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Geographic information system for marine ecotourism and rural lifestyle in Prachuap Khiri Khan

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ABSTRACT

According to the Prachuap Khiri Khan Province tourism statistics report for 2023, there were 11,143,079 Thai and foreign tourists from January to December 2023, which increased by 1,395,195 people or 14.31 percent compared to 2022. Simultaneously, tourist attractions accumulated tourism income in 2023 totaling 44,241 million baht, marking an increase of 11,402.63 million baht or 34.72 percent from 2022. Despite this growth, tourist attractions that are popular with tourists remain centered in Hua Hin District due to a lack of publicity and insufficient information provided to tourists. Consequently, the researcher intended to develop a geographic information system (GIS) for marine ecotourism and rural lifestyles in Prachuap Khiri Khan Province to promote rural tourist attractions and distribute tourism income to the community. The system utilized the classification (precision and recall) model and was developed using ArcGIS and the web app builder ArcGIS. Findings from 8 experts in computers, information technology (IT), and GIS indicated that the overall system efficiency had an average of 4.54 and a standard deviation of 0.50. Additionally, results from the study on retrieval efficiency using the classification (precision and recall) model revealed a precision value of 0.90 and a recall value of 0.95.

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1. INTRODUCTION

In terms of advancements in technology and the economy, tourism must be focused first because the majority of the population uses technology together with tourism to find tourist attractions. Thailand's use of technology for tourism has ranked among the top in the world and has become an industry of great importance to the world's economic system. It is widely acknowledged that the tourist business has risen swiftly in practically every country to become a vital product in the international trade system [1]. Many countries consider tourism to be one of their most significant sectors. From a social point of view, tourism is a sort of relaxation that relieves stress while building understanding between visitors and residents. The tourism industry has prioritized eco-tourism in both nature and culture. The researcher studied and analyzed tourism problems from the Prachuap Khiri Khan Province statistical report 2023. From the Prachuap Khiri Khan Statistics Office presented tourism statistics of Prachuap Khiri Khan Province during January to December 2023, there were 11,143,079 tourists. It can be divided into 10,656,168 Thai tourists and 486,911 foreign tourists, which increased from 2022 to 1,395,195 tourists or 14.31 percent. Total tourism income in

2023 was 44,241 million baht. It can be divided into income from Thai tourists of 38,890.14 million baht and income from foreign tourists of 5,350.61 million baht, which increased from 2022 at 11,402.63 million baht or 34.72 percent and was a very welcome figure. No matter what corner of the world we travel to, we often meet people from many different nationalities who have visited Thailand. Therefore, Prachuap Khiri Khan Province is one of the important tourist attractions of Thailand. On the other hand, the main tourist attraction of Prachuap Khiri Khan province and known to tourists is still Hua Hin. As a result, other community tourist attractions are still not well known and lack popularity, which causes income to not be widespread [2]. In Prachuap Khiri Khan Province, people will choose only tourist attractions that focus on the sea. In reality, Prachuap Khiri Khan Province has many other nearby places and interesting cultures, which the GIS system will help people access easily and the GIS system has not been used for tourist attractions in Prachuap Khiri Khan Province before.

Geographic information system (GIS): can be applied to a variety of tasks such as urban planning, environmental and resource studies, disaster studies and monitoring, and tourism. GIS is a powerful tool used to manage, analyze, and display results at the community and regional level. GIS can be applied to a variety of tourism tasks, including inventorying recreational facilities, managing land tourism, evaluating tourist impacts, tourism information management systems, and tourism decision support systems. The researcher aimed to use GIS technology to develop cultural tourism in Hua Hin District by using the ArcGIS program to display new or unfamiliar tourist attractions [3]. Therefore, the concept of developing a GIS for cultural tourism in Hua Hin District, Prachuap Khiri Khan Province was conceived to display such information to tourists by collecting the data via fieldwork. Tourists can view information through the system and on their smartphones. In addition, the system can also store information in the cultural tourism database of Hua Hin District in Prachuap Khiri Khan Province. It enables both Thai and foreign tourists who are unfamiliar with the places in Prachuap Khiri Khan Province to use the GIS system developed by the researchers. The system will help tourists better reach various attractions and cultural sites in Prachuap Khiri Khan Province, providing coordinates, duration, and information on nearby places to facilitate trip planning. It also helps increase income flow in the community, allowing residents to improve their quality of life and boost household income. In this research, the objectives are as follows: i) to develop a GIS for marine ecotourism and rural lifestyle in Prachuap Khiri Khan Province and to study and discover the efficiency of developing a GIS for marine ecotourism and rural lifestyles in Prachuap Khiri Khan Province; ii) to study and discover the efficiency of developing a GIS for marine ecotourism and rural lifestyles in Prachuap Khiri Khan Province; and iii) to study the efficiency of retrieval using the classification (precision and recall) model.

2. BACKGROUND

In this section, the researcher has conducted a study and review of related research, categorized into three topics: i) area study a topic that presents details of the areas to be studied, ii) related theories a topic that presents the theories relevant to this research study, and iii) related research a topic that presents previous research relevant to this study. The details are as subsection below.

2.1. Area study

This research determined a data collection area and developed a GIS for marine ecotourism and rural lifestyles in Prachuap Khiri Khan Province, focusing on the marine and coastal tourist attractions and communities. Prachuap Khiri Khan Province is one of 25 provinces in the central region of Thailand. It is a medium-sized province covering approximately 6,367.62 square kilometers or 3,979,762.50 rai. The length of the province from north to south is approximately 212 kilometers. The narrowest area is in Khlong Wan Subdistrict, Mueang Prachuap Khiri Khan District, spanning about 12 kilometers from the Gulf of Thailand to the Thai–Myanmar border. In the west of Prachuap Khiri Khan Province lies the Tenasserim Mountain Range, forming the border between Thailand and Myanmar, sloping towards the Gulf of Thailand on the eastern side. Mountains are prevalent throughout both the central and coastal areas of the province, with significant ranges including the Sam Roi Yot Mountain Range. The average height of the western mountain range is about 750 meters above sea level, with the maximum at 1,215 meters and the minimum at 306 meters. The average elevation above sea level on the east coast ranges from 1 to 5 meters. These steep slopes contribute to the formation of creeks that flow into canals and rivers, including the Pranburi River, Kuiburi River, Khlong Bang Saphan, Khlong Bang Nangrom, and Khlong Krut, and into the Gulf of Thailand near the coast, which is dotted with 21 islands as shown in Figure 1. The geographic diversity of Prachuap Khiri Khan Province has led to the development of numerous tourist attractions, making it popular among both Thais and foreigners [2].

Figure 1. Map of Prachuap Khiri Khan Province [4]

2.2. Related theories

Parkkaman [3] stated that GIS is the process of working with computerized spatial data by defining descriptive data or attribute data. It covers information such as addresses and house numbers that are related to spatial locations such as house positions, roads, and rivers in the form of data tables and databases. Wei [5] defined the GIS in "Research on the application of GIS in tourism management" as an emerging science that combines geographic information and computers with science, mathematics, statistics, management, surveying, and mapping into one. It uses spatial data to collect, input, manage, edit, retrieve, model, and display spatial data through computer hardware and software. The space model analysis method can support the presentation of a variety of spatial data and dynamic information [6] to support timely research and geographic judgment through computer technology. Data management, spatial analysis, multi-factor comprehensive analysis and dynamic tracking capabilities make the system even more powerful. It is also an effective decision-making tool and is widely used in land management, urban planning, disaster prevention and mitigation, real estate development, commercial and other areas. Qiao *et al.* [7] applied GIS in sustainable tourism development in China. Kang *et al.* [8] used GIS for visualizing spatial behavior of tourists. In addition, Nur *et al.* research [9] identified an enterprise architecture planning method for designing a cloud GIS framework. The framework they developed has proven successful in implementing cloud GIS technology in Indonesia. Similarly, Baigereyev *et al.* [10] proposed a mathematical model that emphasizes the importance of an efficient GIS for data analysis and interpretation.

Wu [11] stated that ArcGIS is a comprehensive platform for working with all forms of geospatial data across desktop, server, mobile, and cloud technologies. It can be applied to the government, private sector, and a wide range of industrial groups. ArcGIS can help organizations receive the right information at the right time with effective collaboration. ArcGIS provides geospatial data analytics that respond to enterprise processes by using tools to analyze and display insights from internal and external data. It can also publish results in the form of maps, applications, dashboards, and reports [12], [13]. Intarapadung [14] stated that a database is a large group of data that is collected somewhere. It is information that is interrelated and stored systematically. There is software to control the process of use, operation or processing. Users can use information more efficiently. Database management system is responsible for providing users with easy, convenient, and efficient access to information. It covers creating databases, editing databases or searching for information. It can reduce the collection of duplicate data and maintain the accuracy of the data within the database. His research used the XAMPP program as the development tool. It is a program to simulate a personal computer in the form of a WebServer, meaning the computer used will be both the host and the client at the same time. It does not require an Internet connection and allows users to test your website anywhere and at any time. Currently, it is popular among CMS users to create websites. The XAMPP

program has PHP as the language for developing web applications, MySQL as the database, and Apache as the web server. Perl has OpenSSL and phpMyAdmin, a database management system developed with PHP to connect to the database and support MySQL and SQLite databases. Black-box testing is testing that ignores the processes within a system or program. It focuses on the output from each module of a system or program to ensure that the system or software functions correctly as intended. The aim of black box testing is to test software performance and conditions [15], [16], verifying system behavior, software application behavior, basic software characteristics and suitability to user demands [17], [18].

The evaluation model is divided into 2 cases: regression and classification. Iban and Sekertekin [19] stated that for regression benchmarks, target data are scaled or numerical data that are both discrete and continuous and are based on error values [20]. For classification benchmarks, target data are categorical or binary, which includes confusion matrix, precision and recall, accuracy, F-measure, ROC graph and area under curve (AUC).

2.3. Related research

Singh and Annamalai [21] researched on the evaluation of the software development life cycle model with value of testing and quality control. They presented the key goal of the software development life cycle framework to reduce the likelihood of failure and disappointment while improving the quality of the software product. This study presented the concept of testing and its role in quality assurance, experimentation and testing levels including planning, conducting and observing testing. The software development life cycle model used in the presentation was the waterfall model, which had 7 steps: requirement, analysis, design, coding/implementation, testing, operation deployment, and maintenance, respectively. Liangpanit *et al.* [22] researched on development of online journal management system, Faculty of Science and Technology, Nakhon Ratchasima Rajabhat University. They conducted their research based on the software development life cycle in the adapted waterfall model for system development with the following steps: it started with requirements collection and analysis, system design, system development, system implementation, system testing, system deployment and maintenance. At each step, errors could be corrected or steps could be reversed. It was a solution to the problem of traditional waterfall work that could avoid mismatching customer needs and wasting time. Tarapitakwong [23] researched on the development of appropriate information format to enhance the sustainable tourism potential in Mae Wang District, Chiang Mai Province with the participation of the community members. The researcher applied the Software development life cycle in adapted waterfall model as an appropriate information development tool to increase the potential of sustainable tourism in Mae Wang District, Chiang Mai Province. Each step can be reversed to correct errors. The steps are as follows: i) planning, ii) system analysis and design, iii) information system development and user satisfaction survey.

Sadoun and Al-Bayari [24] mentioned the importance of GIS in their research on a GIS system for tourism management that GIS has a wide range of importance and capabilities such as connect, identify, select, analyze, query, and have visuals with hyperlink function between all features (such as tourist attractions and historical sites). GIS is a computer system that provides capabilities such as storing, organizing, and displaying geographic information, such as location-based information. In addition to the analytical and interactive capabilities of the software, it also has the ability to easily edit data and promptly and up-to-date notification of necessary changes on the website. Chang and Caneday [25] researched on the web-based GIS in tourism information search: perceptions, tasks, and trip attributes. The purpose of this study was to examine tourists' trip situations, tasks, and perceptions toward WebGIS. Surveys and electronic data were collected and multiple regression techniques were used to collect and analyze the data. The valid completed surveys were 155, the total possible sample size was 1,265 and the return rate was 12.25%. The results indicated that 'usefulness' and 'fun' were important factors that determined the level of usage and interaction. Users had different behavioral tendencies under different travel and task performance situations when searching for tourism information using WebGIS. Afnarius *et al.* [26] researched on developing web-based and mobile-based GIS for places of worship information to support halal tourism: a case study in Bukittinggi, Indonesia. This research was to develop a web-based and mobile GIS for place of worship information (GPWI) to facilitate Muslim tourists to find mosques and other tourism facilities. The development of GPWI was based on the waterfall model. The GPWI system allowed tourists to search for a given mosque by showing the location, information, local routes and transport to the mosque, as well as other tourist objects and facilities surrounding the searched mosque. The GPWI system used free open-source software (FOSS) PostgreSQL/PostGIS, PHP, JavaScript, and Basic4Android and the spatial-based database. The system was tested using black-box testing. In the final stage, the test results showed that GPWI responds to Muslim tourists, especially facilitating Muslim tourists in finding mosques. In this regard, future research is recommended to develop a GIS for halal food and a GIS for destinations in Bukittinggi, Indonesia.

3. METHOD

The researcher used system development life cycle (SDLC) as shown in Figure 2. [21] as a research tool for this study. It was the concept of the process of developing software systems or programs. It was also a continuous process with many steps from the beginning of the development idea to the end of the development process until the developed system is put into use [27]. Adapted waterfall model was used as a system development concept, with the work steps delineated as follows:

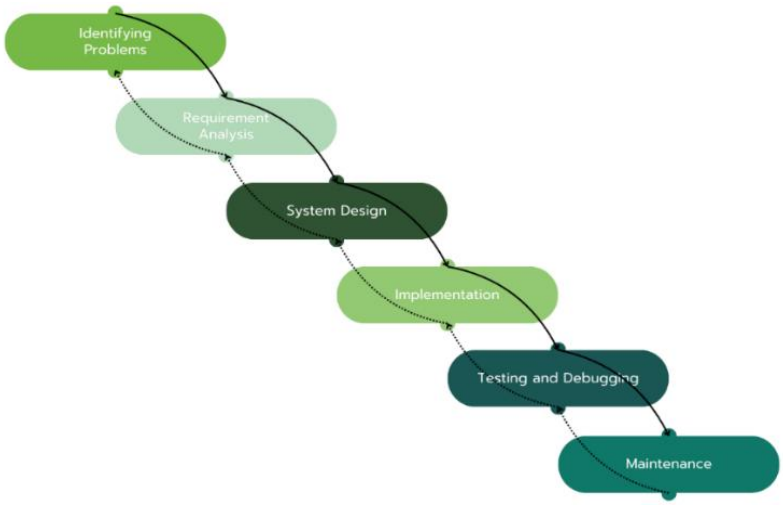


Figure 2. Adapted waterfall model

3.1. Identifying problems

The researcher has provided information to identify the research problem in the introduction and background sections. You may refer to these sections for further details. This will help enhance your understanding of the process of identifying the research problem.

3.2. Requirement analysis

GIS for cultural tourism of Hua Hin District, Prachuap Khiri Khan Province and notifications on smartphones can be described as follows:

- Admin section as follows: i) able to log in and log out ii), able to manage press release information, iii) able to retrieve information, iv) able to manage system user information, and v) able to manage general information.
- Member section as follows: i) able to log in and log out, ii) able to manage travel information, iii) able to manage press release information, and iv) able to view information.
- General user section as follows: i) able to visit and use the website and ii) able to view news.

3.3. System design

Architectural design: GIS for marine ecotourism and rural lifestyle in Prachuap Khiri Khan Province is shown in Figure 3 architecture of system and Figure 4 E-R diagram. From Figure 3, the system architecture is outlined, starting with the developer who develops the system and then grants login rights to both Admin and User. The Admin's duties include inputting all relevant research data into the program, managing various data, and using ArcGIS technology to manage, analyze, and present geographic data or data with specific locations to determine various travel route information. The data is then stored in the SQL database for important general information about the location, while the spatial database is used to store and manage data related to geographic location and spatial characteristics. Spatial data includes information with geographic attributes such as GPS coordinates and various routes. As for the User, tourists can access the system via PC, laptop, and mobile phone to search for tourist routes, accommodations, restaurants, and more. From Figure 4, the E-R diagram of the system is shown. The system includes various databases, such as the Admin database, User database, User_Type database, News database, Tour database, Tour_Type database, and AC-Tour database, which are utilized in the system.

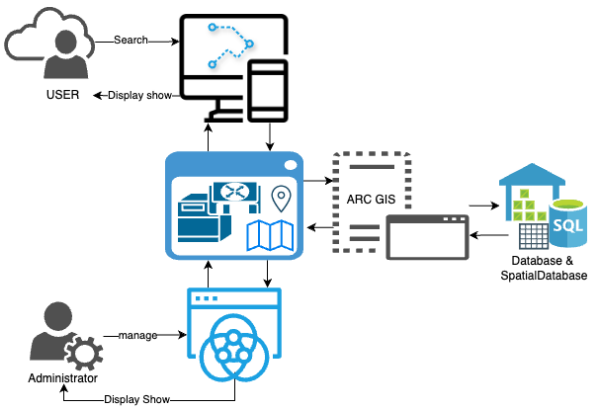


Figure 3. Architecture of system

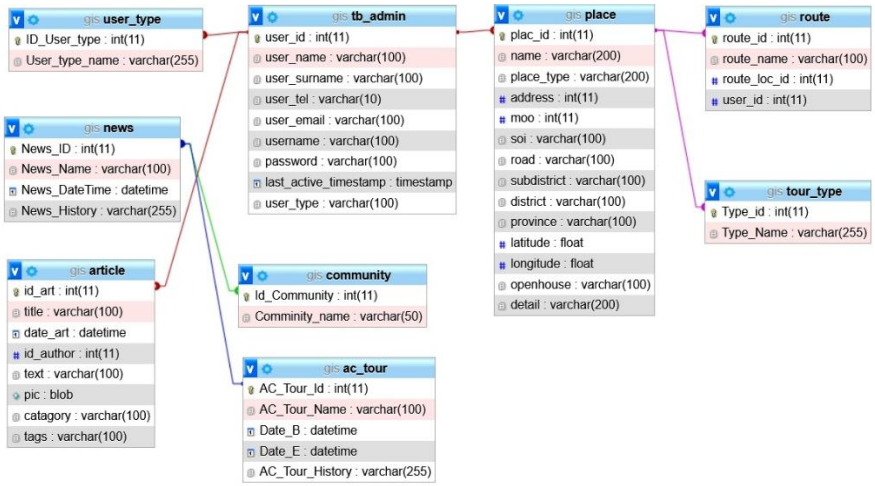


Figure 4. E-R diagram of system

3.4. Implementation

The ArcGIS program is a set of GIS applications that manage geospatial data to meet the needs of various agencies, both public and private, and educational institutions. It is produced and distributed by ESRI Inc., a web development company with the ArcGIS Web app builder [28]. It is a tool that can use data to create responsive web applications, Odiljon [29] using the ArcToolboxSpatial in ArcGIS program to analyze ToolExtractionExtract by mask. The ArcGIS program helps in preparing a spatial database of community tourist attractions obtained from field data collection in the form of digital map data (digital map) as well as creating an attribute database and analyzing the shortest route using the ArcGIS desktop 10-word set program. It can function as network analyst extension according to community tourism routes prepared. XAMPP is an Apache Web Server for simulating a web server to test scripts or websites without connecting to the internet. It is easy to install and comes with PHP, a language for developing web applications, and MySQL for developing databases. Apache will act as the web and server. phpMyAdmin uses a database administration system developed by PHP to connect to and support MySQL databases as shown in Figure 5.

3.5. Testing and debugging

Testing and debugging can be divided into 2 parts:

i) The system was tested by black box testing to test the website components to cover the system requirements by 5 experts in information technology and geographic information technology by entering tourist attraction search terms into the search and processing function. The results show that the results are correct according to the search terms and functions specified in the system requirements and according to the diagrams designed along with the responses to the system performance evaluation questionnaire [30]. Statistics used in the research include percentage, mean, standard deviation and

comparison of statistical values (dependent t-test). The results were compared with the evaluation criteria as follows [31].

ii) The results of the test measured the retrieval efficiency by entering search terms for tourist attractions into the search function revealed that the results were correct according to the search term. The concept used in this research was to measure efficiency by calculating the F-measure value, which could be calculated as the equations of precision and recall [32].

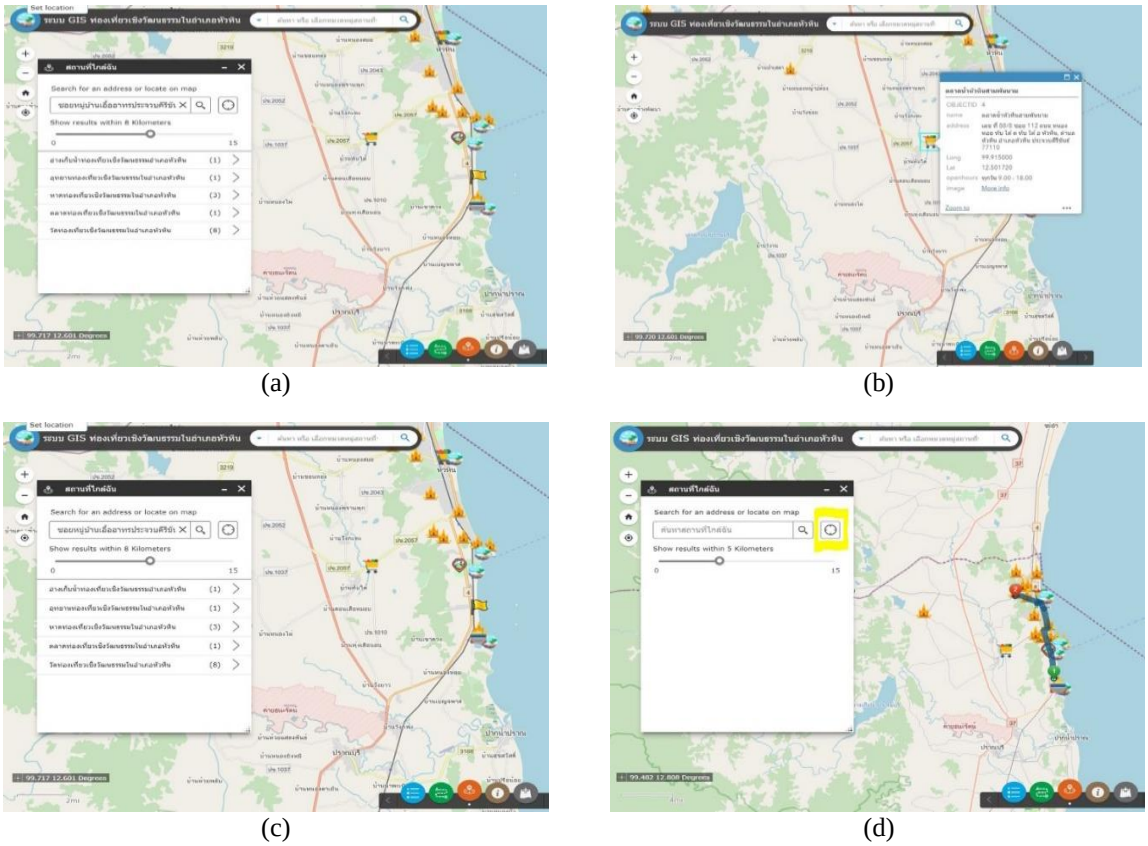
3.6. Maintenance

It was installed and maintained for improvement based on recommendations from expert evaluations and feedback from users, and was immediately implemented in accordance with the system development process [33]. This ensured the system operated efficiently after the maintenance was completed.

4. RESULTS AND DISCUSSION

4.1. The results of the system development

Figure 5 shows the results of developing a GIS for marine ecotourism and rural lifestyle in Prachuap Khiri Khan Province. Figure 5(a) illustrates the system's location search functionality. Figure 5(b) displays location information and other data to support travel decision-making. Figure 5(c) shows nearby places to assist with additional travel decisions. Figure 5(d) provides travel information for the places selected by the user. Additionally, Figure 5(d) shows route information.



(a) (b) (c) (d)

Figure 5. Examples of systems that have been developed: (a) location search, (b) show location information, (c) show nearby places, and (d) show travel information

Table 1 shows the distances between community tourist attractions on each route, as obtained from network analysis. This table provides routes generated by the GIS system for traveling from one starting point to another destination. For example, if the current location is Hua Hin Beach and the destination is Khao Takiab Beach, the system calculates the distance as 7.5 kilometers. Other routes are detailed in the table.

Table 1. Distances between community tourist attractions on each route obtained from network analysis

	Travel route		Distance (km.)
Coastal nature route	Hua Hin Beach	Khao Takiab Beach	7.5
	Khao Takiab Beach	Suan Son Patipat Beach	5.3
	Suan Son Patipat Beach	Prankhiri Beach/Pak Nam Pranburi	13
	Prankhiri Beach/Pak Nam Pranburi	Pranburi Beach	9.6
	Pranburi Beach	Noi	75
	Noi Bay	Manao Bay	85
	Total		**195.4**
Community product route	Hua Hin Beach Community Product Distribution Center	Ban Khao Tao Handicraft Center	13.3
	Ban Khao Tao Handicraft Center	Khao Tao Beach Community Product Distribution Center/Tham Khao Tao Temple	1
	Khao Tao Beach Community Product Distribution Center/Tham Khao Tao Temple	Hua Hin Beach Community Product Distribution Center	13
	Total		**27.3**
Nature conservation route	Sirindhorn International Park	Bo Kaeo Mangrove Forest Park	35
	Bo Kaeo Mangrove Forest Park	Pranburi Mangrove Forest Park	0.6
	Pranburi Mangrove Forest Park	Sirindhorn International Park	8.3
	Total		**43.9**
Community tourism route	Khao Takiab Community	Ban Khao Tao Community	13
	Ban Khao Tao Community	Ban Hua Tan Thaeo Community	34
	Ban Hua Tan Thaeo Community	Nom Sao Island	4.5
	Nom Sao Island	Ban Thung Pradu Community	104.5
	Total		**156**

4.2. System performance evaluation results

The efficiency of the GIS from images of the work was collected into the cultural tourism database of Hua Hin District, Prachuap Khiri Khan Province by 5 experts in information technology and 3 experts in geographic information technology in a total of 8 experts as shown in Table 2. The results of evaluating the performance of GIS for marine ecotourism and rural lifestyles in Prachuap Khiri Khan Province by 8 experts can be divided into 4 areas as follows: i) the capability and display of the system was at the highest level ($\bar{X}$ = 4.51, S.D.=0.44), ii) search accuracy was at the highest level ($\bar{X}$=4.60, S.D.=0.55), iii) system usage was at a high level ($\bar{X}$=4.40, S.D.=0.54) and, iv) safety in using the system was at the highest level ($\bar{X}$=4.65, S.D.=0.45), as shown in Table 2. The results show that the efficiency of the system is generally very good, including aspects such as data display, accuracy in searching for system data, and security in accessing system data. Only the usability of the system is rated at an exceptionally high level. The overall evaluation by experts indicates that the system operates at a very high level of efficiency. This GIS system can be used for trip planning. For example, if you want to visit nine temples for merit-making, the system will provide data on the culture of each temple and display information on nearby temples, allowing you to plan your visit efficiently. This saves travel time and best meets the needs of tourists.

Table 2. Summary of system performance evaluation results from experts

Evaluation	Mean ($\bar{x}$)	S.D.	Performance evaluation level
1. System capabilities and display	4.51	0.44	Highest
2. Accuracy in searching	4.60	0.55	Highest
3. System usage	4.40	0.54	High
4. Safety of using the system	4.65	0.45	Highest
Total	**4.54**	**0.50**	Highest

4.3. Results of retrieval efficiency using the classification (precision and recall) model

The concept of this research was measuring efficiency by calculating the F-measure value according to the equations of precision and recall in evaluating tourism information search. The accuracy and recall values were determined by 5 competency questions that are relevant to all data. There were references from user information and questions to be used in searching for information. Examples of evaluation results are as shown in Table 3.

In addition to location information, the system also includes details about hotels, restaurants, and fuel. In addition, the system also studies the retrieval efficiency using the classification (precision and recall) model. The retrieval efficiency test revealed that the precision=0.90 and the recall=0.95, as shown in Table 3.

The results indicate the accuracy and recall of the system. The system demonstrates very high accuracy and very high recall of data. The test involves searching for places to visit and comparing tourist attraction information obtained from the developed GIS system with the actual location data of Prachuap Khiri Khan Province to verify the system's correctness. The results show that the system is highly efficient and can be effectively used in Prachuap Khiri Khan Province.

Table 3. Summary of system performance evaluation results from experts

Search	Related answers	Retrievable	TP	FP	FN	Precision	Recall
1. Tourist attractions in the community	6	6	6	0	0	1.00	1.00
2. What are the tourist attractions in the community in Hua Hin District?	3	4	3	1	0	0.75	1.00
3. Where are the shopping places for community products in Prachuap Khiri Khan Province?	5	5	5	0	0	1.00	1.00
4. Where are the routes for visiting seaside temples in Prachuap Khiri Khan Province?	9	12	9	3	1	0.75	0.90
5. Natural tourist attractions in Prachuap Khiri Khan Province	5	6	5	0	1	1.00	0.83
		Overview of precision and recall				0.90	0.95

GIS for marine ecotourism and rural lifestyle in Prachuap Khiri Khan Province applied with system development life cycle: SDLC as the system development tool. It was consistent with Ismail *et al.* [34] who researched on GIS and mapping mobile application for local food finder in Shah Alam, Selangor which could develop an application system on communication tools to find local food for tourists in Shah Alam, Selangor, Malaysia. In this regard, the system used ArcGIS technology for development, which is suitable for analyzing spatial data that responds to the search for tourist attractions. It was consistent with Irwansyah *et al.* [28] who researched on analysis of service areas using public transportation for tourist destinations in Jakarta using ArcGIS technology by ArcGIS technology for network analysis with service area and location-allocation analysis. The system performance was at the highest level because the system has user-friendly design and layout elements that are beautiful, modern, and attractive, as well as handle data well. It was consistent with Jantakat *et al*. [35] who researched on web information system for promoting cultural tourism in The Old Moat of Nakhonratchasima City Municipality [35]. It can be concluded that this research is consistent with the studies mentioned above but is more notable because it integrates the advantages of all these studies. Research [34] focused on GIS, research [28] examined traffic routes, and research [35] addressed GIS related to temple tourist attractions. However, this research has consolidated all the information into a single developed GIS system. This system includes tourist attractions from various communities in Prachuap Khiri Khan, tourist routes, a tourist route planning system, and information on restaurants, hotels, and gas stations to provide greater convenience. Another highlight in Prachuap Khiri Khan Province is that this GIS system, which recommends tourist attractions in this format, has never been implemented before in the province.

5. CONCLUSION

The research concluded that the GIS for marine ecotourism and rural lifestyle in Prachuap Khiri Khan, which was developed, demonstrated overall system efficiency according to expert evaluations in all four areas of testing. It was found that the developed system achieved a very good level of overall efficiency. The system's accuracy and data retrieval were also tested and found to be highly efficient. This makes the developed system a valuable source of information for tourists. It will assist both Thai and foreign tourists in planning their travels, as the system calculates distances and travel times to facilitate visits to attractions of interest. Additionally, the system will include information on the local culture of Prachuap Khiri Khan, making it easier for tourists interested in exploring different cultures. The developed system can be used appropriately in accordance with the application of GIS theory. Beyond benefiting tourists, the system is expected to increase income within the community. Previously, tourists would only visit major attractions in the province. However, with this system, tourists will access more community information and plan their visits more effectively, resulting in increased income circulating within the community. Future research should apply the developed GIS system to other provinces to help tourists access tourist attractions in those areas and design their own travel itineraries. Additionally, future research should expand the system to support more languages, such as Chinese, Japanese, French, Indonesian, and others.

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AUTHOR CONTRIBUTIONS STATEMENT

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Sompond Puengsom	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Jakkapong Polpong	✓	✓		✓		✓						✓	✓	
Phisit Pornpongtechavanich	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

This research involved the development of a system and testing and installation that does not involve human research.

DATA AVAILABILITY

- Derived data supporting the findings of this study are available from the corresponding author S. Puengsom on request.
- The authors confirm that the data supporting the findings of this study are available within the article.
- The data that support the findings of this study are available from the corresponding author, S. Puengsom and P. Pornpongtechavanich, upon reasonable request.

REFERENCES

[1] P. Pornpongtechavanich, and P. Wannapiroon, "Intelligent interactive learning platform for seamless learning ecosystem to enhance digital citizenship's lifelong learning," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 16, no. 14, pp. 232-248, 2021, doi: 10.3991/ijet.v16i14.22675

[2] Prachuap Khiri Khan Provincial Statistical Office, *Prachuap Khiri Khan Provincial Statistical Report: 2019*, pchkkhan, 2023, https://pchkkhan.nso.go.th/central-data-set/travel.html.

[3] N. Parkkaman, "Geographic information system to suggest cultural tourism route development on the basis of case study participation, Khlong Hae Sub-district, Hat Yai District, Songkhla Province," *Parichart Journal*, vol. 36, no. 4, pp. 125–141, 2023, doi: 10.55164/pactj.v36i4.264176.

[4] Bangkoksite, *Map of Prachuap Khiri Khan Province*, Bangkoksite, 2002, https://www.bangkoksite.com/Prachuap/PKKMap1.htm.

[5] W. Wei, "Research on the application of geographic information system in tourism management," *Procedia Environmental Sciences*, vol. 12, part b, pp. 1104-1109, 2012, doi: 10.1016/j.proenv.2012.01.394.

[6] W. H. Nur, Yuliana, Y. Susilowati, Y. Kumoro, and Yunarto, "Overview about GIS multi-criteria spatial analysis for micro hydropower plant site suitability in South Ogan Komering Ulu District, South Sumatera, Indonesia," *Bulletin of Electrical Engineering and Informatics*, vol. 10, no. 2, pp.1024-1034, 2021, doi: 10.11591/eei.v10i2.2770

[7] L. Qiao, Y. Zhang, W. Zhang, D. Mao, and L. Yao, "Application of GIS technology in Chinese Tourism," *2009 International Conference on Environmental Science and Information Application Technology*, Wuhan, China, 2009, pp. 401-404, doi: 10.1109/ESIAT.2009.401.

[8] S. Kang, G. Lee, J. Kim, and D. Park, "Identifying the spatial structure of the tourist attraction system in South Korea using GIS and network analysis: an application of anchor-point theory," *Journal of Destination Marketing & Management*, vol 9, pp. 358-370, 2018, doi: 10.1016/j.jdmm.2018.04.001.
[9] W. H. Nur *et al.*, "A cloud GIS-based framework implementation in developing countries," *Bulletin of Electrical Engineering and Informatics*, vol. 11, no. 4, pp.2243-2252, 2022, doi: 10.11591/eei.v11i4.4195
[10] Z. Wang, X. Shen, H. Sun and Q. Wu, "A practical urban distribution network planning method with geographic information system," in *IEEE Transactions on Power Systems*, vol. 39, no. 6, pp. 7038-7049, Nov. 2024, doi: 10.1109/TPWRS.2024.3384534.
[11] Y. Wu, "Analysis of spatial distribution characteristics and influencing factors of rural tourism in Zhejiang Province based on ArcGIS," *2022 4th International Academic Exchange Conference on Science and Technology Innovation (IAECST)*, Guangzhou, China, 2022, pp. 886-890, doi: 10.1109/IAECST57965.2022.10062262.
[12] T. Rahayuningsih, E.K.S. H. Muntasib, and L. B. Prasetyo, "Nature based tourism resources assessment using geographic information system (GIS): case study in Bogor," *Procedia Environmental Sciences*, vol 33, pp. 365-375, 2016, doi: 10.1016/j.proenv.2016.03.087.
[13] E. Zhang, S. Peng and Z. Zhao, "Design and development of targeted poverty reduction geographic information system based on ArcGIS Engine," *2018 IEEE 9th International Conference on Software Engineering and Service Science (ICSESS)*, Beijing, China, 2018, pp. 203-206, doi: 10.1109/ICSESS.2018.8663881.
[14] A. Intarapadung, "Development of ceramic clay map web service in Thailand by applying GIS," *Rajamangala University of Technology Srivijaya Research Journal*, vol. 15, no. 1, pp. 152–164, 2023, https://li01.tci-thaijo.org/index.php/rmutsvrj/article/view/250049
[15] W. Yonwilad, P. Ruangtip, and K. Chinnasarn, "Development of Computerized Adaptive Testing Program for Massive Open Online Courses Based on Machine Learning Approch, " *Journal of Buddhist Anthropology*, vol. 6, no. 9, pp. 326–337, 2021, https://so04.tci-thaijo.org/index.php/JSBA/article/view/249916
[16] R. Arridha, N. Sakinah, and T. Magfirah, "Mobile application of searching and mapping temporary waste disposal site in Fakfak Regency," *Jurnal Mantik*, vol. 6, no. 2, pp. 2453-2462, 2022, doi: 10.35335/mantik.v6i2.2724.
[17] G. W. Sasmito, and M. Nishom, "Testing the population administration website application using the black box testing boundary value analysis method," *2020 IEEE Conference on Open Systems (ICOS)*, Kota Kinabalu, Malaysia, 2020, pp. 48-52, doi: 10.1109/ICOS50156.2020.9293645.
[18] S. Salahudin, H. Husaini, A. Anwar, and Z. Zulfan, "Web-GIS application of agricultural and food crop management," *Journal of Engineering and Scientific Research (JESR)*, vol. 2, no. 1, pp. 25–30, Jun, 2020, doi: 10.23960/jesr.v2i1.39
[19] M. C. Iban, and A. Sekertekin, "Machine learning based wildfire susceptibility mapping using remotely sensed fire data and GIS: a case study of Adana and Mersin provinces, Turkey," *Ecological Informatics*, vol 69, 2022, 101647, doi: 10.1016/j.ecoinf.2022.101647.
[20] Md. M.Rahman *et al.*,"A GIS framework to demarcate suitable lands for combine harvesters using satellite DEM and physical properties of soil," *Journal of Geovisualization and Spatial Analysis*, vol. 7, no. 27, pp. 1-18, 2023, doi: 10.1007/s41651-023-00156-y.
[21] V. Singh, and S. Annamalai, "Evaluation of the software development life cycle model with value of testing and quality control," *2022 International Interdisciplinary Humanitarian Conference for Sustainability (IIHC)*, Bengaluru, India, 2022, pp. 1374-1379, doi: 10.1109/IIHC55949.2022.10060574.
[22] S. Liangpanit, S. Wannasang, K. Puannguluam, K. Kulnawin, Y. Kan-ngan, and K. Kongsrima, "Development of Online Journal Management System, Faculty of Science and Technology, Nakhon Ratchasima Rajabhat University," *Srinakharinwirot Research and Development Journal of Humanities and Social Sciences*, vol. 15, no. 29, January-June, 1–14, 2023, https://so04.tci-thaijo.org/index.php/swurd/article/view/265916.
[23] J. Tarapitakwong, "The development of appropriate information format to enhance the sustainable tourism potential in Mae Wang District, Chiang Mai Provincewith the Participation of the Community Members", *Journal of Science and Technology*, vol. 7, no. 1, pp. 1–18, June, 2023, https://ph02.tci-thaijo.org/index.php/scibru/article/view/247839.
[24] B. Sadoun, and O. Al-Bayari, "A GIS system for tourism management," *2009 IEEE/ACS International Conference on Computer Systems and Applications*, Rabat, Morocco, 2009, pp. 226-232, doi: 10.1109/AICCSA.2009.5069329.
[25] G. Chang, and L. Caneday, "Web-based GIS in tourism information search: perceptions, tasks, and trip attributes," *Tourism Management*, vol. 32, no. 6, pp. 1435-1437, 2011, doi: 10.1016/j.tourman.2011.01.006.
[26] S. Afnarius, F. Akbar, and F. Yuliani, "Developing web-based and mobile-based GIS for places of worship information to support halal tourism: A Case Study in Bukittinggi, Indonesia," *ISPRS International Journal of Geo-Information*, vol. 9, no. 1, 52, 2020, doi: 10.3390/ijgi9010052.
[27] D. Galin, "From SDLC to agile – processes and quality assurance activities," *in Software Quality: Concepts and Practice*, pp.635-666, 2018, doi: 10.1002/9781119134527.app4.
[28] E. Irwansyah, F. J. Kautsar, R. Fawwaz, H. Lucky and S. Santy, "Analysis of service areas using public transportation for tourist destinations in Jakarta using ArcGIS technology," *2022 IEEE Creative Communication and Innovative Technology (ICCIT)*, Tangerang, Indonesia, 2022, pp. 1-5, doi: 10.1109/ICCIT55355.2022.10119131.
[29] T. Odiljon, "Methodology for assessing the tourist potential of the nature of the Fergana Valley using GIS technologies and experimental methods," Preprints 2022, 2022090181, doi: 10.20944/preprints202209.0181.v1
[30] R. Chopra, and S. Madan, "Reusing black box test paths for white box testing of websites," *2013 3rd IEEE International Advance Computing Conference (IACC)*, Ghaziabad, India, 2013, pp. 1345-1350, doi: 10.1109/IAdCC.2013.6514424.
[31] J. Saiysing, "The evaluation of the effectiveness of the educational personnel database storage system", *NEUARJ*, vol. 12, no. 1, pp. 1–15, Mar, 2022, https://ph02.tci-thaijo.org/index.php/itm-journal/article/view/241660/164655.
[32] A. B. Shams *et al.*, "Web search engine misinformation notifier extension (SEMiNExt): a machine learning based approach during COVID-19 pandemic," *Healthcare*, vol. 9, no. 156, pp. 1-14, 2021, doi: 10.3390/healthcare9020156.
[33] S. Gupta, and N. Gayathri, "Study of the software development life cycle and the function of testing," *2022 International Interdisciplinary Humanitarian Conference for Sustainability (IIHC)*, Bengaluru, India, 2022, pp. 1270-1275, doi: 10.1109/IIHC55949.2022.10060231.
[34] N. I. Ismail, N. M. Saraf, and A. R. A. Rasam, "GIS and mapping mobile application for local food finder in Shah Alam, Selangor," *2020 IEEE 10th International Conference on System Engineering and Technology (ICSET)*, Shah Alam, Malaysia, 2020, pp. 32-37, doi: 10.1109/ICSET51301.2020.9265397.
[35] Y. Jantakat, N. Chatpuak, P. Juntakut, and C. Jantakat, "Web information system for promoting cultural tourism in the old moat of Nakhonratchasima City Municipality," *International Journal of Building, Urban, Interior and Landscape Technology (BUILT)*, vol. 15, pp. 65–76, https://ph02.tci-thaijo.org/index.php/BUILT/article/view/240393.

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