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Research article

The Application of Geographic Information Systems (GIS) for Conservative Local Plant Database Development

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Abstract: The study of The Application of Geographic Information System (GIS) for Conservative Local Plant Database Development has the objectives 1) to apply Geographic Information System (GIS) for Conservative Local Plant Database Development, 2) to evaluate the acceptance of Geographic Information System (GIS) for Conservative Local Plant Database Development, and 3) to evaluate the accuracy of searching for conserved plants in the database applying geographic information system. The local plant conservation database system utilizes geographic technology and a database system that can manage user data, search for recorded plant species, update and manage plant species data, and display plant species data and their status. The results of the acceptance assessment from 180 experts and system users revealed that the overall score was high ($\bar{x}$=4.00, S.D. = 0.78), and when separated into categories, the scores were: Actual System Use ($\bar{x}$=4.03, S.D. = 0.78), Perceived Usefulness ($\bar{x}$=4.02, S.D. = 0.79), Behavioral Intention to Use ($\bar{x}$=3.99, S.D. = 0.76), Attitude Toward Using ($\bar{x}$=3.98, S.D. = 0.80) and Perceived Ease of Use ($\bar{x}$=3.93, S.D. = 0.78). The results of the evaluation of retrieval efficiency found that Precision = 0.96, Recall = 1.00, Accuracy = 1.00, and the overall efficiency evaluation F-measure = 0.98 is rated as good.

Keywords: Geographic information system; conservative local plant; database development; technology acceptance model.

1. Introduction

Plants are important ecosystem services and resources necessary for sustainable development. Plant conservation is the conservation of the taxonomic diversity and the ecological functions of plant diversity. Most plant conservation efforts focus on maintaining habitats to support forest populations [1]. The most important approach to conservation of rare and endangered plant species is to complete the study of the flora of Thailand as quickly as possible, as this information not only indicates the characteristics of each plant species, but also includes the distribution of plants in various forest types, as well as information on the apparent plant population, endemic species, etc. This information will serve as building blocks for managing plant resources in the country. When the ecosystem is destroyed, whether by natural or human causes, these plants may become extinct before they are even discovered. For example, mountain tribes in mountainous areas frequently relocate their settlements, and

thus, areas covered with a variety of plants are constantly being destroyed to make way for cultivation and shifting cultivation. As each digging destroys the entire plant ecosystem, conservation of endangered plants must be considered in terms of natural resource management and wood utilization planning. In Thailand, although there has never been a serious study of endangered plants, it is estimated that a significant number of plants have disappeared from their original habitats. The operation of natural resource conservation requires the use of social and legal measures, including the encouragement of local efforts in conserving forest resources and helping to maintain them in their original condition, thereby preventing deterioration for the benefit of local livelihoods. Currently, there are many problems with forest resources [2].

Conservation of plant resources is therefore essential to preserve critically endangered plant species that may hold economic importance in the future, and to conserve special traits among plant populations for plant breeding, such as resistance to insects and diseases, and drought tolerance. The conserved plant species can be used as a base population for further breeding or as a source for future genetic research. This conservation can be achieved through in situ conservation, which involves preserving plant habitats by considering those of near-extinction or at-risk plants (due to human activities). This approach involves stopping the destruction of plant habitats to prevent subsequent loss and attempting to restore destroyed habitats to their natural state. By collecting in a collection plot (Ex Situ), this method involves collecting rare or near extinct plant species and planting them in propagation plots in botanical gardens, arboretums, and trying to make the ecosystem similar to the natural environment where the plants live [3]. The researcher studied the geographic information system, a computer system used to import and analyze geographic location data, which is then displayed as maps or images. Currently, GIS is increasingly applied in conservation work due to its ability to collect, analyze, and display spatial data, as well as provide accurate and quick coordinates. Therefore, geographic information technology is applied to help increase data collection efficiency for the local conservation plant database at Rajamangala University of Technology Rattanakosin, Wang Klaikangwon Campus, as the area covers more than 235 rai and features a variety of plant species, including rare ones. Based on the aforementioned benefits, an information system has been developed to create a database of rare or conserved plant species, enabling the survey and protection of the tree population. However, this study is important for establishing a geographic information platform for local agencies, particularly the Royal Project for Sustainable Resource Conservation (RSPG). Coordinating Center at RMUTR, as part of Activity 8: Special Activities Supporting Resource Conservation under RSPG. However, this focus is not mentioned in the introduction or discussion. The authors should highlight the platform's application to clarify its practical significance. RMUTR, Wangklaiwangwon campus, lacks a systematic approach to collecting, storing, and presenting plant information.

In the order that, the study of the Application of Geographic Information System (GIS) for Conservative Local Plant Database Development has the objectives were to apply Geographic Information System (GIS) for Conservative Local Plant Database Development, to evaluate the acceptance of Geographic Information System (GIS) for Conservative Local Plant Database Development, and to evaluate the accuracy of searching for conserved plants in the database applying geographic information system.

2. Related Theories and Research

In this research, the research team reviewed the basic knowledge theories that led to this research as follows:

2.1 Related theories

2.1.1 The Plant Genetic Conservation Project initiated by Her Royal Highness Princess Maha Chakri Sirindhorn (P.G.S.P.) was established in 1993 to create understanding and awareness of the importance of various resources in Thailand, leading to encouragement of participatory thinking and practice that benefits the Thai people, as well as to create a nationwide resource information system [4]. Since 1960, His Majesty King Rama IX has had the foresight to conserve rubber trees and collect plant species from various regions of the country to be planted in Chitralada Garden. Thus, the Plant Genetic Conservation Project was established to fulfill the royal initiative and continue his intention, as evident in various activities, including the protection

of resources in natural forest areas, surveying and collecting endangered resources, cultivating and maintaining the collected resources in suitable and safe areas, and carefully conserving and utilizing them. There were efforts to study and evaluate resources in various aspects, such as components, properties, and utilization, to create a computer resource information system, initiate long-term (30-50 years) resource planning and development, and promote resource conservation awareness among various target groups [5- 6].

2.1.2 Geographic Information System (GIS)

A GIS is a computer system that analyzes and displays geographically referenced data based on geographical inputs such as maps, satellite images, numbers, letters, and distances, and analyzes them through computer programs. The results are often highly accurate and can be applied in many areas. GIS is useful in many areas, especially environmental management, urban planning, and public utility management, by calculating the area to be used from a map image. This includes measuring the distance for road construction or defining points on a map for laying water pipes [7-9].

2.1.3 ArcGIS

ArcGIS is a geospatial software platform for viewing, editing, managing, and analyzing geographic data. Esri develops ArcGIS for mapping on desktop, mobile devices, and the web. [8] ArcGIS offers spatial data analysis features and tools that align with the organization's work processes, enabling the analysis and display of insights from internal and external data, as well as the publication of results in the form of maps, applications, dashboards, and reports. This study utilized ArcGIS's Data Collection & Management features to efficiently and securely explore, store, utilize, and publish data by integrating with other data storage systems and adding spatial dimensions to these datasets [10].

2.1.4 Technology Acceptance Models (TAM)

The Technology Acceptance Model (TAM) is a significant predictor of technology adoption behavior in learning, combining two key components: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). This model has been accepted and proven effective in explaining the acceptance and adoption of technology in various contexts [11-12].

The Technology Acceptance Model (TAM) is a widely accepted theory for examining the factors and perspectives that influence the adoption of new technologies. The purpose of the TAM, developed by Davis in 1986, is to model user acceptance of information systems. The primary objective of the model is to encourage the adoption of information technology (IT) through acceptance stimulation. This promotion of acceptance can only be successful if the influencing factors can be identified, which can be achieved by studying users' perceptions of technology use [13].

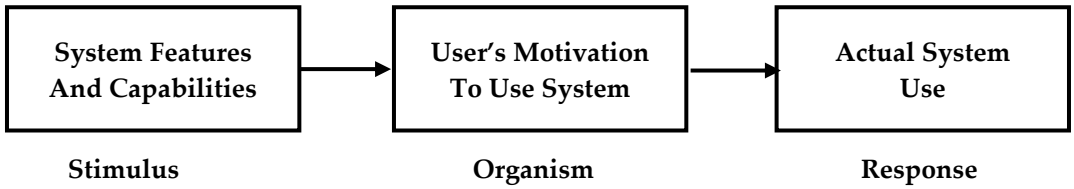


Figure 1. Conceptual Model for Technology Acceptance [1]

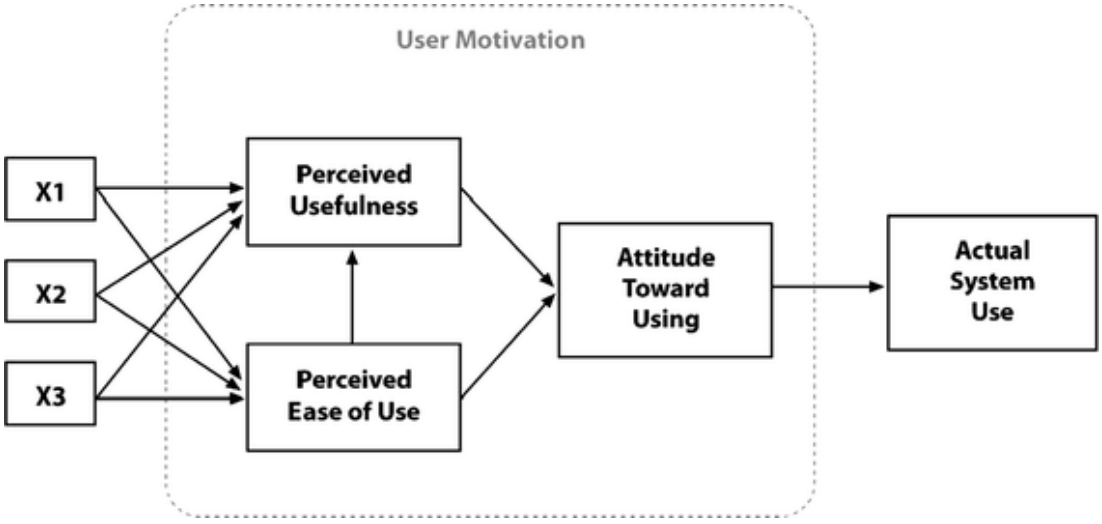


Figure 2. Technology Acceptance Model [15]

Perceived Ease of Use (PEoU), Perceived Usefulness (PU), Attitude Toward Using (ATU), Behavioral Intention to Use (BI), and Actual System Use (ASU).

Model explanation

The benefit of TAM is that it serves as an important tool in examining technology acceptance behavior, as well as:

- Helps in predicting technology adoption and usage: TAM can predict the adoption behavior of new technology users by studying two important factors: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), which help in predicting the extent of adoption [16].

- Helps in developing and improving technology: with TAM, developers or project managers can understand the user adoption factors and can use such information to improve the usefulness or user-friendliness of a technology or design [17].

- Multi-contextual application: TAM can be applied in various fields and contexts, such as education, business administration, medicine, or even mobile applications, which helps in studying and analyzing different aspects of user needs [18].

- Helps in understanding user behavior in different situations: TAM helps in identifying which factors influence the adoption of technology in different contexts, such as the adoption of technology in organizations or education after a technology change [19].

- Can be used as a conceptual framework for research: TAM is used as a conceptual framework for research on technology user behavior, which helps researchers to focus on the key factors affecting the acceptance and use of technology. [20]

Thus, TAM is a helpful tool for researching and developing new technologies, as well as gaining a deeper understanding of users' technology use behavior.

2.2 Related Studies

Acceptance of GIS within ERP Systems: A Research Study in Higher Education by Simona Sternad Zabukovšek et al. [12] utilized the Technology Acceptance Model (TAM), one of the most commonly employed research models for studying the intention to use and usability of information systems, and augmented the TAM with external factors. The primary objective of the study was to identify the factors influencing the acceptance of GIS and individual attitudes towards the use of GIS-integrated ERP systems. Survey data analysis was conducted using structural equation modeling with the Partial Least Squares (PLS) method. The study examined 12 external factors in the TAM model, of which 10 were found to be significant. The most important factors affecting the intention to use ERP-GIS systems were perceived usefulness and attitudes towards the ERP-GIS system, followed by education and training in ERP-GIS systems and perceived enjoyment of using ERP-GIS systems.

The research showed that external factors such as training, education, perceived enjoyment of using ERP-GIS systems, and perceived usefulness of using the system had significant influences on the user attitudes and intentions to use ERP-GIS systems, especially in the context of higher education, in which there was much disparity in knowledge and skills in computer science and ERP systems. Therefore, providing appropriate education and training plays a crucial role in increasing acceptance and promoting the use of technology in the future. This study also emphasizes the importance of increasing the factor of Perceived Enjoyment, which is a crucial factor in attitudes and acceptance of ERP-GIS systems [11].

Application of Geographic Information System (GIS) for the forest database of Magnolia Sirindhorniae, Lopburi Province: The application of GIS to create and manage a forest database for Magnolia Sirindhorniae, a rare and endangered species in Lopburi Province, aims to monitor, conserve and manage the distribution and growth of this species using geographic information and GIS technology to monitor and manage the population of Magnolia Sirindhorniae in Lopburi Province by using GIS to map the distribution of tree species, growth and conservation areas, and create a comprehensive database to store and manage all the collected data. This system was linked to the GIS platform, enabling efficient display, analysis, and updating of data. GIS tools were used to analyze the distributional characteristics of Magnolia Sirindhorniae, which enables the identification of suitable habitats, assessment of potential threats, planning, and management of future conservation efforts [22].

Utami and Ramdani [23] studied GEMAR, a web-based GIS for emergency management and ambulance routing. It utilizes web-based technology to facilitate access to information and decision-making, with a primary focus on ambulance dispatch to the scene of an incident. The development of this system aims to improve the efficiency (namely, speed and accuracy) of the ambulance dispatch process, while also enabling the management of various emergency data. The research employed a system assessment approach to examine technology acceptance and usability issues, with an average score for technology acceptance ranging from 3.70 to 4.40, and an average score for usability ranging from 4.00 to 4.50, as assessed by 10 experts, including 7 medical experts and 3 GIS experts. The average score of technology acceptance was between 3.70 and 4.40, while the average score of usability was between 4.00 and 4.50, indicating that the system had user-friendly features and was ready for future use. Medical experts also noted that the system was easy to use and navigate. Both subsystems were useful for medical practitioners to understand the situation in emergency management. The experts' opinions obtained were used to improve and further develop the system [23].

The development of a web-based geographic information system (GIS) for roadside trees in the Nakhon Ratchasima Municipality aimed to manage and track roadside trees within the municipality's area by utilizing GIS technology to collect and display various tree data, including location, type, age, and health, on online maps. Surveys and the collection of roadside tree data, including GPS location, type, size, and health information, were conducted. A website was created to display GIS maps linked to tree data in the area, allowing users to search or view tree details. A database was used to store tree data so that it can be accessed and updated conveniently by linking GIS maps through GIS map technology such as Google Maps or OpenStreetMap to display tree locations and related data so that the system can help the municipality effectively track and manage tree data, promote sustainable tree care in urban areas, and respond to the needs of the community [24].

Decision Support System for Economic Crop Planning Using Geoinformatics Technology by Phiset Senawong has the objective to develop a geoinformatics database to support decision-making in land use planning that can be used via the Internet by analyzing the plots of interest, consisting of 1) cases of restrictions and conditions on land use, 2) cases of appropriate land use and conservation for sustainable use, and 3) cases of determining alternatives to support decision-making in land use that provides the highest benefit, which has developed tools using the capabilities of Geoprocessing service of ArcGIS for server which can be used and accessed via Web Browser [25]. Wutthitaweewat and Chaiyawat had the following objectives: 1) Study of technology quality factors affecting the acceptance of insurance life technology (InsurTech). 2) Study the level of technology acceptance and decision-making trends in purchasing life insurance policies via applications. 3) Examining the consistency of technology quality and acceptance of InsurTech life insurance technology on the tendency of life insurance policy purchase decisions via an applications model. 4) Study the influence of

technology quality and acceptance of InsurTech life insurance technology on the tendency of consumers to make decisions to purchase life insurance policies via applications in Bangkok. The tools used in the study were a 5-stage evaluation questionnaire, which was created based on the concept and theory of the Information System Success Model (ISSM) and the Technology Acceptance Model (TAM). The results of the study on the level of technology acceptance (Technology Acceptance Model: TAM) found that the overall acceptance of InsurTech technology was at a high level ($\bar{x}$ = 4.25, SD = 0.69) [26]. Sirimongkhon et al. developed a facial recognition-based attendance system to improve attendance management efficiency, reduce errors, and allow effective identification of attendees. The system was tested for accuracy using the Confusion Matrix [27]. The study "Forecasting Direction and Analyzing Dengue Risk in Bangmaenang Sub-District, Bangyai District, Nonthaburi Province" utilized Geographic Information Systems (GIS) and data mining to forecast the direction and identify risk areas of dengue fever outbreaks, analyze their underlying factors, and compare the efficiency and accuracy of the forecasting algorithms. The research study area is Bang Mae Nang Sub-district, Bang Yai District, Nonthaburi Province. In this research, the efficiency of the model is evaluated using the Confusion Matrix, and its performance is measured using Accuracy, Precision, Recall, and Overall Efficiency (F-measure) [28].

3. Research Method

3.1. Developing a GIS-based information system for a local conserved plant database using the Software Development Life Cycle (SDLC) theory [29-30]

3.1.1 System Planning

The researcher studied and analyzed the problems in recording local plant species data in Rajamangala University of Technology Rattanakosin, Wang Klai Kangwon Campus, and nearby areas where plant species had not been systematically recorded. Therefore, the researcher saw the need to develop a GIS-integrated information system to create a database of locally conserved plants, supporting the Plant Genetic Conservation Project (RSPG). The development of the system was based on the following initial requirements:

3.1.1.1 General users can view plant species data, search for recorded plant species data, and view the location of recorded plant species.

3.1.1.2 Members or system staff can log in and out, manage their own member data, and manage plant species data. And can manage system data

3.1.1.3 Administrators can log in and log out, manage member and staff data, grant member system usage rights, manage plant species data, as well as system data. The system is designed to be displayed and usable through all devices using Responsive Web Design techniques [31]. System Analysis: Develop a GIS-based information system to create a local database of conserved plants. The analysis part was done as follows:

3.1.1.4 Design the system architecture according to Figure 3 below.

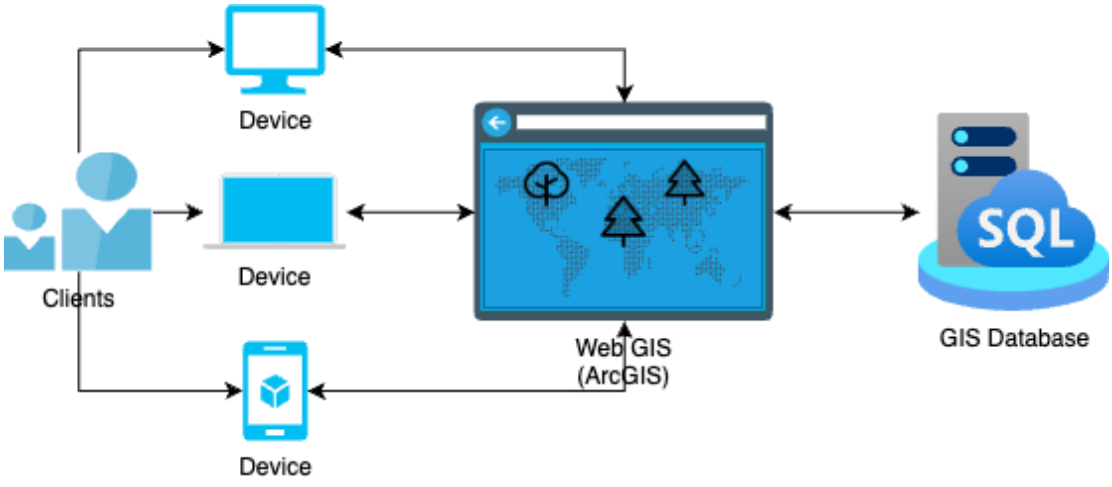


Figure 3. Architecture of the System

3.1.1.5 Context Diagram

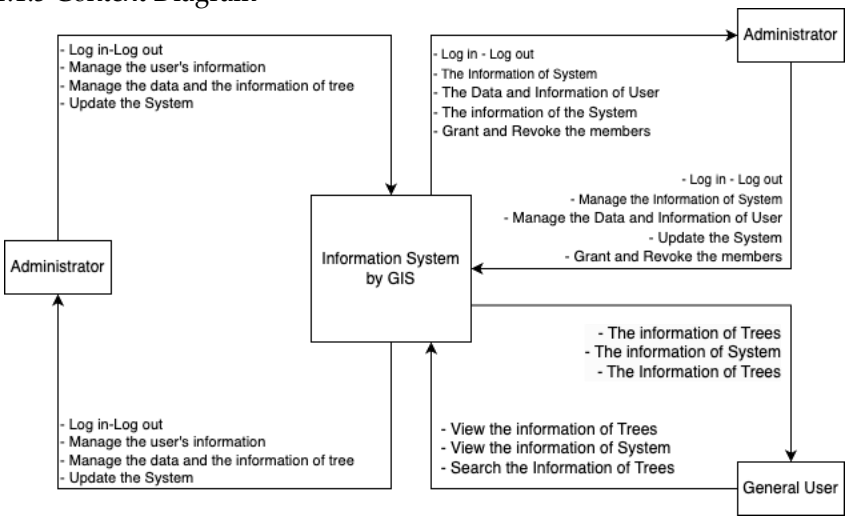


Figure 4. Context Diagram

3.1.1.6 Dataflow Diagram

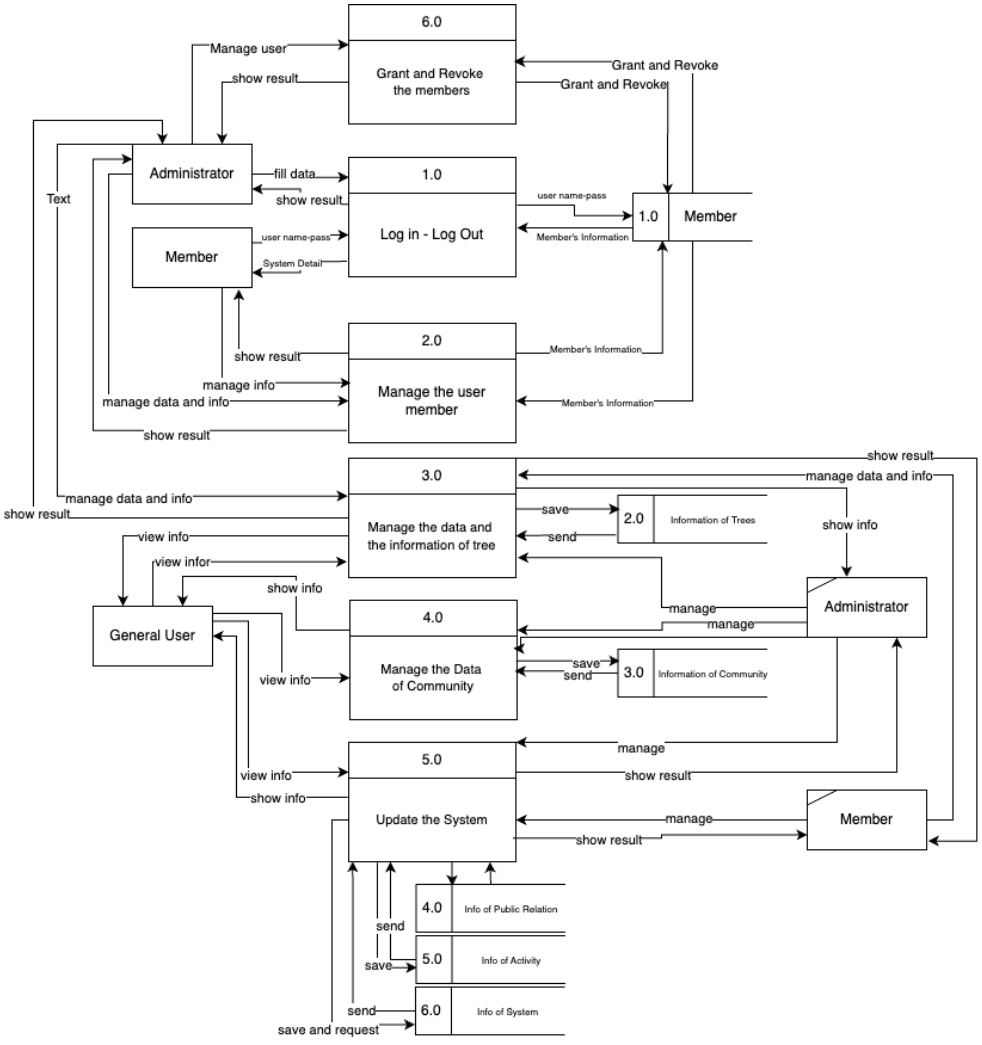


Figure 5. Dataflow Diagram level 0

3.1.1.7 Entity-Relationship Diagram

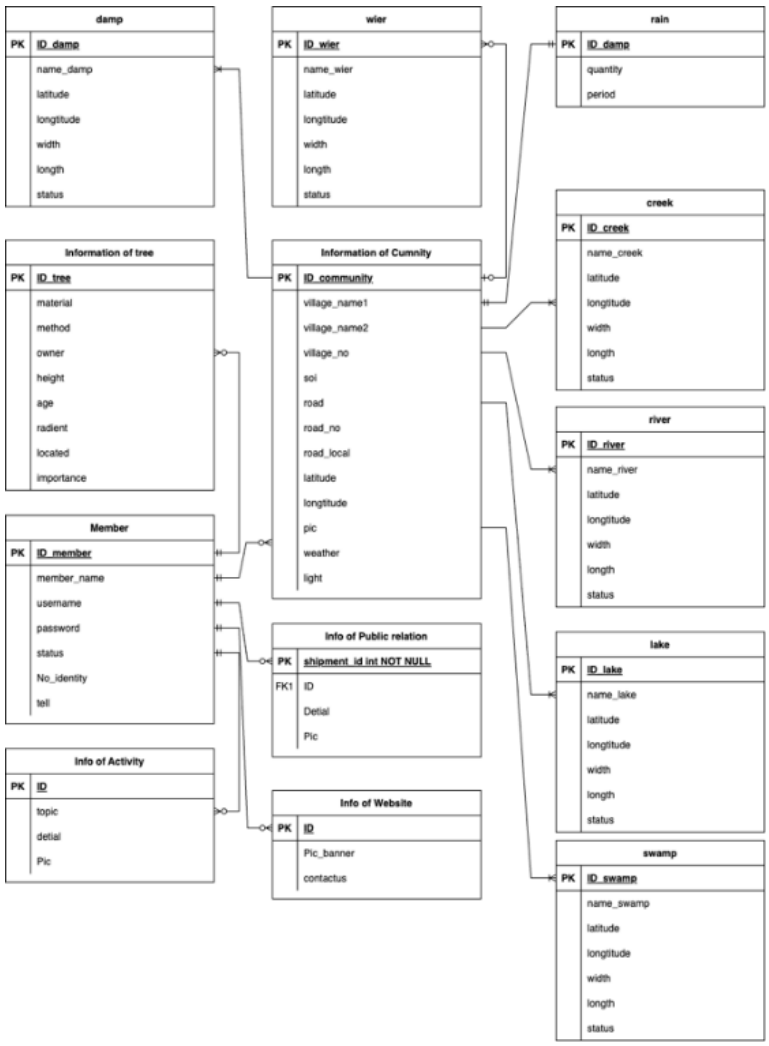


Figure 6. Entity-Relationship Diagram

3.1.2 System Design

The development of the GIS-based system to create a database of local conserved plants was done using ArcGIS API, together with Dreamweaver, a web development tool that facilitates designing and writing HTML, CSS, JavaScript, and PHP codes. These tools can be used to create and manage web applications using the ArcGIS API for JavaScript and a MySQL database management program for storing and retrieving spatial data.

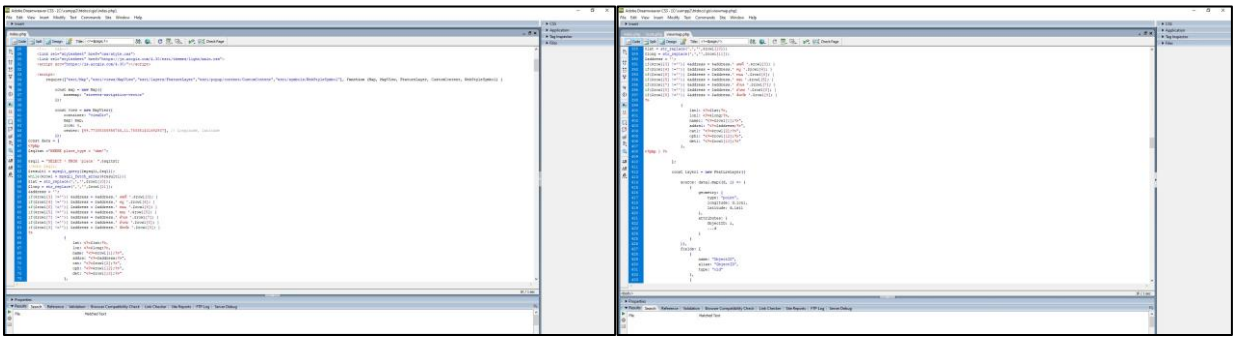


Figure 7. Using Adobe Dreamweaver with ArcGIS API for JavaScript and MySQL.

3.1.3 System Implementation

System implementation involves migrating from the old system to a new one using the direct installation approach or replacing the old system immediately with the new one, and then proceeding to the system testing process.

3.1.4 System Testing: uses the black box testing method

A software testing method that focuses on checking the functionality of the system or application, regardless of the internal structure or operation of the underlying code. It focuses on whether the system works correctly according to the requirements by examining the input and output received through testing various system functions against the requirements or user needs. Five experts were used to test the system's efficiency [32-35]. The testing utilized the plants' records from specific areas, which may not fully represent the entire real-world diversity. Additionally, the controlled testing environment may differ from actual usage conditions. Further evaluation in more diverse contexts is recommended.

3.1.5 System Maintenance

System Maintenance is a process of maintaining and improving the software or hardware system to maintain both long-term efficiency and user satisfaction. This step occurs after the system is in use (Post-deployment Phase) and usually involves correcting errors or bugs in the system, adapting the system to a new environment, and improving features or adding new capabilities to make the system more responsive to user needs [36-38]

3.2 Technology Acceptance Evaluation

Arranging for 180 users and related people to evaluate the acceptance of geographic information technology to create a local conserved tree species database, covering Perceived Ease of Use (PEoU), Perceived Usefulness (PU), Attitude Toward Using (ATU), Behavioral Intention to Use (BI), and Actual System Use (ASU).

3.3 Evaluating the accuracy

Evaluating the accuracy of searching for conserved tree species in the GIS-based database by measuring the Recall and Precision [28].

Table 1. Confusion Matrix

	TRUE	**FALSE**
TRUE	True Positive (TP)	False Positive (FT)
FALSE	False Negative (FN)	True Negative (TN)

$$\text{Accuracy} = \frac{\text{TP+TN}}{\text{TP+TN+FP+FN}} \quad (1)$$

$$\text{Precision} = \frac{TP}{TP+FP} \quad (2)$$

$$\text{Recall} = \frac{TP}{TP+FN} \quad (3)$$

$$\text{F-measure} = 2x\frac{Precision\ x\ Recall}{Precision+Recall} \quad (4)$$

4. Research Result

The result of the application of geographic information technology to create a local plant conservation database, as well as the collection of GIS data, mapping of plant location, and assessment of the accuracy of the conserved plant searching accuracy of the GIS-based database by measuring the precision, recall, and accuracy.

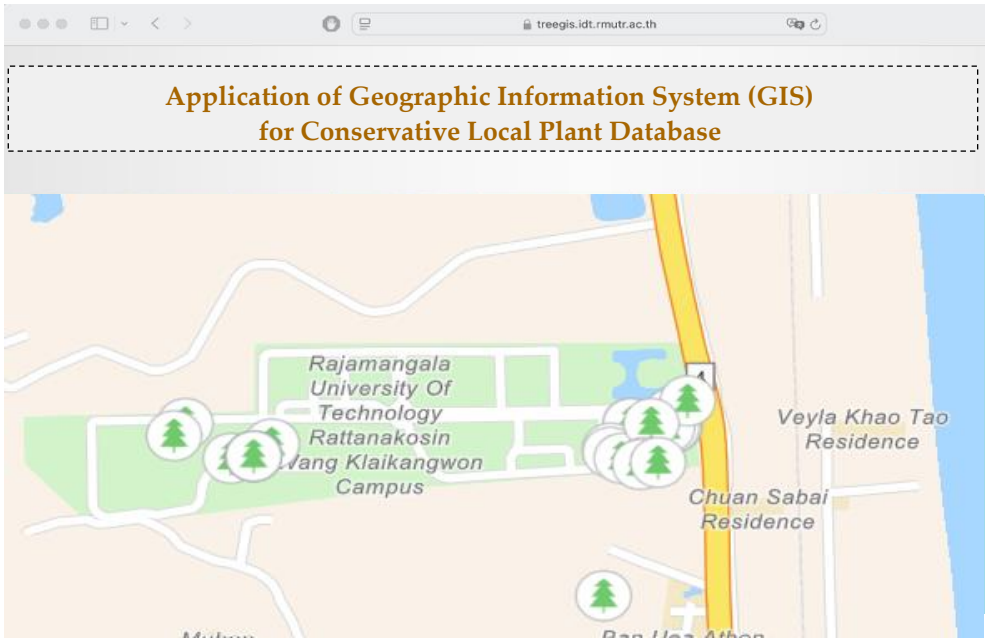


Figure 8. Recorded plant information drawn from the GIS database.

Figure 8 presents the location of plant species recorded via RSPG Form 5, allowing users to view basic information and navigate to each plant's location.

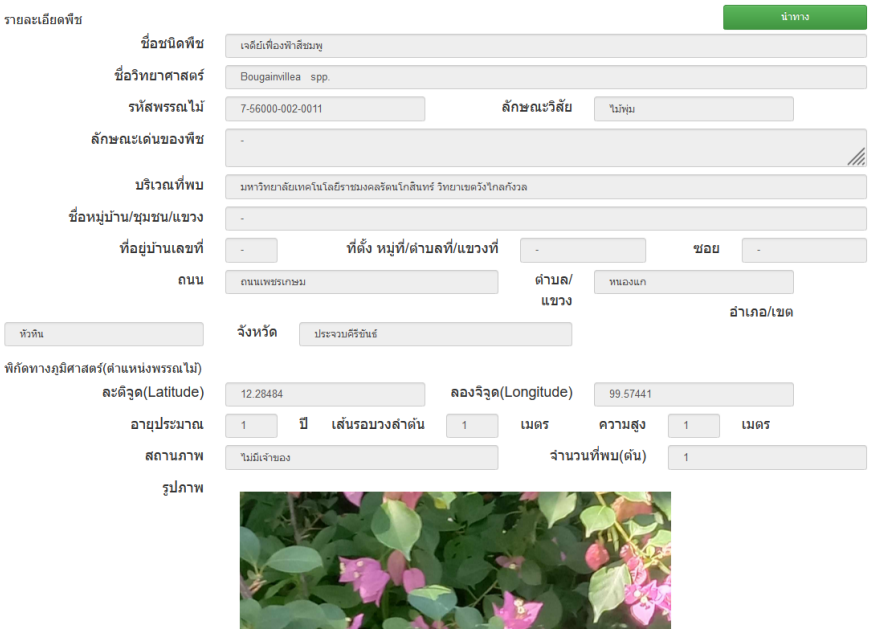
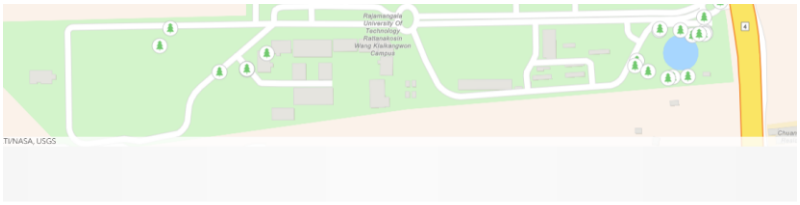


Figure 9. Plant species information and navigation bar

Figure 9 presents the data entry form for plant species based on RSPG Form 5, illustrating the process of recording plant information. The system also enables users to search and retrieve plant data, as demonstrated in Figure 10.



Plants in Rajamangala Universit of Technology

ลำดับ	ชื่อ	รหัสพรรณไม้	ลักษณะ	รายละเอียดพืช
1	เจดีย์เพื่องฟ้าสีชมพู	7-56000-002-0011	ไม่ผุ่ม	เรียกดู | นำทาง
2	ไกสน	7-60000-001-030.	ไม่ผุ่ม	เรียกดู | นำทาง
3	มะพร้าวน้ำหอม	7-24120-001-240	ไม่ใหญ่หรือไม่ยืนต้น	เรียกดู | นำทาง
4	เดยทอง	7-60000-001-100	ไม่ผุ่ม	เรียกดู | นำทาง
5	มะม่วง	7-56150-001-038/1.	ไม่ใหญ่หรือไม่ยืนต้น	เรียกดู | นำทาง
6	ชุมเห็ดเล็ก	-	ไม่ผุ่ม	เรียกดู |

Figure 10. Searching for local plants

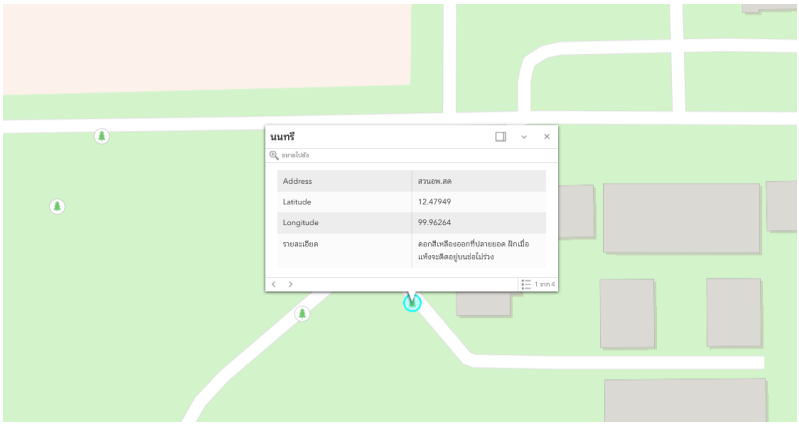
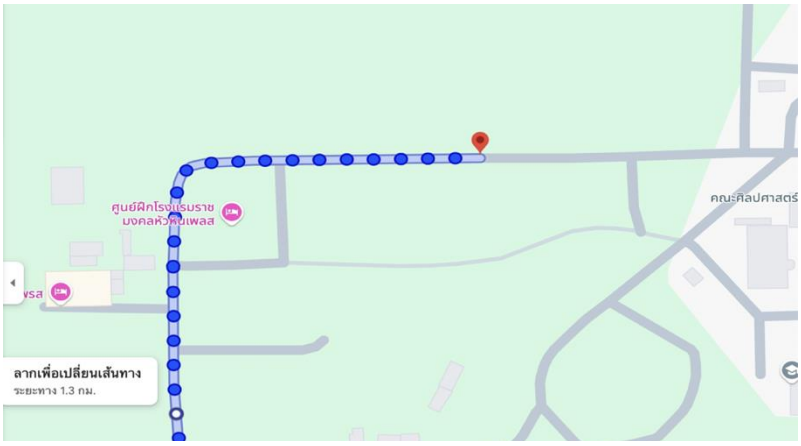


Figure 11. Show the Tree Information

Figure 11 illustrates the basic information of the queried plant species and provides the functionality to identify a route to access the specific plant, as shown in Figure 12.



Worksheet no.1 “Basic Data Collection in the Local Communication

Figure 12. Route to the tree

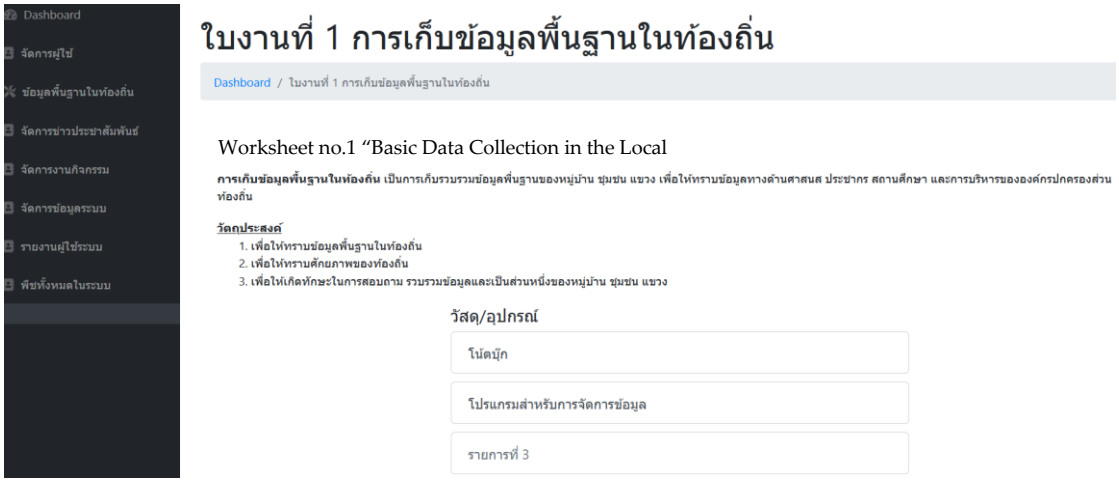


Figure 13. Back end for recorded information per Worksheet no. 1 of the Plant Genetic Conservation Project

Assessment of acceptance of the GIS for the local conserved plant database

The technology acceptance model of the application of GIS in the local conserved plant database was assessed by 180 administrators, experts, and general users. The result was presented as the mean system efficiency and its standard deviation. Table 2 shows the TAM result.

However, the Technology Acceptance Model (TAM) was adopted in this study due to its strong focus on perceived ease of use and perceived usefulness, which are critical factors in understanding user acceptance of information systems. Compared to alternative models such as UTAUT, TAM offers a simpler and more parsimonious framework, making it suitable for studies with limited sample sizes or heterogeneous user groups. In contrast to IS-Success, which emphasizes system quality, information quality, and net benefits, TAM directly examines users' behavioral intention to use the system, aligning closely with the primary objective of evaluating user acceptance of the web-based GIS platform.

Table 2. Assessment of acceptance of the GIS for the local conserved plant database

Aspects	Executives		Plant Experts		IT Experts		General Users		Total		
	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	Rating
Perceived Ease of Use: PEoU	4.12	0.82	3.85	0.81	4.03	0.82	4.02	0.77	3.93	0.78	High
Perceived Usefulness: PU	3.83	0.75	3.98	0.86	4.01	0.81	4.00	0.74	4.02	0.79	High
Attitude Toward Using: ATU	4.10	0.84	3.90	0.71	4.17	0.87	3.89	0.75	3.98	0.8	High
Behavioral Intention to Use: BI	3.80	0.82	4.03	0.77	4.13	0.85	3.99	0.78	3.99	0.76	High
Actual System Use: ASU	4.00	0.68	4.03	0.77	4.08	0.86	4.02	0.87	4.03	0.78	High
Total	**4.00**	**0.78**	**4.00**	**0.78**	**4.10**	**0.84**	**4.00**	**0.78**	**4.00**	**0.78**	**High**

Table 2 shows the acceptance of the GIS for the local conserved plant database as being high ($\bar{x}$ =4.00, S.D. = 0.78). The aspect with the highest mean was Actual System Use ($\bar{x}$ =4.03, S.D. = 0.78), Perceived Usefulness ($\bar{x}$ =4.02, S.D. = 0.79), Behavioral Intention to Use ($\bar{x}$ =3.99, S.D. = 0.76), Attitude Toward Using ($\bar{x}$ =3.98, S.D. = 0.80) and Perceived Ease of Use ($\bar{x}$=3.93, S.D. = 0.78).

Table 3. Retrieval accuracy assessment

Term	Related Answer	Retrieved	TP	TN	FP	FN	Precision	Recall	Accuracy
Tamarind	15	15	15	0	0	0	1.00	1.00	1.00
Burma padauk	8	8	8	0	1	0	0.89	1.00	0.89
West Indian Jasmine	40	42	40	0	2	0	0.95	1.00	0.95
Bush	101	105	101	0	4	0	0.96	1.00	0.96
idigbo	23	23	23	0	0	0	1.00	1.00	1.00
Black afara	3	3	3	0	0	0	1.00	1.00	1.00
Tree species older than 5 years	554	580	554	0	18	8	0.97	0.99	0.96
Perennial trees	678	678	678	0	0	0	1.00	1.00	1.00
Coconut	147	147	147	0	0	0	1.00	1.00	1.00
Aromatic young coconut	25	25	25	122	0	0	1.00	1.00	1.00
Coconut trees in the area of RMUT Rattanakosin	147	147	147	0	0	0	1.00	1.00	1.00
Pine trees in the Khao Tao area	154	154	154	0	0	0	1.00	1.00	1.00
Overall precision and recall							0.98	1.00	0.98

Table 3 presents the assessment of retrieval efficiency related to the local plant species search term, as collected and recorded in the GIS-based database. The search for 12 sample sentences, on average, found that Precision = 0.98, Recall = 1.00, and Accuracy = 0.98

When the results of the assessment of retrieval efficiency related to the local plant species search term, as collected and recorded in the GIS-based database, were examined, Precision = 0.96 and Recall = 1.00 were found.

$$\text{The F-measure was } 2x\frac{0.98x1.00}{0.98+1.00} = 0.99$$

As the F-measure was 0.99, the tool was deemed very good.

5. Discussions

The study: Application of Geographic Information Technology to Create Local Plant Conservation Database has the objectives 1) to apply geographic information technology to create a local plant conservation database, 2) to evaluate the acceptance of geographic information technology to create a local plant conservation database, and 3) to evaluate the accuracy of searching for conserved plants in the database using geographic information technology. The development of geographic information technology to create a database of local conserved plants was done using the theory of software development life cycle (SDLC), as well as ArcGIS API and Dreamweaver, the latter of which is a web development tool that provides convenience in designing and writing HTML, CSS, JavaScript, and PHP codes, which in turn can be used to create and manage web applications that used ArcGIS API for JavaScript. MySQL was used to manage spatial data. From the study and assessment of the acceptance of geographic information technology to create a database of local conserved plants, as assessed by 180 system users, namely executives, experts, and general users, it was found that the level of acceptance of geographic information technology to create a database of local conserved plants was high overall ($\bar{x}$= 4.00, S.D. = 0.78). The aspect with the highest mean was Actual System Use ($\bar{x}$= 4.03, S.D. = 0.78), followed by Perceived Usefulness ($\bar{x}$= 4.02, S.D. = 0.79), Behavioral Intention to Use ($\bar{x}$= 3.99, S.D. = 0.76), Attitude Toward Using ($\bar{x}$= 3.98, S.D. = 0.80) and Perceived Ease of Use ($\bar{x}$= 3.93, S.D. = 0.78). An assessment of retrieval efficiency related to search terms for local plants in the GIS-based

database revealed that Precision = 0.98, Recall = 1.00, Accuracy = 0.98, and F-measure = 0.99. Consequently, the system was deemed very effective, as it is easy to use, practical, and helpful in searching for local plants. Local plant searching efficiency was also found to be very good.

This study concurred with Sritumma, Chantakat, and Hatkhuntod [24], in which three experts and four municipal officials rated technology acceptance as moderate, and the developed website was deemed practical for use. In comparison to previous work, the current study offers a more structured evaluation, encompassing both architecture/database design, as well as user assessment. Sritumma et al. [24] focused on a general web-based platform without detailed integration of spatial databases. This study implemented a GIS-based system with a spatial database that supports efficient storage, retrieval, and visualization of local plant data. Similarly, Suwanthong and Chaiudom [22] developed a GIS application for Magnolia sirindhorniae, utilizing ArcGIS in conjunction with MySQL for database management, and HTML, CSS, and JavaScript for the web interface. However, the current study extends this approach to a broader range of plant species and integrates additional functionality for route guidance to individual plants. Sritumma et al. [24] relied on a small group of three experts and four municipal officials to assess technology acceptance, while Suwanthong and Chaiudom [22] focused primarily on system functionality without a formal evaluation of user acceptance. In contrast, this study employed a structured TAM-based questionnaire and divided evaluators into three groups—administrators, plant experts, and general users—providing a more comprehensive and representative assessment of user acceptance. The findings of this study demonstrate practical and academic significance. The developed GIS platform not only supports the Center of Plant Genetic Conservation Project, under the Royal Initiative of Her Royal Highness Princess Maha Chakri Sirindhorn, in plant conservation at RMUTR, but also provides an effective tool for data management. Furthermore, the system can serve as a reference model for future research and applications, thereby enhancing the overall contribution of this work.

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