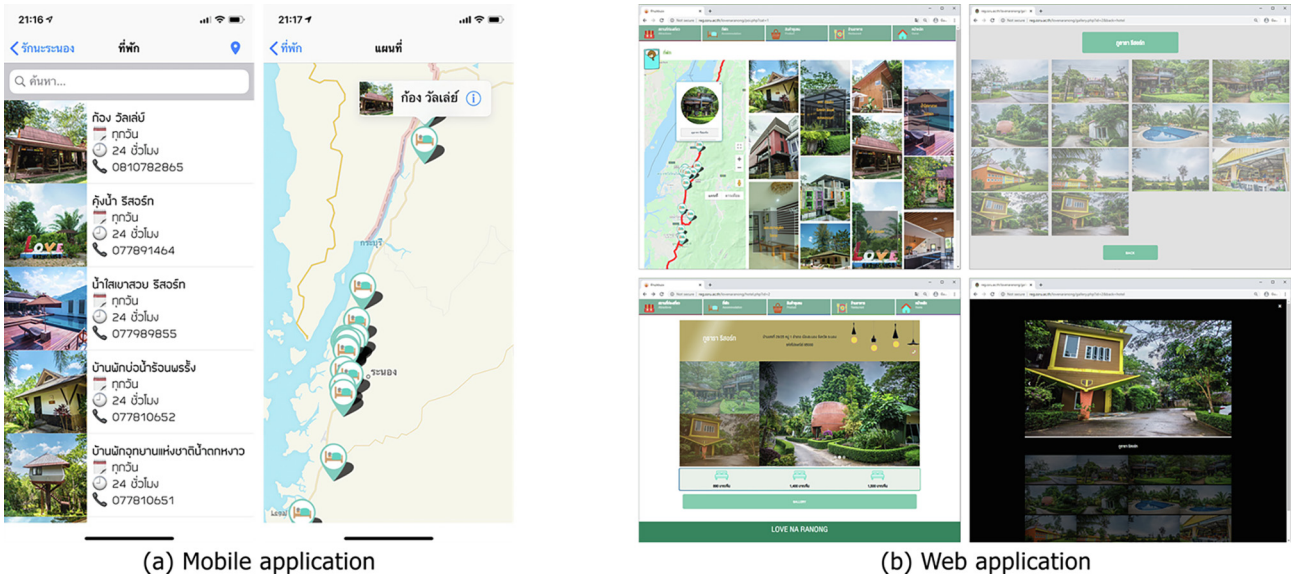

Fig. 7. The example of the user interface for accommodations.

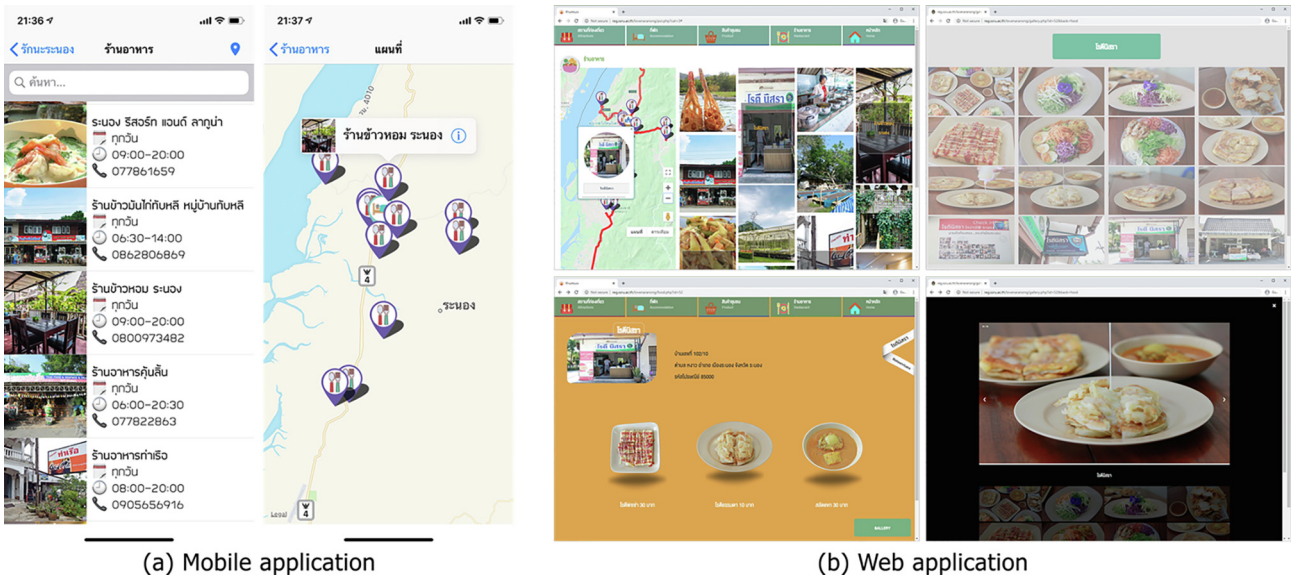

Fig. 8. The example of the user interface for foods and restaurants.

4.3. The evaluation of the application effectiveness by users

The evaluation indicators for the developed application were assessed by forty-five samples of volunteers who took up the test group regarding the comprehension and user experience aspects in eight assessment indicators. The data was analyzed to find the mean and the SD value based on the Likert-scale scoring criteria (Likert, 1932), previously mentioned in Table 4. The evaluation results obtained from the samples showed that related to comprehension and user experience aspect, the comprehension aspect was rated with a mean of 4.73 and SD of 0.45, and the user experience aspect was determined to have a mean of 4.60 and SD of 0.48. It could be implied that both mobile and web application effectiveness at a high level. Since the overall mean was 4.68 and the SD was 0.47, it could be concluded that the applications for tourism development effectiveness at the highest level and received a high consensus of acknowledgment from the samples. Regarding the quartiles, all of the values had an IQR of no more than one, and the QD was no more than 0.5, as illustrated in Table 7. The result suggests that the applications have effectiveness at the highest level with high consensus by forty-five users.

4.4. The efficiency of adaptive tourism recommendation

The developed applications were distributed for the surfer to travelers or tourists, entrepreneurs, and the tourism development agencies who have using it for fourteen days. The real-world application usage data has been recorded in the system. It found that eighty-five surfer tourists come to travel in Ranong province and use developed applications. Thus, the visited locations were compared with the locations in seven recommended travel packages based on the confusion matrix with 1,224 records, as shown in Fig. 11.

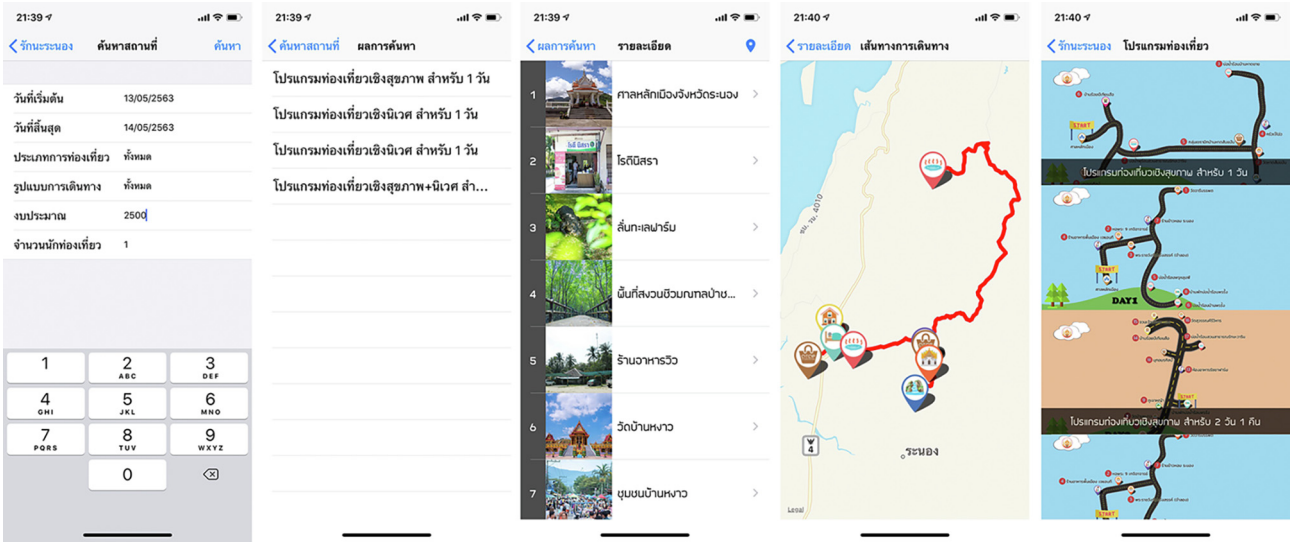

Fig. 9. The example of the user interface for the recommended travel packages on mobile application.

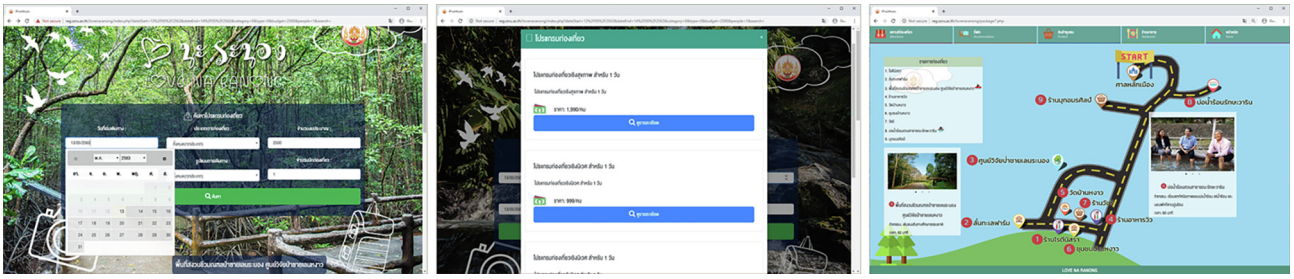

Fig. 10. The example of the user interface for the recommended travel packages on web application.

Table 4
Scoring criteria for the mobile and web application in black box testing.

Rating criteria	Range of weighted mean	Meaning
5	4.51–5.00	The highest
4	3.51–4.50	The high
3	2.51–3.50	The medium
2	1.51–2.50	The little
1	1.00–1.50	The least

According to Fig. 11, it was shown the confusion matrix with 1,224 records by which the values of *TP*, *TN*, *FP*, and *FN* were 793, 395, 25, and 11, respectively. The result demonstrated that the accuracy was 97.06%, and the sensitivity was 98.63%. This result suggested that the recommended travel packages are suitable for tourists in Ranong province with the highest efficiency.

5. Conclusion and future work

This research magnifies Thailand's tourist business opportunities in the new normal settings under the COVID19 pandemic by applying mobile and web applications developed from this work's objective. These applications are capable of boosting up the Thai economy by deploying digital technology. Many Thai businesses take benefits from exploiting them, such as accommodations, restaurants, local stores, and souvenir shops. In terms of methodology, gamification was applied to offline and online activities to promote goal achievement by which the rewards or pins were presented on Google Maps in the developed applications. There are also prizes such as freebies or extra discounts for tourists who used the application and recorded their visited locations that the local entrepreneurs approved. Both contents and features

Table 5
The evaluation results of the applications using black box testing by experts.

Assessment indicators	Mean	SD	Quartiles			IQR	QD
			Q1	Median	Q3		
1. Function requirement test	4.60	0.55	4.00	5.00	5.00	1.00	0.50
2. Function test	4.60	0.55	4.00	5.00	5.00	1.00	0.50
3. Usability test	4.80	0.45	5.00	5.00	5.00	0.00	0.00
4. Performance test	4.60	0.55	4.00	5.00	5.00	1.00	0.50
5. Security test	4.60	0.55	4.00	5.00	5.00	1.00	0.50
Total	4.64	0.49	4.00	5.00	5.00	1.00	0.50

Table 6
The *t*-Test result of evaluating the learning outcomes by users in the training process.

Comparison issue	N	Pre-test		Post-test		*t*	*p*
		Mean	SD	Mean	SD		
Learning outcomes	45	5.95	0.74	9.41	0.39	−31.06	.000

Table 7
The result of the evaluation of the application effectiveness while being used by users.

Assessment indicators	Mean	SD	Quartiles			IQR	QD
			Q1	Median	Q3		
1. Comprehension aspect							
1.1 Promotion	4.74	0.44	4.25	5.00	5.00	0.75	0.375
1.2 Enabling connections	4.63	0.49	4.00	5.00	5.00	1.00	0.500
1.3 Motivation	4.76	0.43	5.00	5.00	5.00	0.00	0.000
1.4 Knowledge	4.78	0.42	5.00	5.00	5.00	0.00	0.000
Total	**4.73**	**0.45**	**4.00**	**5.00**	**5.00**	**1.00**	**0.500**
2. User experience aspect							
2.1 Increases in quality products and services	4.61	0.49	4.00	5.00	5.00	1.00	0.500
2.2 Sources of income	4.61	0.49	4.00	5.00	5.00	1.00	0.500
2.3 Encouragement of sales	4.63	0.49	4.00	5.00	5.00	1.00	0.500
2.4 Confidence support	4.70	0.47	4.00	4.00	4.00	0.00	0.000
Total	**4.60**	**0.48**	**4.00**	**5.00**	**5.00**	**1.00**	**0.500**
Overall	**4.68**	**0.47**	**4.00**	**5.00**	**5.00**	**1.00**	**0.500**

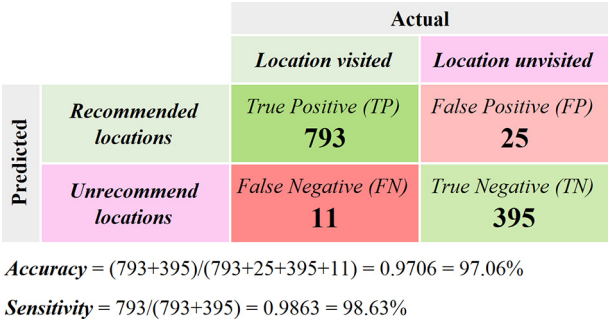

Fig. 11. The confusion matrix of the recommended locations for the travel packages.

design of applications were evaluated by five experts who had expertise in information technology or tourism development. These evaluations were performed using the IOC, and the results indicated that each content item received the CVI scores of no less than 0.8. These content items are designed, including fourteen pins, application user interfaces, and application features. Furthermore, the developed applications were evaluated using the black box testing approach regarding its function requirement test, function test, usability test, performance test, and security test. The overall findings showed that the mean value of 4.64, together with the standard deviation value of 0.49, suggests that the developed application was accurate at the highest level. The developed applications were then introduced to the forty-five samples comprising of tourists, local enterprises, and tourism development officers who were interested in the application. Their learning outcomes were evaluated by pre-test and post-test. The results indicated that their learning outcomes after the training were better than before the training. Statistically tested by *t*-test, the null hypothesis (H_0) was rejected because the significance value was lower than the determined significance level (α=0.05). In this study, the H_1 was accepted, showing that the users successfully learned how to use the application. After evaluating the effectiveness of the application, it could be implied that the comprehension aspect had an arithmetic mean of 4.73 and SD of 0.45, respectively. This suggests that the effectiveness of the application regarding user comprehension was rated at the highest level. For the user experience aspect, the arithmetic mean was 4.60, and the SD was 0.48, meaning the application was practical for providing a pleasant user experience at the highest level. The overall effectiveness had a mean value of 4.68 and the SD value of 0.47. The result suggested that the users rated the application's overall effectiveness to raise community tourism standards at the highest level.

The proposed algorithm was used to improve the recommended travel packages based on the travel history log and visited locations obtained from the system. The efficiency of adaptive tourism recommendation shown that the accuracy rate was 97.06% and the sensitivity was 98.63%. It was clearly shown that both values were consistent, referring to visits from the eighty-five tourists who actually used the application. Moreover, there is some information gained during the mission between tourists and entrepreneurs. Both players could be discussed for exchanging the current situation and information such as travel information, traffic, location environment, and tourists' density. At this stage, the entrepreneurs could recommend a travel destination for tourists based on current information or experiences from other tourists. They then update the flag of recommendation with the reasons into the system. This relevant information can help tourists make immediate decisions or planning new routes or trips for the next destination. As a result, it has become an indirect adaptive tourism recommendation for tourists and consistently with today's tourism.

The development of gamification on mobile and web applications helped the public sector enhance the tourism industry in emerging cities, especially the local businesses or entrepreneurs. The tourism development agency had recorded and updated information about the local businesses and how they improved their business standards regularly. The gamification motivated several local businesses to have a goal and accomplish it by having pins as the rewards shown on the application. It also helped the users to recognize the standardized local enterprises and generated more profits for them. The gamification was applied to the offline activities conducted by the public sector as well, for instance, training, evaluation, surveying, brainstorming, and discussing with the tourists. These were integrated with online technology, which was low-cost and straightforward,

to record inputs and display outputs. In conclusion, the results of this research constitute the following benefits.

- The local enterprises regularly developed and improved themselves to meet the standards implemented by the public sector towards the application of gamification to offline and online activities. Pins in Google Maps represented the development outcomes. This supported them to generate more profits, gain confidence and continue enhancing their businesses further.
- The destination engagement between tourists and entrepreneurs helps them exchange their experiences and beneficial information. Thus, the tourists received information about their destinations and made better decisions when considering standardized local businesses. In addition to the reviews on the existing applications and social media, the developed application recommended the appropriate travel routes and tourist attractions in real-time to revise their itineraries promptly, allowing them to receive better products and services at reasonable prices. Therefore, the adaptive tourism recommendations for tourists were enabled in this activity.
- The tourism development agency could support the local enterprises by engaging them in their training and projects regularly to meet their target groups' expectations. Moreover, they could allocate the budget more productively and improve the travel packages following the demands of the tourists.
- The gamification-based activities promoted sustainable development in the tourism industry and created bonds and collaboration between tourists, local enterprises, and the tourism development agency.
- This study helps improve the recommended travel packages by using the algorithm for adaptive tourism recommendations on the applications. Thus, the tourism development agency could be re-design the recommended travel packages suitable for both tourists and local businesses or entrepreneurs.

For future researches and studies, the research team plans to propose the adaptive tourism recommendation by applying an algorithm integrated with simulated annealing and then comparing it with the greedy algorithm and ant colony algorithm. The researcher will also develop the application to connect the tourist destinations in major cities with those in emerging cities by using ratings and recommendations on social media applications.

Declaration of Competing Interest

The author declares that she has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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