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Baross Gábor Ph.D. Programe for Transport Sciences

Application of Geoinformatics for the Improvement of Airport Processes

Theses of Ph. D. dissertation

By

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1. Preliminaries and timeliness of the research topic

Quick and accurate service, reliability, efficient use of available resources, the highest possible reduction in environmental burden and automation play an important role in air transportation. However, the above must not impair security. Due to acts of terrorism, personal safety is of highest priority, but an accurate tracking and a more efficient organization in the control of other air services must not be omitted by the airport and its organizations either.

Presently, there are many different tracking and IT recording solutions in use at the airports. I integrated these into a unified system, because Geographical Information System (GIS) has been undergoing such a continuous development that it is now able to support indoor tracking in a cost-efficient way. Security rules have been continuously becoming stricter and stricter in the mass air transportation, which implies significant extra costs on airports, operators and airlines. Therefore, it is necessary to find solutions that meet security rules, while being able to render aircraft supply services in a sufficient quality and on time.

I made my recommendations on the economical development and combination of existing technical standards on the basis of an analysis of existing and prospected security rules. This can be summarized in a unified airport system.

The dynamic increase in air transportation (e.g. the numbers of flights, passengers and airports) causes more and more delays and lost baggage, which result in significant economic effects. In addition, airlines and airports require faster and more accurate ground handling, while tending to decrease costs. There is a fierce struggle for passengers on the air transport market. Winning this struggle essentially requires the standard of services to be high (e.g. accuracy of departures and arrivals, accurate baggage handling, etc.).

2. Goals

My initial research goal was to study existing technologies and technologies under improvement, an analytic evaluation of such technologies and to explore any uncovered but still unused development possibilities.

The goal of my research was to work out a GIS system, capable of the followings:

- A better utilization of airport capacity,
- Tracking and mapping moving elements,
- Improving on the efficiency of aircraft handling,
- Automation of passenger and baggage handling and increasing their efficiency,
- Minimizing human errors,
- Minimizing payback period.

I designed the above system with attention to the followings:

- Possibilities to use currently known technologies at an airport (GIS, identification and tracking, security),
- Passenger security and comfort,
- Transparency of current technologies,
- International development trends.

3. Research methods

In compliance with my goals, I used a wide range of classic research methods in my dissertation, including structured text analyses and deep interviews to explore practical experiences and comparative evaluations based on them. I carried out an exploration study on development possibilities considering the present state of technology.

I studied Hungarian and foreign professional journals, bulletins, books, conference materials and web pages on GIS, identification and tracking, security and air transportation. I studied current and future trends in detail. On this basis, I checked the feasibility of my research results and set them into the international trends.

At my fact, data and information gathering trips to Hungarian and foreign airports, I surveyed the procedures, tools, supporting systems, application solutions and bottlenecks of passenger and baggage handling. I worked out an evaluative comparison on the basis of my experiences and local surveys at the different airports.

Based on deep interviews with experts of different fields of air transports (e.g. GIS applications, IT, security, passenger and baggage procedures, etc.) and on passenger experiences, I surveyed currently used technologies and problems.

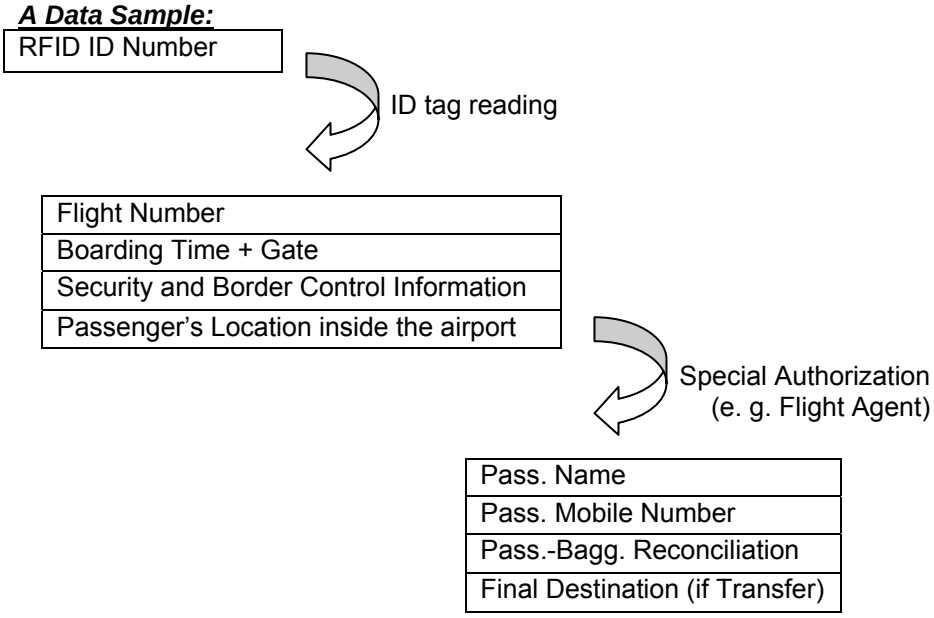
I processed and analyzed available statistical data on lost baggage and flight delays I made recommendations on their causes, amounts and long-term cost reductions with the RFID/GIS technology.

The GIS system shows and tracks RFID tag information of moving elements. The individual subsystems of an airport GIS system can be accessed with the correct authorization only. Access is granted and displayed to the relevant parts of the system and information only. The RFID reader can be integrated into the configuration of the security check device, the unification and automation of the check-in, security check and border control (if necessary) can be achieved *(see 4.1.4.)*. This way the process achieves a faster progression or flow of passengers to the transit area, due to less queue up and waiting times. The combination of different biometrical identifications, RFID, image processing enables a safer control of personnel authorization security, baggage protection against pilferage and the total airport monitoring and security *(see 4.1.5, see 4.1.6).*

New approaches to use GIS and identification methods as described in my dissertation made it possible to work out modern airport IT development methods that meet the security requirements as explored by the analysis. The RFID integrated into GIS made it possible to elaborate a data structure

which facilitates the traffic and operational management and business processes. An exploration of any adaptation possibilities of this solution may help to use the recommended system in other transportation systems as well.

A Data Sample:



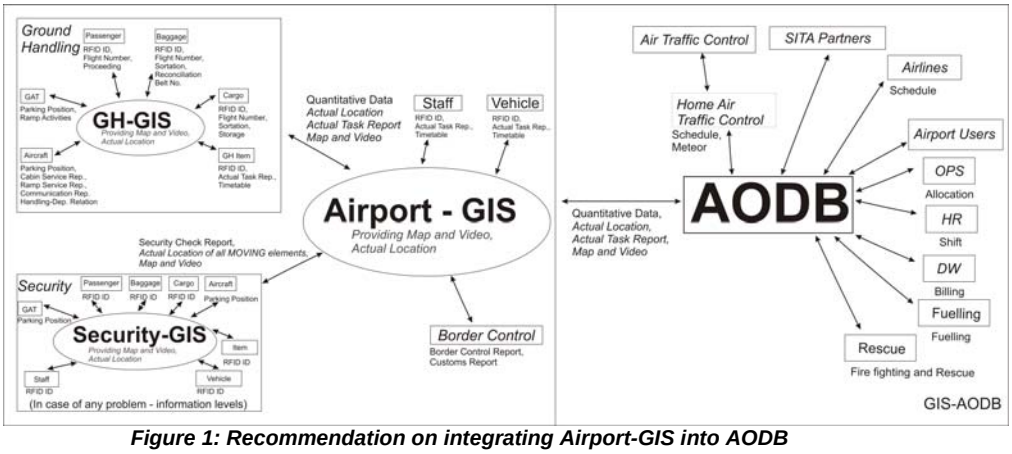


Figure 1: Recommendation on integrating Airport-GIS into AODB

The key Effect Areas of the Complex System are the followings (see 5.):

- A better coordination of ground handling and a decrease in delays
- A decrease in passenger and baggage handling times, an increase in service level
- A decrease in baggage delivery times
- Less human error sources
- Automation of passenger handling processes

My dissertation, which processes and systematizes the theoretical approaches evaluated and the latest application experiences, defines a dynamic tool system for GIS and identification that is sufficiently able to simultaneously manage airport identification and tracking, security and ground handling procedures.

4. New scientific results

4.1. I found that geographical information system (GIS), information technology (IT) and modern radio frequency identification (RFID) together integrated into a common system can identify and track moving elements (e.g. people, luggage, ground handling, mail and cargo) in a restricted space (e.g. airports). *(Bite a., 2010, See 4.)*

4.1.1. The airport infrastructure management uses geographical information system extensively for tracking stationary objects (e.g. property, property-registry and management), and with additional information (primary and secondary radar, GPS), for tracking moving elements (airplanes, airport vehicles). *(Bite c., 2010, See 1.4.7.)*

4.1.2. Currently, the management described in point 1.1 does not include tracking passenger, baggage, staff and ground handling units, due to the lack of information and proper technical elaboration. *(Bite a., 2010, See 1.4.7.)*

4.1.3. I found, that radio frequency identification (RFID) can be channelled into geographical information system through an interface system, which should be installed based on the requirements for handling processes, business processes and security requirements. *(Bite c., 2010, See 4.2.2.)*

4.1.4. Tracking of moving elements (e.g. people, baggage, ground handling equipment, mail and cargo) enables the operative management of business processes, and alerting in case of process errors or abnormal activities (e.g. entering restricted areas without authorization). *(Bite a., 2010, See 4.2.2.)*

4.2. Based on the analysis of information required for the traffic and operational management and monitoring of airports, I defined the proposed data structure and content for an RFID enabled architecture. *(Bite c., 2010, See 4.2.2.)*

4.2.1. I specified the technical requirements for using RFID on airports (minimal memory, data transfer time, reading time and distance). *(Bite c., 2010, See 4.2.2.)*

4.2.2. The proposed information content of the RFID tag includes the information required for traffic, operational management and monitoring. *(Bite c., 2010, See 4.2.2.)*

4.2.3. I proposed data structures for linking passenger to its baggage, marking cargo belongings together (e.g. industrial, military use). *(Bite d., 2008, See 4.2.2.)*

4.2.4. The proposed structure can possibly result in 80% reduction of lost baggage for a regional airport handling 3,006,199 pieces of luggage in a year period. *(Bite d., 2010, See 5.1.4)*

4.3. I was the first one to propose the integration of the tracked processes into the integrated operational information systems of airports. *(Bite c., 2010, See 4.2.3.)*

4.3.1. I proposed the integration of the airport operational information system and tracked processes through a geographical information system. *(Bite c., 2010, See 4.2.3.)*

4.3.2. I extended the use of RFID technology that was originally proposed for passenger and baggage tracking to include other processes with similar characteristics (logistics and transportation). *(Bite c., 2010, See 4.2.3.)*

4.3.3. I showed the benefits of such an integrated system. *(Bite c., 2010, See 5.)*

4.3.4. As part of the planned integrated operational information system I proposed the automation of traffic and business processes, using RFID and combined biometric identification and image processing. I proposed to display information gathered by identification and tracking in geographical information system. *(Bite a., 2010, See 4.2.2.)*

4.4. I elaborated a simplified method for the comparison and evaluation of the air passenger and baggage tracking systems that were created using GIS and RFID. *(Bite d., 2010, See 5.1.)*

4.4.1. I defined qualitative measures for the analysis of the efficiency of air passenger and baggage tracking systems. *(Bite d., 2010, See 5.1.3.)*

4.4.2. I built a model for quantitative analysis based on multi-factor statistical methods. *(Bite d., 2010, See 5.1.4.)*

4.4.3. I tested the model with statistical data collected from an existing barcode-based system. *(Bite d., 2010, See 5.1.4.)*

4.4.4. I performed sensitivity-analysis using the model. *(Bite d., 2010, See 5.1.4.)*

4.4.5. I analyzed the extensibility of the model to include the delays caused by business process errors, I defined the critical factors for delays. I came to the conclusion that the model can in an analogue, parallel way only be partially extended to the flight delays that are due to ground handling activities. *(Bite d., 2010, See 5.2.)*

4.5. I used the simplified calculation method for a regional airport, and I found that the integrated use of GIS and RFID improved efficiency. *(Bite d., 2010, See 5.1.4.)*

4.5.1. In case of a regional airport, a reduction of 21,104 lost luggage and 29 flight delays caused by late passenger can be expected, as shown by the simplified calculation method. *(Bite d., 2010, See 5.1.4.)*

4.5.2. Cost savings of up to 1,954,550 Euro/year are expected for a regional airport due to the reduction of lost luggage and 350 Euro/year of flight delays due to lost passengers, as shown by the simplified calculation method. *(Bite d., 2010, See 5.1.4.)*

4.5.3. The expected break-even time is 1-2 years for a regional airport from reduction of baggage losses, as shown by the simplified calculation method. *(Bite d., 2010, See 5.1.4.)*

5. Usability and development of new scientific results

The results of the dissertation can widely be used in air transportation. The system worked out helps to reduce the costs of airports, operators, airlines and ground handling, while meeting airport security rules. The results may be used in a separated way either only in the field of passenger, baggage handling, staff monitoring, ground support equipment, cargo, etc., but the most advantageous way would be the complex use.

Extendable to other means of transportation separately (road, railway, navigation), or to a common unified ticketing system for all transportation systems, or furthermore, beyond the realm of transportation to the monitoring of hospital equipment and processes for instance.

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