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Original Article

Development of a Census Application for Lamphu Tree Identification and Genetic Conservation

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Abstract *- Conserving endemic plants is essential for the country in today's changing global environment. The objective of this study is to develop a census application aimed at identifying and conserving Lamphu trees. These trees are located in the Kwai Om canal area, specifically in the Bang Sakae sub-district of Samut Songkhram province, Thailand. Lamphu trees serve as habitats for fireflies and play a crucial role in preserving local plant species in Thailand. The application utilizes various data, including the tree's age, height, width, trunk circumference, maturity status, geolocation (latitude and longitude), and photographs. The development of this application follows the Rational Unified Process (RUP) methodology, chosen for its ability to produce high-quality software. Completing the application aligns with successfully attaining the census identification learning objectives. The evaluation of Lamphu tree identification, conducted by experts and users, demonstrates positive and consistent results based on the Quartile Deviation and Interquartile Range analyses. Hypothesis testing, using a t-test, confirms the positive impact of the application's development using the Rational Unified Process methodology on the effectiveness of the learning process, with statistical significance at the 0.05 level.*

Keywords *- Application, Census, Genetic conservation, Lamphu tree, Tree identification.*

1. Introduction

The Lamphu tree, commonly referred to as the cork tree, is widely recognized in scholarly circles as associated with a longstanding belief and legendary love story involving fireflies. Fireflies are frequently observed clinging to the Lamphu tree, making it a popular destination for nocturnal firefly viewing, a rarity in present-day Thailand due to the declining number of Lamphu trees. Additionally, a portion of the Lamphu tree gained recognition for its application as a natural cork substitute for bottle caps and a material for covering container lids [1]. However, alternative materials are now available, leading to a decline in motivation to cultivate and preserve the Lamphu tree. Consequently, removing ten-year-old Lamphu trees poses a significant threat to the firefly habitat, potentially causing its decline.

The Lamphu tree, typically found in wetlands, plays a vital role in water purification by enhancing oxygen levels in the surrounding water, thus preventing water stagnation and decay. Its extensive root system effectively mitigates soil erosion, resulting in loose, aerated soil. Furthermore, the tree contributes to the ecosystem by providing a shaded and cool environment. Furthermore, the tree's ripe fruit is consumed as a tangy fruit alongside shrimp paste, incorporated into dishes like sour curry, or utilized for preparing orange sauce. The fresh flowers are commonly blanched briefly in boiling water and added to zesty salads or enjoyed with Larb (a spicy minced meat salad) and chilli paste [2].

The medicinal properties of the Lamphu tree encompass its branches and stems, which can be finely chopped and boiled with water to create a remedy for treating bruises. Additionally, Lamphu seeds can be boiled with drinking water to alleviate conditions such as stomach pain, stomach disease, indigestion, and food poisoning. Besides its role in ecological equilibrium, the Lamphu tree serves as a tourist attraction and a source of income for the local community. Given these factors, the Lamphu tree qualifies as a genetically valuable plant. It is well-suited for genetic preservation efforts aligned with the Royal Initiative Plant Genetic Conservation Project (PPA) within the context of the resource learning framework. Exploration activities have been conducted to collect and preserve resources in collaboration with the Kwai Om waterfront area in Bang Sakae sub-district, Bang Khonthi district, Samut Songkhram province, Thailand [2].

Presently, efforts in developing plant genetic databases primarily concentrate on gathering data pertaining to plant characteristics, including their functional and medicinal

properties. Information related to plant distribution, cultivation practices, and other relevant details is primarily available for terrestrial environments and limited land areas. However, it is evident that comprehensive digital mapping has not been adequately established to facilitate the precise identification of specific areas along canal rivers at an early stage. In order to facilitate timely care, conservation, replanting, and disease control efforts for individual plants, it is essential to gather information that can be utilized in the development of a local plant census. This census would assist local communities in effectively nurturing plants that hold local significance, enhancing their resilience and capacity, and fostering sustainable development by cultivating a distinct identity for local plant species. Neglecting these challenges can lead to detrimental consequences, such as the pollution of water and soil, as well as the adverse impacts of unpredictable weather patterns on plant life. Particularly in areas attracting tourism, these problems become more pronounced, presenting a multitude of concerns. The management of tourism activities along the Kwai Om waterfront area in the Bang Sakae sub-district, particularly those focused on observing fireflies at night, poses challenges, impacting both the local community and the environment. Inadequate waste management practices and the emissions generated by tourism-related establishments contribute to water contamination. Furthermore, the failure to recognize the valuable contributions of the Lamphu tree can result in its decline and eventual demise [2].

The conservation and propagation of native plants are crucial for intergenerational preservation. However, obtaining information about aquatic plant species can be challenging. Conducting water surveys entails expenses, including the cost of cruises, while also considering factors such as monitoring tidal patterns and associated safety risks. Conducting a survey and data collection can serve as an instructive means for identifying Lamphu trees. By organizing the gathered information in a readily accessible format, potential expenses and risks associated with on-site learning about Lamphu trees in aquatic environments can be minimized. Consequently, facilitating water-based exploration of these trees proves beneficial and affords an opportunity to acquire knowledge and foster conservation efforts [18].

The primary objective of this study is to establish a comprehensive survey of waterways in order to gather pertinent data for the purpose of identifying Lamphu trees. These trees hold local significance, as they are indigenous to the Lamphu region and exist alongside the canal. Preserving the knowledge of Lamphu trees within the local community is crucial, as it benefits the present inhabitants and ensures the transfer of this valuable knowledge to future generations. Furthermore, this research aims to enable the recognition of key characteristics of Lamphu trees, such as their age and quantity, while emphasizing the importance of timely planting and effective disease management. A resilient Lamphu tree serves as a vital source of propagation and sustenance. Acquiring comprehensive knowledge about the identity of the Lamphu tree is instrumental in comprehending its growth patterns, environmental requirements, and ecological interdependencies. This knowledge serves as a valuable tool for conserving the Lamphu tree, which holds great cultural significance within the local and Thai communities. Preserving the enduring legend of the profound connection between the Lamphu tree and fireflies, cherished by the Thai people for generations, is paramount. Additionally, facilitating the storage, accessibility, dissemination, and exchange of this knowledge contributes to developing an extensive genetic conservation dataset, leveraging the advantages of Big Data analysis conveniently.

2. Literature Review

Ongoing advancements in research pertaining to the compilation, exploration, and organization of plant species databases have shown consistent progress in recent years. For instance, a notable contribution in this domain is the development of a storage and retrieval system for plants in the Chom Thong area. This undertaking aimed to establish a comprehensive database system that enables efficient searching and retrieval of plant-related information. The system was designed to accommodate various search conditions, ensuring that users can obtain precise and tailored information aligning with the specific characteristics of their desired plants. The developed system exhibits proficient management of diverse information categories, encompassing four primary aspects: plant species details, garden owner information, location-specific data regarding the plant species, and system-related information. The stored data comprises a plethora of information, including various names attributed to the plant species, their associated benefits, and accompanying visual representations. Furthermore, the system facilitates the storage of garden owners' information, encompassing the number of trees within the garden alongside a geographical map illustrating the garden's precise location. The research findings indicated a commendable level of user satisfaction, affirming that the system effectively meets the users' requirements [4].

A tree information retrieval system employing QR code technology was implemented at the Rajamangala University of Technology Lanna, Nan. The primary objective of this system was to enhance the ease of access to plant-related information for both students and local communities. Extensive data on 100 different plant species, encompassing fruit trees and perennials, was collected and incorporated into the system. To optimize organization and retrieval, the area was divided into three distinct zones, namely the Science Zone, Buddharaksa Zone, and Agriculture Zone. A website was developed to effectively manage and present the collected data, utilizing Google Maps as a visual aid. Users can conveniently access information by scanning QR codes using their smartphones. The evaluation feedback received from system users indicated a commendable level of proficiency in

tree information retrieval. Consequently, this system holds potential for further exploration and utilization in the field of botany, serving as a valuable resource for future research endeavors [5].

The present study focuses on creating an integrated database system that utilizes 2D QR-Code technology to encode and store herbal information. This innovative approach enables seamless information retrieval and display through dedicated information systems on mobile devices. The findings underscore the efficacy of employing 2D barcode technology to establish a connection between the herb base and the Queen Centennial Orchid Garden at Mae Jo University. Consequently, visitors can access a wide range of plant-related information using their mobile devices, particularly within the herbal garden dedicated to honoring the esteemed monarch [6]. Incorporating QR codes in biological data collection offers a streamlined approach to seamlessly connect electronic data with corresponding samples. By utilizing QR codes, data linking becomes more efficient, encompassing various components such as classification, photographs, maps, ecological records, and citations. QR codes possess several advantages over traditional barcodes, including their compact size, enhanced security mechanisms, ability to accommodate greater complexity and volume of information, and cost-effectiveness.

The primary objective of this article is to initiate an academic discourse concerning the utilization of QR codes in the context of biological collection samples [7]. The study presents an innovative system that applies QR code technology to facilitate the registration process of the Botanical Gardens school. This system encompasses a mobile application that enables users to interact with QR codes and a web application designed to manage the plant registration data of the school. The research outcomes revealed a high level of user satisfaction with the implemented system [8]. A comprehensive database system for medicinal plants was developed to store and retrieve information related to medicinal plants, including their benefits and additional details. The system comprises three distinct components: the general user section, the member's section, and the admin section. The evaluation results demonstrated a high level of user satisfaction with the medicinal plant database system, affirming its effectiveness and usefulness in providing access to valuable information on medicinal plants [9].

In remote destinations such as forests, access to accurate plant information holds significant importance for tourists. Often, they heavily rely on guides or reference books to acquire relevant knowledge about plants. To address this need, a system has been developed wherein QR codes serve as labels for tree information. Visitors can conveniently scan these codes using an application, enabling them to access additional information. This innovative approach facilitates remote database searches, allowing for seamless retrieval of plant-related information displayed on the visitor's mobile device. This system directly empowers tourists to acquire accurate and comprehensive plant information while exploring forest environments. Moreover, it facilitates efficient information retrieval during forest visits, eliminating the need to depend solely on tour guides or carry reference books [10].

The acquisition of proficient plant identification skills constitutes a significant component of the higher education botany curriculum. Engaging in practical exercises involving both dried and fresh plant specimens is crucial. Such exercises must account for the diverse range of forms, conditions, and intricacies a species may exhibit. In light of these considerations, developing a web-based assessment system tailored for mobile devices becomes paramount. This system employs location-based functionality to generate relevant questions based on the student's surroundings. The student's location can be determined either through the device's positioning capabilities or by scanning a QR code affixed to a dry wood piece in the herbarium or a fresh plant in the arboretum.

The assessment questions are complemented with detailed comments, which, based on the student's responses, provide insights into potential errors and the correct answers. The results unequivocally demonstrate the superiority of the assessment system compared to traditional methodologies, with students exhibiting highly positive attitudes towards its implementation [11]. In the realm of managing urban green spaces for educational, recreational, and artistic purposes, the utilization of QR codes has emerged as a valuable tool to disseminate information and research data. A comprehensive investigation was conducted, focusing on integrating QR codes into the design of floor lawn decorations and vertical gardening, resulting in an aesthetically pleasing presentation. This study sheds light on applying QR codes to furnish vital information regarding perennial plant species thriving within park green spaces, encompassing their maintenance requirements and precise locations. The developed system serves as a repository for storing and accessing such information. This contributes to understanding the potential of QR codes in urban green space management.

By employing QR codes containing distinct identifiers and leveraging taxonomic databases, researchers have successfully implemented a novel approach for collecting herbal samples, thereby facilitating the creation of extensive phylogenetic datasets. Traditionally, such datasets are limited to a few genetic markers sourced from GenBank, and the availability of validated sequencing sampling protocols that can accommodate thousands of species remains limited.

However, through the development of an integrated Sample-to-Laboratory Data Management System (SLIMS), researchers have overcome these challenges, allowing for efficient handling of high-throughput workloads. This system

enables investigators to explore the genetic diversity across various branches of the phylogenetic tree by incorporating a large number of genetic markers [12]. The process involves the utilization of QR codes and taxonomic databases to assign unique identifiers to herbal samples, ensuring the systematic recording of sampling events and the capture of sample images post-collection. These images are subsequently uploaded to a citizen science platform, facilitating metadata generation.

In addition, a streamlined and highly efficient protocol has been established for herbal DNA sequencing and isolation, enabling the transfer of tissue samples for further analysis [13] and offering significant advancements in the field of herbal sample collection and genetic analysis.

Upon reviewing the aforementioned studies, it becomes evident that there is a research gap pertaining to the implementation of a digital census for the purpose of identifying Lamphu trees and promoting genetic conservation. Additionally, there is a lack of individual tree identification, which hinders efforts to focus on their maintenance, development, and growth. Furthermore, no prior investigations have been conducted regarding creating a digital storage database specifically for Lamphu trees in the Kwai Om waterfront in the Bang Sakae sub-district, Bang Khonthi district, Samut Songkhram province.

Additionally, there is an absence of research regarding the digital mapping of the spatial distribution and growth patterns of Lamphu trees. Establishing a digital platform for these purposes would facilitate the storage, accessibility, publication, and exchange of relevant information. Moreover, such an initiative would contribute to developing comprehensive datasets that aid in conveniently conserving genetic resources. These research gaps are particularly relevant to the Khwae Om canal area, situated in Bang Sakae Subdistrict, Bang Khonthi District, Samut Songkhram Province.

3. Objective

This research determines the 3 objectives:

- To create a comprehensive census application specifically designed for the identification of Lamphu trees, with a focus on preserving their plant genetics. The research site selected for this investigation is Khwae Om Canal, situated in the Bang Sakae Subdistrict within the Samut Songkhram Province of Thailand. Notably, this area is known for the presence of fireflies, commonly found inhabiting Lamphu trees.
- To assess and compare the learning outcomes of users who engage in the census process for identifying Lamphu trees. This investigation involves formulating and testing hypotheses to determine the effectiveness of the census in enhancing users' knowledge and understanding.
- To examine the efficacy of the census application for identifying Lamphu trees by conducting a comprehensive assessment of experts and users with the application. By evaluating the feedback and opinions of both experts and users, the effectiveness of the census application can be thoroughly investigated and analyzed.

4. Methodology

This section utilizes the Rational Unified Process (RUP) approach as the methodology for application development. RUP is a well-established iterative software development framework that ensures a rational and balanced allocation of time, resources, and processes [14] in Figure 1. The architecture cycle of RUP consists of four distinct phases, each serving a specific purpose in the application development process.

- Inception is an initial project phase that involves formulating and defining the fundamental concept and structure. This stage focuses on assessing the project's feasibility, suitability, costs, and required methodologies to ensure successful project completion. Business modeling holds significant importance during this phase, as it helps establish a solid foundation for the project.
- Elaboration is an analytical stage that serves to identify the scope and resources required to achieve the predetermined objectives set during this phase. Through a systematic analysis, the necessary components and resources can be determined to ensure the successful implementation of the project. This stage places significant emphasis on requirements gathering, analysis, and design, which are crucial for guiding subsequent development processes.
- Construction is a phase that involves the systematic development of system components and various features, encompassing activities such as programming, testing, and creating supporting documentation. These efforts aim to create a fully functional system prepared for user deployment. The focus during this stage is primarily on the development process, ensuring that all components are built and integrated effectively.
- Transition is a phase of the product's life cycle; the product is launched and delivered to users for practical implementation. Test user feedback plays a vital role in guiding customization, configuration, installation, and overall user experience. Any usability issues with the product are identified and addressed. This stage serves as a critical point for evaluating the attainment of project objectives. If the objectives are not fully met, it may necessitate the initiation of an iterative development cycle. Emphasis is placed on testing and deployment activities during this phase.

This research follows a structured set of research steps, which include the following:

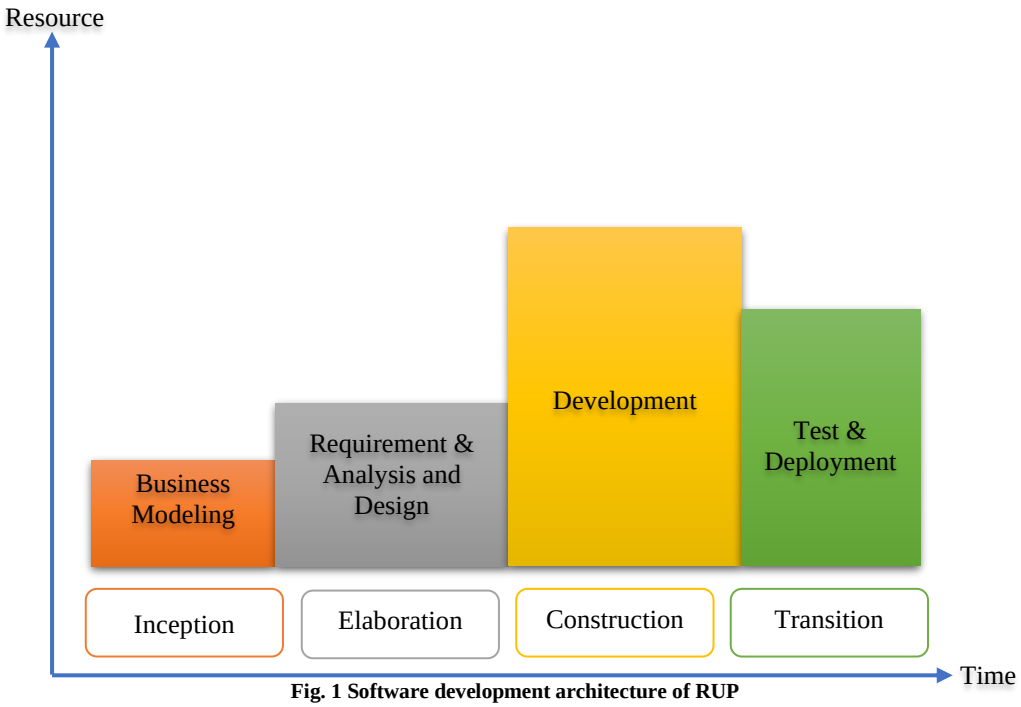

Fig. 1 Software development architecture of RUP

4.1. Data Collection

This research aimed to assess the requirements of community leaders and residents residing alongside the Kwai Om canal and to conduct a comprehensive survey of Lamphu trees. The survey was carried out using boat surveys along the entire stretch of the Kwai Om canal, encompassing all seven villages in Bang Sakae sub-district, Bang Khonthi district, Samut Songkhram province, Moo 1 Ban Bang Sakae Yai, Moo 2 Ban Bang Sakae Yai, Moo 3 Ban Bang Nam Phueng, Moo 4 Ban Bang Khun, Moo 5 Ban Khlong Sue, Moo 6 Ban Bang Sakae Pattana and Moo 7 Ban Bang Sakae Noi. The study area depicted in Figure 2 represents the natural habitat of Lamphu trees and serves as the focal point for researchers, community leaders, villagers, and Lamphu tree breeders.

The survey data comprised a total of 91 trees, revealing that 24.79% of Lamphu trees had been cut down, while 75.21% had not been cut. Among the surveyed Lamphu trees, 10 of them, aged over 10 years, have been successfully preserved, while one tree has unfortunately been cut down. Based on the collected and analyzed data, it is crucial to develop a dedicated Lamphu tree census application incorporating precise location coordinates and map illustrations. This application will enable the community to actively engage in the conservation and timely care of these trees. Additionally, the data reveals that the number of Lamphu trees exceeding 10 years of age is relatively low, emphasizing the significance of their preservation. These trees serve as vital habitats for fireflies, contributing to the local ecosystem and fostering potential tourism opportunities within the community.

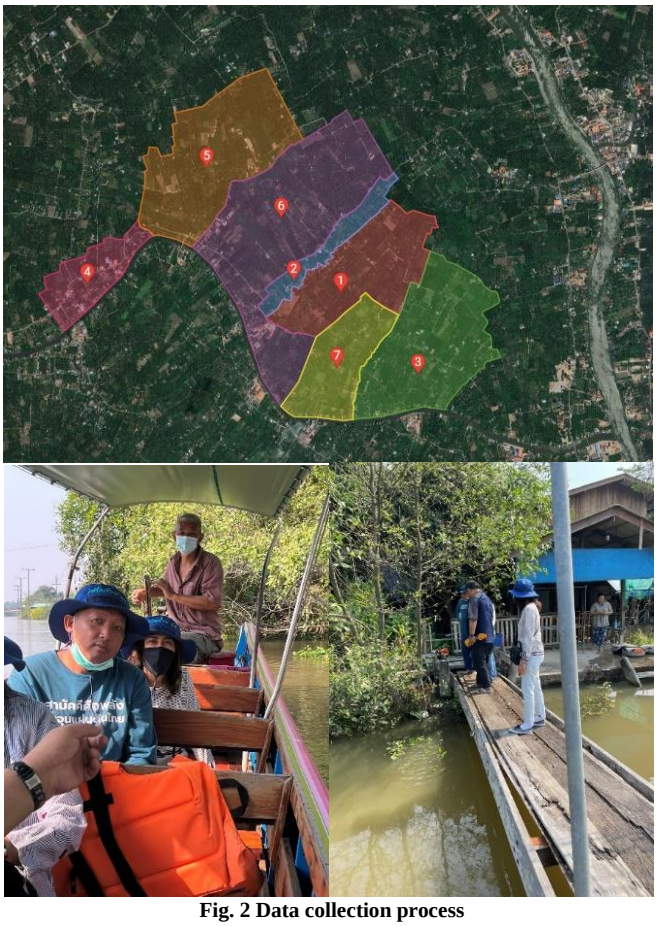

Fig. 2 Data collection process

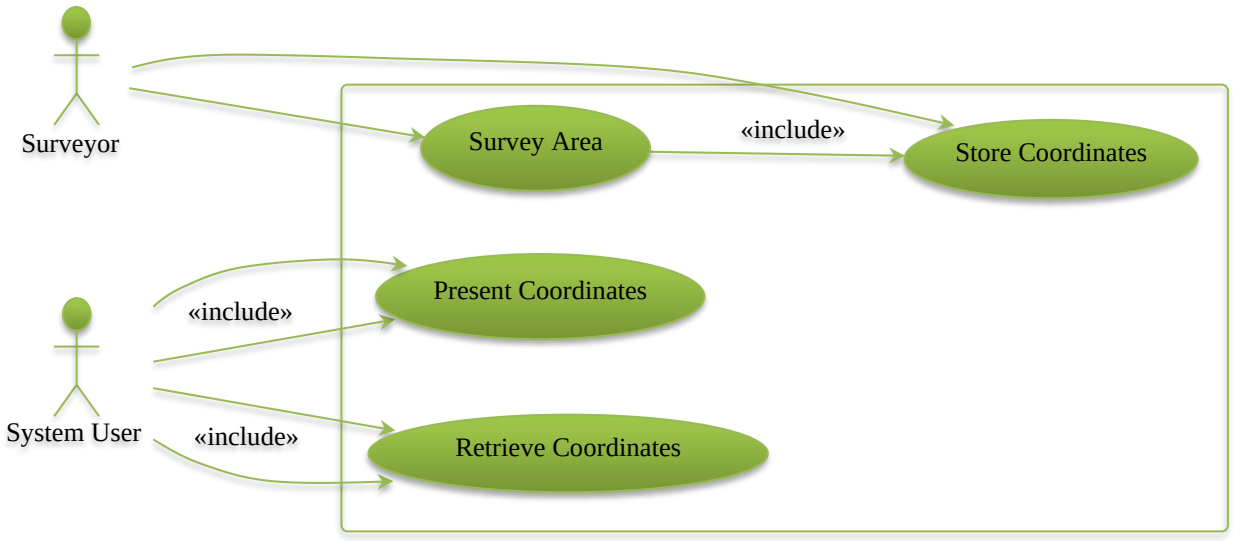

Fig. 3 Use case diagram of application

4.2. System Analysis and Design

This section focuses on the comprehensive analysis and design of the system, employing UML Diagram. The current application employs the utilization of a use case diagram, which encompasses two distinct actors, namely "Surveyor" and "System User." Within this diagram, four use cases are encapsulated, depicting the various functionalities and interactions of the system.

4.2.1. Survey Area

This represents the use case of the surveyor surveying the area of the Lamphu tree and collecting the coordinates.

4.2.2. Store Coordinates

This represents the use case of the surveyor storing the coordinates of the Lamphu tree in the system.

4.2.3. Retrieve Coordinates

This represents the use case of the system user retrieving the stored coordinates of the Lamphu tree from the system.

4.2.4. Present Coordinates

This represents the use case of the system user presenting the retrieved coordinates of the Lamphu tree.

The use case diagram visualizes the interactions between the actors and the system and provides an overview of the system's functionality for surveying, storing, and presenting coordinates in Figure 3.

4.3. Application Development

An application will be developed based on the data collected during the Data Collection step, which encompasses various attributes of the Lamphu tree, such as its characteristics, age, height, width, trunk circumference, current status, photographs, and geographical coordinates (latitude and longitude). This application will serve as a central repository for the census of Lamphu tree species in the Khlong Kwai Om area of Samut Songkhram Province. Development tools will be employed to create an application that facilitates the collection, storage, and dissemination of information, aiming to contribute to the conservation of Lamphu trees and serve as a valuable educational resource for studying the trees along the river.

The application development process relies on the utilization of the Apache web server and is implemented using the PHP5 programming language. All relevant data is stored in a MySQL database to ensure efficient data management. The application is designed to be compatible with various devices, including both computers and smartphones, accommodating different screen sizes. In order to achieve this adaptability, the design is crafted within the Bootstrap framework, which seamlessly integrates with HTML5, CSS3, and JavaScript. The resulting user interface is visually enhanced through the use of pins and is integrated with the Google Maps API. Figure 4 illustrates the framework of the development toolkit employed in this study.

The developed application encompasses a feature that displays the survey route along the Khwae Om canal in Bang Sakae Sub-district, Bang Khonthi District, Samut Songkhram Province. It visually represents the presence of Lamphu trees by placing pins at their respective locations. Each pin is associated with comprehensive information, including detailed descriptions, photographs, and coordinates of the Lamphu tree. Figure 5 to Figure 8 visually illustrates the representation of this information through the application's interface.

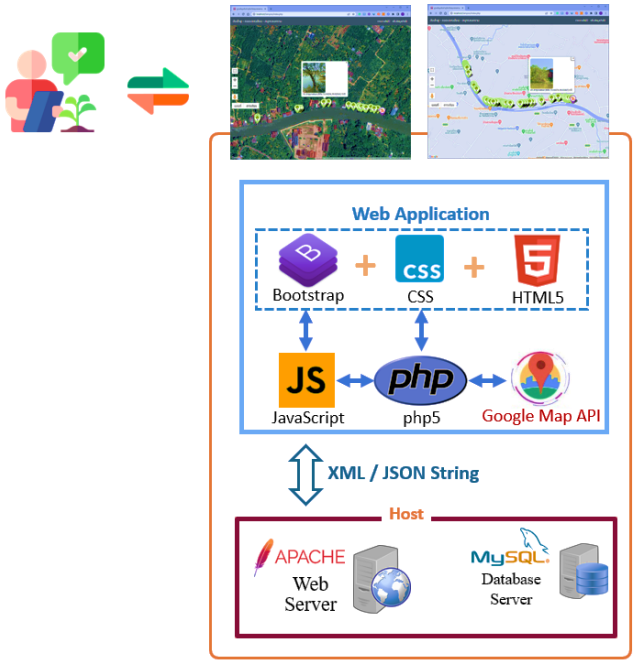

Fig. 4 Development tools

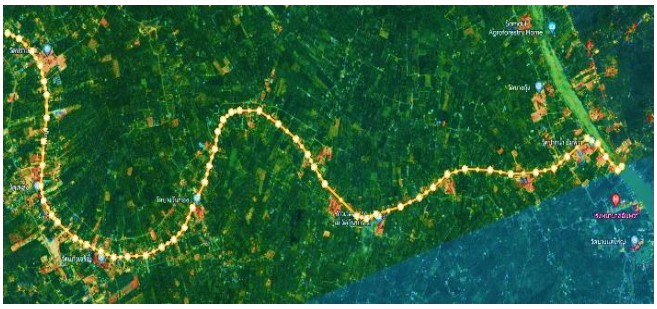

Fig. 5 Route of khwae om canal in bang sakae sub-district, bang khonthi district, samut songkhram province

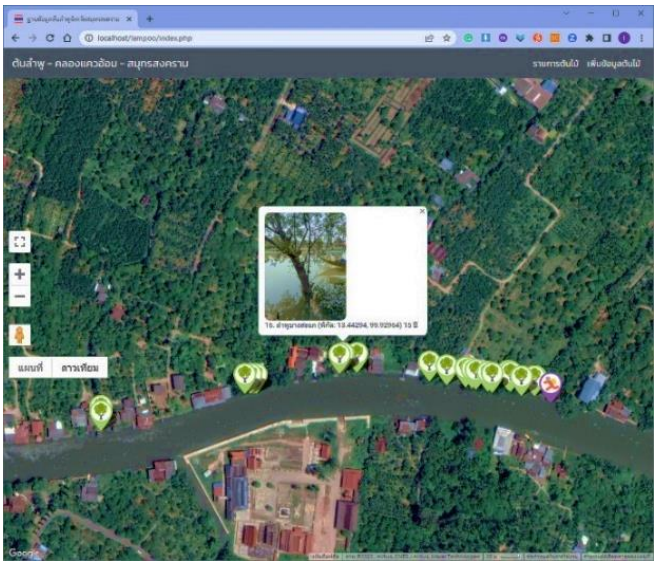

Fig. 6 Displays a satellite map with marked pins indicating the lamphu tree aged over 10 years with pictures and details

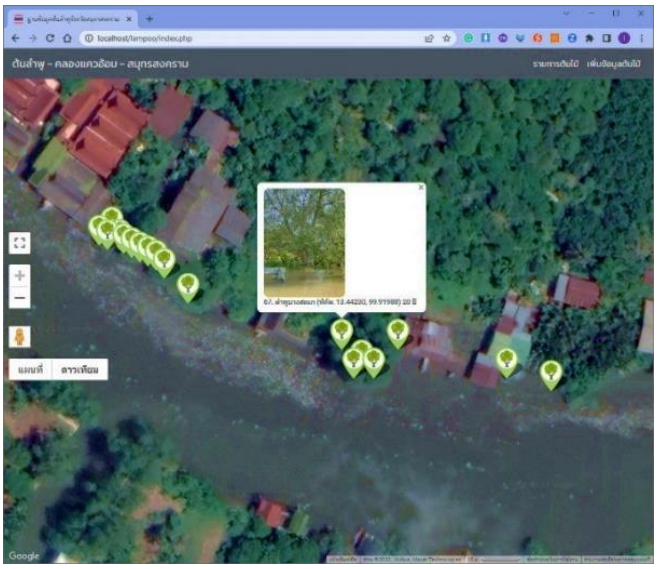

Fig. 7 Displays a satellite map with marked pins indicating the precise coordinates of each lamphu tree, accompanied by corresponding pictures and comprehensive details

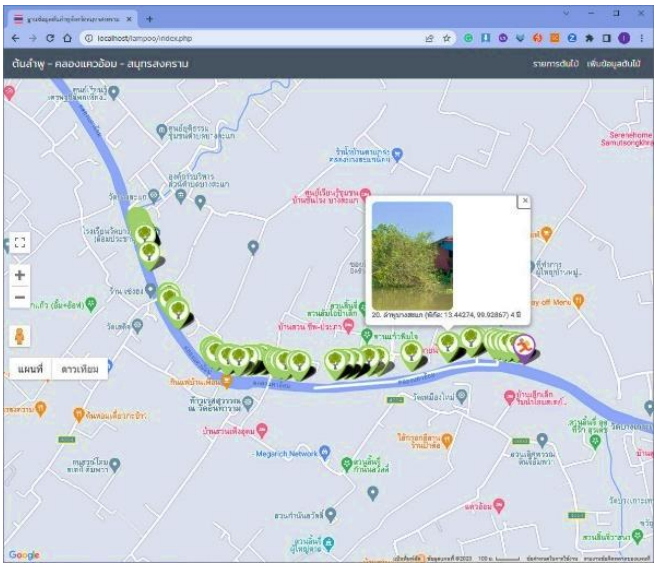

Fig. 8 Displays the coordinates of lamphu trees with pictures and details

4.4. Testing

To evaluate the effectiveness of this research, a comprehensive survey was conducted to gather feedback from 5 experts and 31 users. The survey utilized the Likert scale as a reliable measurement tool, and the collected data was analyzed based on the following indicators to assess the research's efficacy:

"Very satisfied" with a value of 4

"Satisfied" with a value of 3

"Unsatisfied" with a value of 2

"Very dissatisfied," which has a value of 1

Data for this research was collected online through Google Forms, employing a 4-level Likert scale to assess user satisfaction with the developed application [20]. The results were interpreted to determine satisfaction levels, where selecting scales 3 and 4 indicated satisfaction while selecting scales 1 and 2 indicated dissatisfaction. These findings provided valuable insights into the iterative process following the RUP software development architecture. There are 3 areas of evaluation, each of which has the following subsections.

4.4.1. Design (D)
*D1:*Were you satisfied with the user-friendly layout of the application, including aspects such as color, font size, and the number of images?

*D2:*Did you find the reference images appropriate and suitable for this particular application."

*D3:*Did you perceive the overall application as easy to learn and use?

4.4.2. Usability (U)
*U1:*Was it effortless for you to navigate between the primary options within the application?

*U2:*To what extent will the application facilitate managing your exploration activities related to Lamphu trees?

U3:Did you perceive the application as valuable and beneficial?

*U4:*Are you inclined to utilize the application in the future?

4.4.3. Function (F)
*F1:*Will the application contribute to storing, exploring, and presenting identification information about Lamphu trees?

*F2:*Will the application have an impact on our efforts to conserve the Lamphu tree?

Furthermore, the analysis of data distribution using quartiles, interquartile range, and quartile deviation reflected the consensus of opinions from nine experts and users regarding the test results.

This study aimed to examine the learning outcomes of users who interacted with the application without formal training but relied on self-guided learning through manuals and usage clips shared on social networks by the research team. The learning period consisted of a pre-test and a post-test, with a two-week interval in between, allowing participants time to familiarize themselves with the materials provided. A test of 9 items, swapping questions and answering each question differently. The evaluation of learning effectiveness was conducted through online assessments using Google Forms. A t-test was employed as a statistical tool to validate the research hypothesis.

5. Research Finding

The evaluation of the developed application involved a testing approach conducted by a panel of five experts specializing in information technology, community development, and plant species. Additionally, feedback was gathered from a diverse group of 31 users, including community leaders, local residents, students, and the general public. It is important to note that all ethical considerations were carefully followed, ensuring the protection of personal information and adhering to human research ethics protocols.

In terms of design, the expert evaluations indicated the highest level. This was closely followed by effective utilization. Lastly, the function of the application's learning usability also received positive feedback from the experts; all items scored 80% or more, highlighting its high level of effectiveness. The evaluation of the application by 31 users during the testing phase revealed that the design aspect received the highest score. The usability aspect obtained the second score.

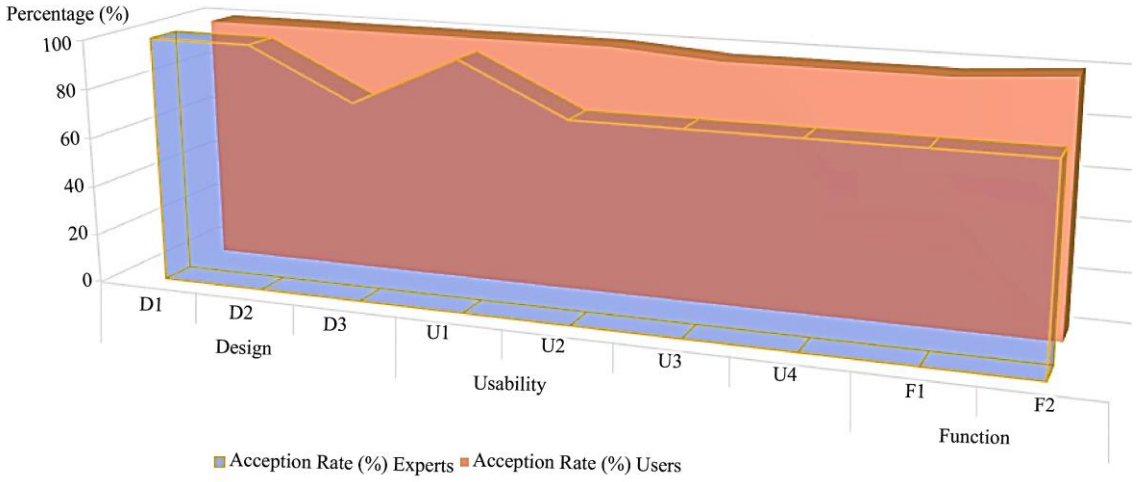

Fig. 9 The results of the evaluation of application performance developed by experts and users

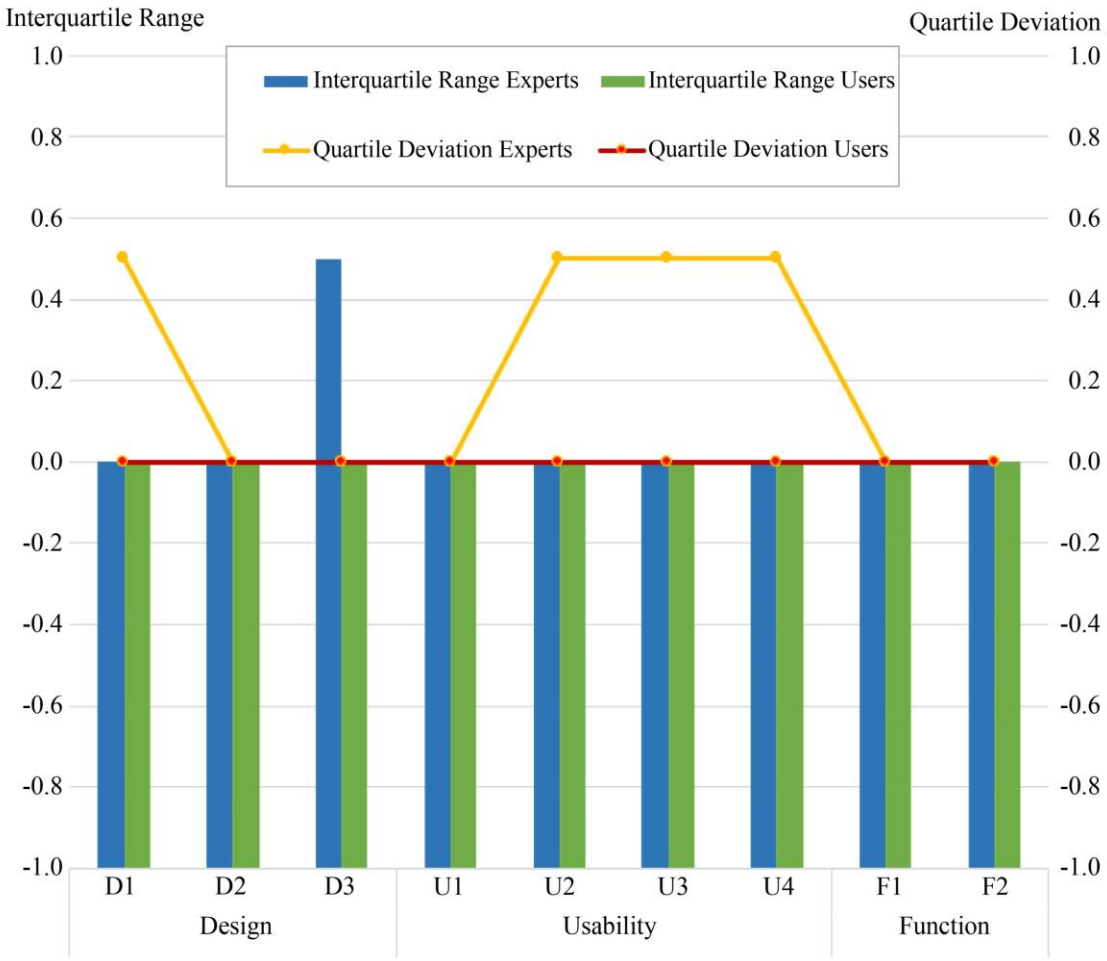

Fig. 10 The results of the quartile range and the quartile deviation by experts and users

Regarding functionality, the last score. The result of all evaluation items is more than 80%. The design aspect received the highest evaluation scores from experts and users, while the utilization aspect was rated secondary. The application aims to facilitate the storage, exploration, and presentation of personally identifiable information related to the Lampoo tree. Additionally, the function aspect of the application is assessed based on its ability to streamline Lamphu tree survey activities. In summary, user evaluations indicate that the application is highly effective in achieving its intended objectives in Figure 9.

Furthermore, the consistency of the developed system was assessed by analyzing the responses of both experts and users across quartiles. The findings revealed that the quartile range was within 1, and the quartile deviation did not exceed 0.5. These results suggest that all participants shared a unanimous opinion and evaluated the application consistently [16]. Detailed information can be found in Figure 10.

This study has formulated the following hypotheses regarding learners' learning outcomes:

H0: There is no significant difference in learning outcomes before and after using the application.

H1: There is a significant difference in learning outcomes before and after using the application.

The hypothesis test was conducted to examine the learning achievement of the user groups who utilized the application. Pre- and post-learning tests were administered to assess users' knowledge before and after the learning process.

The t-test was employed as a statistical analysis method to address the aforementioned hypothesis. The results revealed a highly significant mean difference in the test scores at a confidence level of 95% ($p < 0.05$), indicating a statistically significant improvement in users' learning achievement. The detailed findings can be observed in Table 1.

Table 1. The results of the hypothesis test by t-test

Pre-test		**Post-test**		**N**	***t***	***p***
$\bar{x}$	*S.D.*	$\bar{x}$	*S.D.*	31	17.115	5.00E-17
3.22	0.99	7.77	0.92			

6. Conclusion and Discussion

The aim of this research was to create and assess the effectiveness and learning outcomes of users regarding the Lamphu tree census application, which focuses on the conservation of plant genetic resources in the Kwai Om canal area of Bang Sakae sub-district, Samut Songkhram province, Thailand. The subsequent analysis will present and discuss the findings obtained from the study: 1) Evaluation of the Lamphu tree census application's efficiency in identifying and conserving plant genetic resources. The assessment of design, usability, and functionality revealed that both experts and users consistently recognized the application's high performance. The design aspect received higher evaluations compared to usability and functionality. The opinions of individual experts and users collectively exhibited a consensus, and 2) The study revealed a significant improvement in user learning outcomes following the utilization of the application compared to their initial state. Through hypothesis testing using t-tests, it was determined that the scores exhibited statistically significant differences at a 95% confidence level. This finding indicates that the design aspect of the application plays a crucial role in facilitating user understanding and their ability to employ it effectively, even without formal training. Consequently, the study demonstrates the influential role of well-designed applications in enhancing user learning experiences.

Moreover, the presentation of knowledge through manuals and usage clips further enables users to familiarize themselves with the application's functionalities. As users become proficient in utilizing the application, it can motivate their engagement in activities to conserve local plant species. This individualized learning approach can be expanded to group settings, fostering the development of information technology skills in environmental conservation and plant preservation. These findings align with existing research that highlights the utilization of technology to support plant species preservation initiatives [4-13].

For future research endeavors, it is recommended to investigate the interdependencies between the various plant species coexisting with Lamphu trees. Additionally, expanding the scope of the study to encompass other sub-districts within Samut Songkhram province would be valuable. This expansion would enable broader surveys, data collection, and conservation efforts, facilitating widespread dissemination of findings. Furthermore, such endeavors could contribute to the compilation of a comprehensive inventory of identifiable plant species, laying the groundwork for future research employing machine learning techniques to forecast and assess the presence of Lamphu trees.

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