

THE APPLICATION OF GIS TECHNOLOGY IN TOURISM

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***Abstract:** Geoinformatics, as a scientific discipline, was created as an expression of geographers' need as well as other experts in the science of space, to apply the achievements in information technology and information science in its geographical studies. GIS is used for the collection, storage, management, analysis and mapping of spatial data. This is an information system that builds its specificity on the fact that it manipulates spatial data. Geographic information systems have found their purpose in the field of tourism, too. Tourism has more increasingly expressed demands for new technologies in the management and control of tourist activities, as well as in the decision-making process. In the beginning, just a few of its basic functions were developed to meet the needs of tourists: selection of hotels and information on shopping centers near the hotel or interesting tourist attractions. However, with the development of the tourism industry, GIS soon finds its use, not only in the choice of location, but also in distribution, marketing, tourist analysis and traffic. Today, it is the most widely used in tourism planning, or in management of tourism resources. The emphasis in this paper is put on the use and importance of GIS technology in tourism.*

***Keywords:** application, geographic information system, tourism*

Introduction

GIS is “rationally organized set of computer hardware, software, geographic data and users, which is designed to enable efficient collection, storage, organization, manipulation, analysis and display of spatial geographic and all other information of interest to the user” (Đurđev, 2000). What distinguishes GIS from other information systems is that each data contained in the database has its own space representation. GIS displays data in a visual and simple form that is close to the user (Seferović, 2006).

GIS has enabled spatial data, which are presented in the form of specific thematic maps (in a GIS they are called layers), can intersect with each other (visual overlap). As a result, it is possible to implement a series of spatial analysis, based on which the connections and relationships between objects, phenomena and processes can be revealed although they have not hitherto been easily visible or visible at all with the simple observation systems and

mathematical and statistical analysis of alpha-numeric data. Visual performance of the mentioned objects, phenomena and processes in a GIS was presented with the system of points, lines and polygons (depending on whether they represent individual objects, line objects or surfaces). The corresponding database is connected to them and it describes and analyzes closely the given space study. The link between the database and digital map is interactive, which means that every change in the database is automatically reflected on the map, and vice versa. In the end, all obtained results can be easily and effectively visualized via new, synthetic and thematic maps (new layers).

The development of GIS can be seen through several phases (Pick, 2005) that are directly or indirectly related to the development of hardware and software support, but also to improvement of existing and development of new functions. Basic phases in the development of GIS can be viewed in four segments:

- emergence of GIS as a technique for monitoring the geographical phenomena and processes (a spatial information system that should allow for easier tracking of all changes within a state, in a certain activity was created for the first time mid 20th century);
- the creation of the GIS software packages and acceptance of GIS as a tool for effective monitoring of geographical phenomena and processes at the national level;
- intensive development of computer hardware and production of more sophisticated software packages in the seventies and eighties, which opens up new application possibilities for GIS – creates a more complex database, enhances the spatial analysis, introduces the modeling, visualization, simpler interfaces;
- introduction of GPS, Internet and mobile telephony in the nineties as a way of collecting data, distributing and displaying via new channels of communication (GIS applications became available as web services); the use of GIS in strategic decision-making processes as well as techniques which leads to significant knowledge about the spatial dimensions of these activities, which are becoming important for making informed decisions about reducing the potential risk.

From the initial simple technology for mapping phenomena and processes, GIS has very quickly become widely accepted and used tool in spatial analysis, ranging from navigation devices to complex trade area analysis and direct marketing. Thanks to GIS, a new way of interpreting spatial data was enabled, as well as discovering hidden connections, relationships, and trends in the observed geo-system. GIS has found wide application in cartography, especially in the process of digital thematic maps. At the same time, the function of GIS can be viewed in the context of decision-making, control and management in the business environment, as well as in e-government and development.

The application of GIS in tourism

Tourism uses GIS technology insufficiently to improve business operations, both in the tourist offer, and in the tourist demand. In his comprehensive review of GIS, Maguire (1991) mentions only one study, by Buffied and Coppock (1975), this describes the creation of a simple GIS (Tourism and Recreation Information Package - TRIP) for the three Scottish governmental institutions (Seferović and Stankov, 2009). The aim of this GIS was to assist in the planning of tourism policy. After this study, there is a gap of 20 years when it comes to studies that connect GIS and tourism. During the nineties, the situation begins to change, when there is a large number of studies dealing with the integration of GIS in the tourist industry. Mcadam (1999) devotes an entire study based on the premise that the GIS is used to a limited extent among those who are engaged in the planning of tourism, which the results of his research confirmed.

According to Farsari and Prastacos (2002), Beery used a sector of the Virgin Islands as an example of the use of GIS in spatial analysis in 1991. Using different models, he was able to define areas for conservation, research in the field of ecology, residential and recreational development, while one model was used to resolve conflicts among competitors (Damjanović, 2014). Based on the research of literature in the field of tourism, even in the nineties, Tremblay (2005) states that it is possible to find a large number of surveys and studies related to the potential and development of GIS applications for the purposes of tourism marketing, and IT applications related to mass tourism. However, Wei (2012) considers that the development of information technologies in the field of tourism lags behind the general level of tourism development (Damjanović, 2014). For now, most of the applications of GIS in tourism were related to the inventory of recreational capacities, the management of the use of space for tourism, visitor impact assessment, evaluation of conflicts between recreation-environment mapping, creation of tourist information management system and to help them make decisions, while the aspects for which the GIS was utilized to a very small extent, were related to the scheme of movement in the area, recreational habits, consumption levels of visiting individual attractions and their impact on the sustainability of tourism development.

The application of GIS on the side of the tourist offer

The success of tourism in any country depends on the ability of this country to successfully develop, manage and promote tourist resources and processes. A large number of information in the context of tourist activities can be placed in a variety of analog and digital formats. It often takes a long time to respond to any questions or requests of tourist demand. Therefore, it is necessary to use information systems able to answer questions related to tourist resources. GIS

provides such an opportunity, because it provides tourist information in an integrated way.

Within the tourist offer, in a broad sense, two basic levels of GIS application may differ. The first relates to the national authorities and organizations responsible for tourism, and the relevant ministries and tourist organizations. The second level relates to the tourist economy or individual economic entities within the tourist activity. In practice, the difference often can't be made between these two levels, because identical functions of GIS are often needed in the public and private sectors.

The census of tourist resources may include natural resources, tourist and other infrastructure, demographic data, information on sites of cultural heritage and more. Lists of tourist resources are carried out in order to manage tourism and tourist development that is in conflict or is not complementary to the use of land, available infrastructure and natural resources through which the capabilities and capacities are defined for a particular area. GIS in this case, can use its ability to integrate, store and manipulate different types of data, qualitative and quantitative, spatial and non spatial, as well as to visualize abovementioned information. Another dimension of the census is to provide information about tourist destinations on the Internet. Cartographic information for tourists, which cannot be found on the Web sites, may become a popular application of GIS. An increasing number of tourist destinations use this technology for the promotion via the Internet.

Tourism mostly uses GIS to determine the suitability of sites for tourism development. Conflict and complementary use of land, availability of infrastructure, and enabling or restricting natural resources are the basic geographic variables used to determine the potential and capacity of the city or area as a tourist destination (Seferović and Stankov, 2009). With the help of GIS, it is easier to define locations which are, according to accessibility, capacity and quality, possible locations for organizing tourist activities.

The determination of the location is a part of a broader process of tourism planning. Tourism planning requires the collection and processing of a large number of spatial data, as all locations and their relationships have to be defined and analyzed in accordance with the spatial context (Jovanović et al., 2012). Mejia et al. (2000) reported that GIS technology offer a number of advantages in the documentation of data and their processing to tourism planning, where we can count in the following: the possibility of thematic mapping in a quick and efficient manner, the production of maps of different scales according to the requirements of different users, easy and quick change of information on maps, presentation of the results in the cartographic, statistical and tabular form, dynamic troubleshooting, information can be easily integrated through the automatic relations between different databases that describe the same geographic area through various topics.

However, the use of GIS in tourism and its planning is still not enough. Cooperation between geographers, who deal with spatial planning, representatives of local government and public sector, to put it mildly, is weak. Therefore, the use of a modern tool, such as GIS in the process of management, planning and strategic decision-making, it becomes limited and insignificant.

Using GIS to manage visitor flows can be especially important in the process of planning routes. In Zimbabwe, for example, tourist authorities use ArcView network analysis to determine the best routes from major cities and hotels. Maps formed in this way are placed on the Web (Leipink and Mehta, 2005). In relation to the previous, Wu and Carson (2008) point out that GIS should be used in the analysis and visualization of the trips that include visiting various different destinations. They stress that the visit to multiple destinations include spatial aspect (destinations themselves) and the time aspect (the duration of the visit), and the type of transport between destinations and characteristics of supply and demand in all destinations. These variables can be effectively and efficiently analyzed using GIS.

Wei (2012), in the case of China, points out the fact that little attention is paid to the growing number of independent travelers who organize their activities solely based on their own knowledge and experience. As a reason for that, he mentions the lack of effective management of tourist information, that is – guidance service intended for independent travelers.

Van Riper et al. (2012) emphasize that for better understanding of the conditions that are constantly changing, we should use biophysical and economic values of nature in order to prioritize efforts put into spatial planning and management of human activities which is based on ecosystems. In addition, the same authors examined the importance of social values of services based on ecosystems and therefore they are carrying out research based on spatially defined ecological data with the aim to contribute to the decision making process in the context of a national park, and using mapping as a function of the GIS. Both Sherrouse and Semmens (2014) consider that with the increasing pressure on ecosystems-based services, social values (the values which the public associates with services based on ecosystems), which are attributed to them, are of increasing importance for the management and decision-making in terms of space/land. They find that these social values (in particular those based on the culture) are generally not taken into account in the assessment of ecosystems-based services as much as the economic and ecological values.

The role of GIS in tourism marketing

A large number of applications of GIS appear in the field of tourism marketing. Since the main role of GIS is spatial data management, it is clear that the implications of GIS in marketing precisely relate to the spatial aspect (Stankov, 2008). There are numerous connections between GIS and marketing, but basic features can be singled out: rich spatial insight into marketing data, a

greater potential for the visualization of marketing analysis, numerous data for spatial analysis of the importance for marketing and enriched communication capabilities of marketing reports and presentations (Miller, 2007).

Hsu and Powers (2001) state that GIS can have important application in marketing of the hospitality industry. These authors state that the GIS in this case, is commonly used for the evaluation of locations of certain facilities and identification of places that have the best profit potential. Hotels and resorts, golf courts, restaurant chains, pedestrian route, are examples that are suitable for the effective use of GIS. Location is very important in determining areas which are subject to fires, floods, landslides and so on. Physical and geographical factors may have an effect on the long-term value of investing in a particular area. Also, the location is important in relation to the main traffic and transport routes. GIS has a special value that combines meteorological and other information related to the natural and built environment.

Luberichs and Wachowiak (2010) based their study about segmentation of visitors to Majorca on the view that the geomarketing in tourism and benchmarking tool based on GIS are under-utilized, including the geographic market segmentation. They believe that the regions of visitors' origin usually taken as the only variable in the process, while they agree that other demographic data should be also taken into account. However, they dedicate their research, which was conducted by surveying foreign travelers that came to the destination, to the distribution and segmentation of tourists at the destination. Tourists' wishes and needs are of key importance and they cannot be inferred by merely collecting information about social and demographic characteristics or their behavior during the trip. Therefore, the survey included a variable of tourist expectations, and they conducted research according to predetermined areas in Mallorca. They conclude that, with the help of GIS and geospatial analysis, it is possible to identify areas for the analysis of the consumer, whose advantage lies in the fact that such a zone established according to consumers (instead automatically according to the accommodation capacity, physical characteristics and the like.) can meet the expectations of a heterogeneous group of tourists. These results could lead to using GIS not only in the management and planning of tourism at the destination, but also by using marketing activities directed towards such zones, the appropriate products could be offered to corresponding potential tourists which would lead to a reduction in marketing costs.

The application of GIS on the side of tourist demand

Traveling to foreign countries, meeting new locations, travel planning, determining optimal locations for a visit and accommodation, etc. impose the necessity of the usage of GIS by tourists. Time of GIS usage by the tourist demand is related to the period before and during the tourist trip. The main aspects of the GIS use by the tourist demand are related to: search of tourist

resources, assistance in making decisions about travel and facilitating mobility in transit and tourist destination.

Specific key advantages of GIS for tourists are: visualization of tourist destinations and places via maps, digital images and video contents, valuable information about tourist sites, selective information and special activities, such as route planning, accommodation information, cultural events, special attractions etc., easily accessible information via Web and interactive maps as a result of personal inquiry of tourists and others. (Jovanović et al., 2012).

The most common use of GIS on the side of tourist demand is linked to the Web GIS. One of the factors that contributes to the good positioning of tourist destinations is a quality web-site based on the application of GIS technology with a high degree of interactivity (Hadžić, 2007). Web GIS facilitates viewing map information through a Web browser for the viewers. Today, detailed maps are generated using database and published on the Web, which represents an efficient way of using data and the possibilities of GIS. GIS technology offers great opportunities for the development of modern tourist applications with the use of maps. This technology integrates different common operations within the database with inquiries, with the unique visualization and geographic analysis on the maps.

GIS enables geographic searches (a search of tourist resources) for stacked queries. For example, it is possible to search a combination of tourist attributes, such as type of object (eg. hotel, restaurant, event location, etc.), name of the object, hotel category, etc. in accordance with geographical criteria, such as proximity, distance, location (city or region) or in accordance with the objects located within a particular region on the map. Users need to define, upon inquiry, travel criteria and choose the area to search.

O'Loone (2004) believes that the innovative travel experience, one that uses new technology to improve knowledge management that the tourists need or want to achieve. Therefore, he proposes an innovative tourist product which has four elements:

1. ubiquity (possibility to obtain information via mobile devices belonging to any network);
2. being based on the location (the system's ability to provide information in connection with the exact location of tourists, and to change the given information while the tourist is travelling and thus changing their location)
3. enlightenment (the ability to increase the usual tourist experience with the help of "in-depth" queries in the search for information)
4. engagement (of many interested parties in the production of information).

The same author believes that although today there are numerous structured online tools that help tourists to get to basic information regarding a trip to a destination, there is little or no effective or innovative knowledge management for the purpose of increasing tourist experience.

Using GIS in the monitoring and analysis of indicators of sustainable tourism development

The complex structure of the tourism system imposes the need for a multidisciplinary approach in the planning process for sustainable tourism development. The issue of monitoring the impact of tourism, managing the movement of tourists, tourism marketing, participatory planning, management of cultural resources and the development of systems to support the decision-making process are the most current topics that occupy the attention of many tourism development planners at the destination. The use of GIS in planning of sustainable tourism development at the destination and in the process of implementation of plans requires the development of specific indicators which measure the degree of sustainable development of tourism at the destination, and their monitoring implies the use of numerous and diverse information.

A research conducted by Arnberger, Brandenburg and Muhar (2002) can be given as an example of how the use of GIS can be important (and to what extent) for various aspects of the planning, management and decision-making in sustainable tourism. It was conducted in New Zealand where the rapid increase in the number of visitors increased the concern about the increasing negative impact of tourism on national parks and other natural resources. Therefore, a survey was conducted regarding the exact location of movement of domestic and foreign visitors and establishing a connection between visits to different locations. So they created a very useful tool for planning at the national level of regional patterns of visits. In this way, it is possible to monitor the impacts of tourism on the environment on the different types of natural attractions, while for individual locations it is possible to develop key indicators of acceptable changes. Furthermore, the assumption of future modes of resource use is enabled in this way and negative impacts can be prevented. On one hand, the authors of this study emphasize the benefit of inclusion of survey data obtained at the local level and national data through GIS in which way they gain added value. On the other hand, the emphasis is on the use of new technologies, especially the use of GPS devices and questionnaires based on the Web on intelligent map-servers.

The role of GIS in protected areas

The development of information technology has received extraordinarily high importance in the field of biodiversity, as well as the establishment and management of protected areas. The use of GIS is vital in terms of documenting information and the development of the management model not only at the local level, but especially in large areas. Protection of natural resources has always benefited from the use of maps (for example a map of species distribution, of distribution of the reserve or a map of plant and animal communities). The importance of GIS lies in the fact that it can produce "one-off" maps that are used

for solving the current problem, as well as in having one map that is used to create another map which shows the interactivity of GIS.

When it comes to tourism in protected areas, the ability of GIS to store and use multi-layer data enables the connection of information about the suitability of habitat for some plant and animal species with data on recreational uses or spatial preferences. In this way it is possible to identify where these data layers overlap and what potential conflict areas are. GIS enables combining ecological and spatial knowledge with a preferred pattern of behavior of a specific market segment (Tremblay, 2005). Thus it is possible to reach the index of desirability of ecotourism in the tested area taking into account natural characteristics (forest cover, wildlife potential, the presence of water, etc.), accessibility (distance from road infrastructure), the density of attractions and other characteristics of the area.

In addition to demonstrations of GIS application for sustainable forms of tourism in protected areas, the research conducted by the Boers and Cottrell (2007) can be mentioned. The purpose of the study was to perform mapping (via GIS) of locations for a sustainable development of paths in the protected area by overlapping layers which show the possibility for visitors and the carrying capacity of the area, taking into account all the components and interconnections of the tourist system. Thus the framework for infrastructure planning for sustainable tourism was developed and which will be used to integrate the sets of sustainability criteria (development goals, the expectations of visitors, carrying capacity, impacts on resources) in the planning of infrastructure via GIS.

The role of GIS in the analysis and management of cultural and historical heritage

GIS has multiple roles in managing historical resources. Through more than two decades of work in archeology, GIS technology has shown to be a powerful thing in locating, interpretation and preservation of historical sites. RADARSAT, Landsat and images from the air over the vast regions were important for locating previously unknown temples, cities and fortifications. The findings of many sacred places in Angkor and China were only possible through the use of radar images, which can detect changes in topography, even in areas permanently covered by clouds (Minić, 2010).

These tests made a more detailed model of the past. The discovery of the ancient roads, canals and irrigation systems, using remote sensing data, we expanded our knowledge about the development of human settlements. With the increase in human activity in the once remote areas, the ability to find out more about these important historical sites is greater than in the past. Extensive information can help protect these important cultural and historical sites.

The temple can be photographed using laser technology able to detect even the details of the size of 0.2 mm. In combination with digital photography, it is possible to create a virtual copy of the entire building or location. GIS can be used by scientists, archaeologists, teachers and students around the world, in order to establish an information system that integrates texts, plans, maps, pictures, video and other multimedia content. Finally, this database can be used for virtual tourism, enabling anyone with Internet access, to explore, for example, a large temple complex. Virtual tourism is emerging and becoming significant in promoting and educating the public.

Problems in the use of GIS

Despite all the advantages and advanced features that the use of GIS has, as well as Web GIS in combination with all kinds of software with different functionalities and purposes, the use and application of GIS has its drawbacks. Among them, the following can be found primarily: a large amount of data input and processing; spatial relationships are significant but difficult to reach them, there is irrevocable uncertainty in the output data / products because of the proportions; it is difficult to make data sources compatible; it requires advanced mathematics; there are questions like quantity versus quality; a large number of targets that are difficult to achieve and so on. (Njeguš and Jovanović, 2008). Nevertheless, according to the same authors, there are procedures that, if we follow all the steps which they imply, these problems can be, if not eliminated or avoided, at least alleviated.

Another problem in the use of GIS can be the necessity for training and years of experience in working with it to be able to master all the functions it offers and exploit its full potential, and even increase the reliability of the output data and products. Tsou (2004) points out that before the appearance of Web GIS, the lack of training with complicated software installation as well as the high price of necessary software packages was the main reason why GIS was not used in its full power in dealing with protected areas.

Conclusion

So far, most of the applications of GIS in tourism were related to the inventory of recreational capacity, management of the use of space for tourism, visitor impact assessment, an assessment of the conflict between the recreation and the environment, mapping, creation of tourist information management systems and systems to help with decision-making. In tourism, the use of GIS is different on the side of the tourist offer and tourist demand. The side of the tourist offer mainly uses all of these aspects of the use of GIS. The side of the tourist demand is actually using GIS technology that is installed by the tourist offer. It can be concluded that the side of the tourist offer is the provider and at

the same time a user of GIS (bidirectional/two-way relationship), while tourist demand appears as one of the users (unidirectional/one-way relationship).

The increasing mobility of access to information and communication networks, primarily the Internet, includes a timely access to information, even in a situation when the tourists are not in front of the home computer, but on the road or at the destination. The possibilities of modern information technology are enormous and are steadily increasing. Global information networks and publicly accessible database inform tourists and they can choose the best service within their budget. This is a significant change of competitiveness between tourist services providers.

Tourist service providers that want to remain competitive and visible in the market must understand the characteristics of the new tourist environment, which started its transformation with the arrival of modern technologies. Modern information technologies have the ability to point out the services with the best quality and prices, but also to form their tastes and give priority to certain destinations, tourist services and their providers.

In many areas involving information technology, difficulties can be encountered and they are manifested in the absence of information or information overload, that is, the inability of the individual to process all available information and reach optimal choice. According to that, the market is forming new services and their providers, filtering and evaluating information for the needs of their clients, they take on the part of the decision-making process.

In the process of managing a destination, there is a whole system of interested parties whose merger can achieve maximum value and usefulness of GIS for all users. As tourism is closely linked with many other sectors, as well as various other contents as well as circumstances that are not directly associated with tourism, many are those who can contribute to the collection of information that is stored in GIS and based on which, the analysis is performed and maps are produced. In short, the huge advantage of GIS is enabling the inclusion and integration of the views of all interested parties that use the tourist area, starting from the state institutions, through non-governmental organizations, to private companies and organizations. This may affect the adoption of the best possible decisions in the process of development of tourism in the area.

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