THE CONCEPTUAL DESIGN AND APPLICATION OF WEB-BASED TOURISM DECISION SUPPORT SYSTEMS

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Abstract
Decision support system (DSS) can be defined as an interactive computer-based information system which is designed to support and give solutions to decision problems where there is a geographic or spatial component to the decision, with interactive capabilities to improve the understanding of the problem through the use of models and data processing. Web-based DSS is a system that links decision support information or tools to decision-makers through web environment or internet. The Web-based DSS have reduced technological barriers and made it easier and less costly to make decisions that relevant to information available which geographically distributed locations. The study of decision support systems is an applied discipline that uses knowledge and especially theory from other disciplines and one of them is tourism field. Tourism is the interrelated system that includes tourists and the associated services that are provided and utilized (facilities, attractions, transportation and accommodation) to aid in their movement. The paper aims is to discuss the conceptual design and application of web-based tourism decision support system (TDSS) of Langkawi Island.
Keywords: spatial decision support system (SDSS), tourism decision support system (TDSS), Web-based GIS, Langkawi.

1. INTRODUCTION

Decision support system (DSS) can be defined as an interactive computer-based information system which is designed to support and give solutions to decision problems where there is a geographic or spatial component to the decision, with interactive capabilities to improve the understanding of the problem through the use of models and data processing (Bhatt & Zaveri, 2002; Keenan, 2003; Lee &

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Huh, 2006). While many decision support systems have been used in managerial decision making, a major limitation of these systems has been their inability to exploit spatial and temporal data. Developments IT technologies such as GIS and associated technologies such as aerial and satellite remote sensing imagery, the Global Positioning System (GPS), are seen as the means of improving chances to exploit temporal and spatial data (Masron, et al., 2015a). The integration of GIS technologies and DSS has created a new type of DSS, known as the Spatial Decision Support System (SDSS). The idea of a SDSS evolved in the mid-1980s (Armstrong, et al., 1986), and by the end of the decade SDSS was included in an authoritative review of the GIS field (Densham, 1991). By the early 1990s, SDSS had achieved a recognized place in the GIS community and was acknowledged as a growth area in the application of GIS technology by Muller (1993).

The development information technology changes the world. The new information technologies (IT) known as spatial information technology, which the field obtains, manages and analyses data that have geographic, temporal, and spatial context. With the integration of decision support system, GIS and internet, new technologies known as Web-based DSS emerged. The Web-based DSS provides tools for persuasion that aid in negotiation and coordination across the organizational boundaries. Mahmassani and Chen (1993) investigated the reliability of information on prevailing trip times on the links of a network as a basis for route choice decisions by individual drivers. Ceder & Sarvi (2007) presented an analysis framework and formulation for designing and evaluating passenger ferry routes by using a methodology that combined the philosophy of mathematical programming approaches and decision-making techniques. Li & Ou (2011), design a prototype of web-based sea ice information system (WebSIIS), in order to allow easier visualization and visual analysis of the sea ice data from the CIS ice archive and also for the convenient sea ice data access in terms of data extraction, data packing and data downloading. Another prototype design by Rao, et al. (2006) which integrates a mapping component Automated Feature Information Retrieval System (AFIRS) and a modeling component Soil and Water Assessment Tool (SWAT), named CRP-DSS that use in resource management and assessment of environmental quality. The Web-based also use for public health care. In Zaria Metropolis, a web-based E-health system was designed and implemented in public health care system environment that could be used to locate the nearest hospital, specifying the service they rendered and aid in decision making by providing chances for the healthcare practitioners to gain access to information that can aid in the diagnosis of patient's health conditions or the development of suitable treatment plans (Abdullahi, et al., 2010).

Decision making and planning in tourism development is complex since it's involve various stakeholders, thus requires tools that aid in effective decision making to come to terms with the

competing economic, social, and environmental demands. Both tourism and IT increasingly deliver strategic opportunities and powerful tools for economic growth, redistribution of wealth and development of equity around the globe. Tourism industry depends heavily on information where customers want to acquire enough information about the tourism destination such as locations, accommodations, restaurants, routes, attractions and others before they planned and visit the trip. To get accurate information of the destination, integration between GIS and the internet can assist in describing and identify tourism infrastructure elements geometrically, thematically and topologically. The Langkawi Island Web GIS is a web site which provides tourism related information on Langkawi Island in a form of interactive map with Geographic Information System capabilities (Masron, et al., 2015b). In contrast with usual website, this website presents its information content by using maps more than a text description. The aim of this paper is to discuss further the conceptual design and application of Langkawi Island Web GIS.

2. WEB GIS TDSS

The rapid development of the Internet, it provided a new opportunity to redesign the architecture of information systems to satisfy increasing user requirements for accessing and processing real-time data, and there is now exists a new marketing potential for tourist regions. The growing use of GIS and Internet application increase the development of tourism decision support system (TDSS) that have been used to utilize tourism planning process and gain benefit from their accessibility, accuracy, visualization, data handling and sharing capabilities (Gobbetti & Leone 1996; Hanna & Millar 1997; Bahaire & Elliott-White 1999; Harrison, et al. 1999; McAdam 1999). Web-based information systems are convenient and cost-effective tools to promote the accessibility, efficient distribution, effective administration, and cross-platform flexibility of information. The Web GIS system offers different GIS services for analysis and visualization of geographical information on the Web (Kim & Kim, 2002). Web GIS is a special case of Web applications, meant to deal with complex geographic information data and share them across several users for different business goals. Geographical information data represents objects and actions where geographical location is indispensable information (Aronoff, 1989; Bull, 1994). Geographic information is usually distributed across different layers, which a Web GIS user should be able to handle separately or in overlay mode. The develop Web GIS, allows internet users to access GIS applications from their browsers without purchasing proprietary GIS software.

There is an increase in the number of web-based GIS applications over the recent years, which are develops to attract tourist to visit the tourism destination. Web-based Tourist Decision Support System

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(WTDSS) was developed to offer various tools to the travelling community or tourist visiting Agra City, also known as GeoReferenced Information System for Tourism (GeoRIST) (Singh, et al., 2011a; Singh, et al., 2011b). This system allows user to find routes in the city and query information on sights, accommodations and other place of interest nearby. The same function can be seen in the Henan Tourist WebGIS that are designed for tourism China. Henan Tourist WebGIS have two subsystems known as Province Subsystem and City Subsystem which the main function of Province Subsystem is to introduce the tourist to sights and traffic information of these sights, analyzing of tourist information such as income, visitor number, peak time and carrying capacity, while the other focuses on displaying the sights in the city and some other places for tourist such as restaurants, hotels, marketplaces and others (Wang & Li, 2005).

TrailFinder is GIS-based system that creates to assist Great Smoky Mountains National Park (GSMNP) visitors in choosing the trails that better match visitor preference and personal interests and give them a more satisfying experience during the visit (Dye & Shaw, 2007). GSMNP is known as a national treasure that filled with an abundance of ecological diversity, historical significance and recreational opportunities. Many tourist information systems serve only information for tourists and only a few that have a policy decision support system one of them are Tourism Knowledge System (TKS) that are built by the Korean ministry of culture and tourism (MCT) (Kim & Chae, 2004). This system consists of four major databases; tourism resources (tourist attraction), statistics, law and investments where aid user in getting on national tourism of Korea, also helping local government as a tourism information system. There is also WebGIS that integrates together with the 3D function to increase the quality of the interactive map display. Map2Day is a web-based 3D-GIS service that provides user interaction between 2D city maps, 3D visualization and query which is developed as a marketing tool for tourism targets for different categories entertainment, accommodation, culture, public institution and public health (Ulm, et al., 2005). There are also other additional function added such as area/distance measurement capabilities, support for 12 languages and individual interface appearance allow for different colour schemes.

Another popular tourism web-based is web-based tourist information system (WETIS) which offer detailed information for describing and advertising Eastern Slovakia region and contains historical, cultural, geographical, geological leisure, administrative and hospitality related information complete with photographs and object descriptions (Timčák, et al., 2009). *Facilities of the city of Chania* is a multilingual Information System created for the Municipality of Chania, which provide extensive information about the facilities offered by companies and organisations that belong to the private and public sector in the area of the city of Chania (Christodoulakis, et al., 1998). TIScover is the Austrian

tourism information system that able to use for navigation through a geographical hierarchy, representing various kinds of tourism information; use different search facilities; and even book tourism products online which can be accessed via the www, info kiosks at the holiday destination and cellular phones (Pröll, et al., 1998; Pröll & Retschitzegger, 2000). This application also aids tourist to get information on weather forecasts, avalanche conditions, and snow reports. Web based customized Tourism Information System (TIS) were developed for Eastern U.P., which built on a GIS platform to facilitate tourists, tourism department and other service providers to achieve comprehensive, precise, customized, updated and organized information in the form of maps, photographs, text, video clips with commentary for virtual sightseeing (Tyagi, 2014).

Zaozhuang Tourism Information System in China acts as tourism promoter and provides the tourist attractions information and tourism related transportation, shopping, accommodation and catering and other ancillary travel information to facilitate tourists in which to plan out their travel plans, travel arrangements for specific lines (Yan & Wang, 2012). ZoomAzores system is a Web GIS system developed at the Institute of Statistics and Information Management (ISEGI) and the School of Hospitality and Tourism Estoril (ESHTE) for the Association of the Azores Regional Tourism (ART) which uses dynamic maps and user-generated content features, which are focused on make available useful information for the tourist and the promotion of Nature and Adventure Tourism (NAT) in the archipelago of Azores (Calbet, 2011). The development of the ZoomAzores WebGIS is based on the use of Open Standards (OS) and Free Open Source Software (FOSS), allow creates a lower cost solution without licensing cost software. Other Web GIS that uses FOSS is Tourist Information System for Bhopal City (Nair & Katiyar, 2011). The system use Open Source GIS (OS GIS) software's to create a low cost GIS system and provide data such as tourist spots, hotels, travel hubs, emergency services, national highway, railways, main road and shopping markets.

There are also developments in both integrated and location-based trip planning tools and mobile information access. For example, Duran, et al., (2004) provided a conceptual model and technical on the uses of integrated web-based GIS system combining geographical data with tourism data for public and management usage, while Brisaboa et. al. (2003) has developed an interactive map with JavaApplet to access touristic and cultural information of Galicia, Spain. Explore Hyderabad is a Web-based GIS application that create to promote the Hyderabad city's tourist activities and also provide the users with an innovative way to access the spatial content of the city (Mir Mahammed, 2006).

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3. LANGKAWI WEBGIS TDSS CONCEPTUAL DESIGN

The web-based tourism decision support system (TDSS) has been built upon the almost same basic concept which provides detailed information on the tourist destinations. The information includes a description of the places, events and tourism related facilities. In order to develop and design the Langkawi Web GIS, 6 existing web-based tourism information system was used as references, namely, TIScover (Pröll & Retschitzegger, 2000), WETIS (Timčák, et al., 2009), Facilities of the City of Chania (Christodoulakis, et al., 1998), WTDSS or GeoRIST (Singh, et al., 2011a; Singh, et al., 2011b), WebGIS for Tourist of Bhopal (Nair & Katiyar, 2011) and Tourism SDSS for Yunnan area (Ma, et al., 2008). Generally, a WebGIS TDSS system will provide an interactive map that allows users to select layers, zoom in/out, query information on tourism related. Other than that the system also aids the users in navigating the place and helps them find the best routes in the tourist destination. User can also use the function which helps them to find specific objects within a specified distance. For example, this function helps tourists to find tourism facilities around the designated area. To fulfil all the function listed above, the spatial data of all the information needed in the system need to be prepared and collected before developing the web-based system. Even though the system can be accessed by outside users, it does not allow user inserting or editing any data. This privilege only given to the administrator and registered user where they were allowed to add or update the data, but it will not show until after the data verified by higher level users who are authorized to validate the data. This mechanism is to maintain the quality and validity of the data displayed on the Web GIS map. Table 1 shows the different between each system with Langkawi WebGIS.

TABLE 1 - DIFFERENT BETWEEN WEB GIS SYSTEMS

Function	TIScover	WETIS	WTDSS/ GeoRIST	Bhopal	Yunan	Langkawi
Serach Engine	/	/		/		/
Find routes	/	/	/		/	/
Search nearby			/		/	/
Online shopping/ booking	/					
Allow web user add data	/	/				/

Generally there are two phases in conceptual design of Web GIS system for Langkawi which are during the development of tourism database and Web GIS server (Figure 1). All data related to tourism in Langkawi were collected such as accommodations, restaurants, shopping/market centre, public facility and etc. Other than that, data such as road, river and land use also collected. The data collected will be prepared and import into tourism database created. The second phase is concerned with the delivering Web GIS application and function to a user or web client. There are Web GIS function, graphic function and map layer include. The function consists of find (favourite place, POI, hotels, facilities, and search

nearby); direction (routes); extras (Langkawi API); and tools (draw, edit and print). In the Web GIS, there are two types of layer map that user can choose which were satellite imagery and topographical map. Lastly, as for graphic function, there are zoom in/out, pan and navigation control.

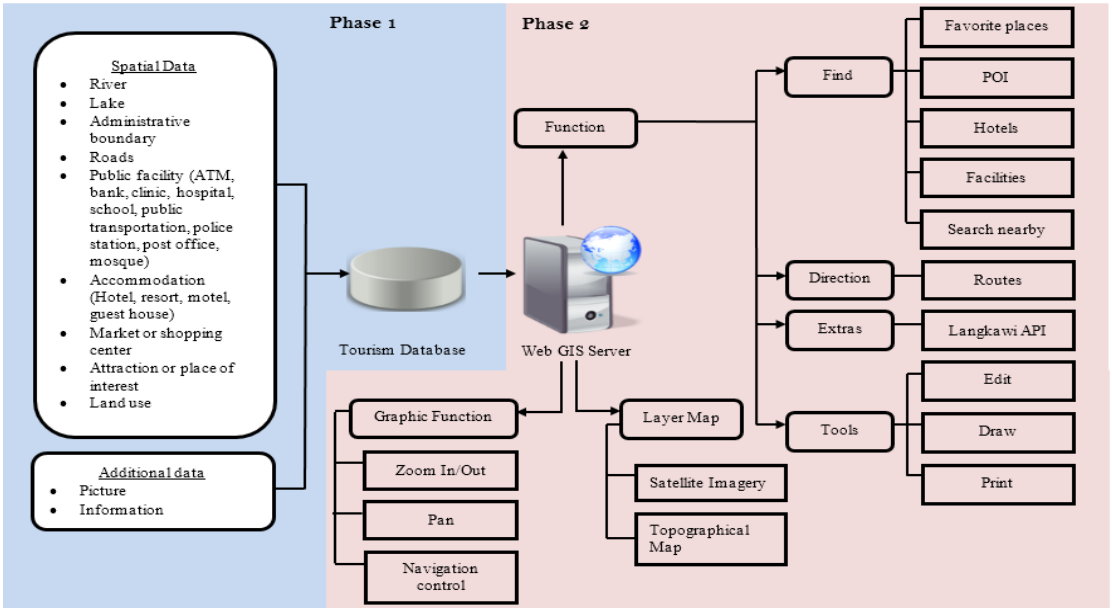

FIGURE 1 - CONCEPTUAL DESIGN OF WEB GIS LANGKAWI

FIGURE 2 - THE WEB-BASED TDSS OF LANGKAWI ISLAND

The Langkawi Web GIS system of Langkawi Island consists of the Web client, Web server, GIS server and tourism database (Figure 2). Other than that, the GIS desktop application also included in the system to perform advanced analysis that cannot be run via Web GIS which still connected to GIS server. The main access of the Web GIS TDSS of Langkawi is through user friendly graphical user interface with show large map of Langkawi as its default map with a list layer on the right side, menu bar at the top, navigation control on the top-left and zoom slider below the navigation control (Figure 3). All the data and information related to tourism in Langkawi Island that collected were stored in the tourism database.

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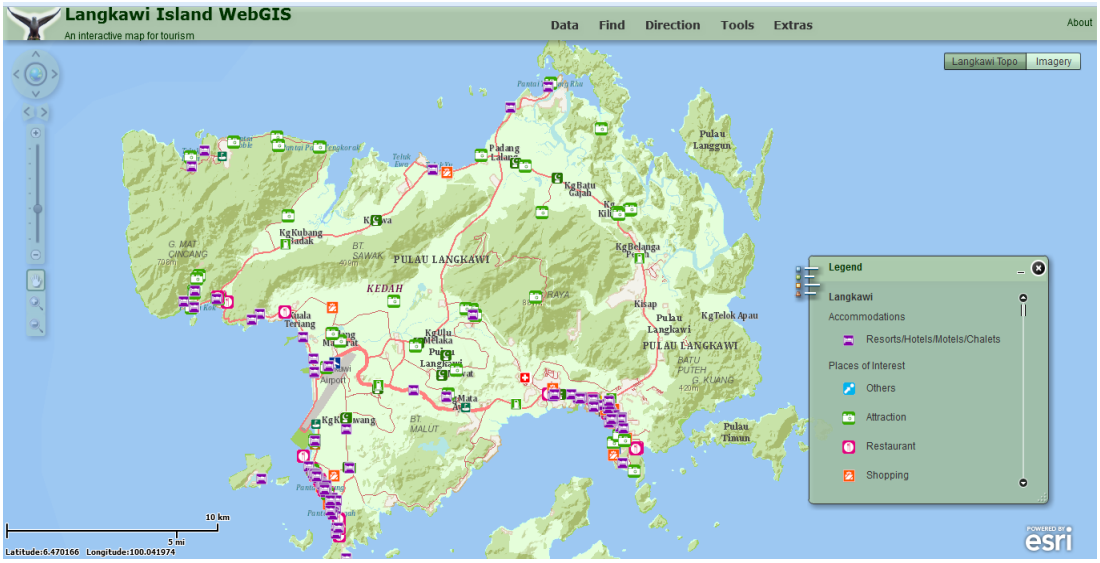

FIGURE 3 - GRAPHICAL USER INTERFACE OF WEB GIS TDSS LANGKAWI

The interconnections between all the components of the Web GIS TDSS were shown in Figure 4. The web client sends a request to the web server which then passes to the server. The GIS server retrieved the required data from the tourism database, perform the analysis or the map operation necessary, and later send the result back to the web server for display in a web document. When the web server received the data, it prepares the web document data and sends it back to the client. The client consists of three type clients known as a user, manager/publisher and administrator. Table 2 shows a further role play of each type of clients exists in this system. The function listed in the Langkawi Web GIS can be found under the bar menu which are; data (layer list, legend); find (favourite places, POI, hotels, facilities and search nearby); direction (routes); tools (edit, draw and print); and lastly extra (Langkawi API).

TABLE 2 - TYPES OF WEB CLIENT.

No	Client types	Role
1	User	The User role type is restricted from accessing ArcGIS Server administrative components and functions. Members of a role with the role type set to User cannot access ArcGIS Server Manager or the Administrator Directory. They can only use or access a service, provided that permission has been granted to their user accounts to access it.
2	Publisher/ Manager	The Publisher role type is given limited access to ArcGIS Server administrative components and functions. Members of a role with the role type set to Publisher can log in to ArcGIS Server Manager and the Administrator Directory with access to only the service and log management features. They can publish new services, manage existing services, and generate maps caches. They cannot configure or change ArcGIS Server security options, but can manage permissions for services.
3	Administrator	The Administrator role type is given unrestricted access to ArcGIS Server administrative components and functions. Members of a role with the role type set to Administrator can log into ArcGIS Server Manager, the Services Directory, and the Administrator Directory with access to all features and functionality. They can add or remove machines from the site, configure security, and so forth.

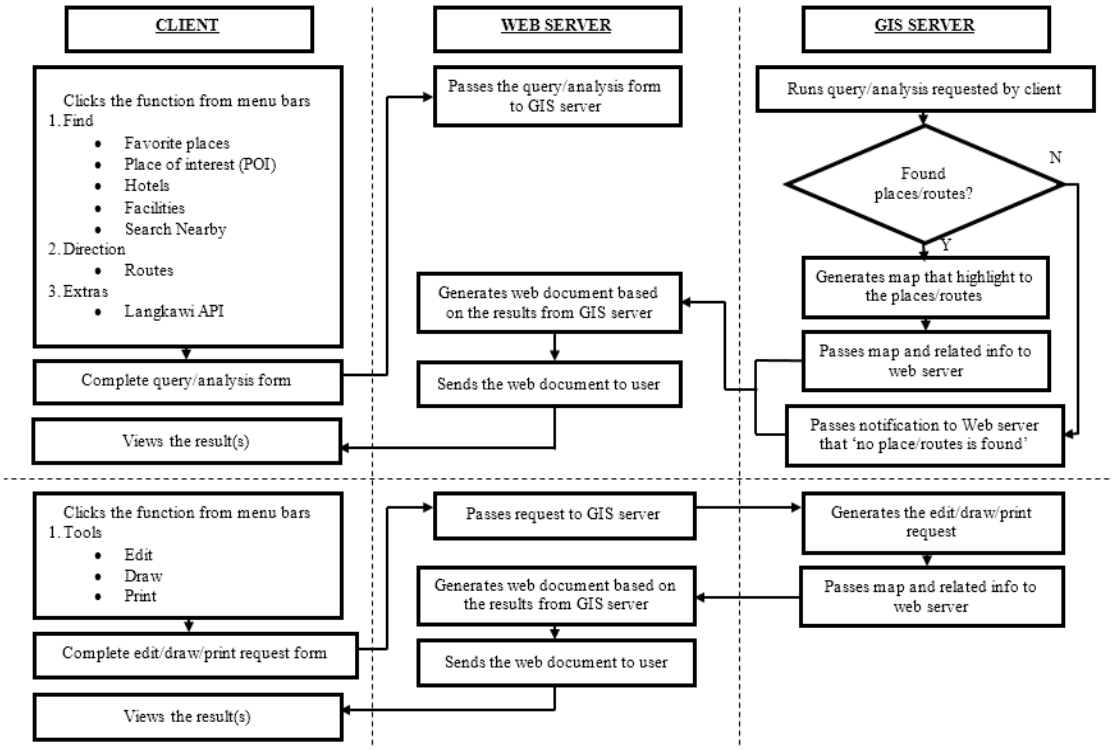

FIGURE 4 - WORKFLOW OF WEB GIS TDSS FUNCTION

The Langkawi Web GIS demonstrates the power of integrating SDSS with GIS for a tourism application. With the help of this system, it can aid the tourist to plan their trip easier since there are many tourist attractions that awaiting for them to explore and experience. The basic idea of the Web GIS for Langkawi Island is to provide comprehensive tourism related information, so that users can easily obtain adequate information and become attracted to visit the island. In a Langkawi Island Web GIS, a map is no longer a static image. A visitor of the Langkawi Island Web GIS can zoom in or out the map and pan the map (or, scroll the map) to view a location. Accommodations, sightseeing attractions, shops, restaurants, and public facilities are shown as different symbols which can be clicked to view their related information. Since the web site has GIS capabilities, visitors can do a number of GIS operation on the map, which are not possible with ordinary websites. For example, a visitor can search for an accommodation or sightseeing attractions based on keywords, or the visitor may find public facilities available within a given distance from his or her hotel. Another example of a useful GIS function provided by Web GIS is finding the shortest or quickest route from one location to other locations (up to 9 destinations). The Web GIS shows the best route on the map and detailed driving direction to travel along the route. The Langkawi Web GIS is not only useful for tourists or potential tourists. The web site also provides maps and data that can benefit researchers or other people. For example, the web visitor can activate land use layer to view the land use map of Langkawi. The Web GIS also has a time

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animation function which shows changes in map over time, such as the change in the Air Pollution Index. In summary, the Langkawi Island Web GIS gives a new way to present information on Langkawi Island.

4. CONCLUSIONS

Tourism is a highly complex activity, and thus requires tools that aid in effective decision making to come to terms with the competing economic, social, and environmental demands of sustainable development. Applications of GIS in tourism and recreation planning illustrate that GIS is a strong and effective tool that can aid in tourism planning and decision-making. The power of GIS lies not only in the ability to visualize spatial relationships, but also beyond the space to a holistic view of the world with its many interconnected components and complex relationships. With the integration of GIS and DSS, it can benefit the tourism industry especially retail businesses in Langkawi Island. The DSS demonstrates innovations in the information technology field that allow for a flexible and robust web-based decision support framework. The DSS removes desktop software dependencies, simplifies scenario testing, and provides a map interface. Decision making and planning in tourism development is complex since it's involve various stakeholders, thus requires tools that aid in effective decision making. Rapidly growing information technologies such as Geographic Information System (GIS) and Internet can also be utilized in tourism planning process to benefit from their accessibility, accuracy, visualization, data handling and sharing capabilities. With online interactive map that provide information on hotels, restaurants, shopping places, public facility and others tourist attraction in the island, it can help local retailer to reach potential customers. This system help customer to plan their trip or visit that meets their preferences.

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