GEOGRAPHIC INFORMATION SYSTEMS AND BUSINESS ENVIRONMENTS

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Abstract: *A Geographic Information System (GIS) is a tool used for correlating the information from a database with digital maps. The system offers advanced modelling functions, planning and design tools and advanced imaging capabilities. Although most of these functions can be found in other systems, GIS is unique because of its emphasis on the representation of cartographically accurate spatial system. The purpose of a GIS is to manage, analyze and visualize all types of georeferenced information. It allows observing, interpreting and visualizing data in many ways that can reveal relationships, patterns and trends, as maps, reports and charts. GIS technology can be integrated into any company's information system. Even though GIS has been used in natural resource, logging and environmental industries for a long time, it is starting to be used for a broader array of management functions such as logistics, marketing, decision-making and planning. Fundamentally, GIS is important for business because most of the issues that an enterprise can encounter include a spatial component, and the system would allow decision-makers to use available resources in a more efficient way, according to the relevant spatial data. This study will present the way in which the system can influence different kinds of businesses and how a GIS is capable of improving or solving existent issues.*

Keywords: *Geographic Information System, georeferenced information.*
JEL Classification: *L86, L96, M15.*

Figure 1. Introduction

GIS (Geographic Information System) is a tool used to link the information available in a database with digital maps. The system offers advanced modeling functions, planning and design tools and advanced imaging capabilities. Although most of these abilities can be found in other systems, GIS is unique because it emphasizes on representing objects in a precise cartographic system. The purpose of a GIS is to manage, analyze and graphically represent all types of geo-referenced information. It allows observation, interpretation and visualization of data in numerous ways which may highlight links, patterns and trends as maps, reports and tables. GIS technology can be integrated into any information system of a company.

Although GIS has been used for a long time in natural resource, forest and environmental industries, it is starting to be used for a wider array of management functions such as logistics, marketing, decision making and planning. Fundamentally, GIS is important for business because most of a company's issues include a spatial component and it allows the decision-makers to efficiently use available resources according to the relevant spatial data. This paper presents the way in which the system can influence various types of businesses (e.g.: optimizing routes for a transport company, impact analysis of a new supermarket being opened, criminality analysis in various neighborhoods of a metropolis, etc.) and improve or solve existing issues.

In 1960 the first operational GIS was launched in Ottawa, Ontario, Canada, developed by the Federal Forest and Rural Development Department. The system was created by Dr. Roger Tomlinson and it was called Canada Geographic Information System (CGIS). Its purpose was to collect information regarding the types of soil, agriculture, fauna, forests and land use at a scale of 1:50.000.

CGIS was a huge step forward compared to the cartography applications available at the time because it offered the possibility to do measurements, digitize and scan. It used a

national coordinate system which was used on the continent and it stored the properties of the elements and the location data in different files. CGIS survived until the nineties and with it, a vast database was created which stored digital information about Canadian lands. It was developed as a main information system whose purpose was to aid federal and local management departments and resource planning. Its advantage was the ability to analyze datasets collected from all over the continent. CGIS was never available to the public.

In the mid 1980's the first shapes of a spatial information framework was starting to form. The main reason of this evolution was that spatial information was valuable and a GIS ensured access to such information. At the same time, data needed to be collected once. In the United States of America, the Executive Order 12906 emitted by President Bill Clinton in 1994 would launch the creation process of a national GIS.

Geographic information is information that is related to specific locations on Earth. It covers a very wide array of data which includes the distribution of natural resources, the way we are affected by pollution, infrastructure description such as buildings, utilities and transportation, land-use patterns, healthcare, wealth, employment, housing, etc.

Most of human activities depend on geographic information more precisely, by knowing the positions of various objects and understanding how these interact with one another.

Many of the information systems used by companies and organizations, use information which contains a spatial component. Any database that contains addresses or postal codes contains spatial information but is not considered a GIS.

A few years ago the systems capable of sustaining and completing necessary GIS activities such as spatial analysis were not available or their prices were very high. The recent drop in prices of computers and the significant increase in performance have changed this in the last ten years and have made a GIS accessible. Applications that needed a well put together information framework before, now can be run on entry-level desktops. Suddenly, any organization can benefit from the advantages of a GIS.

2. Geographic Information System's advantages exemplified

2.1. Movia – Public transportation agency in Denmark

Movia is the biggest public transportation agency in Denmark, performing 214 million trips per year in Copenhagen and parts in eastern Denmark. Having 570 bus lines and 9 train lines in its coverage area, Movia struggles to meet the daily needs of 2.4 million inhabitants.

As a public transportation agency, planning and administering routes represents a very important aspect of this activity and up until now the workflow and planning procedures were not as efficient and simplified as it would have been wanted. The systems and internal procedures needed a technological improvement. The moment when employees needed vital information for planning transportation routes, such as demographic characteristics and institution's locations, the systems made the workflow and processes to be time consuming and way too complicated.

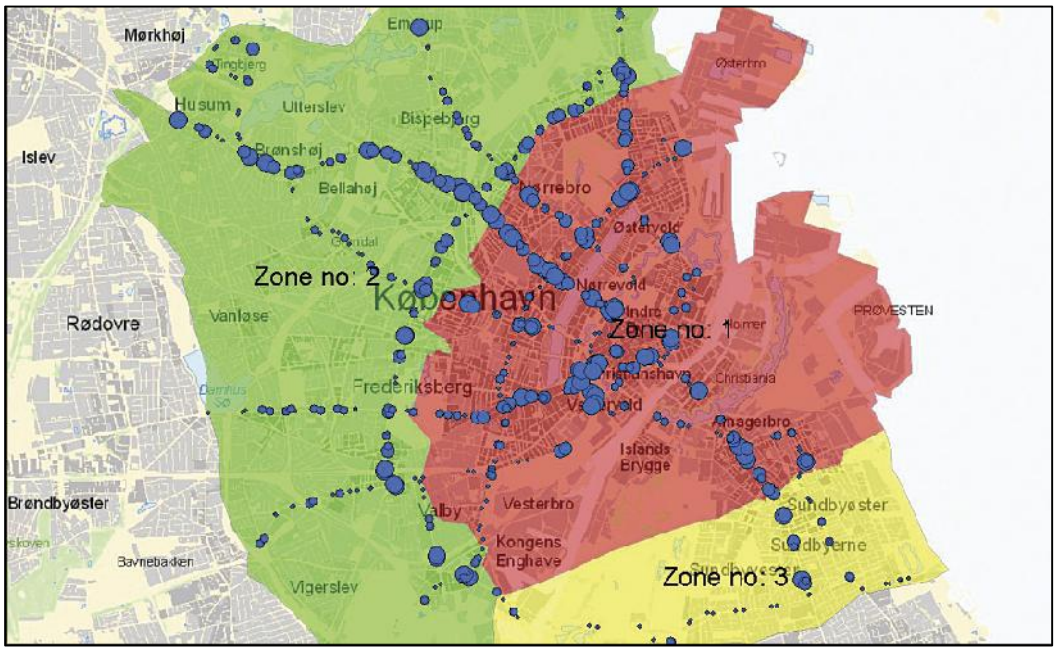

Figure no. 1. The analysis – number of passengers in stations

Source: http://www.esri.com/news/arcnews/spring10articles/spring10gifs/p33p1-lg.jpg

Movia working with InformiGIS and ArcGIS Server software developed GeoTransit, a suite of applications that brought together information from existent systems with tools for spatial analysis. GeoTransit system sustains business processes for the whole company offering the necessary tools for analyzing the spatial location of stops, routes and patterns while offering the possibility to integrate the schedule, passenger number, travelling time estimations and real time information regarding the road status. Before GeoTransit was developed, it could last for three days before a road plan could be attributed to a bus route through a certain area because information was needed that was spread in various systems that could not directly communicate. After the integration, the same procedure now does not last for more than a day. The process has become a lot easier to manage because the system grants direct access to all relevant information and using an efficient workflow and also the time required for training new employees has been shortened.

Using GIS as a central component of IT architecture, data and information that did not have a spatial reference can be linked in the system. This allows Movia to analyze stops more efficiently identifying passengers and their needs in a particular area of coverage. Additional useful information appeared after the identification of the most crowded stops and knowing the number of busses that would follow that particular route to ensure efficient activity. In order to estimate the time in which a bus will reach the stop, the system analyses travelling speed, and sends the data to information kiosks.

The GeoTransit system creates new possibilities and meets the requirements of a modern public transportation agency that aims to rival individual transportation means, such as automobiles. Also, the system and the information collected by it lead to an improvement of the services that are being offered and improving client satisfaction, which guarantees the fact that more and more people will consider Movia a viable transportation alternative. Having more than 15.000 bus stops, 112 train stations and 338 kilometers of railway loaded into the GIS, Movia has the capacity to collect and analyze data in order to plan, manage and monitor traffic in one integrated system.

2.2. Supply-chain

There are varied ways through which a GIS can help a supply-chain. Right now, the flow of goods across the world relies on bits and bytes transmitted between all of the computers on the planet. Every day, software and computers control trading of goods worth billions, between countries. These goods – which can be anything from livestock to mobile phones and coffee beans – travel from farms and manufacturing plants via trucks, trains, planes and ships. Supply-chains connect the whole population of the planet. Our lifestyle is dependent on the precise and efficient flow of such network, but also on its careful management.

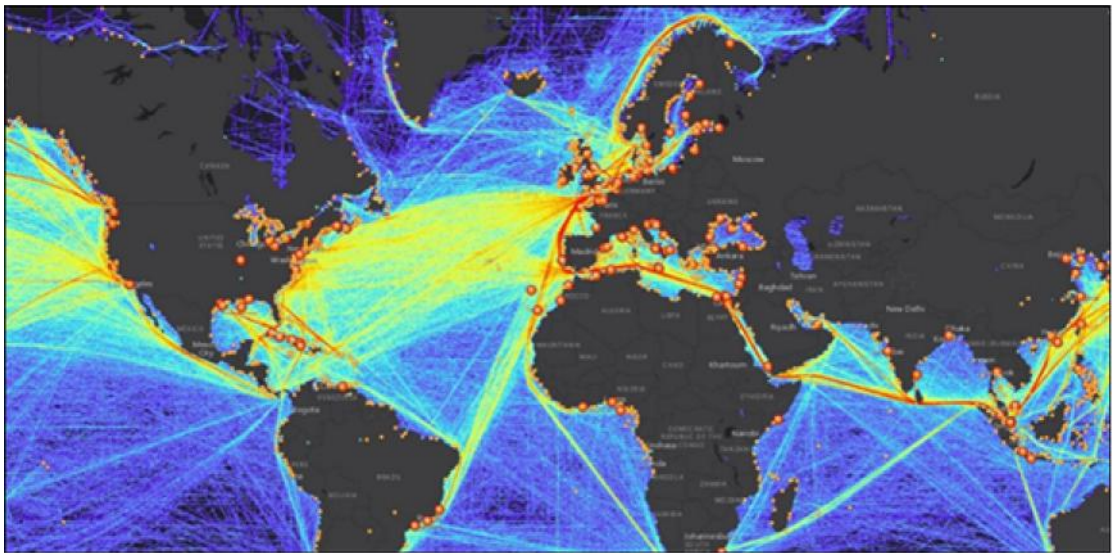

Figure no. 2. Logistics centers in the world

Source: https://medium.com/esri-insider/seeing-is-believing-the-reach-of-supply-chain-management-81d5f7cf4d36#.g1fjojqyc

A supply-chain that is carefully managed is very important for the economy. Because of the high volume of transports and risks (weather, natural disasters, theft, etc.), efficient management is very complex and it requires the analysis of a lot of data.

Complex information becomes intuitive and easy to understand when it is visualized. Our brains have developed and gotten used to recognizing patterns which is why maps are an ideal choice for representing and communicating a complex scenario. GIS is the perfect tool to visualize the complexity of a business using advanced cartography methods and advanced analysis tools for understanding risks and the supply-chain's efficiency level.

Tracking transports in real-time while being able to predict traffic and weather helps with using resources smartly and ensuring efficient functioning of the supply-chain. Modeling and analysis of pauses allow for the understanding of the effects that are created and in the future, such effects in similar situations can be reduced or even avoided. Optimizing transport routes also helps with reducing emissions and pollutants.

3. Presentation of an existant GIS model in Ramnicu Valcea, used by the drinking water and wastewater company

There are numerous advantages in using a GIS in business, but in a company such as the regional drinking water and wastewater operator, the need of a solid, modern and efficient system is huge.

Approximately 80% to 90% of the company's data is in one way or another tied to a geographic location. The positions of pipes, valves, pumps and meters must be known along with other elements that belond to the drinking water or wastewater network. Also,

the locations and use patterns of the clients must be known, along with the positions of the response teams and equipment that might need maintenance. The information system allows the users to query and analyze information based on location but also based on the spatial link of it with other elements which at first sight might not appear to be connected.

Utility companies usually have many databases which have developed independently in time. Creating a link between the items in the databases and the geographic positions to which they refer, these datasets can be connected. For example, GIS applications can help identify trends in main-breaks in order to prioritize replacement or rehabilitation projects. Such projects are usually analyzed by taking into consideration various criteria, such as, pipe material, diameter, age, soil type, proximity to high importance buildings (e.g.: hospitals, schoolsm etc.), main-break history, water quality and coordination with other utility projects. All these criteria can be spatially represented in a GIS and can be associated with pipes. This way the company can not only decide what improvements need to be done first but also the ideal moment to start them.

Once the implementation phase has been passed, a GIS can be enhanced to serve as a data analysis instrument, creating reports and interconnecting with other applications. Some examples will be presented below.

Field data collection – Collecting data is done with the help of hand-held units that have GIS/GPS capabilities that can be sent in the locations where it can support repair or maintenance activities for the drinking water network or wastewater network. This will avoid needing to manually introduce information gathered on field data collection forms, needing to consolidate the data, having to perform additional quality assessment checks or even revisiting the location. Portable hand-held units offer the following benefits:

- ✓ Immediate and precise determination of the location – If the localization of a network element that was located in the past is required because it can not be found in the present.
- ✓ Visualizing existing data – If information regarding the network's elements is needed, which could make the response team's work easier.
- ✓ Immediate validation of data – If confirmation and localization of two locations' altitude difference is needed to be known.

Integration with the customer support system. Establishing common connections between the GIS and the registered clients allows for the real-time association of client's needs with the digital model of the water network. This will help with creating the hydraulic model of the network but it will also help with other types of reports and analyses. Also, it can generate a simulation for the areas affected by valve closures and as a result, automated notifications can be sent to affected clients.

Another advantage of associating clients with the geographic location consists in having the possibility to further improve customer service quality. If there is a registered complaint, the customer support agent can quickly see the location of the complaint and if other complaints have been recorded in the vicinity, only one verification order can be generated. This way, only one visit for that area will be required and this will lead to faster interventions for all customers and an efficient use of the human resources.

Integration with hydraulic modeling of the drinking water network

Hydraulic modeling is usually used for the analysis of water networks – especially for the development of a Master Plan. This modeling activity allows the company to evaluate the performance of the system, identify the issues before they start to arise and generate emergency plans.

Although a lot of the data required for a hydraulic model can be stored within a GIS, hydraulic modeling and GIS have developed in parallel, but similarly. The main GIS objective is to create an accurate representation from a geographical standpoint of the

network. The main objective of a hydraulic model is that of creating a hydraulic accurate representation of the system and how it works in various conditions.

Recent software developments reduced this gap between the two applications. If it is built accordingly, a GIS can be efficiently used to develop a big part of a hydraulic model and the use of advanced spatial analysis modules of a GIS will enhance the results. For example ***Fire flow analysis*** – Most of the hydraulic analysis programs can calculate available flow through the network's nodes. Various land-use categories have different conditions. By associating these conditions with the land-use categories, GIS can evaluate the network's capability to reach the required conditions; ***Drinking water source analysis*** – Considering that the water is obtained from many sources, it is important to understand how it mixes in the network. This is especially important when the water quality level varies according to each source. Customers might want to know where their water comes from, but as time goes by, the same customer might receive water from different sources. Knowing and understanding the way the network behaves, the risk of distributing a mix of source-water can be compensated for, or eliminated completely.

3. Conclusion

Even though GIS and adjacent technologies have a major impact on the way infrastructure and operations are handled, there are still various ways in which the system can be improved. The greatest issue is given by the quality of the available data. Even in this age of information, most of the data is old, incomplete or incompatible. The positive aspect of this situation is that as long as low-quality data is validated, verified and migrated using GIS technology, the situation can only improve.

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