GEOGRAPHIC INFORMATION SYSTEM AND ITS APPLICATION IN AVIATION LOGISTICS

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The following article is dedicated to the creation of geographic information system for the logistical needs of recreational air transport in the model area. The system is referred to as a „real-time online geographic information system“ and is available via the Internet.

K e y w o r d s**:** Geographic Information System, Logistics, Air Transport, Aviation Maps

1 INTRODUCTION

Nowadays, it is hard to imagine our lives without using information systems. In the modern era of science and technology, the emphasis is put on the development of new information systems, aiming to help us and to simplify our work. One such example is the geographic information system, used in many different sectors.

By analysing our economics, we come to realize that logictics is one of the many areas neglected in the past. Today, however, the situation has changed. Better use of logistics reveals a big potential for optimization, which come neccesary for the efficient management of business units.

Air transport is used far more frequently these days than it was in the past. Its main advantage lies in speed as it is the fastest way of transportation, enabling the transfer of people, mail and certain goods. Air transport contributes to the quality of national economy management, and also speeds up the flow of circulatory assets. The requirements, which the air transport must comply with, are speed, safety, quality and cost efficiency.

2 GEOGRAPHIC INFORMATION SYSTEM

Geographic information system is a system, enabling to capture, maintain, analyze and display the information about the characteristics of the objects, objects` activities, location and their spatial relationships. The purpose of GIS is to gather new information for the use of resources and optimal management of a society. The term geographic information system was introduced in 1963, when a territory oriented information system, supported by computer in Canada (as per R.K. Miller and T.C Walker) was created. It was also in this period, when the attention was for the first time paid to new technology, which uses the computer technologies in the processing of spatial information. The GIS enables editing, storage, capturing, organizing, modelling and analysis of spatial data, as well as graphic and text/numerical presentation of this data.

The term „geo“ (originating from Greek) means that each data maintained by GIS relates to a certain point in the Earth’s atmosphere, or Earth’s surface respectively.

The most important part of the GIS is the specific kind of data, processed by it. Therefore, digital capturing of the necessary data bears the utmost importance for the successful GIS functioning.

3 LOGISTICS

Logistics represents the organization, planning, management and execution of flows, which start with development and purchase, and ends with production and distribution according to customer’s order in such a way that adheres to requirements of the market, whilst keeping the cost at a minimum level. The term „logistics“ is known for a long time, and is part of many a dictionary. Interestingly enough, the term itself (logistics) has been known for a few centuries. It originates from Greek „lego“ but also, from French word „loger“. The Greek word „lego“ means to think, from which we can derive the word „logizomai“, meaning to calculate and to reason about. The French word „loger“ was in use as early as in the 12th century, and it marked the temporary accommodation of soldiers and passengers.

Logistics acquired an important role in the army. As far back as in the 10th century, the Byzantine king Leontos VI. (886-911) assigned logistics the whole supply process and the safeguard of the army with ammunition, arms, food etc. This term, however, disappeared from military terminology for some time, only to re-appear again in the 17th and 18th century. The place of its re-appearance was French army, in relation to logical thinking, calculation of the optimal movement of troops and supply, as well as for choosing the cantonment and suitable landscape. Logistics has become a part of military strategy and tactics.

After wide usage in the military sector, the logistics started to be applied in the USA in an increasing number of businesses in the 50ies of the last century. Since then, the logistics as a scienctific discipline has found its assertion in Europe. The fast economic development connected to the international division of labour allows wider and wider application of logistics. From all that has been said before, it is clear that logistics has profiled iself as a new scientific discipline with strong application tendencies, containing information and goods chain from supply to consumption.

4 AIR TRANSPORT

Air transport is one of the youngest means of transportation. Since its formation, it has gone through much more dynamic developments than any other way of transport. Such fast development resulted in an ever increasing speed of aircraft and number of transported passengers, when compared to other means of transportation. Those are some of the reasons, due to which air transport has acquired practically monopoly in transportation of people, mail and certain goods for very long, long and medium distances, all this happening just in a several decades. For Chinese and Persian legends talked about the efforts of mankind to take off along the lines of birds. The European continent is the most famous Greek legend of Icarus, dated the 7th century BC. l . The first person dealing with the possibility of flying was Leonardo da Vinci (1452-1519), who summarized their findings in the notes Code of bird flight and the many design sketches. Because people were in imitation of bird flight failed, they began to conquer sky balloons. The first manned balloon was raised in 1783 near Paris, and took about 25 minutes. Balloon flight in the 19th century became increasingly used to overcome the still larger and larger distances and lasts until today. Use these balloons was limited only to climb up. Immediately, however, began with the development of dirigible balloons. The first real controlled for routine balloon flight was made by Brazilian aviation pioneer Alberto Santos-Dumont. The Brazilian aviator effectively combined an elongated shape balloon with a combustion system for power. On 19 October 1901 has become a globally recognized, though with his airship called "Number 6" flew across Paris and won the Deutsch de la Meurthe. The success of the airship that has controlled and stabilized flight is possible. On 17 December 1903, the Wright Brothers first flight took place on the proven engine driven aircraft heavier than air. This aircraft was not designed for long-distance flights because there were problems with management. After a very quick adoption wing wings showed that the aircraft has become easier to use and only a decade later during World War I became heavier than air aircraft for reconnaissance and useful survey, streliace artillery, or even attacks against enemy ground positions. Humanity began to use air transport for carrying passengers and cargo, and so began construction of aircraft carriers expand and grow their credibility. Huge airships became the first means for carrying passengers and cargo over long distances. The most famous airship of this type was one produced was the German Zeppelin.

5 CONCEPT OF GIS APPLICATION IN THE AVIATION LOGISTICS

The concept of GIS application represents the creation of theoretical model GIS applications for the needs of a small model airport, or, respectively, for the flight operation of a small airport in the environment of Slovak Republic (SR) airspace. The concept is based on the possibility of real data entry under the conditions of the SR environment, bearing in mind the quantity and quality of the necessary data. Baseline application environment of the GIS is the ArcView or the ArcGIS alternatively. Within the framework of this platform, the individual GIS layers are designed, which will contain the required data for a flight operation of a small model airport.

The types of application GIS:

- model airspace, or, respectively, model airport GIS,
- local orography of Earth's surface GIS,
- meteorology data GIS,
- ground infrastructure GIS.

5.1 GIS Model Airspace

The most important application GIS – the first layer. The Master`s Thesis dealt with the model airspace set into airspace of Slovak Republic. In this model application GIS, the individual sublayers contain the following information: The boundaries of SR airspace – horizontal structuring.

The Slovak airspace is structured horizontally and vertically. The horizontal boundaries of SR airspace are SR state borders. These borders are also the boundaries for FIR BRATISLAVA (Flight Information Region Boundary). Boundaries of SR airspace – vertical structuring.

Flight levels according to respective classification class.

Figure 1. SR airspace GIS

5.2 GIS Flight Areas and Flight Regions

The designed GIS will contain the following data:

- Boundaries of Control Zone CTR,
- Boundaries of Military Control Zone MCTR,
- Boundaries of Limited Zone Restricted Area LZR,
- Boundaries of Limited Zone Prohibited Area LZP,
- Boundaries of Temporary Segregated Area TSA,

- Boundaries of Airways AWY,
- Boundaries of Identification field IP,
- Boundaries created by the user.

Boundaries of Control and Military Zone

These areas serve for different operation and activities of airspace users, mostly for the needs of military aviation, or artillery and air defence forces. That is to say that above mentioned restricted areas are established above military shooting ranges, drill-camps etc., so that operation of such areas will not jeopardize the safety of other flights. Besides areas restricted for the purposes of military forces operation, we can come across restricted areas above a particular airport for the duration of aviation competitions (e.g. parachuting competitions). Such areas are not restricted for unlimited time; the restrictions are activated only for a necessary period according to the requirements of individual users. Usually, such usage of the area is planned a month ahead and its validity can be found in a report NOTAM, containing the information about the use of the airspace in a particular month. Naturally, those areas have their vertical and horizontal boundaries too.

Boundaries of Limited Zone Restricted Area LZR

These areas are established above important objects such as nuclear power plants, or factories for production of explosives, in order to prevent an aircraft flying into this area. Possible flight accident would result in major consequences. The validity of restrictions is unlimited, 24 hours a day, all year round. They are monitored by radar service and if there is an indication that unauthorized aircraft is entering such area, a military stand-by aircraft takes off to avert danger. In FIR Bratislava, LZ areas are established above nuclear power plant Jaslovské Bohunice, Mochovce and above factory DUSLO in Šaľa. Again, these areas have their vertical and horizontal boundaries.

These areas serve solely to military aircraft. They fall under the program of flexible use airspace (FUA). They are not occupied all the time and the operation can be planned a day ahead. The information about the activity of TSA can be obtained from a centre of flight operation RLP.

Boundaries of Temporary Segregated Area TSA

The area of interest lies alongside the state borders towards inland; its width being 5km, outside of CTR, MCTR, TMA, MTMA. Flight operation in this area is only allowed when the notice to relevant centre of flight operation has been provided.

5.3 Local orography of Earth's surface GIS

Application GIS with marked orography of surface in the model area, with marked level lines and the highest points, so called natural height points. This layer can also contain so called unnatural height points, or antropogenic height objects (e.g., high rise buildings, chimneys, etc).

5.4 GIS Meteorological Data

Meteorological data is very important parameter for flight operation of every type of flights, starting with sports aviation on a parachute glider through to e.g. acrobatic aviation.

GIS assigned for the processing of:

- statistics (average annual data in the form of processed database) of selected meteorological data,
- up-to-date records (direct link to source of records – SHMÚ),
- forecast within a horizon (direct link to source of records – SHMÚ) of:
  - 1 day,
  - 2 days,
  - 3 days,
  - a week,
  - a month.

Type of data:

- Average daily temperatures,
- number of days:
  - with clear skies,
  - partly clouded,
  - with clouds,
- number of days with falls (rain/snow),
- the atmospheric pressure on individual flight levels,
- number of foggy days,
- number of days with inversion,
- number of windy days,
- number of windless days,
- average speed of wind flow in directional wind rose on individual vertical levels,
- vertical temperature bedding.

This type of GIS can be maintained in the form of table file for a certain chosen point, or area of flight respectively.

5.5 Local ground infrastructure of GIS

For this application GIS, it is necessary to create the following layers:

- road grid – line objects,
  - 1st to 3rd class roads,
  - highways and high-speed roads.
- other line objects,
  - power line.
- Other objects,
  - height objects (chimneys, high rise buildings, bridges, etc).
  - water areas.

5.6 Real-time GIS

So called real-time GIS is the result of intersection of all application GIS`s. The basis for the whole system is its creation in the form of the Internet application, available 24 hours a day.

After the user sign-in (identification), the application user can choose from the following options:

- Read Only,
- Data Input.

Read Only option means that user can read/view all data, such as planned flights for a selected airport, weather forecast for a chosen period, the actual weather situation at a particular airport, number of flights planned for a selected period, etc.The second option means that the user is authorized to enter the data (whilst respecting the boundaries created by the individual restrictions) into the system, with creating the new boundary, or new restrictions for the next user.

Concept of the proposed GIS

The proposed GIS is based on ArcView or ArcGIS platform, provided by Esri. ArcView is the most frequently used desktop GIS application in the world, due to fact that it offers a simple approach to using the GIS data. It comes with a user friendly interface, a well structured context help and plentiful documentation, which enables a simple and quick start for working with geographical data.

A proposed GIS consists of the following layers:

- orthophotomap of East Slovakia,
- layer of level lines of Control Zone CTR,
- layer of level lines of Military Control Zone MCTR,
- layer of level lines of Limited Zone Restricted Area LZR,
- layer of level lines of Limited Zone Prohibited Area LZP,
- layer of level lines of Temporary Segregated Area TSA,
- layer of level lines of Airways AWY,
- layer of level lines of identification fields IP,
- layer of level lines of airways planned by other users.

The above mentioned layers, or GIS maps of aforementioned flight areas, create the basis for all the map layers for the user. User thus cannot change those layers.

User can choose the following layers as suitable:

- layer containing the data from local orography of Earth's surface,
- layer with meteorological data,
- layer of ground infrastructure.

User can choose the individual layers and sublayers as needed. Putting general knowledge of aviation to use, the user can choose the most convenient flight conditions for a selected time on a chosen airport. Thorough planning of a convenient flight path for a particular type of flight in certain time, so called creation of time and space trajectory, is a very important aspect. This practically means that users books their flights. By connecting to the Internet, the next user can then simply find out the details of actual occupancy status of flight space on a level of a model airspace of a small airport. At the same time, feedback is being provided to the big and special airports, or to the centres of flight operations of civil and military aircraft, about the actual, or planned flights in the particular area. By clicking on them, a GIS application user will see the following information, which was entered by a user who planned the flight:

- basic data of a user who booked the flight,
- type of flight,
- type of used aircraft,
- flight duration,
- vertical and horizontal co-ordinates of flight.

Based on the above, an overview of flights planned in the model area can be created. Such an overview can prevent dangerous colisions from occurring, and thus ultimately, flight accidents can be avoided.

6 CONCLUSION

Air transport is the fastest and most efficient mode of transport not only abroad but also for us. Of course, increase in its intensity at different types of air traffic placed increased demands on information systems, respectively. geographic information systems. Air travel has made full use of geographic information systems tools. Based on the theoretical knowledge of aviation, aviation and logistics possibilities of geographic information systems, in this article have been processed proposals applications commercially available geographic information system for the needs of recreational aviation. The principle of this design solution is to create geographically and online database system to simplify, clarify, and in particular to ensure safe recreational aviation in Slovakia. The results are the specific outputs of the proposed geographic information system for aviation. By applying the proposed method of solving the geographic information system to create a quality tool in the field of logistics and air transport in the form of real-time updated web applications.

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