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APPLICATION OF GEOGRAPHIC INFORMATION SYSTEMS IN FORMATION OF EFFECTIVE URBAN TRANSPORT INFRASTRUCTURE FOR SUSTAINABLE DEVELOPMENT[18]

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Abstract: *Geographic information systems (GIS) are tools that support the collection, display, and analysis of spatial information. They are integral today in natural resource management. The focus of this paper is on the theory, concepts, and applications of GIS-T to format an effective urban transport infrastructure for sustainable development.*

Keywords: *Geographic information systems, Urban Planning, Transport infrastructure, Sustainable development, GIS-T.*

INTRODUCTION

Transport infrastructure is a key component to the success of any country. It is the backbone of any economy and without it countries would not be able to transport people, goods and services from one place to another. Without efficient transportation systems and infrastructure, our cities would not be functional. Their sustainable development is also essential. It means a better way of life for us and for future generations. The idea of sustainability implies that economic growth, social cohesion and environmental protection go together and complement each other and is defined as development that "meets the needs of the present generation without compromising the ability of future generations to meet their own needs".(Source: NSI).

Geographic information systems (GIS) are changing society very quickly and in recent years have taken on an increasingly important role in the architecture of electronic management of administrations at the central and local level. GIS is a type of information system consisting of computer software and hardware, a database and users, which is used to input, store, manipulate, analyze and retrieve geographic data for the purpose of solving a variety of tasks in various fields - environmental management, transport, demography, public administration, business, etc. (Popov, A. 2012).

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The substructure of GIS that specializes in transportation problems (GIS-T) is one of the fastest growing in the field of geographic information systems. It enables the analysis and visualization of spatial data, which enables the integration of geographic elements in transport planning and management. The benefits of using GIS in transportation are numerous, including improved efficiency, safety and sustainability.

The aim of this paper is to provide guidance and highlight the importance of designing an efficient urban transport infrastructure, whose main tasks need to be fulfilled:

- To indicate the potential areas of application of geographical information systems in the context of transport accessibility;
- To present the functional capabilities of a software product through which an efficient urban transport environment could be designed.

EXPOSITION

GIS is an important tool in the design of policies to support the organization, management and promotion of transport efficiency processes. In mobility and transport, GIS is essential in the analysis of all basic information (statistical or cartographic) related to the travel movement.

The main function of the geographic information system is to transform data into information through the following processes (Georgieva A.):

1. Converting – transforming the data from one format to another, from one measurement unit to another, and/or from one classification system to another (recoding);
2. Organizing – organizing the data in databases, in accordance with certain rules and procedures;
3. Structuring – structuring the data in an appropriate way (file formats, directories, etc.) so that they are recognizable for the given software application or the information system used;
4. Modeling – includes statistical analyses, data visualization, etc., which will enrich users' knowledge and enable them to make more informed decisions.

After the correct construction of the GIS architecture, the database is visualized using layers (Fig.1):

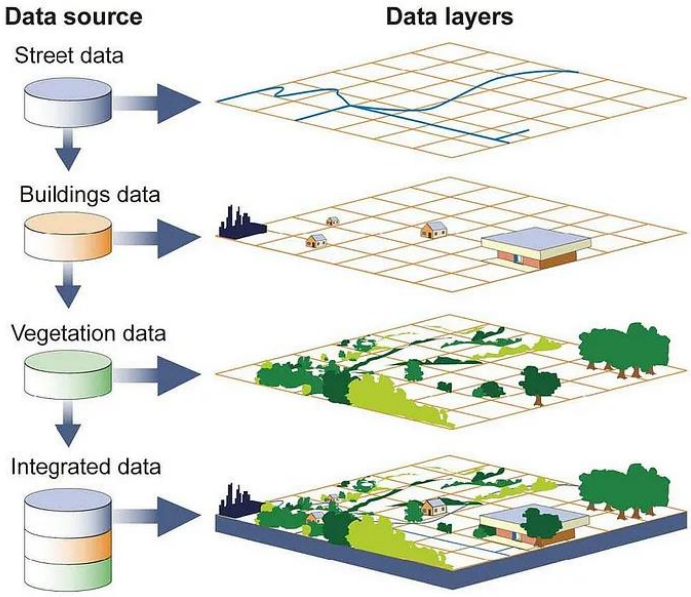

Fig.1. Structure of geographic information systems: source GAO

Along with the expansion of the GIS market and the subsequent development of new transportation analysis applications, the concept of GIS-T emerged. As can be seen in Fig. 2, GIS-T is a system that is a combination of an enhanced GIS and a Transportation Information System (TIS).

(Agyemang, 2013; Thill, 2000). Therefore, GIS-T applications are aimed at analyzing transport networks that are used for management and public transport planning and for business logistics.

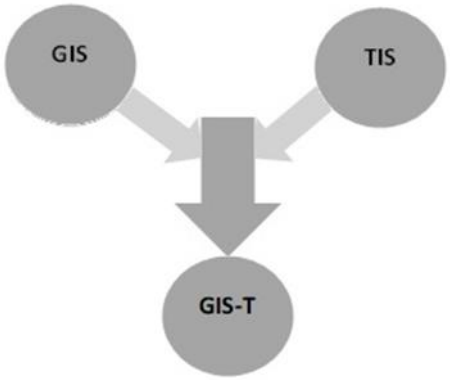

Fig.2. GIS-T - system of advanced GIS and TIS

GIS-T is used in various transport applications to:

- route planning and analysis. GIS can be used to identify the most efficient or cost-effective routes for vehicles;
- traffic analysis and management. GIS is used to analyze traffic patterns and identify bottlenecks or areas of congestion;
- planning and timetable of public transport. GIS is used to optimize routes and schedules based on demand and other factors;
- fleet management and logistics. GIS can be applied which would allow the tracking and optimization of vehicle routes and resources. (Equator platform)
- analysis and management of the relationship between road accidents and poor road surface or lack of markings. What is needed is to have information about the accidents that have occurred from the police department in the area and the condition of the road infrastructure. Thanks to the performed analysis, we can draw conclusions about what and how it can be improved, what funds will be needed, what needs to be corrected most urgently, etc.
- the development of autonomous vehicles, which will require sophisticated GIS systems for safe navigation and operation.
- integrating GIS with artificial intelligence is another area of potential growth as AI can help analyze and interpret large amounts of data in real time. These and other innovations have the potential to further revolutionize transportation planning and management, making it more efficient, safe, and sustainable.

GIS are not just a way to create maps. They combine the map with various tables filled with structured information. Thus, for each object of the cartographic field, there can be a set of additional qualitative and quantitative information, applied in a database. It is this information, combined with the location of the objects, that is used to perform spatial analyses. Maps are a fundamental element of GIS. In addition to displaying the location and type of objects, they can also be used to visualize spatial analysis results.

Thanks to a variety of classic and modern approaches to the presentation of cartographic information, data processed by GIS technologies are transformed into useful as well as beautiful maps. They can be used not only by specialists, but also by a wide range of users.

With the development of GIS technologies, three-dimensionality prevailed in addition to visualization and data processing. This allows a new and closer to reality look at the information and further develops the possibilities for analyzes and solving problems in the 3D space.

The specialized software product (Geographic Information Modeling System) consists of several separate modules that can function both independently of each other and together. What makes their joint work possible is a single common database in the architecture of the ArcGIS server platform (Manev, P. 2022).

One of the main advantages of web applications is that they are characterized by great flexibility. Unlike desktop software, they are almost completely independent of hardware and can be used on any smart device with an installed web-browser and real-time Internet access (ESRI-Bulgaria). The web module of the above-described system aims to provide the ability to quickly perform the most basic operations necessary in the work process. Some of its main functionalities are:

- visualization of traffic jams, traffic accidents, traffic jams, etc. on a map;
- visual representation and visualization of information on a layer and/or object;
- search for objects and the possibility of editing basic data in real time;
- possibility of distribution of geospatial information to stationary and mobile devices if there is an Internet connection;
- possibility of grouping the information in different layers;
- possibility to share information to all users;
- possibility to prioritize the access level of a specific user, etc.

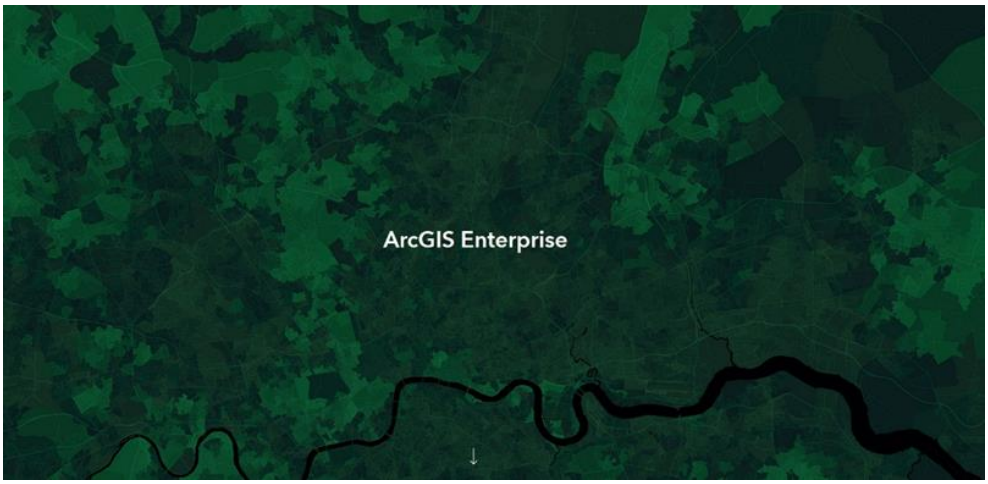

Fig. 3. ArcGIS Enterprise Web Application home page

The mobile application has a significantly simpler interface, suitable for working with a mobile device (phone, tablet) in the field. It offers the possibility to view all the data that is also visualized in the web application, as well as similar possibilities for adding and/or editing data. The editing is visible in parallel in real time and through the web-browser of the web module.

Dashboard is a web-based application whose main purpose is to provide an opportunity to quickly present the overall operational picture, using maps, charts, dynamic lists and a number of other tools. It allows filtering by a number of criteria for a better visualization of the current operational picture, and also prioritization of the level of access - in principle, with the highest level of access are the management teams, making decisions.

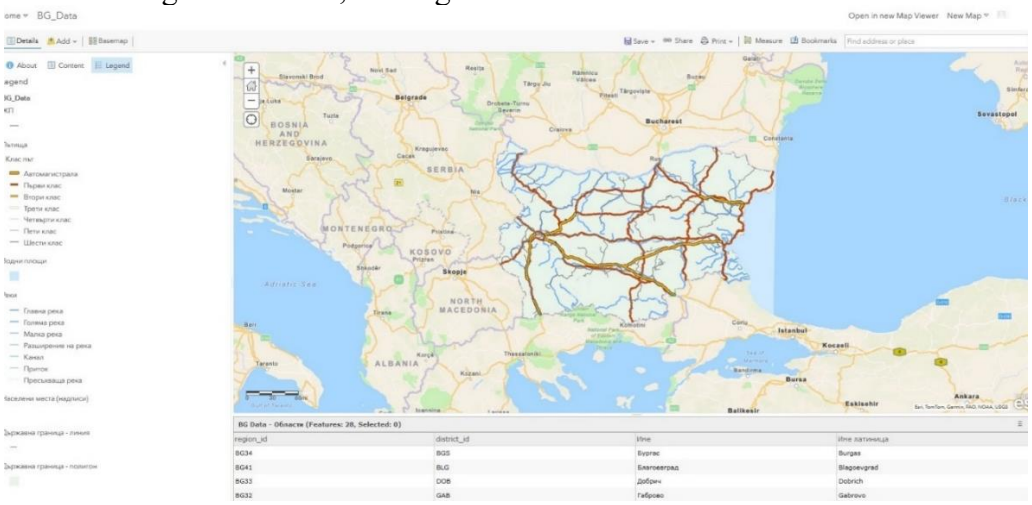

Fig. 3. Dashboard – operational view of the situation and decision-making

by teams in real time

CONCLUSION

One example of the use of GIS in transportation is the implementation of a GIS-based transportation management system by a city. A city can use GIS to analyze traffic patterns and identify areas where traffic can be improved. This may involve using GIS to analyze data on traffic volume, accidents, speed and other factors to identify problem areas. Based on this analysis, the city can then implement measures such as adjusting signal timing or adding turn lanes to improve traffic flow. The results of using GIS in this way can include reduced congestion, shorter travel times and improved safety.

In conclusion, GIS is an essential tool for transportation planning and management, offering a wide range of advantages and applications. As transportation continues to evolve, GIS will play a critical role in ensuring the efficient and sustainable movement of people and goods.

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