# COMPARISON OF ROAD TRAFFIC INTELLIGENT TRANSPORT SYSTEMS APPLICATION LEVELS IN REPUBLICS OF MACEDONIA AND SLOVENIA

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**Abstract**

Intelligent transport systems (ITS) rely on the application of advanced information and communication technologies in transport and covers all modes and elements of transport systems including vehicles, infrastructure, users, all of which in dynamic interaction. With the ability to receive, process, analyze and share information in real time, as core feature, ITS can help reduce congestion and emissions while smoothening door to door mobility, all-together contributing to transport efficiency.

The traffic related problems like congestions, safety, carbon footprint, high costs, etc., could not be solved entirely only through new road infrastructure, so measures like ITS can help by providing the basis for connecting technology, society, and transport systems with systems for automation, communication and information exchange.

This paper presents analysis and comparison of ITS application levels in Republic of Macedonia and Republic of Slovenia. The research was carried out within the framework of the bilateral research project cooperation between these countries.

***Keywords – Intelligent Transport Systems, ITS services, ITS application.***

## INTRODUCTION

Intelligent Transport Systems (ITS) are a global phenomenon, attracting worldwide interest of transportation professionals, automotive industry, and policy decision makers [1]. ITS rely on the application of advanced information and communication technologies to transport and covers all modes and elements of transport system including vehicles, infrastructure, users, all of which in dynamic interaction. *ITS presents a new approach to solving old traffic problems*. By changing approaches and trends in transport and traffic research ITS can help reduce congestions, pollution and improve transport efficiency and safety.

Every country and every city has its own transport system so different ITS technologies are used in order to develop the effective local, context - appropriate traffic and transport solutions. This paper provides an overview of the current status of ITS implementation and deployment in Republic of Macedonia and Republic of Slovenia based on the ITS services in the road transport.

This paper is organized as follows. The second section gives a basic description of ITS services. The third section presents analysis and comparison of ITS implementation level in the Republic of Macedonia and the Republic of Slovenia. Paper ends with a conclusion towards similarities, differences, and lessons learned from the different implementation.

## ITS SERVICES

Categorization of ITS activities is one of the first steps in defining the range of activities, where some or all of which can be supported by any ITS implementation. It serves to delineate different sectors of the ITS industry [2]. The ITS service are: (i) traveler information; (ii) traffic management and operations; (iii) vehicles; (iv) freight transport; (v) public transport; (vi) emergency services; (vii) transport related electronic payment; (viii) road transport related personal safety; (ix) weather and environmental monitoring; (x) disaster response management and coordination; (xi) national security; (xii) ITS data management; xiii) performance management. The categorization of the services into 13 groups does also not imply that all ITS architectures and implementations deployed from them should be required to follow this construction [2]. Decision makers in transport sector have freedom in developing and implementing appropriate strategies for solving problems.

The above mentioned ITS services are used in this paper to present an overview of the current status of ITS implementation in both countries. A review regarding these experiences is presented in the following section.

## ITS IN THE REPUBLIC OF MACEDONIA

The Republic of Macedonia is at the very beginning of the process of applying ITS. Solutions from the area of *traveler service information, traffic management and operations and public transport services* are implemented mainly in the capital city of Macedonia, Skopje. With a population of over 600000 inhabitants, and as the Macedonian center for administration, education, business institutions and activities, the city faces a constant increase of travel demand. Due to a significant increase of vehicle-based mobility in the past decade and year-long neglecting of transport infrastructure build up, the city of Skopje is plagued by severe congestion during the morning and afternoon peak hours. This forces the city authorities to undertake systematic approach to solve the problem. ITS can be applied to support the mentioned systematic approach.

### Traveler Information Services

Traveler Information Services are a key element of ITS deployment and essential component for an effective and efficient traffic management. They are designed to provide the traveler with comprehensive real - time traffic information allowing for well-informed travel decisions (pre-trip information) and during the journey (on-trip). In Skopje, five *variable messages signs* have been implemented. They include real time information concerning a road network and traffic conditions.

One way to promote greater use of public transport is by providing *real time passengers information*. The automatic location of the vehicles allows to obtain the time of departure/arrival and transfer from one to another vehicle that stands out at the stops, at home, etc. In Skopje, there are several signs on certain public transport lines on the bus stops, which show real - time bus arrival.

### Traffic Management and Operations Services

A special and crucial element for traffic management and ITS is the Traffic Management and Control Centre (TMCC). To cope with the increased traffic demand a TMCC using the UTOPIA (Urban Traffic Optimization by Integrated Automation) adaptive system has been built in Skopje in 2014 as a result of FP7 project CIVITAS RENAISSANCE and with extra funding from EBRD grant [3]. Currently, it monitors and manages 90 intersections in real time. New parts of the road network are being constantly added. TMCC is organized based on the highest standards and its main functions are: obtaining traffic data in real time, regulation of the traffic signal system, traffic monitoring, giving priority to public transport and providing real time information for drivers. For this purpose, detectors and sensors have been installed at urban intersections, as well as 50 cameras

for traffic flow monitoring and 47 new traffic signal controllers. Today, this Centre is fully functional and is the first example of an IT based advanced traffic management and control system in Macedonia. This Centre constitutes a solid base for the introduction of new incoming solutions such as Smart Parking or Smart Free Parking System in the Skopje center, as well as Share Transport solutions [4].

### UTOPIA (Urban Traffic Optimization by Integrated Automation)

UTOPIA belongs to the third generation of adaptive control systems and is an innovation in urban traffic control as a hierarchical, adaptive, distributed and open system. The system offers a wide range of strategies designed to suit any road network. A range of strategies are available: from plan selection to traffic responsive and fully adaptive, to permit the ideal solution for each specific site. The effectiveness of mentioned system for a congested corridor of 7 signalized intersections in the wider center area of the City of Skopje is presented in [5]. Consequently, research is constantly being undertaken on in - depth analysis in this area.

### Public Transport Services

These services aim to improve the efficiency and friendly attitude of public transport to passengers. *Public transport priority* can be given by integration in urban traffic management systems. Public transport priority is a means to make the switch from individual to public transport more attractive. The introduction of the *Automatic Vehicle Location (AVL)* system in the public transport of the city of Skopje is the last project in this area. From 1 January 2016, electronic tickets and AVL system have been put into use in public transport, but problems regarding BUS locations are detected during system field testing. *Electronic bus tickets* have become available in private transport on May 1, 2016. So far, the equipment has been installed in 377 buses, including GPS systems, processors, fiscal devices, audio devices for advertising, displays, etc.

## ITS IN THE REPUBLIC OF SLOVENIA

The Republic of Slovenia, as an EU member, is developing its strategy of ITS implementation according to the Directive 2010/40/EU [5], which is oriented into a more sustainable, efficient and safer traffic in the European Union. The priority areas for the development and use of specifications and standards defined in Directive 2010/40, are [7]: (i) optimal use of road, traffic, and travel data; (ii) continuity of traffic and freight management of ITS services; (iii) ITS road safety and security applications; (iv) linking the

vehicle with the transport infrastructure. The following detailed descriptions of current and planned implementations of ITS in road transport are mostly summarized from the Slovenian report [7].

Traveler information
(Optimal use of road, traffic, and travel data)

According to the [7], *activities linked to the traveler data and information* were already widely implemented and their further implementation is planned also in the future.

Already now, variety of real-time traveler information services are available – they are given to users separately for different transport modes, both in Slovenian and English language. Main services are on-line and reachable by different communication media. These services are operated by different operators, especially for public transport. The project "Integrated public transport system" (IJPP) established Google transit platform for Ljubljana public transport (bus operator) and Slovenian Railways (railway operator). Establishment of a national public transport management center is planned, as well as travel planning in intermodality and integration on national level.

*Real-time travel information service* is provided by Traffic Information Centre for Public Roads (PIC). The information is available on-line via free-of-charge voice station, telephone number, teletext, live reporting on local radio and TV stations. Partially is transmitted to drivers also via Variable message sign (VMS), implemented mostly on the whole motorway network, and via RDS-TMC system, which is still private provider. Information on current Level of Service on state roads in Slovenia is available on-line (www.here.com). Freight traffic real-time travel info is also provided, while the provision of information on dangerous freights optimization is planned. *Real-time cross-border traffic data* monitoring and exchange was established between Italy and Slovenia with TCC in Palmanova (Italy) and Kozina (Slovenia) and between Austria and Slovenia for monitoring traffic situation and for defining common measures in case of accidents in motorway tunnel Karavanke (cross-border tunnel).

*Road, traffic and transport services data* for the national road network are available with coordinates and therefore are suitable for further *use in digital maps*. Currently, data are collected only for the infrastructure management and spread in different databases in Slovenian motorway company DARS d.d., Traffic Information Centre for state roads, the Surveying and Mapping Authority of the Republic of Slovenia, Slovenian Roads Agency, etc. "SIJPRIS" is geographical information system for the management of the public inter-urban bus transport services and represents a central public

transport database. The system offers central public transport database, web services for data exchange, tools for maintenance and analysis of infrastructure data, time-schedule register, and it supports running business with concessioners.

*Road safety related traffic information* are available via Traffic Information Centre, Administration of the Republic of Slovenia for Civil Protection and Disaster Relief - national notification center, other associations (e.g. AMZS Roadside Assistance – EuroRAP,), and media.

In the future, Slovenia will implement *multimodal travel information services* and also continue with the activities for optimal road use, and real-time traffic and travel data and information, also applicable for digit maps and with provision of road safety information free of charge.

Traffic and Freight Management
(Continuity of traffic and freight management ITS services)

Slovenia is involved in many projects supporting ITS deployment on the European and National level. The largest volume of ITS activity has been realized in the field related to *information and communication infrastructure* through the implementation of TCS introducing new telecommunication hub of the RNC Ljubljana. This RNC together with PIC became a temporal center for the management of the entire Slovenian part EU corridor between tunnel Karavanke (Austria) and Zagreb (Croatia) and represents the infrastructure base for the new National Traffic Management Centre (NCUP), taking into account the new EU directive on the deployment of intelligent transport systems in the field of road transport. NCUP includes all public road network in Slovenia, i.e. all national roads and strategically important local roads. Within NCUP the integration of five components was made.

Because of the small size of the Republic of Slovenia, the activities concerned with continuity of traffic and freight management ITS services are handled quite moderate. For the transit traffic in direction West-East and South-North management of multimodal freight transport is well developed by private logistics operators (international port in combination with railway and/or road: e.g. use of block trains on international journeys). The use of RFID is foreseen, but can be freely changed to other technologies, used by other systems and services.

From April, 1st of 2018 a new, *modern electronic toll system* in free traffic flow, applying to the vehicles whose max. permissible weight exceeds 3.5 tonnes, named DarsGo, was introduced. Tolling is possible with the help of special unit, installed in the vehicle. The tolling portals, spread out over the entire highway and motorway network, detect the unit as the vehicle pass

by, and this is the basis for charging toll amounts for each passed section (there are 126 tolling sections on the total distance of 618 km). A toll fee depends on the traveled distance and the properties of the vehicle.

*Control of commercial vehicle in Slovenia* is organized with WIM point detection system, called SI-WIM (operated by Cestel Ltd. on behalf of DRSC). Control of dangerous goods transport in Slovenia is accomplished in three fixed locations (control points) on Slovenian motorways. It is planned to improve information for freight traffic, e.g. information service on available parking places, service for planning safe freight itineraries (specific dimensions, gross weight, axle load) and for planning and risk management of dangerous goods transport.

*Monitoring of goods* in sense of tracking and tracing of freight on road and railway networks in Slovenia is a matter of an agreement between transport operator and contracting authority.

The *Urban Traffic Management* was made as a proposal, which will be used in the case of new center for non-motorway roads, called CUVP (State for traffic management of non-motorway state roads), established by Slovenian Road Agency. This center will exclude the cities Ljubljana and Maribor, which have their TCC on the Municipality level. Base for the Slovenian Urban ITS architecture was project "FRAME", therefor the conceptual design of Slovenian framework is compatible with the European framework.

ITS road safety and security applications

*Emergency call system* (e-Call) is implemented on the motorway road network and it is integrated into the existing traffic information system that ensures quick and reliable mean of providing traffic information to traffic control center and 112 regional Public Safety Answering Point. The system use Cell ID/ Sector ID based localization.

In the Republic of Slovenia, some public *parking places* are secured with video surveillance and are free of charge. Private operators provide more secure and physically protected parking places usually not free of charge.

Transport operators use different solutions for vehicles and freight tracking. Usually, the solutions are not integrated as the original equipment of the vehicle but are built-in later.

RDS-TMC service is available in public-private partnership; the public RDS-TMC service is planned. The information shall be provided in DATEX II format.

Linking the vehicle with the transport infrastructure

*Cooperative traffic management* is not yet implemented at regional or national level. There are some pilots on the local level, such as using

wireless ZigBee DSRC communicators to request for signal bus priority and for better information about bus stop in the City of Ljubljana (see Civitas Elan project).

*Design and implementation of integration of different ITS* in an open in-vehicle platform as well as of cooperative systems (vehicle-vehicle, vehicle-infrastructure, infrastructure-infrastructure) depends on international solutions. Also, the implementation of RFID in transport is not realized yet.

## RESEARCH RESULTS AND DISCUSSION

The research analysis shows that levels of ITS deployment in both countries are different, as expected. Comparison of categories of ITS (according to EU Directive 2010/40) and their implementation status between Republics of Macedonia and Slovenia are presented in Table 1.

Table 1. Comparison of categories of ITS (according to EU Directive 2010/40 and their implementation status between R. of Macedonia and R. of Slovenia

| **ITS services[1]** | | **R. of Macedonia** | **Comment** | **R. of Slovenia** | **Comment** |
|---|---|---|---|---|---|
| Traveler information (Optimal use of road, traffic, and travel data) | Real-time travel information service | ✓ | Implemented | ✓ | Implemented |
| | Real-time cross-border traffic data | | | ✓ | Implemented |
| | Road, traffic and transport services data | | | ✓ | Implemented |
| | Road safety related traffic information | | | ✓ | Implemented |
| | Multimodal travel information services | | | ✓ | Implemented |
| Traffic and Freight Management (Continuity of traffic and | Electronic toll system | | | ✓ | Implemented |
| | Control of commercial vehicle | | | ✓ | Implemented |

[1] According to the Directive 2010/40/EU

| | | | | | |
|---|---|---|---|---|---|
| freight management ITS services) | Monitoring of goods | | | ✓ | Implemented |
| | Urban Traffic Management | ✓ | Implemented | ✓ | Implemented |
| ITS road safety and security applications | Emergency call system | | | ✓ | Implemented |
| | Parking places are secured with video surveillance | | | ✓ | Implemented |
| Linking the vehicle with the transport infrastructure | Cooperative traffic management | | | ✓ | Not yet implemented |
| | Design and implementation of integration of different ITS | | | ✓ | Not yet implemented |

According to the comparison (Table 1) of categories of ITS and their implementation status between both republics, it could be seen that most of the ITS components already implemented in Slovenia are not yet implemented in Macedonia. As an example, in the category of Traveler information (Optimal use of road, traffic, and travel data) only the real-time travel information service is implemented in Republic of Macedonia. The Republic of Macedonia has shown a slow progress in the process of ITS services implementation and the level of maturity of ITS is very low.

We can conclude, that the implemented ITS services in R. of Macedonia are fragmented, uncoordinated and cannot provide benefits for transport users. The very first steps and recommendations regarding ITS development and implementation for the Republic of Macedonia are: 1) Awareness of policy makers about the importance of ITS; 2) Creation of national ITS strategy of development and implementation according to the Directive 2010/40/EU; 3) Defining priority areas for development and use of specifications and standards defined in the above directive, upon broad systematic approach; 4) Introduction of Macedonian national laws to the European Directive regards ITS; 5)Following of the Slovenian good practices at the operational level.

## CONCLUSIONS

The analysis of current status of ITS implementation shows that in the Republic of Slovenia the implementation of various ITS systems and services is much more advanced and can serve as example and *road map* for

the Republic of Macedonia, while its components are prescribed with the 2010/40 EU directive. The experiences of ITS application in Republic of Macedonia are modest, while in Republic of Slovenia many systems for the integration of different transport modes and vehicles are already implemented and many planned for the implementation and the improvement in next years. Therefore, the main objective of the common project was to make the review of the systems and services already implemented and found out how the Republic of Macedonia benefit from the knowledge gathered from Slovenian experiences.

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