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An Innovative Mobile Application for Wellness Tourism Destination Competitiveness Assessment: The Research and Development Approach

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Abstract

Objectives: This research developed and evaluated the effectiveness of an innovative mobile application for wellness tourism destination competitiveness and also studied the adoption effectiveness of this application. *Methods/Analysis:* A mixed-methods research and development approach was applied to construct a wellness tourism destination competitiveness evaluation model for qualitative research using in-depth interviews, followed by quantitative research using a questionnaire. Weighted scores of criteria and indicators for wellness tourism destination competitiveness were evaluated by the DEMATEL method. The cut-off points for classifying the competitiveness level were set by K-means cluster analysis, while the internal and external accuracy of the model were validated by the confusion matrix technique and the Kruskal-Wallis test. The innovative mobile application was developed using a linear waterfall conceptual design consisting of five software development phases: requirement, design, implementation, verification, and maintenance. A questionnaire was also used to assess the adoption and commercialization of the innovative mobile application. *Findings*: Results showed that 1) the model gave high accuracy with the confusion matrix technique at 85.42% and the Kruskal-Wallis test classified destination competitiveness at a significance level of 0.0001; and 2) the level of adoption of the innovative mobile application was high. Target users were interested in purchasing a license as the commercial mode of the program. *Novelty/Improvement:* This research provides a tool to assess the overall competitiveness of wellness tourism destinations. Results can be used to support decision-making and provide practical suggestions for wellness tourism cluster users to adapt when conducting their own competitiveness assessment. The competitiveness assessment results were accurate and in line with the research objectives.

Keywords: Innovative Platform; Mobile Application; Wellness Tourism; Destination Competitiveness; Competitiveness Assessment.

1. Introduction

Wellness tourism is a policy that promotes niche marketing and stimulates foreign currency expenditures. Thailand's wellness tourism strategy plan includes increasing the provision of healthcare competitiveness by focusing on the development of healthcare personnel with academic excellence at all levels while developing the potential of community

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enterprises and small-scale entrepreneurs to support wellness tourism by promoting marketing and public relations. This strategy plan is also one of the goals of the Thai Government's industrial development policy and strategic plan (2017–2026) to transform Thailand into a central hub for medical and wellness tourism [1]. The Thai Government has placed importance on promoting wellness tourism, but increasing knowledge of the competitive development capacity of a destination to deliver goods and services that outperform other destinations in aspects that tourists consider important [2] is still limited. Previous research focused on studying the demands of wellness tourism, including tourist trends, behaviors, needs, experiences, and satisfaction [3–8]. Wellness tourism research mainly focuses on studying management models of tourist attractions and the development of routes or goods to support wellness tourists [9, 10], as well as how to improve the quality of wellness tourism activities at business and community levels in a specific area [11–15]. Scant research has been published on creating and developing wellness tourism destination competitiveness holistically, even though wellness tourism generates significant revenue for the country. Wellness tourists are often well-educated, moderately affluent, prefer long-term stays, and have a higher tourism expenditure per trip than ordinary tourists.

The value of the Thai wellness tourism market is gradually increasing because of long-standing cultures and traditions, beautiful locations, good-natured people, and exceptional services. The Global Wellness Institute [16] ranked Thailand's wellness tourism market as the 4th largest in Asia (after China, Japan, and India) and the 4th largest spa market (after China, Japan, and South Korea). Thailand was also ranked 17th globally in Traditional & Complementary Medicine and 18th in Healthy Eating, Nutrition, & Weight Loss. Traditional Thai therapies and herbal remedies are often incorporated into spa regimes, and Thai massage has global renown in spa circles. Medical wellness facilities also offer comprehensive preventive checkups and wellness retreats that meet diverse needs, from heart wellness to brain wellness at the genetic and cellular level, with cost-effective prices compared to many rival destinations. Thailand is therefore an ideal and accessible destination for world-class health and wellness services. Tourism agencies from both the public and private sectors should understand the different aspects of wellness tourism and apply their knowledge to improve and develop wellness tourism destinations competitiveness by introducing distinctive products or services that meet the needs of niche tourists. This can be achieved through the application of computers, information technology, and communication techniques and methods as tools to create innovative systems for wellness tourism industry management, thereby increasing the efficiency of business operations and raising competitiveness to an international level to achieve the United Nations Sustainable Development Goals (SDGs) [17]. Goal 8 focuses on promoting inclusive and sustainable economic growth, employment, and decent work for all; Goal 9 focuses on building resilient infrastructure to promote sustainable industrialization and foster innovation; and Goal 17 focuses on revitalizing global partnerships for sustainable development.

Gulyas & Molnar [17] introduced components and indicators of wellness tourism destination competitiveness utilizing bibliometric analysis methods including co-citation analysis, bibliometric coupling, reference analysis, and keyword analysis. Sampling for the bibliometric analysis was conducted using the Clarivate Web of Science (WoS) and Scopus databases, considered the main sources of references by the academic community. Wellness tourism analyses focused on the overview and research directions during the past 10 years. Gulyas & Molnar [17] did not employ CiteSpace software, while Wang et al. [18] conducted a visual analysis of international wellness tourism during the past decade from the Web of Science wellness tourism field using CiteSpace analysis to combine literature reviews and bibliometrics of core journals, core authors, and core areas in the field. However, Wang et al. [18] only selected the core dataset from the Web of Science, potentially omitting some research results. The large number of studies referenced in their paper also made it difficult to analyze the pre-, post-, and moderating variables of each cluster. Their paper focused solely on international research concerning wellness tourism, and no comparison was made with domestic wellness tourism research or addressed the limitations of CiteSpace software, such as potential biases in data selection and interpretation. Phuthong et al. [19] developed a model to assess the potential of wellness tourism destinations using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach to conduct a literature review and identify wellness tourism destination assessment factors and indicators. However, their research was based on a systematic literature review, which had possible limitations in terms of the reliability of the wellness tourism destination assessment model constructed using empirical data from wellness tourism stakeholders.

An empirical statistical research study was conducted by Zeng et al. [20] to explore factors affecting the relationships between destination competitiveness, tourism satisfaction, and tourists' behavioral intentions to return and recommend a location to others. A questionnaire was used to collect data from 550 tourists who visited five mountain-based health and wellness tourism destinations in Panzhihua, China. Structural equation modeling (SEM) was used to construct and test a model of satisfaction, tourist behavioral intentions, and destination competitiveness. This research study had limitations because the results only applied to mountain-based health and wellness tourism and were not generalizable to other types of tourist destinations, while the measurement scale was specific to the city of Panzhihua with its unique cultural and natural environment. Bočkus et al. [21] examined the concept of wellness tourism among wellness enterprises and investigated how wellness tourism services operated using multiple case studies encompassing Eastern Finland, Russian Karelia, and Lithuania. They employed qualitative methodology by conducting individual, semi-

structured interviews with participants to address the research questions. Secondary data were also utilized to supplement the interview data and investigate factors impacting differences within the destinations. Data from the destination websites was also extracted for content analysis. A list of wellness services from previous literature was used to classify the service offerings. Researchers from each country collected data about legislation, state standards, certifications, and other official documents related to wellness tourism services. The material was compared and cross-checked, with interpretations and translations agreed upon by the research group. This study acknowledged the limitation of a small number of interviews, which did not fully reflect the market as a whole. The need for further research to explore the influence of culture, nature, legislation, natural resources, and other factors on the concept of wellness and wellness tourism offerings was also highlighted.

Chai-Arayalert et al. [22] focused on technological application development to support growth in the context of tourism, including applications to design and develop a digital platform-mediated tourism system for self-service information support in small-town destinations. They used a qualitative approach, with data collection methods including document analysis and interviews. The data were then analyzed, developed into a system, and a system evaluation was performed. One limitation of this research study was the small sample size. The authors will not develop the prototype to evaluate its long-term impact or explore additional technologies to investigate its effectiveness in other destinations. Buangam et al. [23] developed a mobile application for information system management of agro-tourism activities and attractions. This study collected data on agro-tourism activities and attractions in four sub-districts of Noppitam district, Nakhon Si Thammarat Province, and selected 12 agro-tourist attractions as research models to develop an information system for the management of agro-tourism activities and attractions. They used the retrieved data to analyze interface design and system development and employed user case diagrams, interface designs, and MySQL for database management. The system was developed using the PHP-language YII framework, was accessible through a web portal, and was compatible with both Android and iOS devices. The final output was a mobile application information system that was compatible with different devices. Users could filter data of interest, such as agro-tourist attractions or restaurants. However, the study had limitations in terms of scope, focusing only on the Noppitam district in Nakhon Si Thammarat Province and selecting a limited number of agro-tourist attractions as research models. No information was provided on the evaluation or testing of the developed system, which could be considered a limitation in terms of assessing its effectiveness and usability. Further studies are required to improve the development of information systems for the effective management of agro-tourist attractions and activities to better assist tourists in decision-making and tailoring tour programs to individual needs.

Yuensuk et al. [24] developed an application recommending cultural tourism activities using machine learning technology. Their research methodology involved collecting data from Facebook conversations of 385 tourists who traveled to a famous tourist destination in Maha Sarakham Province. Three classification techniques, including Naïve Bayes, Neural Networks, and K-Nearest Neighbour, were used to develop a predictive model for cultural tourism management using text mining techniques. The model performance evaluation tool consisted of a confusion matrix and cross-validation methods. A questionnaire was used to assess the satisfaction of using the application for cultural tourism management. This research study was limited because only data from Facebook conversations was collected, and these did not represent the entire population of tourists in Maha Sarakham Province. The study also focused on a specific tourist destination in Maha Sarakham Province, thereby limiting the generalisability of the results to other cultural tourism contexts [25]. The research used three classification techniques for model development, but other machine learning techniques could also have been explored for comparison and validation. The satisfaction assessment of the application was based on a questionnaire that was possibly subject to response bias while not capturing the full range of user experiences.

Oliveira et al. [26] developed a mobile application to strengthen the relationship between agents of local communities/entities to promote mediation mechanisms among all stakeholders in the process of territorial-based innovation, and evaluate the usability of the mobile app prototype. The development of the CeNTER application prototype involved a co-creation approach combining focus groups and brainstorming techniques to define its main functionalities and features, involving ten local community initiatives. Low-fidelity mockups were created, tested, and discussed among the team members. The sketches were then converted to wireframes using the Sketch application, and improvements were made based on team feedback. Principle software was used to develop a medium-fidelity prototype capable of realizing complex interactions such as dragging on a map, swiping on a carousel menu, or tapping to collapse visible content. However, this prototype did not address any potential ethical considerations or limitations related to data privacy, security, or user consent in the development and evaluation of the CeNTER application.

Samsudin et al. [27] designed and developed a mobile app, termed Travel Assist, for visitors to Malaysia by integrating three common web services: Google Translate, Google Maps, and XE Converter into one app, which was then tested by a group of users to confirm its functionality, feasibility, and validity. A questionnaire was used to evaluate the ease of use of Travel Assist. Results indicated that the app was easy to use, user-friendly, met users' expectations, and was flexible. However, this research study did not provide detailed information about the specific methods used in the design and development of Travel Assist or include a comprehensive evaluation of the app's performance or user feedback. The scalability or potential issues that might arise when implementing Travel Assist on a larger scale and potential privacy or security concerns related to the use of the app were also not addressed.

Wang [28] built an intelligent system that integrated data analysis using a mobile cloud IoT computing platform to promote the rural leisure tourism industry and developed a machine learning algorithm to mine tourism data. A specific time series model was also employed to predict the development trend of national cloud computing in the tourism market. Grey correlation analysis was used to evaluate the degree of correlation between various indicators and analyze the impact of different factors on cloud computing guided tour demand. One limitation of this research was that it did not provide any information on potential biases or limitations in the data analysis or gray correlation analysis conducted in the study.

İlkan et al. [29] investigated how mobile application features impacted user engagement and intention for use in tourism using the Diffusion of Innovation (DOI) and Uses and Gratifications (UGT) theories. The study utilized an online survey questionnaire to collect data from European consumers. Statistical remedies were used to check for common method variance, including Harman's single-factor test and unrotated exploratory factor analysis. This research was limited because it focused on only four popular applications used in Europe, with limited generalisability of the results to other specific mApps. The issue of cross-sectional data also limited the ability to analyze perception pattern changes over time.

Oliveira et al. [30] proposed an iterative process to evaluate a mobile application prototype that promoted collaboration between various agents involved in the areas of tourism, health, and well-being using the views of experts and end-users. The mobile application prototype was evaluated in two stages: first by the experts and then by the end-users. The evaluation by experts used a heuristic inspection technique, while the evaluation by end-users involved collecting both quantitative and qualitative data. Quantitative data were obtained through user experience evaluation tools (SUS and AttrakDiff) and usability metrics of effectiveness and efficiency, with qualitative data obtained using the think-aloud protocol. This study had limitations related to the small sample size and short duration, which restricted the generalization of the results. The Principle software used for the prototype did not allow certain types of interactions, such as pinch gestures and personalized data insertion by the user. There were also limitations to gestures like drag and drop. However, these limitations did not impair the evaluation of the user experience, which focused on the acceptance and pleasant experience of using the prototype. Further studies are needed to assess the adoption, use, and impact of this application in promoting the processes of articulation and approximation between local agents, as well as the construction and diffusion of knowledge and innovations.

These previous studies all had certain limitations. Therefore, to fill this research gap, our study employed a research and development approach to develop a theoretical framework for a wellness tourism destination competitiveness assessment model and an assessment tool. The research objectives were 1) to develop and test the effectiveness of an innovative mobile application for wellness tourism destination competitiveness assessment and 2) to study the acceptance of an innovative mobile application for wellness tourism destination competitiveness assessment. To achieve these two main research objectives, a theoretical framework for a wellness tourism destination competitiveness assessment model was constructed using a mixed-methods approach. Qualitative research was conducted through in-depth interviews, and the main themes and sub-themes identified were developed into a research questionnaire for the quantitative assessment of wellness tourism destination competitiveness and used as a tool to collect data from wellness tourism clusters. The variable relationships were grouped using exploratory factor analysis (EFA), with confirmatory factor analysis (CFA) also applied to the wellness tourism destination competitiveness assessment model. The model elements and indicators were then developed into criteria for wellness tourism destination competitiveness assessment by experts in the field using the multiple criteria Decision-Making Trial and Evaluation Laboratory (DEMATEL) method. The weighted values were then calculated, and the indicators of the assessment factors were prioritized. The analytic hierarchy process (AHP) was used to calculate the weighted values within the wellness tourism destination competitiveness assessment model, and the cut-off scores were determined using the cluster analysis technique. Prediction efficiency to solve the classification issue was appraised using the confusion matrix technique and the Kruskal-Wallis independent samples test. The innovative mobile application was developed using a linear waterfall conceptual design, while a questionnaire was also used to assess the adoption and commercialization of the innovative mobile application.

The remainder of this paper is organized as follows: Section 2 outlines the theoretical framework of the wellness tourism destination competitiveness assessment model development; Section 3 presents the developed methodology; Section 4 displays the results; Section 5 discusses the research outcomes; and conclusions are drawn in Section 6.

2. Theoretical Framework of the Wellness Tourism Destination Competitiveness Assessment Model Development

A mixed-methods approach was used to develop the theoretical framework of a wellness tourism destination competitiveness assessment model. This involved qualitative research through in-depth interviews with 13 primary informants, including 3 representatives from public agencies driving and supporting wellness tourism, 5 representatives from academic institutions/professional associations/institutes, 3 representatives from all-inclusive tourism and wellness service businesses, and 2 wellness travelers and tourists. Information gathered from the interviews was then subjected to content and thematic analyses using NVivo 12 computer software to determine node clusters by coding similarity diagrams and the similarity metric of Jaccard's coefficient.

Data analysis results indicated that the competitiveness assessment factors of wellness tourism destinations consisted of seven main themes, including 1) destination image and hospitality; 2) destination policies and strategies to accommodate travel and wellness tourism; 3) infrastructure and wellness tourism carrying capacity; 4) man-made and cultural resources for wellness tourism; 5) wellness promotion service strategies and structures; 6) innovative capacity of destinations; and 7) collaborative networking and destination branding. The theme of destination image and hospitality consisted of 6 sub-themes; the theme of destination policies and strategies to accommodate travel and wellness tourism consisted of 4 sub-themes; the theme of infrastructure and wellness tourism carrying capacity consisted of 5 sub-themes; the theme of man-made and cultural resources for wellness tourism consisted of 4 sub-themes; the theme of wellness promotion service strategies and structures consisted of 8 sub-themes; the theme of innovation capacity of destinations consisted of 5 sub-themes; and the theme of collaborative networking and destination branding consisted of 9 sub-themes.

The main themes and sub-themes identified by studying the wellness tourism destination competitiveness assessment factors were developed into a research questionnaire for the quantitative assessment of wellness tourism destination competitiveness. The formulated questionnaire was then examined by five academic dignitaries and scholars on wellness tourism to determine the index of item-objective congruence (IOC), which should ideally be over 0.5 [31]. Answers to the research questions gave IOC values between 0.60 and 1.00, reflecting that the questionnaire was suitable for use. The questionnaire was then tested with 30 non-sample wellness tourism entrepreneurs to determine discrimination values for each item, the item-total correlation value of the entire questionnaire, which should be more than 0.4, and Cronbach's alpha coefficient value (Cronbach, 1970), which should be over 0.7. Results showed that all items had item-total correlation values of over 0.4, while the reliability test using Cronbach's alpha coefficient showed that all variables passed the stipulated minimum threshold with values between 0.718 and 0.926. Therefore, the questionnaire was used as a tool to collect data from a wellness tourism cluster sample consisting of 216 subjects.

The variable relationships were then grouped using the exploratory factor analysis (EFA) technique to decrease the number of factors using a statistical method called principal component factor analysis employing varimax rotation. In this research, the threshold for the number of factors was decided using eigenvalues, which must be higher than 1, and factor loading, which must have a value of more than 0.5. The analysis results showed that all factor groups passed the stipulated thresholds and had Cronbach's alpha coefficient values, which should be over 0.7, between 0.841 and 0.954, proving that the questionnaire was sufficiently reliable [32]. The results from the exploratory factor analysis were used to conduct a confirmatory factor analysis (CFA) using the Asset Management Operating System (AMOS) software to confirm the structural equation model by testing whether the correlation of the wellness tourism destination competitiveness assessment model fit the empirical data in accordance with the research hypothesis. The model results correlated with the empirical data, as shown by the overall model fit. The absolute fit index of the relative Chi-square: $\chi 2/df$ value was equal to 1.031 and passed the stipulated threshold at a lower level than 5. When considering the group indices with values of more than or equal to 0.90, all indices, including the Tucker-Lewis index (TLI) (value 0.996) and comparative fit index (CFI) (value 0.997), passed the stipulated thresholds [33]. For group indices with values lower than 0.08, all indices, including the standardized root mean square residual (SRMR) (value 0.023) and root mean square error of approximation (RMSEA) (value 0.014), passed the stipulated thresholds [34]. Therefore, the research hypothesis that the developed wellness tourism destination competitiveness assessment model fit with the empirical data was accepted. Other conditions, such as the convergent and discriminant validity and reliability of the model, also met the validity and reliability requirements of the CFA. Results showed that the 41 observed sub-themes as variables achieved the stipulated threshold values of factor loading (threshold >= 0.5 at between 0.618 and 0.919), construct reliability (CR) (threshold >= 0.7 at between 0.793 and 0.955), and average variance extracted (AVE) (threshold >= 0.5 at between 0.500 and 0.749). The variables also achieved maximum shared variance (MSV) and average shared variance (ASV) values that were less than the average variance extracted (AVE) threshold, ranging between 0.417 and 0.498 and 0.075 and 0.215, respectively [34].

The model of the achieved elements and indicators was then developed into criteria for wellness tourism destination competitiveness assessment by utilizing the opinions of experts in the field using the multiple criteria Decision-Making Trial and Evaluation Laboratory (DEMATEL) method [35] to determine the influence level between the criteria (C) and their respective indicators (I) and the weighted values of elements and indicators. Eight experts from academic institutions (academics) and six experts from the tourism industry (industries) were involved with the development of wellness tourism destination competitiveness, making up 14 in total. Pairwise matrix correlation was used to ensure the correct influence and direction between the factors, organized into a linguistic scale with 5 influence levels as follows:

Level 0: No influence;

Level 1: Very low influence;

Level 2: Low influence;

Level 3: High influence;

Level 4: Very high influence.

The DEMATEL method was applied to determine the weighted values and prioritize the factors of wellness tourism destination competitiveness assessment, consisting of the following steps:

Step 1: Creation of direction relation average matrix (Z)

A pairwise comparison of the identified parameters was performed by the experts to determine the influence potential of one parameter over others. Each expert indicated their responses using integers (0 to 4) in the matrices, with each matrix indicating which parameter (i) had five levels of influence over every other parameter (j).

The responses of the experts led to the formation of a non-negative matrix (n*n). After taking into account the responses of all the experts, an average direct relation matrix (Z) was obtained in the form of an n*n matrix, where 'n' is the number of identified parameters while 'i' and 'j' represent row and column, respectively.

The average initial direct-relation matrix (Z) was computed using Equation 1 where matrix Z (average initial direct-relation matrix) = $[z_{ij}]$;

$$Z= z_{ij}= \frac{1}{H}\sum_{k=1}^{H} X_{ij}^{k} \quad (1)$$

where, H refers to the number of experts, n refers to the number of factors, k refers to the number of respondents questioned and, X_{ij}^{k} refers to the degree of influence of criterion i on criterion j in relation to the k^{th} expert.

Step 2: Creation of normalised direct relation matrix (D)

The direct relation matrix (Z), as determined in Step 1, was then multiplied by a factor of F to get an n*n normalized direct relation matrix (D). The factor F was determined using Equation 2, and the normalized direct relation matrix (D) was created using Equation 3.

$$F = \min\left\{\frac{1}{\max i \sum_{j=1}^{n}|z_{ij}|}, \frac{1}{\max j \sum_{j=1}^{n}|z_{ij}|}\right\} \quad (2)$$

$$D =F\times Z \quad (3)$$

Each element in the normalised direct relation matrix (D) holds a value ranging from 0 to 1. with the major diagonal elements being 0.

Step 3: Calculation of total relation matrix (T)

The total relation matrix (T) indicates the total relationships between all pairs of identified parameters. The matrix T was calculated using Equation 4 and element 't_{ij}' of matrix T indicates the indirect influence that parameter 'i' has over parameter 'j'. The indirect influence continuously reduces along the powers of T.

$$T=N+N^2+N^3+\cdots N^k= N\left(I+N+N^2+\cdots+N^{k-1}\right)$$

$$[(I-N)(I-N)^{-1}]= N(I-N)^{-1}(I-N^k)$$

Thus, when $\lim_{k\to\infty} N^k = [0_{n\times n}]$

$$T=N(I-N)^{-1} \quad (4)$$

where, 'I' is a n×n identity matrix.

Step 4: Determination of sums of rows and columns of total relation matrix (T)

The sums of the rows and columns of matrix T were determined as per Equations 5 and 6 and represented by vectors R and C respectively.

$$R=(R_i)_{n\times 1}= \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1} \quad (5)$$

$$C=\left(C_j\right)_{1\times n} = \left[\sum_{j=1}^{n} t_{ij}\right]_{1\times n} \quad (6)$$

R_i is the sum of the i^{th} row and indicates the direct and indirect effects of parameter 'i' over other parameters. C_j is the sum of the j^{th} column and indicates the direct and indirect influences of other parameters on parameter 'j'.

Step 5: Development of weighted score and ranking

The vectors R and C determined in Step 4 were utilized to develop the weighted score. In this step, vectors R+C indicated the importance of the identified parameters. The results of inquiring for the opinions of the experts regarding the wellness tourism destination competitiveness assessment were used to prioritize and weight the component factor groups of the wellness tourism destination competitiveness assessment, as displayed in Table 1.

Table 1. Calculation results of matrix Z per Equation 1 of the component factor groups of wellness tourism destination competitiveness assessment

		C1	C2	C3	C4	C5	C6	C7
	C1	0.0000	3.3571	3.4286	3.2857	3.2857	2.9286	3.2857
	C2	3.3571	0.0000	3.5714	3.0714	3.3571	2.9286	3.4286
	C3	3.3571	3.4286	0.0000	3.0714	3.0000	3.0714	3.0714
Z =	C4	3.2143	3.0000	2.7857	0.0000	2.9286	3.0000	3.2143
	C5	3.2857	3.4286	3.1429	3.0714	0.0000	3.2857	3.1429
	C6	2.8571	3.0000	2.9286	2.8571	3.2857	0.0000	3.3571
	C7	3.1429	3.2857	3.0714	3.0714	3.4286	3.3571	0.0000

After receiving the correlations of matrix Z, the next step was to calculate the direct correlations of matrix D per Equations 2 and 3 and determine the average values for direct correlations of matrix D, with results displayed in Table 2.

Table 2. Calculation results of matrix D per Equations 2 and 3 of the component factor groups of wellness tourism destination competitiveness assessment

		C1	C2	C3	C4	C5	C6	C7
	C1	0.0000	0.1703	0.1739	0.1667	0.1667	0.1486	0.1667
	C2	0.1703	0.0000	0.1812	0.1558	0.1703	0.1486	0.1739
	C3	0.1703	0.1739	0.0000	0.1558	0.1522	0.1558	0.1558
D =	C4	0.1630	0.1522	0.1413	0.0000	0.1486	0.1522	0.1630
	C5	0.1667	0.1739	0.1594	0.1558	0.0000	0.1667	0.1594
	C6	0.1449	0.1522	0.1486	0.1449	0.1667	0.0000	0.1703
	C7	0.1594	0.1667	0.1558	0.1558	0.1739	0.1703	0.0000

From the direct correlation values of matrix D, the total correlation values of matrix T were calculated per Equation 4, with results displayed in Table 3.

Table 3. Calculation results of matrix T per Equation 4 of the component factor groups of wellness tourism destination competitiveness assessment

		C1	C2	C3	C4	C5	C6	C7
	C1	4.2394	4.4401	4.3360	4.2317	4.3966	4.2453	4.4348
	C2	4.4136	4.3236	4.3697	4.2512	4.4280	4.2732	4.4690
	C3	4.2787	4.3351	4.0831	4.1212	4.2795	4.1475	4.3194
T =	C4	4.1098	4.1534	4.0454	3.8289	4.1130	3.9864	4.1594
	C5	4.3417	4.4017	4.2855	4.1846	4.2134	4.2195	4.3887
	C6	4.1240	4.1816	4.0781	3.9821	4.1543	3.8815	4.1927
	C7	4.3351	4.3952	4.2815	4.1834	4.3606	4.2213	4.2500

Then, the r values as the sum of rows in matrix T and the c values as the sum of columns in matrix T were calculated. The r values and c values were then used to calculate the significance values, as displayed in Table 4.

Table 4. Calculation results of weighted values and priorities of the component factor groups of wellness tourism destination competitiveness assessment

Assessment factors	r	c	r+c	Significance
C1	30.3239	29.8424	60.1663	3
C2	30.5283	30.2307	60.7590	1
C3	29.5646	29.4793	59.0439	4
C4	28.3964	28.7831	57.1795	6
C5	30.0351	25.5849	55.6200	7
C6	28.5944	28.9748	57.5692	5
C7	30.0272	30.2141	60.2413	2

The weighted values were then calculated and the indicators of the seven assessment factors were prioritised. The analytic hierarchy process (AHP) was used to calculate the weighted values within the wellness tourism destination competitiveness assessment model, with results displayed in Table 5.

Table 5. Weighted values of the component factors and indicators in the wellness tourism destination competitiveness assessment model

Factor	Indicator	Weighted value
1. Destination image and hospitality (C1)		**0.1465**
	A business environment that promotes wellness tourism business (I1)	0.1700
	Safety and security of the destination (I2)	0.1699
	Health and hygiene management in wellness tourism areas or destinations (I3)	0.1694
	Human resource readiness of personnel working in wellness tourism establishments or businesses with a responsibility of providing products and services to tourists (I4)	0.1731
	Human resource readiness of local people with a responsibility of being good hosts to welcome wellness (I5)	0.1642
	Information technology and communication readiness (I6)	0.1534
2. Destination policies and strategies to accommodate travel and wellness tourism (C2)		**0.1480**
	Placing importance on travel, tourism and wellness services (I7)	0.2561
	Opening up to the world specifically to promote wellness tourism (I8)	0.2574
	Capacity for determining the price level of wellness products and services (I9)	0.2447
	Creating an environmentally friendly experience in destination areas (I10)	0.2419
3. Infrastructure and wellness tourism carrying capacity (C3)		**0.1438**
	Transportation infrastructures that are ready to support wellness tourism (I11)	0.2063
	Infrastructures that support services and tourism (I12)	0.2062
	Capacity for supporting venues, accommodations and facilities (I13)	0.2063
	Capacity for catering support (I14)	0.1942
	Capacity for supporting recreation and entertainment (I15)	0.1870
4. Man-made and cultural resources for wellness tourism (C4)		**0.1393**
	Natural tourist attraction readiness (I16)	0.2473
	Cultural and intellectual tourist attraction readiness (I17)	0.2507
	Resources that accommodate the development of tourist attractions and routes or the establishment of new activities to meet the needs of wellness tourists (I18)	0.2500
	Readiness of resources in promoting tourist health (I19)	0.2521
5. Wellness promotion service strategies and structures (C5)		**0.1355**
	Strategies to improve the quality of service and restoration (I20)	0.1279
	Promoting tourist attractions' fame and certification awards (I21)	0.1196
	Planning a strategy of providing services to give a satisfying customer experience (I22)	0.1259
	Connecting various products, services, activities and elements of wellness tourism to tourists at their destinations (I23)	0.1237
	Tourist attractions offer therapeutic and beauty activities (I24)	0.1274
	Tourist attractions offer healthy body activities (I25)	0.1271
	Tourist attractions offer healthy mind activities (I26)	0.1255
	Tourist attractions offer activities to educate on the local community's way of life (I27)	0.1230
6. Innovative capacity of destinations (C6)		**0.1402**
	Knowledge of developing new products and services, as well as activities and elements of wellness tourism that are of high speed and high quality (I28)	0.1954
	Knowledge of meeting the needs of customers or tourists as much as possible (I29)	0.2040
	Human capital for developing new products and services (I30)	0.2048
	Acceptance of service innovation (I31)	0.2016
	Creating new wellness products or services using community resources based on the distinctive local way of life and identity (I32)	0.1941
7. Collaborative networking and destination branding (C7)		**0.1467**
	Creation of cluster groups for collaboration and communication to all stakeholders (I33)	0.1119
	Allowing or supporting the local communities to participate in planning wellness tourism (I34)	0.1100
	Collaboration between public and private agencies (I35)	0.1119
	Marketing of wellness products and services jointly with allies from public and private agencies on regional, national and international levels (I36)	0.1119
	Building brands for destinations to allure tourists, such as presenting distinctive slogans, logos and health promotion services (I37)	0.1132
	Creating a brand identity that is more memorable than the competition (I38)	0.1089
	Communicating marketing for advertising and public relations jointly with online social media on wellness (I39)	0.1127
	Simulating the environment in real locations for target customers and interested individuals to experience, understand and have a transparently clear picture of wellness tourism destinations (I40)	0.1096
	Jointly building the brand values, such as content created by tourists through online reviews and satisfaction assessment through online channels (I41)	0.1100

After calculating the weighted values of the factors and indicators of the wellness tourism destination competitiveness assessment model, the cut-off scores of the wellness tourism destination competitiveness assessment were determined using the cluster analysis technique for the 216 samples gathered from quantitative research as well as the K-means cluster analysis technique.

The overall cut-off scores of the factors in wellness tourism destination competitiveness assessment were determined, as displayed in Table 6, with the cut-off scores of the seven individual factors in wellness tourism destination competitiveness assessment displayed in Table 7.

Table 6. Summary of the overall cut-off scores of the factors in wellness tourism destination competitiveness assessment

Score <= 3.35	3.36 < Score <= 4.25	Score > 4.25
Low potential	Moderate potential	High potential

Table 7. Summary of the cut-off scores of the seven factors in wellness tourism destination competitiveness assessment

Factor	Low potential	Moderate potential	High potential
1. Destination image and hospitality (C1)	Score <= 4.18	4.19 < Score <= 4.40	Score > 4.40
2. Destination policies and strategies to accommodate travel and wellness tourism (C2)	Score <= 3.89	3.90 < Score <= 4.20	Score > 4.20
3. Infrastructure and wellness tourism carrying capacity (C3)	Score <= 3.71	3.72 < Score <= 4.03	Score > 4.03
4. Man-made and cultural resources for wellness tourism (C4)	Score <= 3.49	3.50 < Score <= 3.84	Score > 3.84
5. Wellness promotion service strategies and structures (C5)	Score <= 3.66	3.67 < Score <= 4.06	Score > 4.06
6. Innovative capacity of destinations (C6)	Score <= 4.14	4.15 < Score <= 4.49	Score > 4.49
7. Collaborative networking and destination branding (C7)	Score <= 4.22	4.23 < Score <= 4.53	Score > 4.53

The internal and external validity of the developed wellness tourism destination competitiveness assessment model were tested by gathering information from scholars and researchers from academic institutions in areas where wellness tourism businesses were located. A total of 24 wellness tourism businesses that participated in Thailand Tourism Awards events in the Health and Wellness Tourism category hosted by the Tourism Authority of Thailand were selected to test the accuracy of the assessment tool. The developed innovative mobile application for wellness tourism destination competitiveness assessment was expected to achieve at least 80% accuracy.

The prediction efficiency to solve the classification issue was appraised using the confusion matrix technique. This crucial tool assessed the prediction results from the developed model following the guidelines of the prediction assessment accuracy test of machine learning [36], as displayed in Table 8.

Table 8. The 3x3 confusion matrix

Number of times tested		Actual result		
		A	**B**	**C**
Predicted result	A	*TA*	*FA1*	*FA2*
	B	*FB1*	*TB*	*FB2*
	C	*FC1*	*FC2*	*TC*

where TA has a predicted result of "A" and an actual result of "A", TB has a predicted result of "B" and an actual result of "B", TC has a predicted result of "C" and an actual result of "C", FA1 has a predicted result of "A" and an actual result of "B", FA2 has a predicted result of "A" and an actual result of "C", FB1 has a predicted result of "B" and an actual result of "A", FB2 has a predicted result of "B" and an actual result of "C", FC1 has a predicted result of "C" and an actual result of "A", FC2 has a predicted result of "C" and an actual result of "B".

The prediction assessment accuracy tests of the developed model were then calculated using an equation developed by Ting [37] as follows:

$$\text{Accuracy (AC)} = \frac{T}{T+FA1+FA2+FB1+FB2+FC1+FC2} \times 100\% \quad (7)$$

where, $T = TA + TB + TC$.

The results of the internal validity and external validity tests of the developed model are displayed in Table 9.

Table 9. Test results of the efficiency of the prediction to solve the classification issue

Number of tests: 48 times		Low potential		Moderate potential		High potential	
		Actual result	Percentage	Actual result	Percentage	Actual result	Percentage
Prediction Result	Low Potential	2	40.00	3	60.00	0	0.00
	Moderate Potential	2	8.70	19	82.60	2	8.70
	High Potential	0	0.00	0	0.00	20	100.00

Substituting the values in the prediction assessment accuracy equation gave a prediction assessment accuracy of (41/48)*100, or 85.42%, which was sufficient to solve the classification issue, with an accuracy of over 80% exceeding the stipulated minimum level.

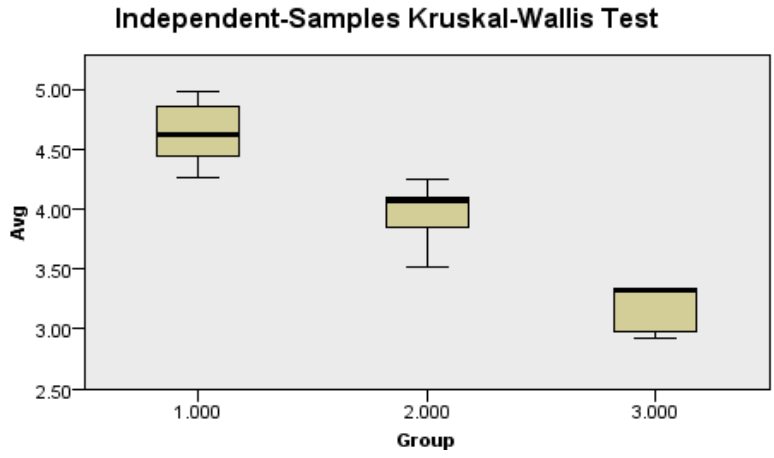
The Kruskal-Wallis independent samples test was employed to confirm the efficiency of the prediction to solve the classification issue, as well as using the confusion matrix technique, in accordance with the guidelines of the prediction assessment accuracy test of machine learning.

Results showed that the cut-off scores of the developed wellness tourism destination competitiveness assessment model showed clear differences between the average scores of the three potential groups (low potential, moderate potential, and high potential), both in the context of the overall perspective and in each of the seven factors individually. The scores were reliable and statistically significant. A comparison of the overall differences in median scores gathered from the developed wellness tourism destination competitiveness assessment between the low, moderate, and high potential groups is displayed in Table 10.

Table 10. Comparison of the overall differences in median scores gathered from the developed wellness tourism destination competitiveness assessment between the low, moderate and high potential groups using the Kruskal-Wallis test (n = 24)

Group	n	M	SD	Mean rank	X^2 (Chi-Square)	p (Sig.)
High potential	10	4.65	0.55	19.50		
Moderate potential	9	3.97	0.74	10.00	19.976	0.000
Low potential	5	3.18	0.71	3.00		

The results of the Kruskal-Wallis test (Table 10) showed differences between each potential group of wellness tourism destination competitiveness assessments. Differences in the overall average scores received from the wellness tourism destination competitiveness assessment gave 0.0001 statistical significance. The high-potential group had a median score of 4.65, the moderate-potential group had a median score of 3.97, and the low-potential group had a median score of 3.18, as displayed by the histogram in Figure 1.



Total N	24
Test Statistic	19.976
Degrees of Freedom	2
Asymptotic Sig. (2-sided test)	.000

Figure 1. Histogram displaying the differences between median scores of the three potential groups of wellness tourism destination competitiveness assessment using the Kruskal-Wallis test, with statistically significant differences

3. Research Methodology

The development of an innovative mobile application for wellness tourism destination competitiveness assessment was performed using a research and development approach.

The test results of internal validity, external validity, and efficiency of the prediction accuracy of the wellness tourism destination competitiveness assessment model showed statistically significant prediction accuracy at a reliable level. The development of an innovative mobile application for wellness tourism destination competitiveness assessment involved a software development process with multiple sequential steps. These ranged from studying the requirements to software designing and implementation as per the conceptual diagram of the linear waterfall model that was improved from the model created by Peter Kemp and Paul Smith, consisting of five phases of software development [38].

These phases were conducted in sequential design and development steps, with the output of each step becoming the input for the next sequential step, as detailed below:

3.1. Requirements

Innovative mobile applications for wellness tourism destination competitiveness assessment that can be used as self-assessment tools as part of the decision-making process to accurately elevate the competitiveness of wellness tourism clusters in various areas of Thailand are not currently prevalent.

Therefore, this study researched and developed an innovative mobile application for wellness tourism destination competitiveness assessment, the first of its kind in Thailand. The responsive web design allowed use on various devices, such as desktop computers, tablets, and smartphones, with data inputted and analyzed and results displayed in a readily understandable graphical format. Our mobile application also has a suggestion system to improve and develop capacities in areas that have low scores and store this information in the database, allowing users to compare area-based assessment results annually to promote and support wellness tourism clusters in various areas of Thailand to efficiently develop their competitiveness in both the Thai context and on the international level.

This step involved determining the requirements of an innovative mobile application for wellness tourism destination competitiveness assessment. The requirements for using the system and the necessary qualities to meet the needs of users were gathered by testing the working concept with a user group through engaging in conversations, using semi-structured questionnaires to find faults in the system, and using the data to improve the efficiency of the system.

The user group that participated in the working concept test included 3 representatives from public agencies driving and supporting wellness tourism, 3 representatives from associates or agencies promoting wellness tourism, 3 representatives as entrepreneurs of wellness tourism businesses, 3 representatives as managers at tourist destinations, and 2 representatives as wellness travelers or tourists. The results were summarized and displayed in Table 11.

Table 11. Results from questionnaires regarding the suitableness of the model design for an innovative assessment system for wellness tourism destinations

Innovative mobile application functions	Suitable	Not suitable
1. User Data Entry		
1.1. Main screen/log-in function	√	
1.2. Registration system per user groups	√	
1.3. Logging in/identity verification system	√	
1.4. Log out function	√	
2. Data Assessment and Gathering System		
2.1. Questionnaire to assess the competitiveness level	√	
2.2. Answering the questionnaire to assess the competitiveness level. Users can determine the weighted values of factors and indicators within the assessment by themselves.	√	
3. Reporting System, Suggestion System and Results Comparison System		
3.1. Reporting the analysis results of wellness tourism destination competitiveness, both overview and per individual factor and providing suggestions for competitiveness improvement	√	
3.2. Recalling historical competitiveness assessment results of oneself for comparison, ranging from every 3 months, every 6 months and yearly	√	
3.3. Recalling historical competitiveness assessment data and comparing with those of other areas	√	
3.4. Writing criticisms/reviews and voting the satisfaction score	√	

The results gathered from group conversations and answering questionnaires on the suitableness of model design for an innovative mobile application for wellness tourism destination competitiveness assessment showed that the aforementioned functions of the model for innovative systems were all suitable for model development. The results from this requirement study were developed into a working system in the next step.

3.2. Design

This step involved designing the innovative mobile application in various relevant areas, especially regarding crucial qualities as prioritization for assessment factors to satisfy the needs of users in the wellness tourism cluster and as an equation to efficiently analyze and classify wellness tourism destination competitiveness levels within the framework of the seven assessment factors.

The equations for analyzing and classifying the total wellness tourism destination's competitiveness are detailed as follows:

$$Total = (0.1465*Total\ DE\ Score)+(0.1480*Total\ POL\ Score)+(0.1438*Total\ INF\ Score)+(0.1393*Total\ MAC\ Score)+(0.1355*Total\ WEL\ Score)+(0.1402*Total\ INN\ Score)+(0.1467*Total\ COL\ Score) \quad (8)$$

- The total DE score is the total destination image and hospitality potential score of wellness tourism destinations.
- The total POL score is the total destination policies and strategies to accommodate travel and wellness tourism potential score of wellness tourism destinations.
- The total INF score is the total infrastructure and wellness tourism carrying capacity potential score of wellness tourism destinations.
- The total MAC score is the total man-made and cultural resources for wellness tourism and the potential score of wellness tourism destinations.
- The total WEL score is the total wellness promotion service strategy and structure potential score of wellness tourism destinations.
- The total INN score is the total innovative capacity potential score of wellness tourism destinations.
- The total COL score is the total collaborative networking and destination branding potential score of wellness tourism destinations.

Innovative mobile application users for wellness tourism destination competitiveness assessment were classified into four groups, including: 1) wellness tourism business clusters; 2) public agencies driving and supporting wellness tourism; 3) wellness travelers and tourists; and 4) system administrators responsible for managing innovative mobile application systems. The user case diagram of the innovative mobile application for wellness tourism destination competitiveness assessment is displayed in Figure 2.

3.3. Implementation

This step involved writing the programming codes for the innovative mobile application.

It was separated into two parts: designing the user interface with the Figma website and writing programming codes to determine the work functions with HTML using a responsive web design that can support multiple devices as both mobile and web-based applications.

The innovative mobile application software presented the wellness tourism destination competitiveness assessment under the concept of "Technology, Innovation, and Management". "Technology" means the data analysis technology used to develop the innovative mobile application; "Innovation" means the mobile application with an innovative design to assess the competitiveness of wellness tourism destinations; and "Management" means developing the sustainable competitiveness potential of wellness tourism destinations.

The mobile application consisted of 10 user interface parts, including the user registration system, login system, user profile editing system, assessment questionnaire section, weighted values of factors and indicators of the assessment per user requirements input system, assessment report and printing system, personal assessment comparison and printing system, area-based assessment comparison and printing system, reviews/suggestions and satisfaction scoring system, and logout system.

User interface picture examples of the innovative mobile application for wellness tourism destination competitiveness assessment are displayed in Figures 3 to 8.

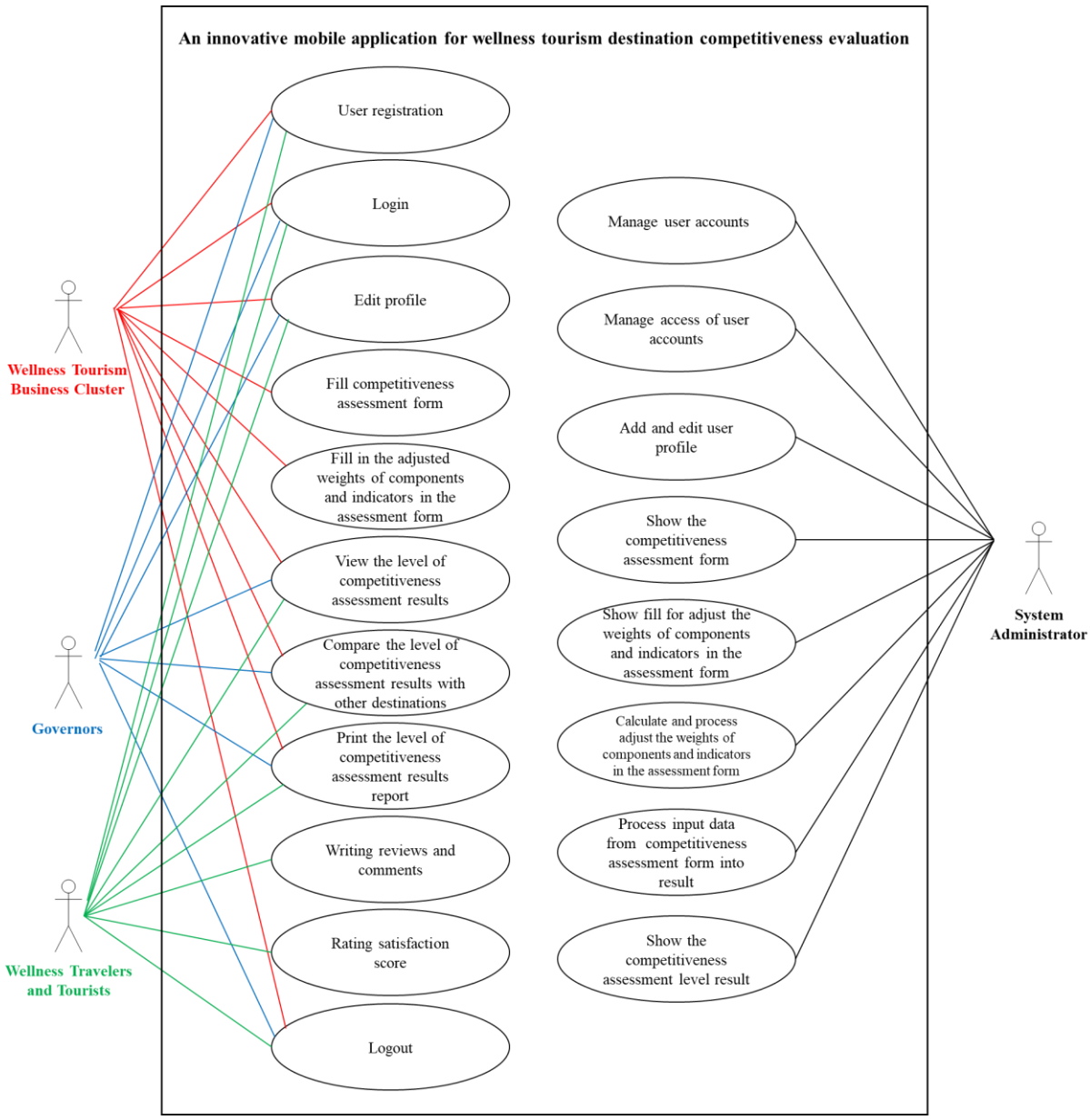


Figure 2. User case diagram of an innovative mobile application for wellness tourism destination competitiveness assessment

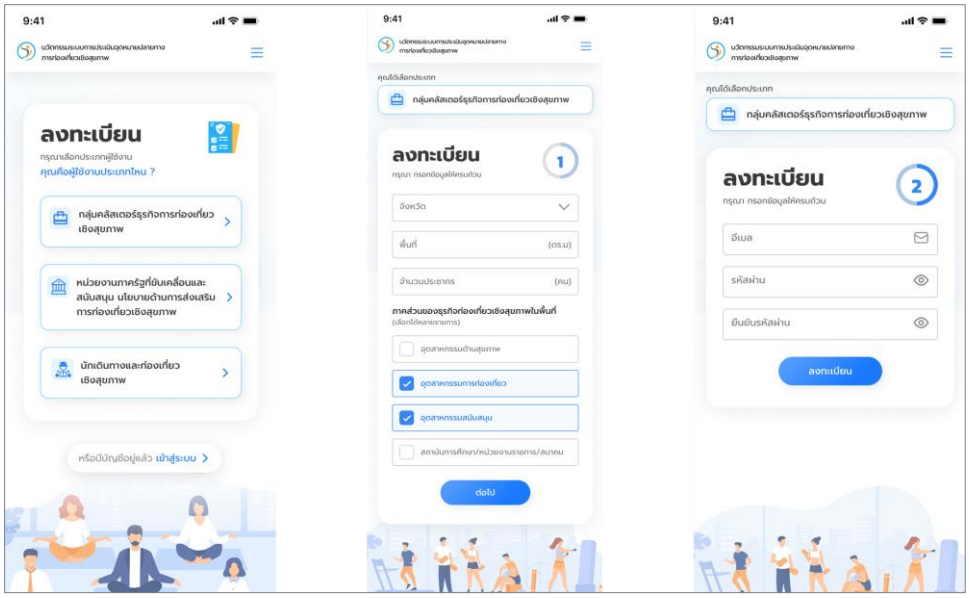


Figure 3. User registration screens

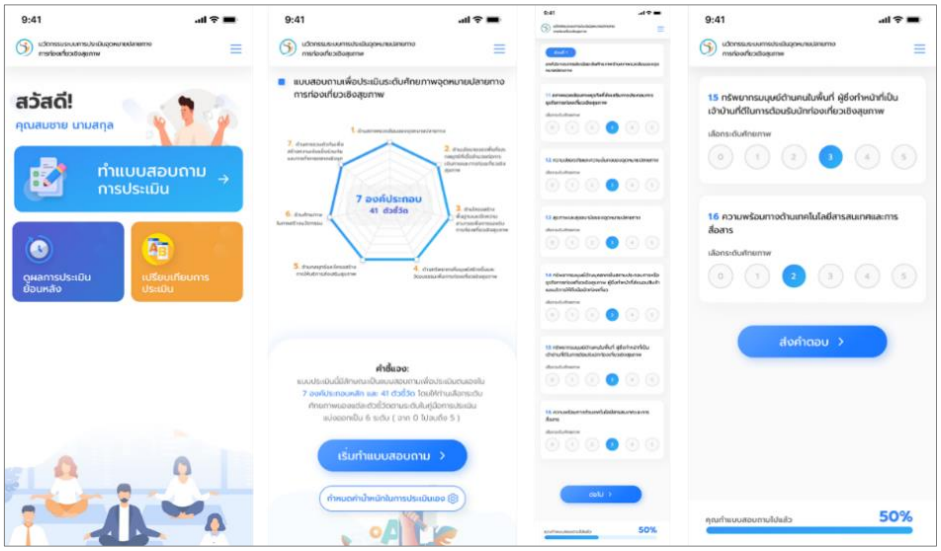


Figure 4. Wellness tourism destination competitiveness assessment questionnaire screens

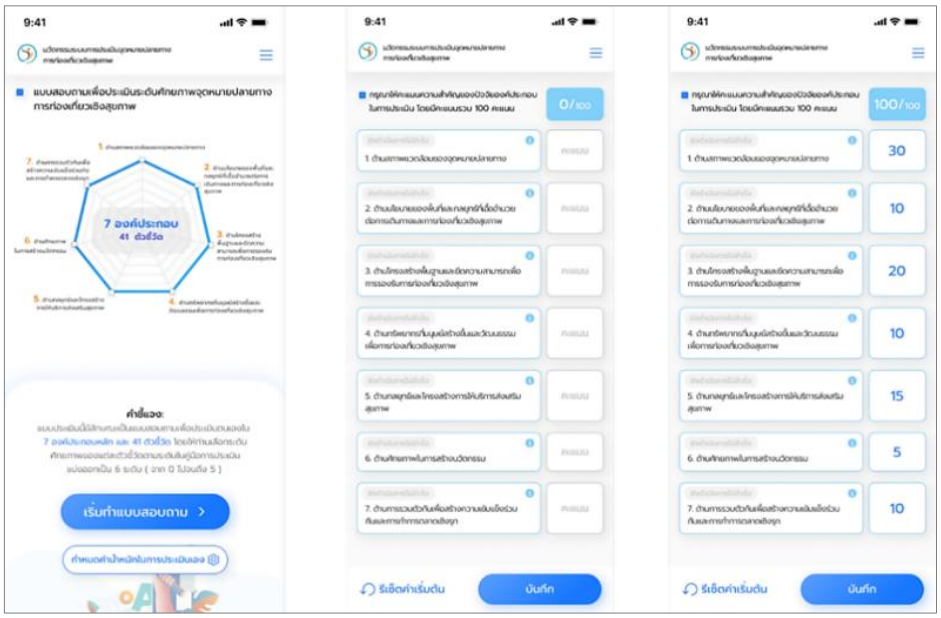


Figure 5. Instruction for inputting weighted values of factors and indicators of the assessment per user screen requirements

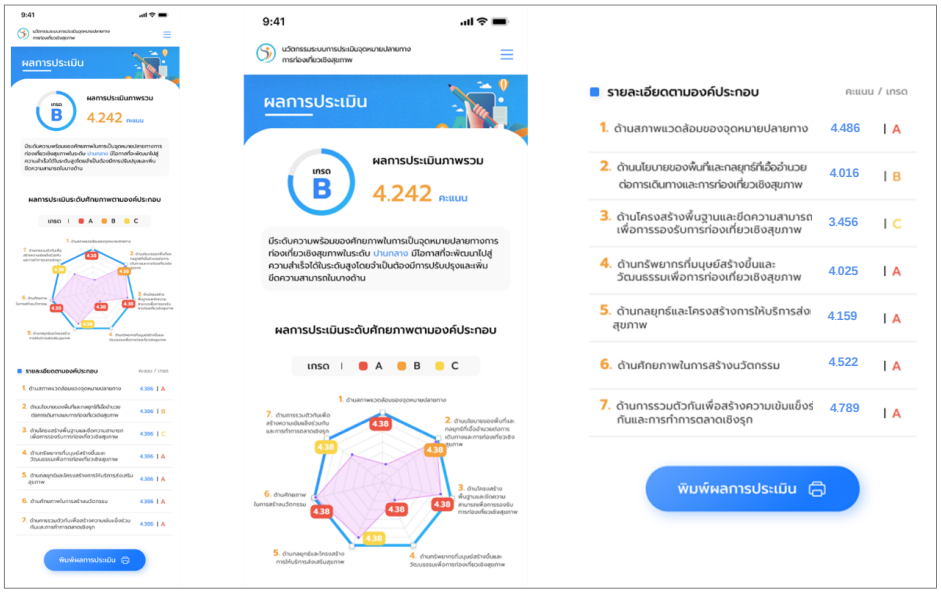


Figure 6. Assessment report and printing screens

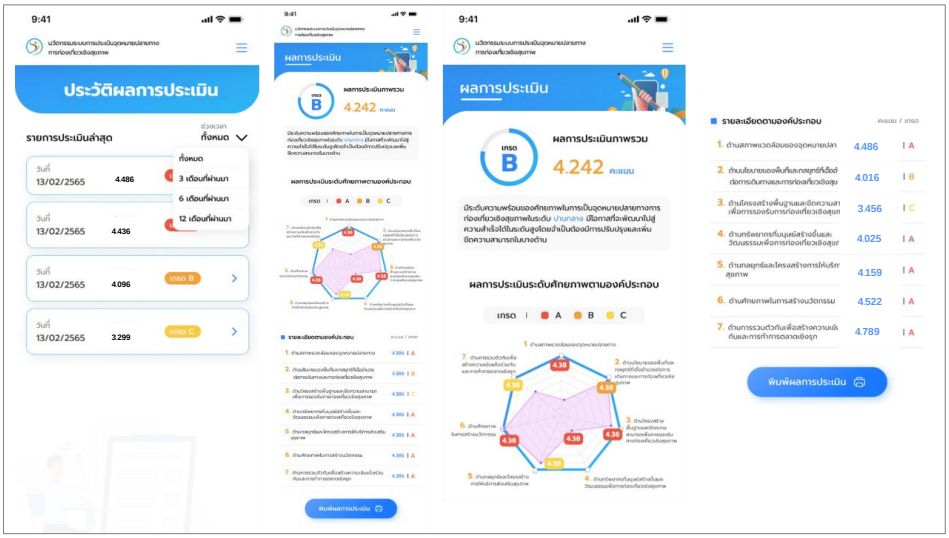


Figure 7. Screens displaying historical assessment data comparison menus every 3 months, every 6 months and yearly, as well as results reporting and printing screens

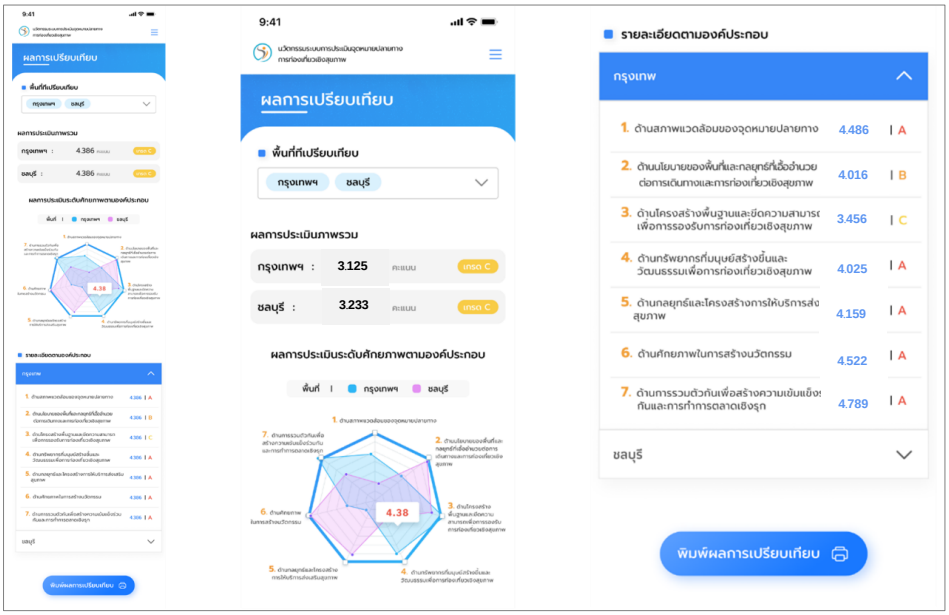


Figure 8. Screens displaying personal and area-based assessment comparisons, as well as reporting and printing screens

3.4. Verification

This process involved testing the operational status of the innovative mobile application for wellness tourism destination competitiveness assessment by uploading its host and its domain to the internet and allowing 40 target users to conduct practical tests of the application. A research questionnaire was created as a tool to study the acceptance factors of the innovative mobile application by applying the technology adoption model [39, 40] as a conceptual study framework. This model consisted of screen designs, assessment question designs, results, perceived usefulness, perceived ease of use, and behavioral intention to use. These factors were assessed for acceptance and developed into a research questionnaire to collect data from the target users.

The questionnaire was separated into three parts, as follows:

Part 1 involved general information about survey takers, consisting of four questions about gender, age, education level, and experience working in the wellness tourism business or using wellness tourism services.

In Part 2, questions related to the acceptance factors of the innovative mobile application for wellness tourism destination competitiveness assessment. A total of 32 questions included 4 questions about screen designs, 5 questions about assessment question designs, 6 questions about displaying results designs, 5 questions about perceived usefulness, 7 questions about perceived ease of use, and 5 questions about behavioral intention to use. The criteria were determined by converting the average values into innovation adoption levels, using absolute criteria to find the average score. Innovation adoption was classified into five levels related to the significance of various factors, as follows:

Average values between 4.21 and 5.00 mean that the target users have a perspective trend towards the highest innovation adoption level.

Average values between 3.41 and 4.20 mean that the target users have a perspective trend towards a high innovation adoption level.

Average values between 2.61 and 3.40 mean that the target users have a perspective trend towards a moderate innovation adoption level.

Average values between 1.81 and 2.60 mean that the target users have a perspective trend towards a low innovation adoption level.

Average values between 1.00 and 1.80 mean that the target users have a perspective trend towards the lowest innovation adoption level.

The meanings of standard deviation values with the five rating scales were as follows:

A standard deviation value of more than 1.75 means that the target users have a perspective trend towards innovation adoption with a very high variance.

A standard deviation value between 1.25 and 1.75 means that the target users have a perspective trend towards innovation adoption with moderately high variance.

A standard deviation value of less than 1.25 means that the target users have a perspective trend towards innovation adoption with low or near equal variance.

In Part 3, questions related to the commercialization of the innovative mobile application for wellness tourism destination competitiveness assessment. Five questions were posited about opinions on the reuse of software, expected times of software usage, types of interests in the commercialization of the mobile application, the affordable price/willingness to pay (baht) to use the mobile application, and additional comments or suggestions.

3.5. Maintenance

This step involved the maintenance and improvement of the innovative mobile application for wellness tourism destination competitiveness assessment using the performance test results and the acceptance test results from target users. These included fixing issues and errors and making improvements to allow the software to be used continuously.

4. Results

4.1. Innovative Mobile Application for Wellness Tourism Destination Competitiveness Assessment

The innovative mobile application for wellness tourism destination competitiveness assessment comprises computer software that allows wellness tourism cluster groups in various areas to participate in an online questionnaire to analyze their own competitiveness. The questionnaire consisted of two parts. Part 1 contained data related to areas that needed to be assessed, while Part 2 was a questionnaire for wellness tourism cluster groups to conduct self-assessments using an assessment manual developed by the researchers.

The application gathered data from the assessment to calculate the prediction equations and weighted values of the stipulated factors and indicators. Before completing the self-assessment, if the wellness tourism cluster groups wished to determine their own weighted values of factors and indicators, they could do so by inputting the data.

After the wellness tourism cluster groups had completed all seven factors of the questionnaire, the system displayed the overall score and scores for each of the individual factors in radar chart format as the competitiveness levels of each group rated low, moderate, and high, with suggestions on how to improve these competitiveness levels, comparison with historical personal scores every 3 months, 6 months, or 1 year, and also comparison with data from other areas.

Wellness tourism cluster groups could download the assessment report in PDF format. Users from public agencies driving and supporting wellness tourism promotion policies could access the assessment reports of wellness tourism cluster groups in various areas, and users who were wellness travelers and tourists could also access the assessment reports of wellness tourism cluster groups in various areas. They could also provide feedback as a wellness tourism destination satisfaction assessment in various areas. The overview of the innovative mobile application for wellness tourism destination competitiveness assessment is displayed in Figure 9.

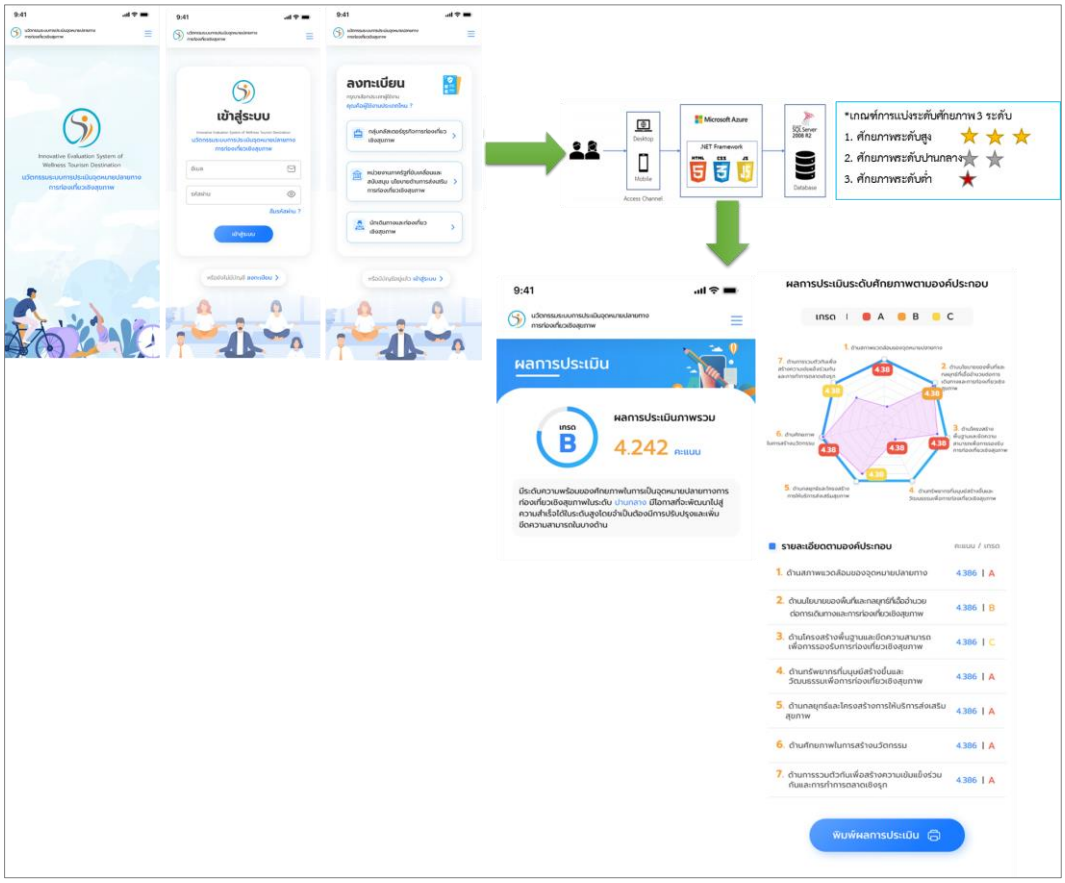


Figure 9. Overview of the innovative mobile application for wellness tourism destination competitiveness assessment

4.2. Technology Acceptance Test

4.2.1. General Data of Questionnaire Informants

Analysis results of the demographic characteristics of questionnaire informants from a sample group of 40 members of a wellness tourism cluster group showed that most members were female, between 41 and 56 years old, had a Bachelor's degree and between 1 and 5 years of experience working in the wellness tourism business or using wellness tourism services (Table 12).

Table 12. Demographic characteristics of questionnaire informants

Demographics of questionnaire informants		Quantity (person)	Percentage
1. Gender	Male	16	40.00
	Female	20	50.00
	Not specified	4	10.00
2. Age	Below 25 years of age	1	2.50
	25 - 40 years of age	15	37.50
	41 - 56 years of age	20	50.00
	57 - 75 years of age	4	10.00
	Over 76 years of age	0	0.00
3. Education level	Undergraduate	5	12.50
	Bachelor's degree	23	57.50
	Master's degree	10	25.00
	Doctoral degree or above	2	5.00
4. Experience working in the wellness tourism business or using wellness tourism services	Below 1 year	12	30.00
	1 - 5 years	13	32.50
	6 - 10 years	10	25.00
	11 - 15 years	0	0.00
	16 - 20 years	4	10.00
	Over 20 years	1	2.50
Total		**40**	**100.00**

Table 13. Average and standard deviation values of acceptance levels of the innovative mobile application for wellness tourism destination competitiveness assessment factors

Factor	$\bar{x}$	S.D.	Innovation adoption trend
1. Screen designs	***4.02***	***0.69***	***High***
1.1 The innovative mobile application has a balanced and beautiful screen element arrangement.	4.05	0.63	High
1.2 The innovative mobile application uses a text style with clear size and colour and is easy to read.	4.10	0.66	High
1.3 The innovative mobile application has appropriate colour selection that is comfortable to look at.	3.93	0.72	High
1.4 The innovative mobile application has distinctive icons that convey clear meanings.	4.00	0.71	High
2. Assessment question designs	***4.00***	***0.72***	***High***
2.1 Questions in the innovative mobile application have correct and compact wording that can be easily understood by respondents.	3.98	0.65	High
2.2 Questions in the innovative mobile application have clear content structure and correlation with each other.	4.00	0.81	High
2.3 Questions in the innovative mobile application are appropriate for user groups.	3.98	0.72	High
2.4 Questions in the innovative mobile application use a text style that is easy to read.	4.08	0.75	High
2.5 Questions in the innovative mobile application generate positive outcomes that can lead to further applications to develop wellness tourism destination competitiveness.	3.98	0.65	High
3. Displaying results designs	***3.93***	***0.71***	***High***
3.1 The innovative mobile application uses colour scales to reflect the levels of wellness tourism destination competitiveness.	3.98	0.76	High
3.2 The innovative mobile application has appropriate descriptions of the colour scales.	3.80	0.71	High
3.3 The innovative mobile application provides guidelines on the system process appropriately.	3.93	0.69	High
3.4 The innovative mobile application has an appropriate scoring system.	3.88	0.71	High
3.5 The innovative mobile application provides guidelines on improving and developing wellness tourism destination competitiveness that are appropriate for each user group.	4.00	0.67	High
3.6 The innovative mobile application leads to further learning for user groups who are stakeholders in improving and developing wellness tourism destination competitiveness.	3.98	0.72	High
4. Perceived usefulness	***4.03***	***0.70***	***High***
4.1 The innovative mobile application helps to analyse the levels of wellness tourism destination competitiveness in various factors effectively.	4.13	0.60	High
4.2 The innovative mobile application can provide crucial and necessary suggestions in developing wellness tourism destination competitiveness in various areas for the user.	4.05	0.74	High
4.3 The innovative mobile application is a tool that can help those involved with planning and developing wellness tourism destination competitiveness correctly.	4.13	0.68	High
4.4 The innovative mobile application can decrease the assessment time to plan and develop wellness tourism destination competitiveness efficiently.	3.93	0.69	High
4.5 Overall, the innovative mobile application is useful in supporting users' requirements.	3.93	0.75	High
5. Perceived ease of use	***3.99***	***0.76***	***High***
5.1 The innovative mobile application has clear operational processes and instructions that are easy to understand.	4.03	0.65	High
5.2 The innovative mobile application has appropriate and logical assessment criteria and explanations.	4.15	0.76	High
5.3 The innovative mobile application allows quick and accurate data input and assessment in every process	3.95	0.77	High
5.4 The innovative mobile application has a reporting system for the wellness tourism destination competitiveness assessment results that is clear and easy to understand.	4.00	0.81	High
5.5 The innovative mobile application can support various devices, such as desktop computers, tablets, smartphones, etc.	3.83	0.74	High
5.6 The innovative mobile application can be used to satisfy the user's needs at anywhere and anytime.	3.98	0.72	High
5.7 Overall, the user believes that this innovative mobile application is easy to use.	3.98	0.82	High
6. Behavioural intention to use	***3.98***	***0.70***	***High***
6.1 Using the innovative mobile application to assess the wellness tourism destination competitiveness can provide satisfying results for the user.	4.05	0.74	High
6.2 The user is satisfied with the quality of the innovative mobile application for wellness tourism destination competitiveness assessment.	3.88	0.75	High
6.3 The user is confident in the accuracy of the innovative mobile application for wellness tourism destination competitiveness assessment.	4.08	0.65	High
6.4 The user feels safe and has adequate privacy when using the innovative mobile application for wellness tourism destination competitiveness assessment.	3.93	0.75	High
6.5 The user intends to use the innovative mobile application for wellness tourism destination competitiveness assessment.	3.98	0.61	High
Overall	**3.99**	**0.72**	**High**

4.2.2. Results of the Innovative Wellness Tourism Destination Assessment System Acceptance

Data results from 40 sample group respondents were analyzed to study the acceptance level of the innovative mobile application for wellness tourism destination competitiveness assessment. The respondents had a high acceptance level of the innovative mobile application ($\bar{x}$ = 3.99, S.D. = 0.72). When considering each respective factor, the perceived usefulness factor had the highest acceptance level ($\bar{x}$ = 4.03, S.D. = 0.70), followed by the screen designs factor ($\bar{x}$ = 4.02, S.D. = 0.69), while the factor with the lowest acceptance level was the displaying results designs factor ($\bar{x}$ = 3.93, S.D. = 0.71). The target user sample group had a perspective trend towards innovation adoption with low or near equal variance, as seen from the standard deviation in factors having values between 0.69 and 0.76 and an average value of 0.72, lower than the stipulated threshold of 1.25. These values are displayed in Table 13.

4.2.3. Exploring the Guidelines of Commercialization of the Innovative Mobile Application for Wellness Tourism Destination Competitiveness Assessment

Out of the 40 questionnaire respondents in the sample group, 31 (77.50%) stated that they would reuse the software because it was novel, had never been seen before, offered new perspectives during the assessment, was convenient and easy to use, was beneficial in decision-making processes, offered trustworthy data, saved time, had changeable weighted values of factors and indicators according to one's needs, had clear instructions and accompanying pictures, and offered useful benefits that could assist in making an accurate wellness tourism destination competitiveness assessment. Most of the respondents expected that they would use the application more than 10 times, accounting for 37.50% of the sample group. Sixteen respondents were interested in the commercialization of the application by purchasing a license to use the entire software, accounting for 40.00% of the sample group, with data displayed in Table 14.

Table 14. Opinions on the guidelines of commercialisation of the innovative mobile application for wellness tourism destination competitiveness assessment

Survey topic	Quantity (person)	Percentage
1. The user's opinion on reusing the application software		
Reuse	31	77.50
Do not reuse	0	0.00
Unsure	9	22.50
2. Number of times expected to use the application per year		
Once	5	12.50
2 – 3 times	8	20.00
4 – 10 times	12	30.00
More than 10 times	15	37.50
3. Interest in the commercialisation of the innovative mobile application for wellness tourism competitiveness assessment		
Purchasing the entire software in the form of the purchasing the software license	16	40.00
Purchasing the entire software in the form of individual user licensing	8	20.00
Using the software as an exclusive member (with subscription)	4	10.00
Using the software as an ordinary member (without subscription)	12	30.00
Total	**40**	**100.00**

Respondents in the sample group were willing to pay for a subscription to receive results of wellness tourism destination competitiveness assessments in every aspect, as well as guidelines on how to develop and improve competitiveness in each area, at an average price of 455.08 baht for each assessment and an average price of 2,647.38 baht for unlimited assessment attempts.

Lastly, additional suggestions or opinions were noted regarding the development of the innovative mobile application. These included the notion that the researchers and developers could sell the application to relevant public agencies such as the Tourism Authority of Thailand (TAT) as well as implement the application for practical use rather than as an innovative model.

5. Discussion

Research results for objective 1) to develop and test the effectiveness of an innovative mobile application for wellness tourism destination competitiveness assessment showed good internal and external model validity using the confusion matrix, following the guidelines of the prediction accuracy test for machine learning, with a prediction accuracy of 85.42%.

Results of the Kruskal-Wallis test for independent samples indicated that the cut-off scores of the developed wellness tourism destination competitiveness assessment model showed significant differences between the average scores of the three potential groups as low, moderate, and high potential. This reflected the efficiency of the innovative mobile application, which has a high capacity for classifying input data to assist in accurate and reliable decision-making. Our results concurred with Divayana et al. [41] and Faricha et al. [42], who noted that standard scales could be used as the basis for categorizing calculation quality simulation, with values between 75% and 100% considered acceptable for testing the classifier performance and used to solve the classification issue.

The prediction accuracy test results for machine learning in this study were compared with the study of Bi & Liu [43] for the hybrid intelligent categorization approach based on visitor selection behavior. This effectively assisted travelers in deciding whether or not to visit a specific vacation location by utilizing machine learning techniques to predict user behavior and travel decision-making. The cross-validation testing and performance assessment results indicated the effectiveness of our proposed categorization method at 80.90%. The efficiency of our innovative mobile application showed a higher capacity for classifying input data to assist in accurate and reliable decision-making than previous studies in the tourism-related field. The test results showed that our developed wellness tourism destination competitiveness assessment model was suitable for further development as an innovative mobile application for wellness tourism destination competitiveness assessment.

However, enhancement of the prediction accuracy test for machine learning requires further investigation by adopting a variety of techniques and methods to generate more accurate prediction results using the three classification techniques recommended by Yuensuk et al. [24], including Naïve Bayes, Neural Network, and K-Nearest Neighbour, to develop a predictive model for classifying wellness tourism destination competitiveness level.

Research results for objective 2) to study the acceptance of an innovative mobile application for wellness tourism destination competitiveness assessment showed a high acceptance level of the innovative mobile application. The target user sample group considered that the innovative mobile application was useful and worth adopting for wellness tourism destination competitiveness assessment.

However, opinions varied regarding the level of innovation adoption. This novel software has never been developed before, and some of the target users in the sample group were not sure if they would reuse the software, with concerns regarding personal information security and the accuracy of the results compared to the traditional paper and pencil assessment method that they were more familiar with. The target user sample group had varying opinions about the innovation adoption level, concurring with research by Aris et al. [44]. They found that user acknowledgement of technology readiness had a positive correlation with innovation adoption levels when using mobile applications. Similarly, Aydin [45] reported that privacy risk concerns had a negative correlation with innovation adoption level for using the mobile application, while Sembiring et al. [46] indicated that many users accepted the innovation adoption of mobile payment technologies, especially the smart mobile tourism app [47], as novel technology.

Results from inquiring about the opinions of sample group respondents regarding the topic of reusing the innovative mobile application showed that 77.50% of the sample group wished to reuse the application. The target user sample group reasoned that the application was convenient and easy to use, could save time in decision-making to assess wellness tourism destination competitiveness, offered user confidence and reliability in using the mobile application assessment, and allowed users to modify the weighted values of factors and indicators of the assessment to suit their own needs. The target user sample group is expected to use the application over 10 times per year, a considerably high frequency value. Thus, the target user sample group had a high level of acceptance of the innovative mobile application system.

Sia et al. [47] found that performance expectancy had a positive effect on behavioral intention to use the smart mobile tourism app, while Ferreira et al. [48] indicated that perceived ease of use had a positive impact on perceived usefulness, while perceived usefulness had a positive impact on tourists' intentions to use mobile ticketing solutions. Lei et al. [49] demonstrated that perceived personalization positively influenced the intention to adopt mobile travel advice, while Choi et al. [50] showed that trust had a positive effect on the intention for continued use of travel apps.

Results from inquiring about the opinions regarding the topics of interest in the commercialization of the innovative mobile application showed that purchasing a license to use the entire software was a form of commercialization that most interested the target user sample group. This reflected that the innovative mobile application was accepted by the target user sample group for practical use with wellness tourism clusters within each target user's respective areas. The target user sample group was willing to purchase a license to use the entire software from the researchers and developers, with an affordable average price/willingness to pay 455.08 baht for each assessment and 2,647.38 baht for unlimited assessment attempts. The subscription prices were considered to be inexpensive for full access to the software, especially when compared to general market prices, as most of the wellness tourism clusters in many areas were small and medium-sized enterprises (SMEs) with limited capital and budget.

The target user sample group showed an intention to accept and use the innovative mobile application assessment. One suggestion stated that the researchers and developers should sell the application to public agencies related to wellness tourism clusters, such as the Tourism Authority of Thailand (TAT), while another suggestion stated that the application should be implemented for practical use rather than as an innovative model. These positive suggestions reflected that the target user sample group accepted and showed a behavioral intention to use the innovative mobile application, even though the sample group had limited capital and budget support.

In conclusion, public agencies driving and supporting wellness tourism promotion policies, such as the Department of Health Service Support, the Ministry of Public Health, the Ministry of Tourism and Sports, and the Tourism Authority of Thailand, should take measures to procure the innovative mobile application for wellness tourism clusters in various areas for practical use as a self-assessment tool to further improve wellness tourism destination competitiveness in various areas of Thailand.

6. Conclusions

Innovation is not just about creating something new; it should improve current technology to uphold the foundation of a nation's community. Previous studies focused on technological application development to support growth in the context of specific areas related to wellness tourism such as a digital platform-mediated tourism system for self-service information support in small-town destinations [23], mobile applications for information system management of agro-tourism activities and attractions [24], applications recommending cultural tourism activities [25], mobile applications to strengthen the relationship among agents of local communities/entities and promote mediation mechanisms among all stakeholders [26], Travel Assist, a mobile app for visitors [27] and an intelligent system that integrated data analysis over a mobile cloud IoT computing platform to promote the rural leisure tourism industry [28]. However, limited literature is available concerning the development of innovative mobile applications for wellness tourism destination competitiveness assessment and classifying the competitiveness level of wellness tourism destinations for accurate and reliable decision-making. Therefore, this research developed an innovative mobile application to assess wellness tourism clusters in developing countries, with the goal of bringing university knowledge to the local community. The main objective was to research and develop an innovative mobile application for wellness tourism destination competitiveness assessment. The sub-objectives of this research consisted of two issues: to develop and test the effectiveness of an innovative mobile application for wellness tourism destination competitiveness assessment, and to study the acceptance of an innovative mobile application for wellness tourism destination competitiveness assessment.

The research results showed that the model had an accuracy of prediction efficiency to solve the issue of classification at an acceptable level of 85.42%, which was over the stipulated minimum threshold of 80%. To confirm the prediction efficiency and solve the issue of classification, a Kruskal-Wallis statistical analysis – a type of independent samples test – was conducted. Results showed that the cut-off scores of the developed wellness tourism destination competitiveness assessment model had clear differences between the average scores of the three potential groups as low potential, moderate potential and high potential with statistical significance. As a result, the efficiency test results were used to develop the innovative mobile application following the design procedures and the software development process involving multiple sequential steps. These steps consisted of studying the requirements of use, designing, developing the innovative model, testing and verifying the application and improving the application. Results from the group discussions and the questionnaire regarding the suitableness of the model design for an innovative mobile application for wellness tourism destination competitiveness assessment indicated that the model functions were suitable for further development into an innovative mobile application. The innovative mobile application had high acceptance from the target user group, with the perceived usefulness factor having the highest acceptance level followed by screen designs, assessment question designs, perceived ease of use behavioural intention to use and displaying results designs respectively. Over 80% of the target user sample group stated that they intended to reuse the software as it was a novelty that had never been seen before, offered new perspectives during the assessment, was convenient and easy to use, was beneficial in decision-making processes, offered trustworthy data and the weighted values of factors and indicators could be changed to suit individual needs. Most respondents stated that they would use the application more than 10 times per year and were interested in the commercialisation of the application by purchasing a license to use the entire software. The target user group had an affordable price/willingness to pay for subscriptions at an average price of 455.08 baht per assessment and an average price of 2,647.38 baht for unlimited assessments. Lastly, additional suggestions or opinions regarding the development of the innovative mobile application by the target user group included that the researchers and developers could sell the application to relevant public agencies such as the Tourism Authority of Thailand (TAT).

This research and development increased the understanding of the wellness tourism destination competitiveness framework. This knowledge can be adapted to develop an innovative mobile application for wellness tourism destination competitiveness assessment. This application can be used as a tool to assess the overall competitiveness of wellness tourism destinations and support decision-making by providing suggestions for wellness tourism cluster users to adapt and conduct their own competitiveness assessments efficiently and effectively. This can be achieved using accurate data that correlates with the assessment manual in line with the assessment objectives.

This software system can provide suggestions on how to develop and improve wellness tourism destination competitiveness for wellness tourism clusters as operational guidelines to improve competitiveness efficiently and effectively in various areas. Wellness tourism cluster users can conduct assessments as many times as they wish, every 3 months, every 6 months, or annually. They can also compare their results with those in other areas. Public agencies driving and supporting wellness tourism promotion policies can adopt the assessment reports and relevant suggestions from the software for practical use to plan their lecture courses, thereby educating wellness tourism clusters on how to improve competitiveness and development priorities. Public agencies driving and supporting wellness tourism promotion must place importance on tracking and assessing progress continuously to allow wellness tourism clusters to improve their competitiveness and capacity and create sustainable future competitive edges on an international level.

Wellness travelers and tourists can also use this application, which has a responsive web design that supports multiple devices such as computer desktops, tablets, and smartphones, to view wellness tourism destination assessment reports in various areas as part of the decision-making process to consider where they could go for sightseeing, relaxation, and using wellness promotion services.

The application also has a scoring system to evaluate user satisfaction and a system whereby wellness travelers and tourists can leave feedback suggestions and comments, generating combined value from the "demand" group—wellness travelers and tourists—and the "supply" group—wellness tourism clusters—to catalyze the improvement and development of the competitiveness of wellness tourism destinations to meet the needs of wellness travelers and tourists.

Interested parties can expand and increase the scope of innovative mobile applications for wellness tourism destination competitiveness assessment by conducting a longitudinal study as well as comparing the assessment results of wellness tourism destination competitiveness before and after adapting the developed factors and indicators for practical use to improve competitiveness sustainably. The development of weighted assessment factors and indicators in the framework of wellness tourism destination competitiveness assessment could involve adapting a variety of techniques and methods, thereby generating more accurate prediction results, using simple additive weighting (SAW), the technique for order preference by similarity to an ideal solution (TOPSIS), and analytic network process (ANP) technology.

7. Declarations

7.1. Author Contributions

Conceptualisation, T.P.; methodology, T.P.; formal analysis, T.P.; investigation, T.P.; data curation, T.P.; writing—original draft preparation, T.P.; writing—review and editing, T.P.; visualisation, T.P.; supervision, P.A., A.C., and K.P. All the authors have read and agreed to the published version of the manuscript.

7.2. Data Availability Statement

The data presented in this study are available in the article.

7.3. Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

7.4. Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Research Ethics Review Committee for Research Involving Human Subjects: The Second Allied Academic Group in Social Sciences, Humanities and Fine and Applied Arts at Chulalongkorn University (COA No. 071/2565, March 21, 2022).

7.5. Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

7.6. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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