THE EFFECTS OF THE VMS USE IN ATHENS

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ABSTRACT
The aim of this paper is to test whether an Advance Warning message informing the drivers about the location of an incident and possible delays would result in different driver behaviour compared to a Travel-time Information message in which the effect of an incident is reflected in the increased travel times. The comparison, in terms of resulted queue, depending on the degree of saturation at the time of the incident and the duration of the incident's effect indicated that there is no statistical significant difference between these two types of messages.
KEYWORDS: VMS, travel time, incident, queue

INTRODUCTION

The Athens Traffic Management Centre (ATMC) started its operation in July 2004. The main objectives of the Centre are:

- Traffic optimisation of the most heavily loaded roads of Athens
- Quick incident response
- Provision of travel time information to the drivers
- Collection and analysis of the traffic quantities (traffic flow, occupancy and average speed of the vehicles) collected from the monitoring positions
- Real-time intervention in the traffic signal programs
- Supply of real-time data to providers for real-time information to the drivers
- Cooperation with other Traffic Management Centres

The main apparatus of the Centre consists of 500 monitoring positions (single inductive and video-detections loops), 208 CCTV control cameras, 24 Variable Message Signs and the SITRAFFIC CONCERT [1] software, where all the traffic data –collected from the loops - are processed.

The use of Variable Message Signs is not new in Athens. In recent years, VMS have been used either for research purposes [2] or for pilot projects [3]. For the needs of the ATMC operation, 24 permanent-overhead three lines Variable Message Signs were installed and are extensively used since the Olympic and Paralypmic Games of 2004. The Athens Traffic Management Centre uses the 24 Variable Message Signs for three types of messages; Immediate and Advance Warning, Travel-time Information and Public Service Announcement messages.
Immediate and Advance Warning messages provide information to the driver for incidents which are either unexpected (such as accidents, demonstrations, broken-down vehicles and extreme environmental conditions) or programmed (such as road closures, construction and

maintenance sites). These messages have a standard structure; the first line describes the incident, the second line gives information about its location and the last line informs the driver about the impact of the incident on traffic (e.g. “delays”) [4].

Travel-time Information messages provide real-time information to the drivers on the time needed to access specific destinations. Several routes are being monitored for each VMS, and the average time needed for a private car to reach the specific destinations is estimated by splitting the route into several sections (each section begins at one loop and finishes at the next downstream one). The travel-time for each section is estimated by taking into account the appropriate traffic quantities collected from the loops and by using specially designed mathematical formulas [5]. Hence, the sum of the travel-times of the sections comprising the route results in the travel-time of the whole route. Furthermore, information about possible congestion at specific traffic sites, which are considered to be important for the drivers passing through each VMS are also displayed.

The Public Announcement messages are “soft” messages, which are not of any traffic use to the road user and are only used in special events (such as road safety related messages or greetings on National Holidays).

There is a priority rule governing the use of the VMS messages. The Immediate and Advance Warning messages have the highest priority, the Travel-time Information messages have medium priority and the Public Announcement messages have the lowest priority.

ESTIMATION OF THE VMS EFFECT

The impact of the VMS use on drivers’ behaviour can be studied mainly through three approaches; driver questionnaire surveys and analysis [6], network monitoring [7] and use of dynamic traffic assignment models [8]. Several studies have taken place to estimate this impact [9, 10, 11]. The aim of this paper is to test the relative impact that the Advance Warning messages and the Travel-time messages have on drivers’ preferences. More specifically, in the cases of roads with VMS, the drivers receive constant information about the time needed to reach specific destinations. If an incident takes place, the obvious choice would be to send an Advance and Warning message to the drivers. On the other hand, the existence of such an incident would result in increased travel times and that would be reflected in the Travel-time Information message. Hence, if no Advance Warning message is preferred to a Travel-time Information message, the driver would still get informed about the consequences of the incident.

The Advance Warning message would specify the location of the incident and inform the drivers about possible delays and then it would be up to the drivers to qualitatively estimate the extent of the delays and hence to possibly decide on using an alternative route. If, on the other hand, a Travel-time Information message is preferred, the drivers would not exactly know the cause of the high travel-times but they would get accurate information about the time needed to reach specific destinations and it would once again be up to them to decide on using an alternative route or not.

For the needs of this study the Kifisou Freeway, direction towards the north, was chosen. Kifisou Freeway is the 512km freeway connecting Athens to Thessaloniki. The first section of the road - between Piraeus and Kifisia - is an urban road within the greater Athens Metropolitan Area. The section between Piraeus and Kifisia is 20km long and operates as a highway, since it does not include any signal-controlled junctions. It has 3 to 4 lanes and a capacity of about 1700 vehicles/hour per lane. The ATMC apparatus includes 54 monitoring positions (all of them being Video-detection loops), of which 31 correspond to the main road

and 23 correspond to the entries and exits from and to other arterial roads crossing the Kifisou Freeway. This section of the road is used by every-day commuters for their work, commercial or leisure trips.

This direction of the Kifisou Freeway is served by two Variable Message Signs (as illustrated in Figure 1). The first one is close to Piraeus road (VMS 5 - 2200m upstream of the southern end of the Freeway) and the second one before Athinon avenue (VMS 6 - 4760m upstream of the southern end of the Freeway). For the Travel-time information messages of VMS 5, the travel times of three routes are monitored. The destination of the first one is Lenorman road (5727m upstream of VMS 5), the destination of the second is the city centre via Athinon avenue (4521m upstream of VMS 5) and the destination of the third one is Acharnon avenue (9743m upstream of VMS 5). For the Travel-time Information messages of VMS 6, the travel times of two routes are monitored, the destination of the first one being Dafni via Athinon avenue (1962m upstream of VMS 6) and the destination of the second one being Attiki Odos (10739m upstream of VMS 6). Hence, drivers travelling through this direction of the Kifisou Freeway receive adequate travel-times information about the time they need to reach several of the arterial roads crossing the freeway.

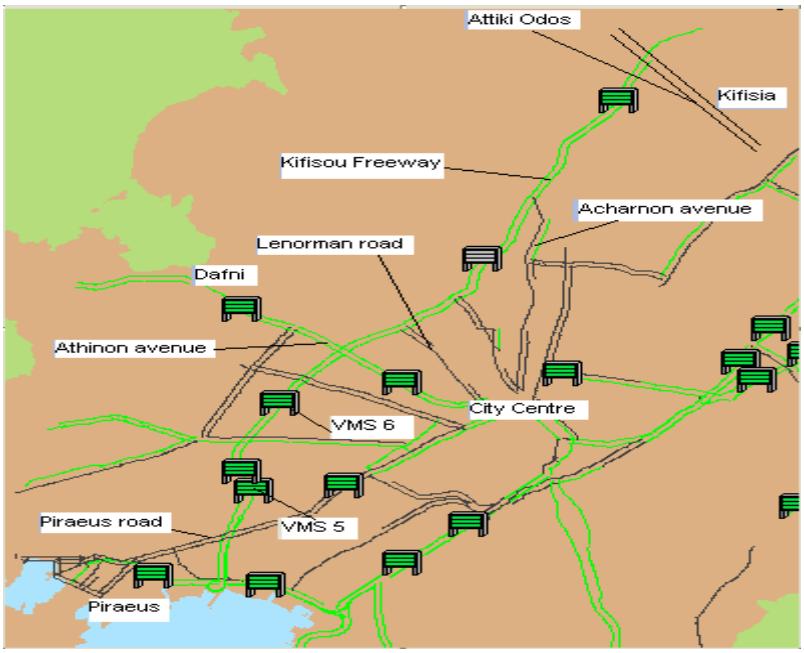

Figure 1 - Kifisou Freeway

INCIDENTS ANALYSIS

Due to the high traffic flow, a considerable amount of incidents take place every day in Kifisou Freeway. The incidents which were of interest for the present study where incidents that either took place within the routes (for which the travel times are estimated) or those that took place downstream of these routes, but still had an effect on the traffic data of the routes.

For the period from November 2005 to July 2006, 103 incidents were recorded that met the needs of this research. These 103 incidents comprise 54 in which an Advance Warning message was sent to at least one of the two VMS and 49 in which no Advance Warning message was sent but instead Travel-time Information messages reflecting the increase in

travel-time due to the incident were used. The characteristics of the incidents that were analysed were the location of the incident, the traffic condition of the freeway at the time of the incident, the duration of the incident's effect and the resulted queue. The location of the incident was found from the Operators recordings and then, each incident was attributed to the first loop upstream of its location. Hence, the examined length of the freeway was split into the same sections that the freeway is split for the estimation of the routes' travel-times.

The traffic condition of the freeway at the time of the incident was taken into account by calculating the degree of saturation. The degree of saturation is the ratio of traffic flow to saturation flow of the road segment at the location of the incident. In the case of the Kifisou Freeway, since it involves no signals, the saturation flow is equal to the capacity of the road segment at the location of the incident. This ratio gives an indication of how saturated the road was at the time of the incident.

The duration of the incident's effect was estimated by analysing the aggregated traffic data (in 15 minutes time-intervals) of the first loop upstream of the location of the incident to estimate the time that it took for the traffic data of this loop to produce values which were not statistically significant of the typical values of the same day and time for the specific loop. This duration was preferred to the duration of the incident as recorded by the Operators, because the Operators recordings were biased due to possible delay of visual contact with the incident.

The resulted queue of an incident was defined as the distance between the location of the incident and the last loop in which the traffic data were statistically significantly affected by the incident. The resulted queue was estimated by examining the variation of the traffic data in the loops upstream of the location of the incident and identifying the last loop where the incident resulted in statistically significant changes in the traffic data. That loop was identified as the end of the queue and the distance between that loop and the location of the incident was measured and used as the resulted queue from the incident. This estimation is not accurate since it does not take into account the exact location of the end of the queue, but the queue estimation is expected to present difficulties, as the queue is a dynamic quantity.

The distribution of the resulted queue of the incidents in relation to the time they occurred is illustrated in Figure 2.

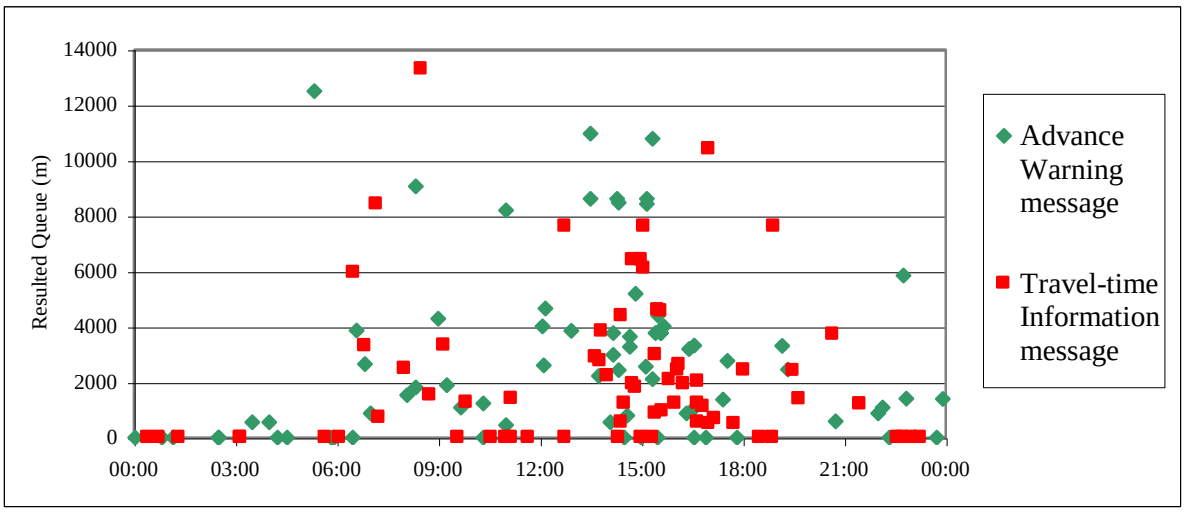

Figure 2 – Distribution of the resulted queue of the incidents in relation to the time they occurred

The incidents were grouped on whether an Advance Warning or a Travel-time Information message was sent. An F-test was carried out to test the hypothesis that the variances of the two samples were equal and then, a two-tailed t-test was carried out (for equal or unequal variances of the two samples depending on the result of the F-test) to test the hypothesis that the means of the two samples were not different. Both tests were carried out at a 95% confidence level. The F-test value was calculated to be 1.17 and because this value was less than the critical F value (1.60), it was concluded that the variances of the two samples were not different. The results of the t-test (for equal variances of the two samples) are shown in Table 1.

Table 1 - t-test analysis for the comparison of the resulted queue depending on the use of an Advance Warning message or a Travel-time Information message

	Advance Warning Message	Travel-time Information message
Mean	3781,78	3348,84
Variance	9446685,72	8082949,06
Observations	54	49
degrees of freedom	101	
t-value	**0,74**	
P(T<=t)	0,46	
t-critical	**1,98**	

Thus, the hypothesis is true and the resulted queue is not different depending on the use of an Advance Warning message or a Travel-time Information message. Hence, drivers react in the same way to an Advance Warning message or to a Travel-time Information message when an incident takes place.

Effect of VMS use in relation to the incident location

For this analysis, the incidents were grouped depending on their location (as defined previously). Then, an effort was made to analyse their effect, in terms of the resulted queue, depending on whether an Advance Warning or a Travel-time Information message was sent. This effort was not successful due to the fact that the sample of the incidents for each loop was not big enough to make meaningful comparisons. Moreover, an effort to join the incidents taken place in neighbouring loops with similar geometrical characteristics was not successful because the geometrical characteristics at successive loops were in the vast majority of the cases considerably different.

Effect of VMS use in relation to the degree of saturation

For this analysis, the degree of saturation at the time that each incident occurred was calculated. Depending on the resulting degree of saturation, the traffic condition of the freeway at the time that the incident took place was defined. In the case of a degree of saturation value lower than 0,70 the traffic condition was defined as light. In the case of a

degree of saturation value between 0,70 and 0,90 the traffic condition was defined as medium and finally for a degree of saturation greater than 0,90 the traffic condition was defined as heavy.

After classifying the incidents in terms of the traffic condition, it was tested whether the resulted queue due to the incident was different in the case of an Advance Warning message being preferred to a Travel-time Information message or not. The F-test indicated that at light flow, the variances of the two samples were different (F-value=88.69 > F-critical=8.89), whilst at medium and heavy flow, the variances of the two samples were equal (F-value=1.05 < F-critical=2.07 at medium flow and F-value=1.05 < F-critical=2.06). The t-test results are shown in Table 2.

Table 2 - t-test analysis for the comparison of the resulted queue depending on the use of an Advance Warning message or a Travel-time Information message at light, medium and heavy flow

	Light flow		**Medium flow**		**Heavy flow**	
	Advance Warning Message	Travel-time Information message	Advance Warning Message	Travel-time Information message	Advance Warning Message	Travel-time Information message
Mean	3646,88	1128,75	3680,65	3282,71	3967,20	3776,71
Variance	15176114,13	171110,25	9175261,60	8713244,11	8629521,54	8217504,65
Observations	8	4	26	21	20	24
degrees of freedom	7		45		42	
t-value	**1,81**		**0,45**		**0,22**	
P(T<=t)	0,11		0,65		0,83	
t-critical	**2,36**		**2,01**		**2,02**	

Once again, there is no difference in the samples and hence, the resulted queue is not different at any level of traffic flow depending on whether an Advance Warning message or a Travel-time Information message is used. Hence, the drivers do not change their travel behaviour according to the type of message they see in a VMS regardless of how saturated the network is.

Effect of VMS use in relation to the duration of the incident's effect

For this analysis, the duration of the incident's effect was grouped into 30 minutes interval. The F-test and the t-test analysis for all time intervals are shown in Tables 3 and 4.

Table 3 F-test analysis for all time intervals

Time interval	**F-value**	**F-critical**	
0-30 minutes	2,12	2,37	equal variances
31-60 minutes	1,70	2,75	equal variances
61-90 minutes	2,03	4,35	equal variances
91-120 minutes	0,92	0,24	equal variances
>120 minutes	0,50	0,23	equal variances

Table 4 - t-test analysis for the comparison of the resulted queue depending on the use of an Advance Warning message or a Travel-time Information message at 30 minutes time intervals

	0-30 minutes		31-60 minutes		61-90 minutes		91-120 minutes		>120 minutes	
	Advance Warning Message	Travel-time Information message	Advance Warning Message	Travel-time Information message	Advance Warning Message	Travel-time Information message	Advance Warning Message	Travel-time Information message	Advance Warning Message	Travel-time Information message
Mean	2479,42	2110,84	2764,30	1892,73	6649,00	6071,13	3329,00	4385,20	8236,57	5445,33
Variance	4615529,72	2180830,92	2880924,22	1692912,42	33924248,00	16737270,70	5535348,00	6007717,70	4733041,62	9426812,67
Observations	12	19	23	11	4	8	8	5	7	6
degrees of freedom	29		32		10		11		11	
t-value	**0,57**		**1,50**		**0,20**		**-0,78**		**1,91**	
P(T<=t)	0,57		0,14		0,84		0,45		0,08	
t-critical	**2,05**		**2,04**		**2,23**		**2,20**		**2,20**	

Once again, there is no difference for any time interval in the resulted queue when an Advance Warning message or a Travel-time Information message is sent. Thus, drivers do not alter their travel behaviour according to the type of message they receive regardless of the duration of the incident that takes place.

CONCLUSIONS

The Athens Traffic Management Centre uses the 24 Variable Message Signs in the city of Athens to provide information to the drivers about the time needed to reach specific destinations by using Travel-time Information messages. In the case of an unexpected or programmed incident, an Advance Warning message might be preferred to a Travel-time Information one which informs the drivers about the location of the incident and possible delays. The aim of this study was to test whether the use of an Advance Warning message or of a Travel-time Information message results in a change in drivers' behaviour and hence in the resulted queue due to the incident.

103 incidents in the Kifisou Freeway - in the direction towards the north, which is served by two VMS - comprising of 54 incidents in which an Advance Warning message was used and 49 incidents in which Travel-time Information messages were used, were analysed. The resulted queue due to the incident for both types of messages was also analysed depending on the degree of saturation at the time of the incident and the duration of the incident's effect.

In all cases, there was no difference between the two sets of resulted queue. Hence, it can be concluded that the resulted queue does not depend on the type of message used. The drivers do not seem to change their behaviour depending on the type of message they see in the VMS. There are three reasons behind this driver behaviour. The first one involves either the non-existence of alternative routes or the extended diversions needed in the few alternative routes that exist (for some destinations). Thus, the drivers who are aware of the neighbouring network and its shortage of alternative routes prefer to use Kifisou Freeway despite the extra delay.

The second reason involves that this road is used by frequent users who seem to address the information they receive via a VMS in the right way. They seem to be familiar with the way

that the Kifisou Freeway operates and the travel-times information that they receive from the VMS about several arterial roads crossing the freeway and hence, they react to either the information of an incident or to the increased travel times in the same way. Thus, in the case of an Advance Warning message they estimate more or less the excess travel time correctly and in the case of the increased travel times being displayed in a Travel-time Information message they assume that an incident might have occurred.

The final reason involves the response of the drivers to the VMS messages. A considerable drivers' percentage might either not consider the information in the VMS to be useful or not completely understand the information presented or still be unaware of the VMS existence

Hence, in the examined experimental scenario, the use of an Advance Warning message does not seem to change the drivers' behaviour and the Travel-time Information messages seem to provide adequate information to the drivers. Further research has to take place in roads in which either the information that the drivers receive is less or the alternative routes to reach typical destinations are more.

REFERENCES

[1] Sitraffic Concert User's Guide : SITRAFFIC CONCERT: Traffic Control and Monitoring System. (2001), *Manual*, Siemens.

[2] QUARTET PLUS (1999). *Final Report*

[3] EUROSCOPE (1999). Evaluation Results and Comparative Assessment phase I: Part II. Detailed Validation Results – Piraeus, EU Project TR 1023 EUROSCOPE *Deliverable* 15.

[4] Sermpis, D. Babis, C. (2006). and Theofilis, I. Travel Time Information via VMS in Athens. In Proceedings 1st *International Symposium on Freeway and Tollway Operations*, Athens, Greece.

[5] Sermpis, D. Babis, C. (2006). The Effects of the VMS Use in Athens. In Proceedings *13th World Congress and Exhibition on Intelligent Transport Systems and Services*, London, UK.

[6] Bonsall, P.W. (1993). Research methods for the study of driver response to in-vehicle and roadside guidance-methods. In : Frybourg, M., Bonnafous, A. (Eds), Selected Proceedings of the *6th World Conference on Transport Research*, Vol. 4 : Technical Innovation and Network Management, WCTRS, Lyon, pp. 2515-2530.

[7] Tarry, S. Graham, A. (1995). The role of evaluation in ATT development. *Traffic Engineering and Control* 36 (12), pp. 688-693.

[8] TRL, (1999). MCONTRM Userguide: Version 2.01, Transport Research Laboratory, Crowthorne.

[9] Chatterjee, K. Hounsell, N.B. Firmin, P.E. Bonsall, P.W. (2000). Driver response to variable message sign information in London. *Transportation Research Part C*, Vol. 10, pp. 149-169.

[10] Carden, P.J.C. Meekums, R.J. Beck I.H. (1998). The Midlands driver information system : operation and analysis of benefits. In Proceedings of the *IEE 9th International Conference on Road Transport Information and Control*.

[11] Wardman, M. Bonsall, P.W. Shires, J.D. (1997). Driver response to variable message signs: a stated preference investigation. *Transportation Research Part C*, Vol. 5 (6), pp. 389-405.