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Problems of ITS Components Selection that Meet the Needs of Smart Cities

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ABSTRACT
The article presents selected problems of selecting ITS system components that meet the needs of users of urban transport systems. An algorithm that enables solving problems of selecting ITS services is presented. The article contains examples from selected cities of the urban agglomeration.

KEYWORDS: ITS system, Smart Cities

1. Introduction

Contemporary trends in the planning and development of urbanized areas are heading smart cities. Despite the rapid pace of development of ICT technology constituting the basis of solutions in the field of intelligent transport systems, the main barrier to urban development towards smart cities is the problems arising from transport congestion occurring in urban transport systems. The complexity of functioning of urbanized areas and urban transport systems in connection with the transport needs of their users result in the necessity to develop dedicated system solutions shaping transport accessibility of urban space and the mobility of its users. In the further part of this paper selected issues concerning such dedicated system solutions of ITS in the form of functional and operational ITS configuration are presented.

2. ITS functional and operational configuration

The ITS functional and operational configuration defined at the ITS design level is the appropriate ITS architecture in which a specific set of ITS services has been implemented. The ITS architecture (Fig. 1) [2, 14] includes logical and physical aspects of ITS, including ITS services, which should satisfy the aspirations of ITS stakeholders (Fig. 2), in particular aspirations of ITS users in the urban area. Because ITS services can be implemented by various transport telematics systems, the ITS functional and operational configuration can be present in various technical and organizational variants, which comprise ITS service packages [16]. In addition, defining several ITS configuration variants is associated with the need to implement ITS subsystems in stages, including for organizational and financial reasons. In such cases, subsequent technical and organizational variants of the ITS configuration are associated with the subsequent stages of the ITS implementation.

The development of the ITS systems concept for urban agglomeration areas [6-8] takes into account technical and organizational variants of the ITS functional configuration. The subsystems that make up the ITS configuration include:

- Zonal Traffic Control System,
- Drivers Information System,
- Passengers Information System,
- Video Surveillance and Monitoring of Public Space System,
- Surveillance and Enforcement of Traffic Rules System,
- Public Transport Management System.

The functional-operational attributes of the ITS configuration include among others:

- main goals,
- specific goals,
- functionality,
- system integration.

Technical-organizational attributes of ITS configuration include among others:

- main technical components of the ITS installation, location of ITS technical components.

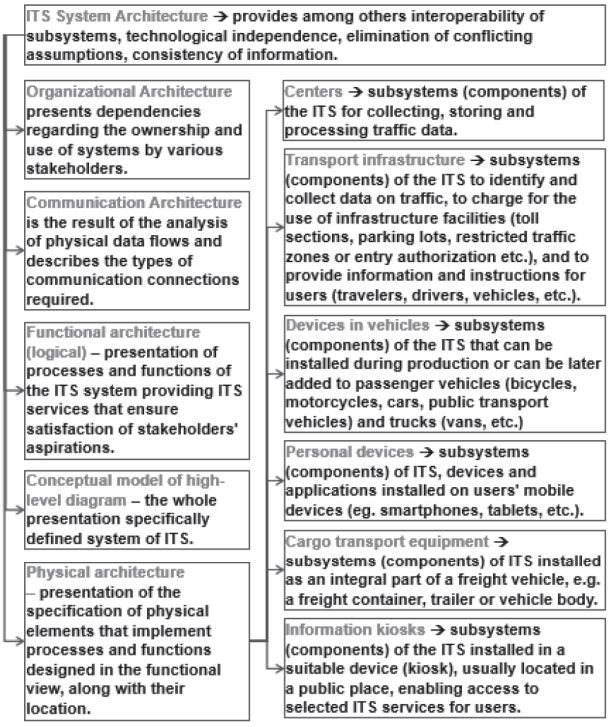

Fig. 1. ITS Architecture [own study]

The assignment of the characteristics of ITS subsystems together with the functional-operational and technical-organizational attributes of ITS creates the variant of the ITS functional and operational configuration. Changing any item in such a list may create a new variant of the ITS configuration, where the changes may be of a functional and operational nature if they relate to such functional-operational attributes or technical and organizational character if they concern technical-organizational attributes.

Technical and organizational changes justify the adoption of a new variant of ITS configuration, because in the next stages of ITS development – during detailed design – in the new variant, other technical systems will be taken into account which are other technological solutions of ITS subsystems, including for example with another location of technical infrastructure.

The ITS functional and operational configuration variants may also include delimitation of the urbanized area into sub-areas of traffic control, taking into account administrative delimitation and integration of the planned ITS system with:

- external systems, eg with ITS systems in neighboring cities of the urban agglomeration or with the national traffic management system,
- internal systems – ITS systems in selected cities of the urban agglomeration – in the case of ITS design for the whole urban agglomeration.

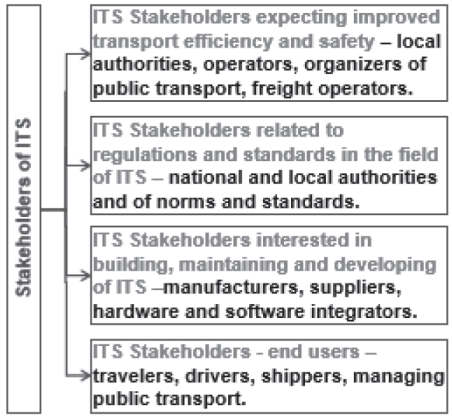

Fig. 2. ITS Stakeholders [own study]

It is worth noting that administrative delimitation of settlement clusters and their settlement structures may also have an impact on the formulation of ITS functional and operational configuration.

3. Functional-operational attributes of the ITS configuration – example for city of urban agglomeration

In the ITS concept project for the city [3, 4], the main goals are to increase the investment attractiveness of the city, agglomeration, region and country through the development of technical infrastructure, while protecting and improving the environment, health, preserving cultural identity and developing territorial cohesion. These goals are to be achieved through the implementation of improved traffic management in the form of modern ITS – an intelligent traffic management system and public transport along with increasing the attractiveness of public transport. In the ITS concept project for the [3, 4] detailed goals were adopted, the description of which is given in Fig. 1.

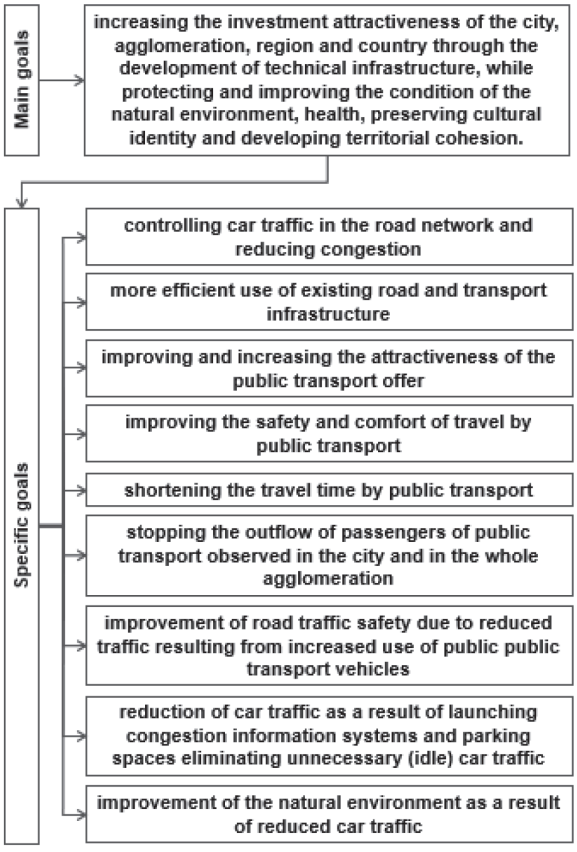

Fig. 3. Main and specific goals of ITS – example for city of urban agglomeration [own study]

4. ITS configuration variants as elements of the logic of activities during ITS deployment – example for city of urban agglomeration

The ITS project for the city [9, 11, 12] defines the following ITS configuration variants (V1-V4), distinguishing their basic functions:

- V1 – improving the traffic of public transport tram and, as a result, increasing the tram transport speed in the main transport corridors of the city,
- V2 – in addition to the variant V1, improving the traffic of public transport vehicles (bus) and partially passenger cars - in the city center,
- V3 – in addition to variant V2, distribution of information for drivers about congestion and, as a result, balancing the network load at communication peaks,
- V4 – in addition to the variant V3, improving car traffic by adding to the traffic control system the main road routes to the city center.

The development of ITS variants and appropriate measures results from the adopted ITS configuration logic (Fig. 4), which takes into account the ITS project implementation process, including the right sequence of actions, which minimizes the undesirable results of the ITS system - results contrary to the main and specific objectives. Examples of undesirable results of the ITS system's operation in increasing the smoothness of traffic flows may include among others:

- creation of the so-called induced traffic – increased car traffic caused by increased traffic flow in the initial period of operation of the traffic control system and, as a result, re-congestion of the urban transport network,
- inefficient use of public mass transport caused by improper shaping of transport behavior of users – premature improvement of car traffic conditions in the network and thus increasing the attractiveness of a passenger car; lack of attractive public transport offer due to non-adaptation to the users' needs of the following system components: timetables, routes of transport lines and spatial location of bus stops, stations and multimodal nodes,
- lack of system integration of urban transport in the scope of: joint ticket for all public urban transport subsystems, park & ride interchanges, use of new, innovative ways of moving, among others: bikesharing, carsharing and electric personal transport vehicles (electric scooter, electric bike , etc.).

In addition to the four variants of V1-V4, a variant V5 was also proposed, in which, in addition to the variant V4, the improvement of cargo transport and the integration of urban public transport systems (tram and bus) with regional rail transport and international air transport; the following subsystem functionalities were adopted:

- freight transport management, including: automatic security inspection (pre-selection of overloaded vehicles) and control of dangerous goods transport (identification of marked vehicles transporting hazardous materials),
- management of regional rail transport in the city area, including: automatic localization of trains, information for travelers about arrivals and departures of trains and communication with public urban transport – on trains, at railway stations and stops as well as multimodal transport nodes,
- information for travelers about communication of public transport systems with the nearby international airport, including: information for travelers at airport terminals and multimodal transport nodes.

The scheme (algorithm) of selecting the ITS configuration variant constituting the basic component of the structure of the ITS project using the transport model is shown in Fig. 5. The ITS project evaluation should be prepared before and after its implementation (ex-ante and ex-post), taking into account the quantitative and qualitative effects of ITS configuration effects.

The problem associated with the assessment before and after the launch of ITS is the method of performing this assessment. To evaluate the ITS project before its implementation, the transport model is used, in which the ITS effects for the assessed configurations are mapped [5, 10, 13]. However, after the implementation of ITS, appropriate tests and measurements

of the actual transport processes should be performed in order to determine the values of measures adopted at the ITS design stage [3, 4]. Therefore, the results of the assessment depend on one hand on the accuracy and detail of the transport model and the accuracy of mapping in this model of the planned ITS system and the results of its operation. On the other hand, the results of the assessment depend on the scope and accuracy of the implementation of appropriate tests and measurements of transport processes.

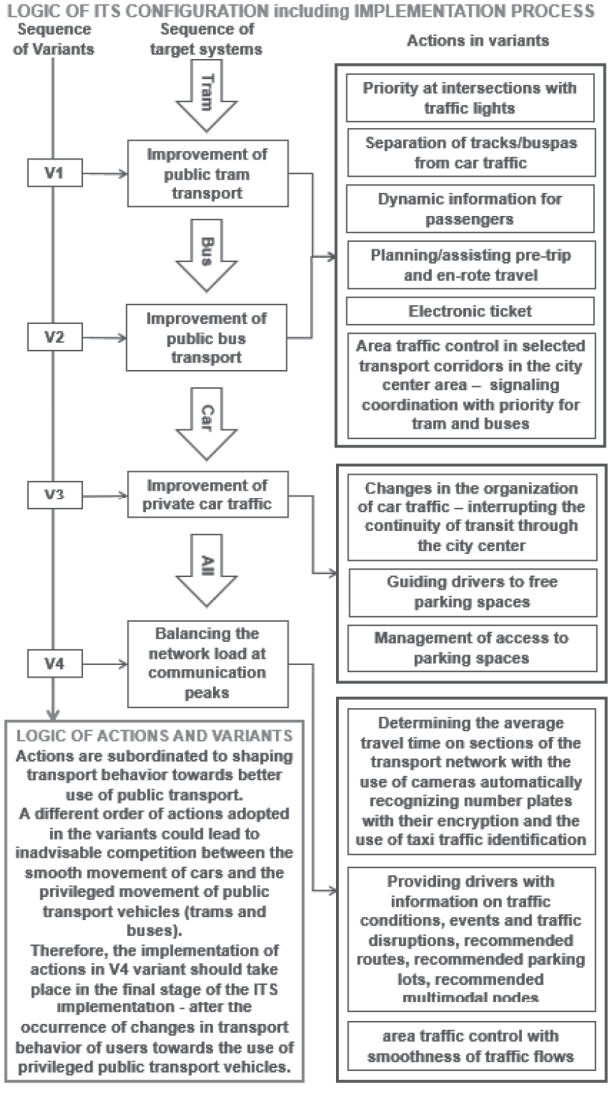

Fig. 4. Logic of ITS configuration including implementation process – example for city of urban agglomeration [own study]

5. Conclusion

The ITS system design described in the article in the form of specific ITS configuration variants covers multidisciplinary issues concerning the basic aspects of the functioning of technical-human systems, which include ITS systems, and socio-economic systems that include cities and urban agglomerations. Therefore, method models and tools from systems engineering are used to develop the ITS configuration [1, 2, 14, 15]. However, in spite of their application, the factors that are difficult to take into consideration are additionally the issues of the policy of the municipal authorities and their ability to finance the ITS project. These conditions are reflected in the aspirations of the stakeholders, but sometimes their inclusion makes it difficult or impossible to develop the ITS configuration variant appropriate to solve the problems of functioning of smart cities.

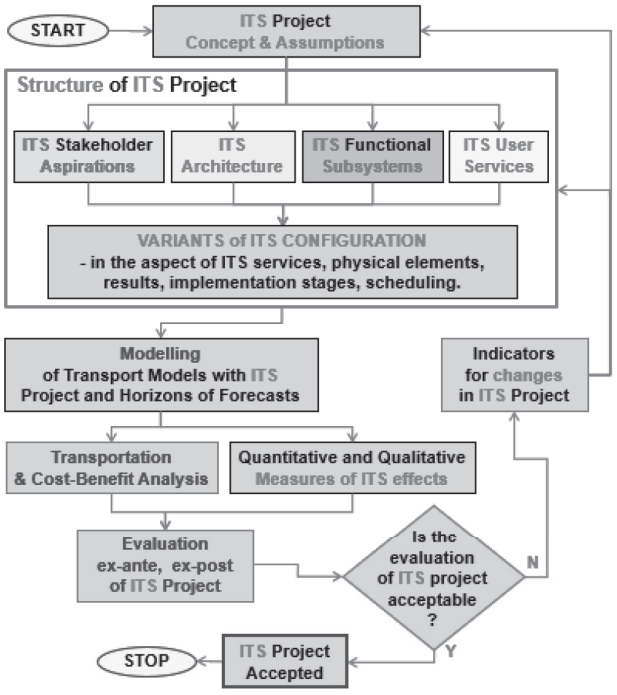

Fig. 5. The scheme (algorithm) of selecting the ITS configuration variant [own study]

Bibliography

[1] Architecture Development Team for Research and Innovation Technology Administration (RITA), National ITS Architecture. Service Packages. US Department of Transportation Washington D.C., 2012

[2] European Intelligent Transport System (ITS) Framework Architecture (E-FRAE), http://frame-online.eu/ [date of access: 12.02.2017]

[3] KAROŃ G.: Analysis of the current status in the development of pre-design documentation for the project entitled, Intelligent Transport Management System for Katowice City (in Poland). Report of Research Work for City Hall of Katowice, Poland, 2016

[4] KAROŃ G.: Guidelines for the selection of the contractor of project and documentation of Intelligent Transport Management System for Katowice City (in Poland). Report of Research Work for City Hall of Katowice, Poland, 2016

[5] KAROŃ G.: Kształtowanie ruchu w miejskich sieciach transportowych z wykorzystaniem inżynierii systemów (eng. Traffic Shaping in the Urban Transport Network with the Use of Systems Engineering). Wydawnictwo Politechniki Śląskiej. Gliwice 2019

[6] KAROŃ G., MIKULSKI J.: Forecasts for Technical Variants of ITS Projects – Example of Upper-Silesian Conurbation, in Mikulski J. (ed) Activities of Transport Telematics, Springer Verlag, Berlin Heidelberg, CCIS 395, pp. 67-74, 2013

[7] KAROŃ G., MIKULSKI J.: Functional Configuration of ITS for Urban Agglomeration, in Mikulski J. (ed) Smart Solutions in Today's Transport, Springer Verlag, Berlin Heidelberg, CCIS 715, pp. 55-69, 2017

[8] KAROŃ G., MIKULSKI J.: Modelling of ITS Service Configuration and Stakeholders Aspirations. Archives of Transport Systems Telematics vol. 11, Iss. 3, pp. 24-29. PSTT, 2018

[9] KAROŃ G., MIKULSKI J.: Problems of ITS Architecture Development and ITS architecture implementation in Upper-Silesian Conurbation in Poland, in Mikulski J. (ed) Telematics in the Transport Environment, Springer Verlag, Berlin Heidelberg, CCIS 329, pp. 183-198, 2012

[10] KAROŃ G., MIKULSKI J.: Problems of Modelling of ITS Services in Transportation Models. Archives of Transport Systems Telematics vol. 11, Iss. 3, pp. 30-34. PSTT, 2018

[11] KAROŃ G., MIKULSKI J.: Problems of Systems Engineering for ITS in Large Agglomeration – Upper-Silesian Agglomeration in Poland, in Mikulski J. (ed) Telematics - Support for Transport, Springer Verlag, Berlin Heidelberg, CCIS 471, pp. 242-251, 2014

[12] KAROŃ G., MIKULSKI J.: Selected problems of ITS Project Development – Concept Exploration and Feasibility Study, in Mikulski J. (ed) Smart Solutions in Today's Transport, Springer Verlag, Berlin Heidelberg, CCIS 715, pp. 1-15, 2017

[13] KAROŃ G., MIKULSKI J.: Structure of Transport Model on Strategic Level of Management for Assessment of ITS Configuration. Journal of KONES Powertrain and Transport. Vol. 24, No. 3, 2017

[14] National ITS Architecture 7.1, http://local.iteris.com/itsarch/ [date of access: 12.02.2017]

[15] Systems Engineering Guidebook for Intelligent Transportation Systems. U.S. Department of Transportation. November 2009

[16] ŻOCHOWSKA R., KAROŃ G.: ITS services packages as a tool for managing traffic congestion in cities. In: Sładkowski A., Pamuła W. (eds.) Intelligent transportation systems - problems and perspectives. Studies in Systems, Decision and Control, vol. 32, pp. 81-103. Springer International Publishing Switzerland, 2016