TECHNOLOGY AND INNOVATION

THE BENEFITS OF ADVANCED TRAFFIC MANAGEMENT RECEIVED BY THE URBAN USERS

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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. A general call for "…something has to be done**…**" becomes obvious. The best practices have shown that this can be realized through unconventional solutions, i.e. by means of advanced traffic management (ATM). A very reasonable example of such a system is the vehicle actuated control system that we have found to be quite challenging to do our research. It was concluded that the overall intersection performance could be improved both by adequate inductive loop detector placement and by interaction with signal parameters.

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Introduction

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 (Testing, 2008) .

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 responsive traffic management. Although artificial intelligence and its application in traffic management and control systems have already entered the stage, we concluded that at this point of identified problems, we should start from a very reasonable signal control system.

For this purpose, a semi-actuated signal control strategy on an appropriately chosen signalized intersection was designed. Since the appropriate detectors' placement is considered to be one of the significant parameters of the vehicle actuated control operations, this paper deals with the impact that the detector placement has on the overall intersection performance expressed by the delays and the level of service achieved.

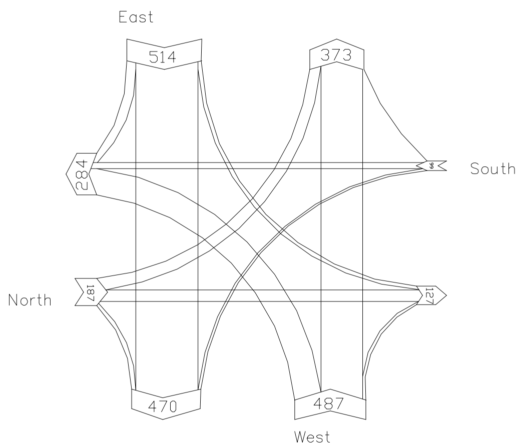
Data collection and operational analysis of the intersection performance

In order to make intersection performance analysis, the following data were necessary:

a. Intersection characteristics - type of area, number of lanes, lane width, grade (presented in Table 1);
b. Traffic conditions (traffic flows, % of HGV (heavy goods vehicle) and Bus, the peak hour);
c. Traffic signal parameters (cycle length, green time, yellow time).

The traffic data were collected on the basis of sixteen hours counting (from 6 am till 10 pm) in 15 minutes' intervals on 4 counting points (approaches 1, 2, 3 and 4). The data processing showed that the peak hour was from 3 pm to 4 pm. Peak hour demand flows in vehicles per hour are depicted in Figure 1.

FIGURE 1. PEAK HOUR TRAFFIC DEMAND FLOWS



The misbalance of the traffic volumes is evident (major flow/minor flow - East, West/North, and South). In certain day periods, the ratio major/minor flow is larger than 3:1, particularly distinctive is Approach1/Approach2 ratio. The flow ratio is the main prerequisite for developing and implementing the semi-actuated traffic signal control which would provide unconditional priority to the major flow.

The indicator for the intersection's performance was vehicle delays (VISSIM, 2006) at the approaches and the level of service (LOS). The analysis of the simulation results has led to the following observations:

d. The largest delays appear at the major street (Approaches 1 and 3). The LOS = C;

TABLE 1. INTERSECTION FIELD DATA

Approaches	Parameters	Data
Approach 1 - E	Area Type	Other
	No of lanes	2 Entry lanes
		1 Exit lane
	Lane width	3.00 m
	Grade	0%
	Separate left/right turn lanes	Separate left turn lane
	Parking provisions	None
Approach 2 - S	No of lanes	1 Entry lane
		1 Exit lane
	Lane width	3.00 m
	Grade	0%
	Separate left/right turn lanes	None
	Parking provisions	None
Approach 3 - W	No of lanes	2 Entry lanes
		1 Exit lane
	Lane width (m)	3.00 m
	Grade (%)	0%
	Separate left/right turn lanes	Separate left turn lane
	Parking provisions	None
Approach 4 - N	No of lanes	2 Entry lanes
		1 Exit lane
	Lane width (m)	3.00 m
	Grade	0%
	Separate left/right turn lanes	Separate left turn lane
	Parking provisions	None

TABLE 2. BEFORE-AND-AFTER ANALYSIS OF INTERSECTION PERFORMANCE

Approach	Delays (sec)		
	Current State (sec)	Scenario 1	Scenario 2 (sec)
Approach 1	32.8	25.2	21.9
Approach 2	3.59	10.1	8.9
Approach 3	34.8	23.7	21.2
Approach 4	3.18	11.15	9.3
All	27.7	23	19
	Delays Ratio (%)		
Approach		Scenario 1vs. Current state	Scenario 2 vs. Scenario 1
Approach 1		- 33	15
Approach 2		135	13
Approach 3		- 32	12
Approach 4		127	23
	Overall LOS		
	Current State	Scenario 1	Scenario 2
	LOS=C	LOS=B	LOS=B

e. The minor flow appears to be interesting. For both approaches (2 and 4), LOS=A. This is due to the low vehicle flows. During the simulation process, a state where no vehicles during the green intervals were perceived. (Especially on Approach 2);

f. The general performance is not poor (overall LOS = C);

g. If semi-actuated control is going to be implemented, before-and-after intersection operational analysis has to be made. The outcome results concerning the time losses (delays) will be worthy of note.

Design of semi-actuated signal control logic

The suggested actuated controller has been designed to work in four phases with allowed left turns and a double barrier.

Within the order defined, the traffic signals operate in the following way: if on the major approach the signal is green and if there is a call on the minor approach, then the counting down for the maximum green time on the major approach starts. When the given value has been achieved, the green time is provided for/switched to the minor approach. If the non-occupancy inductive loop time on the minor approach is longer than the given extension unit (time of passage), then the green time is terminated and switched to the major approach.

Implementation of the algorithm and inductive loops in the VISSIM network

After the model was designed, two scenarios of the inductive loop placement in VAP were developed. The following time parameters were taken up: Scenario 1: Placing of the inductive loop at the STOP line; Scenario 2: Placing of the inductive loop at 8 meters from the STOP line

A comparison analysis of intersection performance for both types of signal control strategies (pre-timed vs. semi-actuated control) is shown in Table 2.

As compared with the current state, the overall delay reduction for Scenario 1 is 17% and 32% for Scenario 2. The reduction of delays for changed detector placements (Scenario 2 vs. Scenario 1) is 18%. The LOS for both scenarios is B (one level higher as compared with the current state).

What do transportation users expect?

ATM are expected to yield benefits when they are applied to current transportation problems. Just as the power of technology promotes major operational improvements in business, so it is expected to bring about traffic congestion reduction, vehicle safety, economic benefits, environmental improvements, and driver convenience. In addition, the direct benefits of ATM may include economic stimulus to a number of sectors.

ATM benefits will accrue to three groups: individual travelers, specialized road users (e.g. commercial trucking companies) and society in general. In assessing the value of information technology to roadway travel, these benefits and their impact must be considered.

Individual travelers may value and be willing to pay for their direct savings in energy usage through pay-for-use fees, but they are unlike to be willing to pay fees for that portion of the benefits to be received by society in general. On the other hand, reduced congestion will benefit individual urban travelers and specialized users in a very direct and measurable way and can be easily funded by user fees.

The ATM have the potential to improve traffic flow, diminish congestion, and help people and goods to move, and will reduce the need for building new roads. Traffic management systems could reduce travel time by 10-15%. Certain ATM implementations have particularly strong potential for congestion relief. If demand management techniques lead to the removal of one car in ten, it would reduce total delay time by 48%. Furthermore, demand for roads at peak times would be reduced, and the cost of using them would be distributed directly to the users.

Conclusions

Just as the power of technology promotes major operational improvements in business, so it is expected to bring about traffic congestion reduction, vehicle safety, economic benefits, environmental improvements, and driver convenience. In this paper, a particular advanced traffic control system was presented. In case of large traffic flows misbalances (major vs. minor flow), implementation of a semi-actuated traffic signal control is recommended as a good substitution for the conventional pre-timed signal control. As compared with the current state, the overall delay reduction for Scenario 1 is 17% and 32% for Scenario 2. The reduction of delays for changed detector placements (Scenario 2 vs. Scenario 1) is 18%. The LOS for both scenarios is B (one level higher as compared with the current state).

For the Republic of Macedonia, the implementation of advanced traffic management will entail development of equipment and standardization. It is expected that it will bring lot of benefits for the current and potential transport users, particularly in bigger cities.

References

Al-Mudhaffar, A., 2006., “Impacts of traffic signal control strategies”, Doctoral thesis in traffic and transport planning, Infrastructure and Planning Royal Institute of Technology, Stockholm, Sweden.

Akcelik, R., 1993. “Analysis of vehicle-actuated signal operations’’, Australian Road Research Board, Working Paper WD TE 93/007.

Akcelik, R.,1995. “Signal Timing Analysis for Vehicle Actuated Control“, Working Paper WD TE 95/007, ARRB, Transport Research Ltd, Australia.

Bombol, K., 1997. “Modern requirements of traffic flow control systems - current development‘‘, Zbornik referatov, ISEP 97, Elektrotehnika Zveza Slovenije, Ljubljana, Slovenija, pp 261-264.

Bombol, K., 1998. “The implication of advanced transportation technologies (ATT) on transportation research outlook‘‘, University of Pennsylvania, School of Engineering and Applied Sciences-Department of Systems, USA.

Courage, G., Papanou, P. 1997. “Estimation delay at traffic–actuated signals“, Transportation Research Record, 630, pp 17 – 21.

Колтовска, Д., 2008. Проценка на ефикасnота на работа на изолирана крстосница со поттикната сообраќајна сигнална контрола, Магистерски труд, УКЛО, Битола, Република Македонија.

McShane, W. et al., 1998. “Traffic Engineering”, New Jersey, pp 503 - 524.

Testing innovative strategies for clean urban transport for historic European cities, RENAISSANCE (FP 7 Project, 2008- 2012).

The Diebold Institute for Public Policy Studies, INC 1995. “Transportation Infostructures - The development of Intelligent Transportation Systems’’, Praeger Publishers, pp 35-49.

VISSIM 4.20, 2006. User Manual, PTV Planung Transport Verkehr AG.