USE OF INFORMATION SYSTEMS IN THE FIELD OF SMART MOBILITY MANAGEMENT, IMPLEMENTATION BENEFITS AND LIMITATIONS

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Abstract: *Information systems are widely used in various areas of life and work. Their benefits are also manifested when building Smart Cities concepts, especially in the specific part of smart mobility. The aim of the article is to point out, on the basis of data from secondary analyses, the positive impact of the implementation of intelligent traffic information systems, technologies and applications, including the limitations associated with their use in practice. In addition to secondary analyses, the method of summarizing implementation benefits and limitations was also used in the discussion section, best practice, the selection of which was conditioned by the criterion of relevance, projects using information systems in the field of mobility and the mentioned effects of the case studies. The selected systems are STRIA, TRIMIS and TRAMsim, which can provide quality feedback in real time, improve transport systems and develop new trends in the field of smart mobility. Limiting elements are mainly the low quality of information obtained for the needs of monitoring and determination of critical success factors, the harmonization of STRIA and TRIMIS systems or the influence of a large number of stakeholders on current transport systems, the disadvantage of TRAMsim is its low ability to model social interactions and synergistic effect. The main output of the article is a proposed own model for the effective implementation of information systems in the field of smart mobility, which affects not only the technical, but also the social and managerial aspects of transport systems, technologies, applications and projects.*

Keywords: *smart mobility, intelligent information systems, STRIMS, TRIMIS, TRAMsim*

JEL Classification: *L91, M15, N7, O18, Q01*

1. INTRODUCTION

The connection of transport systems that collect, analyze and process data for effective communication, calculations and management and decision support in transport, including the integration of information and communication technologies, are called intelligent information systems. The development of information systems in the field of mobility is determined by the progress of geographic information systems, which ensure simple execution of the managerial function of planning traffic interactions [1, 2]. In terms of classification of applications and technologies in the field of mobility, there are the following categories [1, 2, 4, 5]:

- TM (traffic management),
- FFA (field force automation),
- FFM (vehicle fleet and freight transport management),
- SCE (supply chain management),
- AID (automatic incident detection),
- WIM (weight in motion), provides information on the weight of vehicles in traffic,
- ATMS (advanced traffic management systems), analyzing data in real time,
- AVI (electronic vehicle identification and online payments),
- AFMS (optimization of delivery storage in real time),
- operational, payment and emergency systems for vehicles on an online basis,
- digital maps, intelligent transport systems,
- geographic information systems, network traffic databases,
- sensors, detectors on the pavement for counting vehicles in traffic, image detectors,
- optical, mobile and telematic network,
- intelligent traffic lights and city platforms,
- internet, monitoring, radar sensors on the towers (sensing the number of vehicles, driving speed, etc.),
- systems for managing public transport and travel.

The chain of information sharing in transport systems is based on the process of data acquisition, their subsequent processing into information, their distribution to specific users (managers, citizens, etc.), who will use them mainly for the need of management and decision-making [1, 2].

2. INFORMATION SYSTEMS IN THE FIELD OF MOBILITY

2.1. STRIA and TRIMIS

Since 2016, the strategic program for research and innovation in transport has been dealing with the aspect of green mobility, which largely affects economic, social and environmental aspects. The European Commission has created a set of the following measures to support research activities and innovation activities [1]:

- Automate transport on a collaborative basis with the aim of increasing efficiency, safety and quality of life.
- Invest funds in science and research in the field of ICT implementation in "smart" transport, the design of new electric cars, alternative sources of fuel and propulsion energy or transport systems that control urban infrastructure through the network through a newly created methodology.

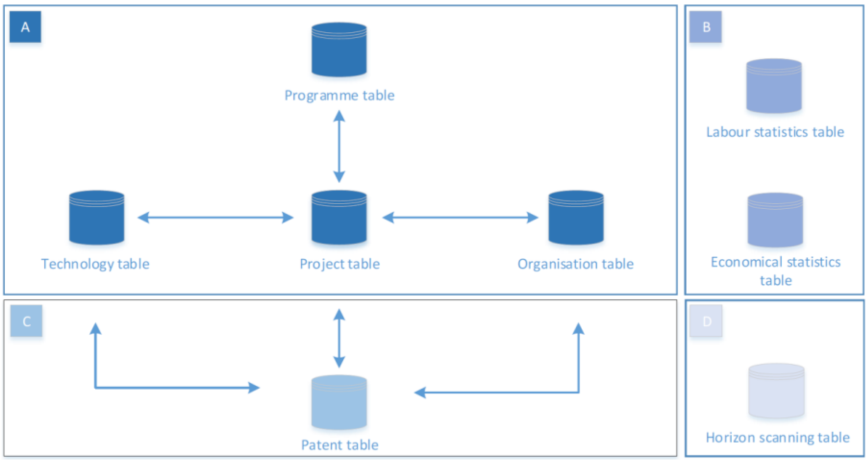

Figure 1. TRIMIS database and its main parts
Source: [1]

The tool for evaluating the implementation of the STRIA program is the so-called TRIMIS. The purpose of the holistic system is to evaluate traffic processes, investigate and analyze traffic trends and, based on the results obtained, to constantly improve and increase the efficiency of traffic processes in the city [1]. Functions of the TRIMIS system include [1]:

- technology support in transport, obtaining data from sensors,
- measuring KPIs, monitoring, assigning content to data, which turns it into information,
- human resources management, investments for information systems in mobility, involvement of all stakeholders.

Information is shared through an open platform that all stakeholders (universities, investors, European Union, researchers and the city) have access to. An innovative element of TRIMIS is the integration that includes strategic foresight and data from the social and economic fields. The obtained data are analyzed in the form of historical trends, monitored and improved through feedback [1].

Area A in Figure 1 presents information on innovative transport projects, including technologies and organizational structures in the programs. The data tables in Part B form a database for evaluating innovations in an ad hoc manner based on data from economic statistics. Partial part C generates knowledge from the so-called PATSTATU, i.e. statistical database of patents, which harmonizes patents with selected research projects in mobility. Block D summarizes all knowledge into a comprehensive database. Its goal is to mediate future development. Trends, new development concepts and information systems interconnection for a partial area of transport in the Smart City issue are addressed by the NETT project, which identifies weak signals and deficiencies in the transport infrastructure through network scanning [1]. The benefits of NETT for the TRIMIS system are [1, 6, 7]:

- Discovering and developing new and innovative transport systems for practice by implementing ICT in mobility.
- Feedback for current systems.
- Improving transport processes.

STRIA and TRIMIS are differentiated, but act as complements, i.e. a strong level of correlation is found between them. TRIMIS, in the form of a transformation process, evaluates the transformation of inputs into outputs including the overall efficiency of transport systems and activities. STRIA solves the strategic level (Figure 2), i.e. setting goals, needs, determining roles, responsibilities and powers [1].

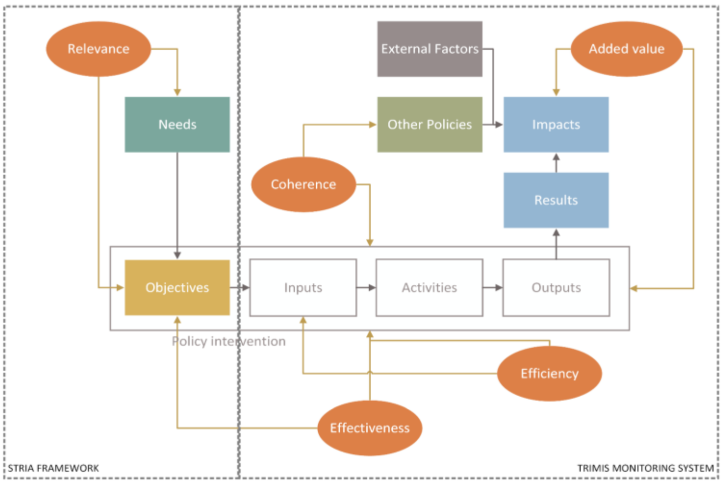

Figure 2. Interconnection between the STRIA structure and the TRIMIS monitoring system
Source:[1]

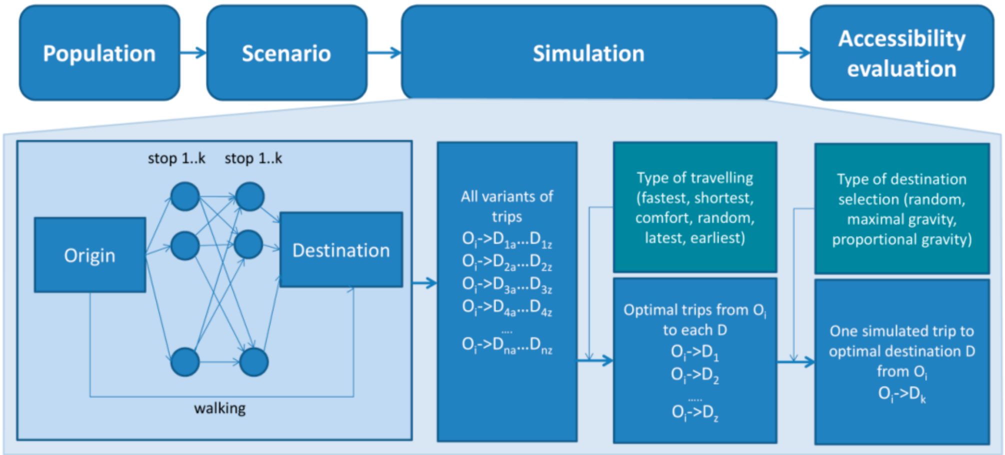

Figure 3. TRAMsim simulation modeling
Source: [3]

2.2. TRAMsim

The model view of the simulation transport system TRAMsim (Figure 3) consists of four areas. In the first part, a sample is selected from the population, including the identification of essential characteristic parameters such as [3]:

- walking distance,
- stops,
- time tolerances and aspects.

In the scenario, activities are defined, which are assigned the exact order of succession. The following are simulations of different types of variants. The last area is the overall evaluation of variants, simulation results and the selection of one solution [3, 8].

3. CASE STUDIES

The selection of case studies was conditioned by the criteria of professional relevance in connection with the issue of the implementation of the selected systems in practice, including established projects and expressed positive and negative effects of their implementation. In addition to secondary analyses, the method of summarizing implementation benefits and limitations was also used in the discussion section.

3.1. Electrification of transport with low emissions in the European Union

The project was implemented in the countries of the European Union, in the area of decarbonization of electricity for electromobility with a positive impact on the protection of limited resources. The development program includes environmental challenges. Financing has been ongoing since 2009, currently the European Union has reserved 3.6 billion Euros for the given project, 2.8 billion Euros for electrification and 0.8 billion Euros for the use of alternative fuels. Out of the total number of 2,422 projects, up to 797 transport technologies were identified. To support transport management, information technologies and systems are used in connection with [1, 9, 10]:

- electric cars and buses,
- intelligent tires,
- modeling tools,
- system modules for the management of efficient use of batteries,
- changes in public infrastructure and transport,
- introducing Li-on batteries,
- searching for alternative fuels, etc.,
- it is necessary for the strategic management of the city to make greater efforts in supporting and implementing new technologies in the field of transport. Recommended frameworks are e.g. STRIA or TRIMIS.

The advantages of the implementation of STRIA and TRIMIS in practice are management support and decision-making, fast, safe transport processes, fewer accidents, restrictions, financial and time savings. Disadvantages include [1, 11, 12]:

- Low data quality will negatively affect KPI monitoring via TRIMIS.
- Harmonization of systems can be complex and problematic - Feedback is difficult, as STRIA can set ambitious goals that will be very difficult or impossible to achieve.
- The limitation is the impact of the system on the current functioning of research in the transport area - the action of a large number of stakeholders.

The solution for the three negatives (problem areas) is to ensure relevant data, control and adequate monitoring, balance and compliance can be achieved by setting goals through the SMART principle, building communities, communication and trust, understanding needs and preferring a win-win strategy is an appropriate way of solving and elimination of the system's negative impact on transport [1].

3.2. Implementation of TRAMsim in traffic processes in Ostrava

The implemented simulation took place on the basis of daily travel to 94% of employers in the geographical area of Ostrava. More than 70% of them have their headquarters in the center of Ostrava for better accessibility. The results of the study pointed to very long and inefficient transport processes. Residents and employees travel an average of 60 to 90 minutes per day, not only to the outskirts of Ostrava, but also to the city center [3, 13].

Table 1. Implementation limitations of systems in the field of transport

Disadvantages	STRIA	TRIMIS	TRAMsim
Low data quality will affect the entire system and the relevance of the data.	Yes	Yes	Yes
Challenging feedback and harmonization.	Yes	Yes	No
Inability to model social interactions.	No	No	Yes
It cannot capture the synergistic effect of the system.	No	No	Yes
A large number of stakeholders acting on the system.	Yes	Yes	No

Source: own processing according to [1, 3]

The selected sample is the inhabitants of Ostrava, the scenario consisted of the interaction of traveling from home to work and back home. The total time included not only mobility, but also waiting for a connection. The simulation pointed to a reasonable travel time and the state of the current state of transport in Ostrava. The disadvantage of the system in practice is the fact that it cannot model social interaction and use the synergistic effect. Its benefit is primarily understanding current processes, reducing stress and promoting efficiency in modern cities [3, 13].

4. DISCUSSION

Among the main implementation benefits of the introduction of the STRIA, TRIMIS and TRAMsims systems, the secondary analysis shows the following [1-13]:

- support of managerial functions of planning, management and decision-making,
- development of scientific and innovative activities in the field of smart transport,
- collaborative principle with an effort to automate transport,
- efficient, safe mobility that positively affects the quality of life,
- development of new trends in the form of creative designs, concepts and projects of electric cars, alternative sources of fuels, propulsion energies, etc.,
- generation of a new methodological framework for the field of smart mobility in connection with intelligent transport systems,
- effective processing of data from sensors, their analysis and transformation into information,
- improving transport processes based on feedback, measurement, monitoring,
- satisfying the needs of stakeholders by creating communities for the field of transport, which strengthens the information and communication aspect and the technological base.

Implementation limitations, which can also be perceived as disadvantages of information transport systems, can be found in the following table.

The strong link between STRIA and TRIMIS also manifests itself in the same limitations, a single disadvantage that affects all systems is the low quality that affects the entire system, the relevance of input data and the predictive ability of results.

The recommended model in Figure 4 consists of the STRIA and TRIMIS connection part. Data from external databases captures information about the needs that generate the set goals for smart transport. Achieving goals is realized through a classic transformation process. Inputs for the field of intelligent transport systems are determined on the basis of the TRAMsim simulation system, i.e. the initial element is the selection of the population. Activities that transform inputs into outputs form implementation scenarios that generate data for the design database. The data is tested in the form of simulations, the results of which represent the output. The effects are evaluated by describing the positive and negative effects of information systems on transport technologies and applications. The entire model connects not only technological (databases), but also managerial (goals, management), mathematical (simulations) or social (needs, population, etc.) aspects.

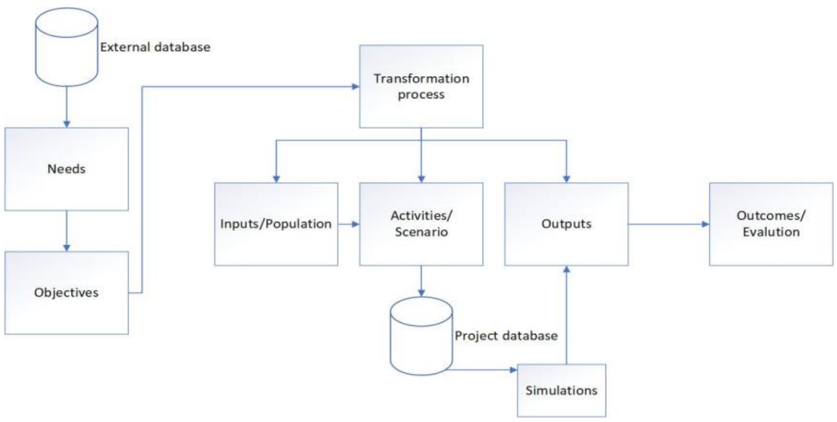

Figure 4. Recommended implementation process of information transport systems based on the principle of STRIA, TRIMIS and TRAMsim
Source: own processing according to [1, 2, 3]

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