INTELLIGENT TRAFFIC MANAGEMENT AND CONTROL IN THE CITY CENTRE OF SKOPJE

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Abstract

Despite the flow fluctuations and increased traffic demand in Macedonian cities in the last fifteen years, Republic of Macedonia is one of those countries which still employ only the traditional systems of traffic management and control. Those are fixed control systems, which burden the network with problems such as increased travel times and travel expenses as well as environmental degradation. A general call for *something to be done* becomes obvious. The best practices have shown that this can be realized through unconventional solutions i.e. by means of intelligent traffic management systems.

It is the first time that in R. Macedonia a decision has been reached to have a system and thorough approach in the replacement and modernization of the traffic control system. The first step has been made with a research project aiming at intelligent traffic management and control system in the centre of the city of Skopje as a constituent of the Testing Innovative Strategies For Clean Urban Transport For Historic European Cities - RENAISSANCE - FP7 Project.

The study denotes the process of designing intelligent management for city centre, and defines the phases of design and the corresponding technology.

Our main goal was to create a "smart" traffic management and control system so that the city of Skopje can cope with the increased traffic problems. What we primarily had in mind here was meeting the needs of all kinds of traffic users with reference to mobility, safety, sustainability, accessibility, environmental protection. We believe that the city of Skopje will make a step forward and "learn" that there are "intelligent" techniques for improvement of traffic conditions only by sharing both the best practices with the other cities – project participants and the positive results that the adaptive traffic management and control system – UTOPIA has shown. We are convinced that we have slightly diverged from the current conventional approach and therefore made the right choice with a vision from a higher prospective.

Keywords

.....signalized intersections, traffic management and control, intelligent traffic solution, traffic management centre

INTRODUCTION

Traffic problems arise mostly because of the impossibility to significantly enlarge the useful traffic realms, which imposes the necessity of correct management of the current traffic surface. It is difficult to coordinate the different and opposite interests of traffic users unless there is an appropriate concept and strategy in the traffic management and control.

In the city of Skopje signalized intersections are operated with fixed control and their work is based on the so called historical data, with a fixed cycle and phase split.

Due to the large number of intersections in a small space, classic solutions – reprogramming, as well as partial replacement of outdated technology of the local traffic signals at certain intersections only, appear inefficient because the current technological system cannot be adapted to the new conditions.

The discrepancy between the performance of the traffic signals and the traffic demand creates a bad image with traffic congestion especially in the peak hours. Thereby, a need emerges for an urgent action in the whole system of city traffic management and control.

The new technologies enable a greater availability of the traffic network in the cities. The need for a systems approach to modernization of the traffic flows management and control becomes a must.

This paper is divided into two parts. The first one contains the analysis of the intersection performance in the study scope area. The research refers to the traffic parameters that denote average time losses, the level of service and the degree of saturation. The critical intersections to be examined within the scope of the research are defined.

The second part depicts the whole process of designing intelligent urban traffic management and control in the centre of the city of Skopje; the approach philosophy, the concept of the system, the phases of the implementation of the same, the traffic control centre.

A presentation of the factors of success, the obstacles to implementation of certain elements and the steps to be taken is included**.**

The Background

Over the last decades, the city of Skopje has experienced huge problems with the traffic because of the break down of the old industrial system and the reorientation of the inhabitants to secondary and tertiary activities, which on the other side causes greater mobility of people and thus consequently increased traffic use – the most utilized mode of all being the car ride.

The traffic network in the research study scope area (within the project) is presented in Fig. 1**.**

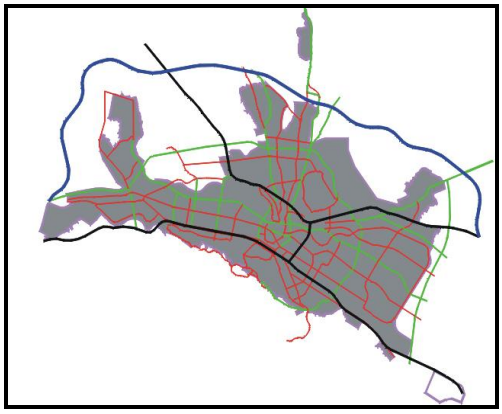

Figure 1 Scope of the traffic network considered

According to the research done, the critical issues perceived are:

- Traffic congestion (the most serious one)
- Intersections operate near or over capacity
- Travel time losses
- Public Transport – low commercial speed, low Level of Service (LOS)

General Remarks and Approach Philosophy

We started with the notion that transport of people is crucial because of the following reasons:

- Economic functioning and development
- Urban co-operation in social and political life
- We assumed that the city of Skopje has to be understood to work as an organic whole. Hence:
- An infrastructure has to be provided to all land use areas (connective aspects)
- Provision of sufficiency (capacity aspects) has to be considered
- Provision of certain travel speed (quality aspects) has to be considered

We decided to apply an approach philosophy that is based on identification of issues and objectives, definition of the ways of treating the issues and designing the ways of how to achieve the ultimate goal (Fig. 2).

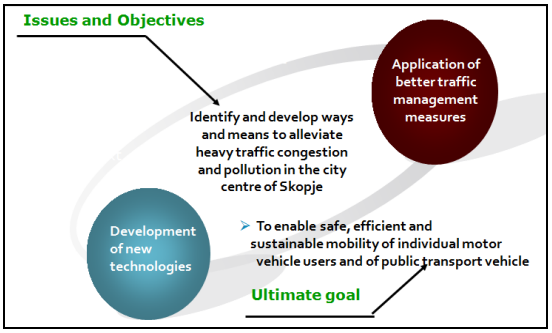

Figure 2: Approach Philosophy

Based primarily on the sustainable urban development policy, which implies the capability of city functionality, the quality of life for the citizens, and the quality of the city of Skopje as a place for economic activity should be kept, traffic management system is a crucial term for the concept of traffic problem solving.

In order to achieve the intelligent solution pattern, the aspects of traffic engineering, systems engineering and organizational aspects have to be included (Fig. 3).

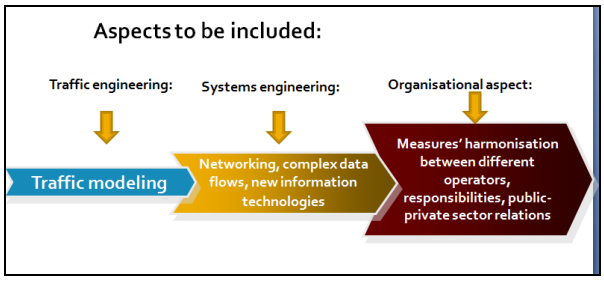

Figure 3: Intelligent solution pattern

Figure 4 shows the global concept of the intelligent traffic management system.

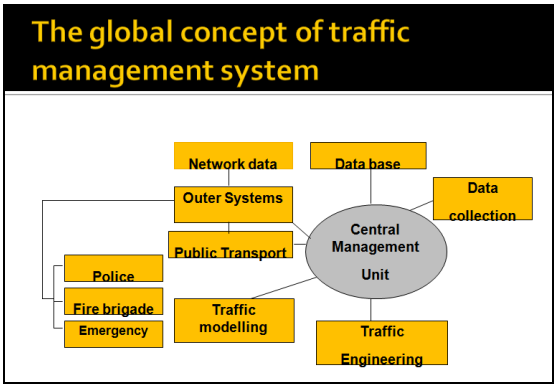

Figure 4: Global Concept of Traffic Management System

We used the *Bottom – up* approach, which integrates the following levels:

1. The level of isolated and signalised intersection
2. The level of linked signalised intersections and optimisation along the corridor (open network)
3. The level of signalised intersections network (closed network)

OUR STARTING POINT

Our vision was based on the following components:

- Transport management system with all major elements
- Monitoring and control of road traffic
- Public transport management
- Parking information, guidance and management

The point or the core element we started from was traffic signals with their relevant components such as:

- Traffic actuated signal programs
- Adequate controllers
- Detection

According to the experts' opinion for traffic problem solutions, there are top two to be regarded when finding "smart" solutions:

1. Traffic light system's potential (high in solving the problems)
2. Information technology's potential

The above mentioned aspects lie behind of what made our vision and the starting point.

The first step was to define the number of intersections in the centre of the city (28) (Fig. 5).

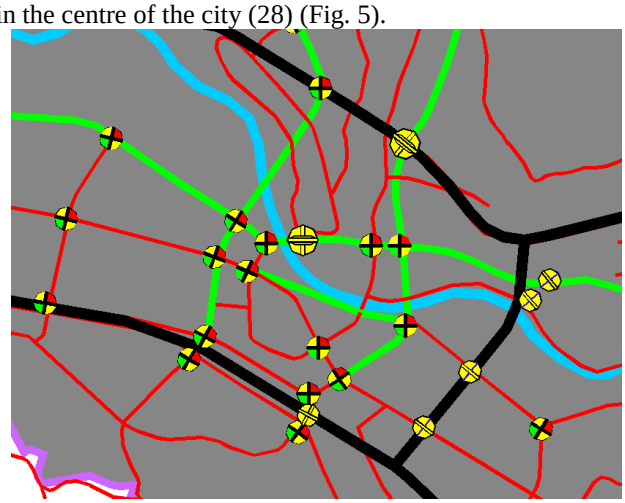

Figure 5: Intersections of interest in the city center

Analysis of current state

The traffic demand was determined by counting the dynamic traffic. The traffic was counted for five days on each intersection according to approach/lanes and vehicle categories (passenger cars, heavy vehicles, buses) in two different periods of the day:

- In the morning from 07:30 to 08:30 and from 08:30 to 09:30 , and
- In the afternoon from 15:30 to 16:30 and from 16:30 to 17:30

The overall demand flows at intersections in the morning peak hour (from 08:30 to 09:30) is 110 000 veh/h, whereas in the afternoon peak hour (from 16:30 to 17:30) is 118 000 veh/h.

Analysis of the intersection performances was conducted with the software programmes SIDRA and SYNCHRO in accordance with the needs.

The analysis was based on the parameters: average delays, level of service, and degree of saturation.

Out of 28 intersection, 14 are identified as critical on the basis of the following criteria: degree of saturation (>1), average time losses per vehicle (>100 seconds) and the worst level of service (LOS). (Table No.1).

Table No.1: Performance of critical intersections

Number of Critical Intersections	Degree of Saturation	Average delays (s/v)	Worst LOS
14	1.19 – 2.9	109 – 961	F

The necessity for something to be done is obvious. The best practices have shown that this can be realized through unconventional solutions i.e. by means of intelligent traffic management systems.

Definition and selection of traffic control strategy

The City of Skopje has decided to implement the adaptive traffic management and control system - UTOPIA (Urban Traffic Optimization by Integrated Automation).

UTOPIA has two levels of control with emphasis on decentralization of optimization in its lower (intersection) level by decomposing a large-scale network problem so that the resulting problems can be solved in a hierarchical manner. The intersection level consists of two components: a microscopic model and an optimization model. It is an open loop feedback control implemented through the rolling horizon framework. The physical view of the system UTOPIA is shown in Figure 6.

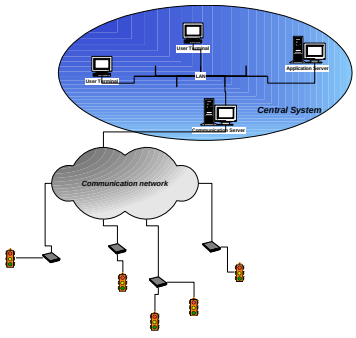

Figure. 6 Physical view of the UTOPIA

UTOPIA has three system components:

1. The central system (LAN architecture – modularity)
2. The communication network (flexible - WAN architecture support for TCP/IP protocol)
3. The multi functional outstations intelligent controllers – can connect other devices (VMS)

UTOPIA's main functions can be defined as:

- *Diagnostics* (The diagnostic status is kept updated for all the system components. UTOPIA stores all the diagnostic data, make them available through dedicated screens and detailed reports, and elaborates performance indicators to support maintenance
- *Monitoring* (UTOPIA stores all gathered traffic data and estimated parameters, for both on-line and off-line analysis)
- *Control* (Fully dynamic and adaptive control, traffic responsive traditional strategies, plan selection, fixed plan can be implemented by UTOPIA according to the specific local needs)
- *Public Transport (PT) Priority* (Priority to PT vehicles is provided according to several schemes, ranging from functional integration with AVM systems, to local detectors, to dedicated detectors managed through the PT Locator functionality)

UTOPIA aims to minimize the total time spent in the network (Min $(T_1+T_2+ ...+T_i+\ldots+T_N)$ over a long (infinite) time interval (Fig. 7).

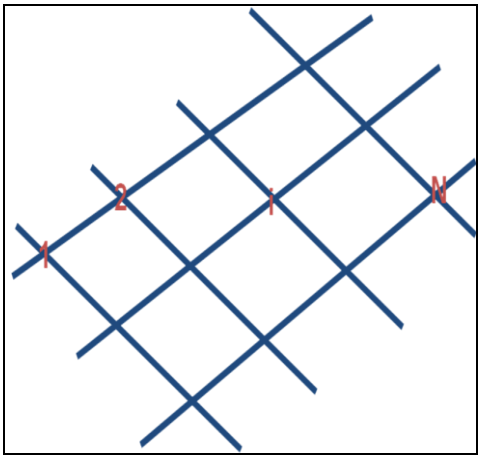

Figure 7: The UTOPIA adaptive control

EXPECTED RESULTS AND GOALS TO BE ACHIEVED

After we have defined the traffic control strategy, the next step will be to implement the traffic control and to put the hardware and software equipment in operation. The expected outcome is the establishment of traffic management and control centre (TMC). The project will be completed with the demonstration project in front of the EC in the mid 2012. The time diagram to achieve the ultimate goal of the project is presented in Fig. 8.

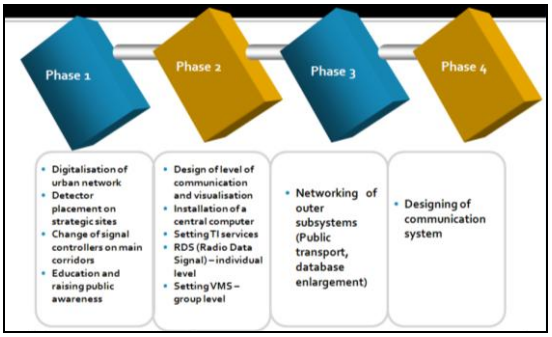

Figure 8: Towards Traffic Management Centre (TMC)

The expected results (short term) are going to be:

- Optimization of traffic flow (capacity, travel time, emission)
- Prioritization of public transport (travel time, costs and quality of supply)

After the completion of the project, the goals to be achieved (next steps) will be in line with the improvement of:

- Local networks
- Network capacity management
- Incident strategies
- Demand management
- Information and reliability of users' system
- Opening the opportunities for future funding of the proposed measures
- Increased attractiveness of the old part of the city

Since we are aware of some risks and obstacles that are almost always present, we have developed an evolution strategy concerning the *institutional development*, *restrictions* and *requirements* in order the project to run and to be completed successfully.

As far as the *institutional development* is concerned we thought about the definition of tasks and responsibilities and identification of a strategy and distribution of tasks (administration, public transport).

The *restrictions* apply to the amount of budget sufficient to realize the project and to make it to be sustainable.

The *requirements* address the system integrity which assumes the synergy between all the elements that must be connective, the information transmission and the control mechanisms.

Every step of evolution must contain its own benefit fitting to the overall strategy.

The risk assessment is presented in the following diagram (Fig. 9)

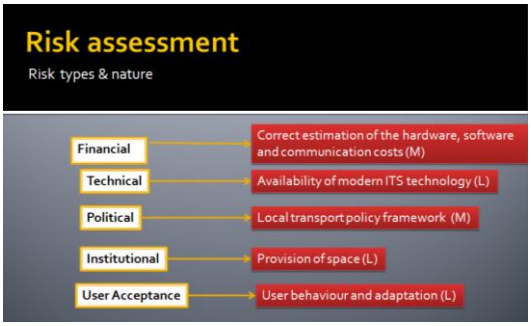

Figure 9: Risk assessment

INSTEAD OF CONCLUSIONS

It is the first time that in R. Macedonia a decision has been reached to have a system and thorough approach in the replacement and modernization of the traffic control system. The first step has been made with a research project aiming at intelligent traffic management and control system in the centre of the city of Skopje as a constituent of the Testing Innovative Strategies For Clean Urban Transport For Historic European Cities - RENAISSANCE - FP7 Project.

Our main goal was:

- To show the impact of advanced traffic technology (ATT) deployment on traffic policy decision makers
- To propose and accept ATT as a means to control, solve the traffic congestion and environmental issues and improve traffic safety
- To express the need of integrated systems approach, knowledge-based research work, to emphasize the shift from traditional to new thinking
- To show systematic & open international exchange of experience and research results that is a strategic element in supporting transport decision makers
- To meet the vision and to add a vision (prospective scientific, technological and societal trends)
- To show that universities, government, transport planners, business, citizens are influenced by factors unrelated to environmental concerns (prices and quality of services, the availability of modal choices, travel time and the organization of economic and social life)
- To take part in the EU principal activities - providing technical or policy support for non EU countries & sharing best practices as a driving force

Eventually, we are convinced that *we are not missing the boat.*

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BIOGRAPHY

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Education

- (1996) - PhD, University "St. Kliment Ohridski", Bitola,
- (1989) - MSc (Eng), University of Belgrade, Belgrade, Serbia
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Academic stays and field specialization

- (1998) - Postdoctoral Fulbright grant holder at the University of Pennsylvania, Department of Systems Engineering – Philadelphia, US
- (1997) – Individual Mobile Grant holder (Tempus Phare Programme). Institute for Transport Studies, University in Leeds, UK
- (1992/1993) – British Council scholarship holder. Institute for Transport Studies at the University in Leeds, UK.
- (1983/1984) - Swiss government scholarship holder, Federal School of Technology in Zurich, Institute for Lightweight Structures.

Career development

- 2006→Full professor in traffic management and control, UKLO
- 2004→ Head of Postgraduate and doctoral studies at the Faculty of Technical Sciences (FTS), UKLO
- 2001 → Associate professor in Traffic Management and Control, UKLO
- (1998 -2001) Assistant professor in Traffic Accidents analysis and Prevention (postgraduate studies), UKLO
- (1996 – 2001) Assistant professor in Traffic Management and Control (undergraduate studies), UKLO
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Selected publications in the last five years

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Awards and Acknowledgments

- Acknowledgment for co-operation and active participation with papers at the International Symposium on Traffic Science, Opatija, Croatia, (2000, 2001, 2002, 2004)
- Silver Plate for scientific work in the area of transportation awarded by the Croatian Scientific Society for Traffic and Transport, 2000
- Silver Plate for collaboration with the University *La Rosa di Gerico*, Rome, Italy, 1999
- Silver Plate award for extraordinary successful student delivered on the occasion of 40-th Anniversary of the Faculty of Transport &Traffic Engineering, Belgrade, 1990
- 4 Awards for being the best student at the Faculty of Transport &Traffic Engineering - Belgrade (1977, 1979, 1980, 1981

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- (2001) – Graduate eng. in Traffic and Transport Engineering, University of Bitola, Faculty of Technical Sciences

Career development

- (2008) - Assistant fellow, University “St. Kliment Ohridski”, Bitola (UKLO)
- (2001) - research and teaching associate University “St. Kliment Ohridski”, Bitola.

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