THE IMPACT OF A TRANSIT STRIKE ON THE TRAFFIC PATTERNS IN THE ATHENS ROAD NETWORK

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ABSTRACT
The transportation system of a big city like Athens relies heavily on Public Transport. This paper estimates the effect of the transit strike that took place in Athens on the road network of the city. The analysis was based on a before and after comparison of the traffic data of traffic flow, time occupancy and average speed collected from the loops of the main arterial roads. The estimated impact indicated both quantitatively and qualitatively an early start and a late finish of the three peak-hour periods, a development of extra congestion and a change in the drivers’ preferences.

1. INTRODUCTION

Public Transport strikes are expected to have an effect on traffic. Such strikes have taken place in many big cities such as Paris, London, Lyon, New York and Los Angeles. Various studies have been carried out to quantify the effect of a strike on traffic, but they have mainly been concerned with either the change in the modal split of the trips (Marmo, 1990; Blumstein and Miller, 1983; PbIVVS, 1984; Bonsall and Dunkerley, 1997;) or with the total change in traffic volume (Crain and Flynn, 1975) and the extension of the peak-hour periods (Coindet, 1995; Lapierre, 1998; Lo and Hall, 2006). This study is concerned with the changes in the traffic patterns of the main arterial roads in the greater Athens Metropolitan Area.

The Athens Traffic Management Center (ATMC) of the Hellenic Ministry for the Environment, Physical Planning and Public Works became operational in July 2004. It operates 24 hours per day, 365 days per year and its main apparatus includes 500 monitoring positions (single inductive and Video Detection loops),
208 CCTV control cameras, 24 Variable Message Signs (VMS), the SITRAFFIC CONCERT (Siemens, 2001) software (where all the traffic data are processed), traffic lights’ controllers in the signalized intersections for the communication between the 1,100 signalized intersections and the ATMC, 1 control room with 10 workstations, 1 video-wall, 42 monitors for the screening of the CCTV cameras and the appropriate telecommunication network. The primary objectives of the Center are:

- Traffic optimization of the most heavily loaded urban roads of Athens
- Provision of travel time information to the drivers via Variable Message Signs (Sermpis and Babis, 2006)
- Quick incident response (Sermpis et al, 2006)
- Collection, analysis and use of the traffic data (traffic flow, time occupancy, average speed) collected from the 500 monitoring positions
- Real-time intervention in the traffic signal programs
- Supply of real-time data to providers for real-time information to the drivers

2. TRANSPORTATION SYSTEM IN ATHENS

The capital of Greece has a population of around 5 million citizens, which corresponds to 50% of the total Greek population. The majority of the Athenians live outside the city centre (in the suburbs), whilst the majority of businesses (and especially, the public sector) is in the city center. Hence, the vast majority of the weekday trips include trips between the city center and the suburbs.

The Public Transport network in Athens is constantly growing. The six Public Transport Modes operating in Athens are either daughter companies or
supervised organizations of the Athens Urban Transport Organization S.A. (AUTO S.A.), which is owned by the Greek State under the supervision and control of the Ministry of Transport Communications.

The three daughter companies are (AUTO, 2006):

ETHEL S.A owns the thermal buses. It comprises 310 bus lines including core, inter-municipal, local, express and school lines covering the whole greater Athens Metropolitan Area. It operates 15,000 routes daily having 2,099 buses at its disposal. During peak-hour periods 1,822 buses are in full operation.

ILPAP S.A. operates an electric bus network of 22 lines that mainly serve the Athens city centre. Its fleet comprises 366 trolley buses. The number of operated trolley bus routes per day is 1,943.

ISAP S.A. owns the Athens-Piraeus electric railway and is the oldest Public Transport Mode in the city. Nowadays, the total length of the network is 25.6km operating 607 routes daily. Its fleet consists of 44 trains.

The three supervised organizations are:

AMEL S.A runs the underground METRO system in Athens. There are 2 METRO lines with a total of 23 stations. The frequency of the trips is 3 minutes during peak-hour periods and 5 to 10 minutes during the non peak-hour periods.

TRAM S.A. runs the light rail in Athens. It has 3 lines mainly linking the south suburbs of Athens to the city center and its fleet comprises 35 trams. The TRAM network is 26km long including 47 stops.

PROASTIAKOS S.A. runs the suburban railway, connecting the Athens Airport Eleutherios Venizelos and the Athens city center. Currently, its network is 39km long.
The estimated average daily numbers of passengers using each Public Transport are listed in Table 1:

**TABLE 1 Average Daily Number of Passengers per Public Transport Organization**

Athenians tend to prefer using their car to the Public Transport Modes. It is estimated that the average number of trips in a typical weekday is 8,00,000. Taking into account that 2,651,689 (33%) are made by the Public Transport Modes, the remaining trips are divided into 39% by cars, 9% by taxis, 9% by foot, 6% by powered two-wheel vehicles and 4% by other vehicle categories. Hence, it is estimated that about 3,120,000 trips are made by cars daily.

The vast majority of the weekday trips involve people traveling to and from work (work trips) and people going to the shops (commercial trips). Working hours for the public sector are from 07:00 to 15:00, whilst for the private sector 09:00 to 17:00. Shops are open from 09:00 to 15:00 (daily) and from 17:00 to 21:00 (on Tuesdays, Thursdays, and Fridays).

Hence, there are three peak-hour periods identified during a typical weekday in Athens for the roads linking the suburbs to the city center. The first one is the morning peak-hour period (usually running from 07:00 to 09:30, which at the beginning involves people working in the public sector going to work, later involves both people working in the public and private sector and at the end involves people working in the private sector). The second one is the afternoon peak-hour period (usually ranging from 14:00 to 16:00, involving people working in the public sector returning home). The third one involves the evening peak-hour period (usually running from 17:00 to 20:30, involving people working in the private sector returning home and people going to and from the shops).
Depending on whether the road is also used for other kinds of trips (leisure, etc), the peak-hour periods can be extended.

On the 15th of December 2005 (Thursday), a 24 hour strike took place being called by Greece’s two largest labor unions. Thus, all the Public Transport Modes came to a complete standstill for 24 hours starting at 00:00. In Greece, 24 hour strikes are rather rare, but instead hourly strikes take place occasionally. The participation percentage in the strike is not possible to be estimated, because of the standard practice of both the State and the labor unions to provide contradicting participation percentages. Moreover, no effort has ever been made to make a credible study on the exact number of people participating in such strikes. Empirically it certainly affected the public sector considerably more than the private one. It should be noted that there was adequate public awareness of the impeding strike well in advance.

The 24 hour Public Transport Modes strike meant that all the trips made by Public Transport Modes on a typical weekday would not take place by Public Transport. This would however not result in the 2,651,689 trips being made by alternative transport modes, because of the participation of a considerable amount of Athenians to the strike, who would cancel their trips to work anyway.

The strike was also anticipated to have an effect on the rest of the trips made by other transport modes on that day. To estimate the effect of the strike on the traffic patterns in the Athenian roads, the Athens Traffic Management Center analyzed the traffic data - of traffic flow, time occupancy and average vehicle speed - collected from the loops of the monitoring positions and made a before and after comparison. It should be noted that by the term time occupancy, the amount of time (given in percentage) that the loop was occupied by vehicles
during the examined time interval is meant. In particular, the traffic data of that particular day were compared to the average values (of 15 minutes time intervals) of the traffic data of all Thursdays of a typical 3 months period. This comparison took place in all arterial roads described in the following chapters and for each road the analysis was made for at least five monitoring positions (which correspond to five different sites at each arterial road). This comparison would illustrate the possible differences between the traffic patterns on that day and on a typical Thursday.

4. ANALYSIS OF THE TRAFFIC PATTERNS

For the needs of this research, the greater Athens Metropolitan Area was split into five sections – Northern, Eastern, Southern and Western Suburbs and City Center – to analyze the effect of the strike on traffic in full detail (Figure 1).

FIGURE 1 Athens Road Network

4.1 Northern Suburbs

The Northern suburbs of Athens are served by thermal buses (ETHEL S.A.), electric railway (ISAP S.A.), METRO (AMEL S.A.) and suburban railway (PROASTIAKOS S.A.). The road network in the area involves mainly two major arterial roads, Kifisias Avenue and Mesogeion Avenue linking the suburbs to the city center.

Mesogeion Avenue – direction towards the city center

The analysis of the traffic data of that day showed that a specific traffic pattern attributed to the excess traffic of that day was evident. This traffic pattern
was named “The Extra Congestion Traffic Pattern” and it was split into five stages as illustrated in Figure 2.

**FIGURE 2 The Extra Congestion Traffic Pattern**

*Stage 1:* The peak-hour period starts earlier than on a typical Thursday, because drivers choose to start their trip earlier to avoid both the typical peak-hour period and the extra traffic (and hence, congestion) to be expected due to the strike. At the beginning of the extended peak-hour period, the increase in traffic flow can easily be accommodated, because it does not reach the traffic capacity level of the road. Therefore, the changes in average speed and time occupancy are trivial.

*Stage 2:* The typical peak-hour period starts (with an extra traffic flow due to the strike) but the increase of the traffic flow is less than in Stage 1, because the road quickly reaches its capacity level as it does on a typical Thursday. Hence, the changes in average speed and time occupancy are small.

*Stage 3:* The change in traffic flow becomes unsubstantial, because the capacity level has been reached and no more vehicles can pass through the road compared to a typical Thursday. At the same time, the changes in average speed and time occupancy start to become substantial.

*Stage 4:* The traffic flow starts to decrease, because the network has become full earlier than on a typical Thursday. Therefore, vehicles almost come to a standstill contributing to the extra congestion phenomenon. At the same time, the average speed rapidly falls and the time occupancy rapidly rises. Thus, vehicles speeds become low meaning that vehicles hardly move and need considerable time to travel through the road compared to a typical Thursday. Moreover, the time occupancy increases meaning that the vehicles remain idle for long periods over the loops.
Stage 5: After a considerable time, the number of entering vehicles becomes less than before, the network starts to be able to accommodate them, the already slow-moving vehicles find more road capacity to absorb and the values of average speed and time occupancy tend to take values closer to the ones at light flow. This phenomenon might lead to an extension of the typical peak-hour period.

The time and data values’ characteristics of these stages have to do with the special characteristics of traffic on each road and therefore are discussed separately for each arterial road in the rest of the analysis.

In Mesogeion Avenue – direction towards the city center, the peak-hour period seems to start earlier than on a typical Thursday by about 45 minutes. The increase in traffic flow is evident until 08:00 and it is about 30% on the beginning of the peak-hour period rising to 40% in areas closer to the city center (due to the fact that closer to the city center, the excess traffic of all the suburbs using this Avenue merges). After 08:00 the traffic flow starts to decrease (ranging from 40% to 50%), the time occupancy values start to increase (by 15% close to the north rising to 30% closer to the city center) and the average speed values start to decrease (by 20% close to the north rising to 40% closer to the city center). There is also an extension of the peak-period by about 30 minutes.

During the two other peak-hour periods (afternoon and evening ones), there is a considerable decrease in traffic flow. It does not result in any extension of the peak-hour periods, meaning that despite the fact that a considerable amount of drivers chose to drive to work early, they did not start their trip back home earlier as well. Therefore, the start of these peak-hour periods is the same as on a typical Thursday. When the afternoon and evening peak-hour periods start, a quick decrease in traffic flow becomes apparent (about 20%). At the same time,
an increase in time occupancy (ranging from 20% to 40%) and a decrease in average speed (ranging from 15% to 40%) are also evident. The two peak-hour periods could still be segregated at the beginning of the road but closer to the city center the phenomenon of one (and not two) longer peak-hour period starting from 14:00 and finishing at 20:30 is evident.

Mesogeion Avenue – direction towards the north

There is an early start of the morning peak-hour period by about 90 minutes. The road does typically not reach its capacity level in this direction and hence, an increase in traffic flow is evident throughout the peak-hour period. This increase ranges from 10% (at the north) to 40% (closer to the city center). Hence, there are no statistically significant changes in the average speed and the time occupancy values. This phenomenon is illustrated in Figure 3.

FIGURE 3 Excess Traffic Flow Accommodated by Road Capacity

During the other two peak-hour periods, only a slight increase in the traffic flow is evident.

Kifisias Avenue – direction towards the city center

Kifisias Avenue seems to be more congested than Mesogeion Avenue. There is an early start of the morning peak-hour period by about 90 minutes and a late finish by about 30 minutes. The initial decrease in the traffic flow is about 50% and the traffic flow decrease (which starts to take place after 07:15) ranges from 40% to 60%. At the same time, time occupancy increase ranges from 20% to 50% and average speed decrease ranges from 30% to 40%.

During the other two peak-hour periods, an interesting pattern is evident. Due to the fact that this area does not have a considerable number of public sector services and offices, there is no change in the traffic data during the afternoon.
peak-hour period. On the other hand, during the evening peak-hour period, the extra congestion phenomenon is evident, time occupancy values increase by about 30% to 40% and average speed values decrease by about 30% to 50%.

All the above are illustrated in Figure 4:

**FIGURE 4 Traffic Pattern in Kifisias Avenue – Direction towards the City Center**

*Kifisias Avenue – direction towards the north*

At about 60 minutes before the typical start of the morning peak-hour period, there is a considerable increase in traffic flow (by about 40%), but after a short time, the traffic flow takes its typical values. Due to the fact that few public sector services and offices are located in the north, only few people decided to go to work earlier to avoid excess traffic. The extra congestion is evident around 09:00 and the peak hour finishes later than typical by about 45 minutes. Traffic flow decrease is about 40%, time occupancy increase is about 30% to 40% and average speed decrease is about 30%.

During the two other peak-hour periods, the segregation between them is more evident closer to the city center than closer to the north. Congestion is not as heavy as in the morning peak-hour period, traffic flow decreases by about 15%, time occupancy increases by about 20% and average speed decreases by about 25% whilst no peak-hour period extension takes place.

### 3.2 Eastern Suburbs

The Eastern suburbs of Athens are only served by thermal buses (ETHEL S.A.). Few people live in that area (compared to the other suburbs of Athens) and there is no significant arterial road linking this area to the city center. The only
way of traveling to the city center is by connecting this area to the arterial roads that mainly serve the Northern and the Southern suburbs. Hence, the effect of the strike on traffic in that area is estimated in the analysis of the Northern and Southern suburbs.

3.3 Southern Suburbs

The Southern suburbs of Athens are served by thermal buses (ETHEL S.A.), light rail (TRAM S.A.), electric railway (ISAP S.A.) in its western areas and METRO (AMEL S.A.) in its northern area.

The road network in the area involves mainly three major arterial roads, Poseidonos Avenue (linking the western –Piraeus– to the eastern part of the suburbs and crossing both Kifisou Freeway and Syggrou Avenue), Bouliagmenis Avenue (linking the eastern part of the suburbs to the city center) and Syggrou Avenue (linking Poseidonos Avenue to the city center).

*Poseidonos Avenue – direction towards the east*

The morning peak-hour period starts 30 minutes earlier close to the Kifisou Freeway and 60 minutes close to Syggrou Avenue, indicating that the drivers were expecting heavier extra congestion during the morning peak-hour period in the Kifisou Freeway than in the Syggrou Avenue. In both cases, the increase in traffic flow is 20%. Close to Kifisou Freeway, extra congestion starts at 08:00 and does not last for more than a typical morning peak-hour period, resulting in an about 15% increase in time occupancy and a 40% decrease in average speed. Close to Syggrou Avenue, the values of traffic flow remain unchanged (well within capacity), and hence, no statistically significant changes
in the other two traffic data values are evident. No changes are found closer to the western and eastern parts of the suburbs.

During the other two peak-hour periods, there is an increase in traffic flow (ranging from 10% to 20%) and no substantial changes in the values of time occupancy and average speed. These changes were not evident closer to the eastern part of the suburbs.

**Poseidonos Avenue – direction towards the west**

During the morning peak-hour period, close to the Syggrou Avenue, no changes were found. Close to the Kifisou Freeway, no extension of the peak-hour period is evident, but after 08:00 an about 20% increase in the traffic flow leads to an about 15% increase in time occupancy and a 30% decrease in average speed. In the western part of the suburbs, there is a 45 minutes earlier start in the peak-hour period, a constant 20% increase in traffic flow and after 08:15, a 30% increase in time occupancy and a 20% decrease in average speed.

During the other two peak-hour periods, a difference in the traffic patterns is evident only in the center of Piraeus with a constant 20% increase in traffic flow and a 15% decrease in average speed.

**Bouliagmenis Avenue – direction towards the city center**

During the morning peak-hour period, there is a 30 minutes earlier start in the peak-hour period, but extra congestion is only evident closer to the city center, where after 07:45, traffic flow decreases by about 15%, time occupancy increases by about 50% and average speed decreases by 20%. The same phenomenon is observed in the other two peak-hour periods (which can still be clearly segregated).

**Bouliagmenis Avenue – direction towards the east**
During the morning peak-hour period, a change in the traffic patterns is evident only in that part of the Avenue, which is close to the city center, where traffic flow increases by about 20%. No other changes in the time occupancy and the average speed are observed, because the excess traffic can be accommodated by the road capacity.

During the evening peak-hour period, time occupancy increases by about 15%, average speed decreases by about 15% and there is no late finish of the peak-period.

Syggrou Avenue – direction towards the city center

During the morning peak-hour period, there is a 30 minutes earlier start to the peak-hour period with a traffic flow increase ranging from 30% to 60%. After 07:45, extra congestion is evident with traffic flow decreasing by about 40%, time occupancy increasing by about 40% and average speed decreasing by about 60%. Moreover, there is also a late finish of the morning peak-hour period by about 30 minutes.

During the other two peak-hour periods, there is a constant 30% increase in the traffic flow resulting in extra congestion only close to the city center (for drivers traveling through the city center), an about 40% increase in time occupancy and an about 40% decrease in average speed.

Syggrou Avenue – direction towards the suburbs

During the morning peak-hour period, there is an increase in the traffic flow by about 30%, but once again the excess traffic can be accommodated by the road capacity. During the other two peak-hour periods, there is a 20% increase in traffic flow resulting in a 40% increase in time occupancy and a 25% decrease in average speed.
3.4 Western Suburbs

The Western suburbs of Athens are served by thermal buses (ETHEL S.A.) and a small part of them by METRO (AMEL S.A.). The road network in the area involves Kifisou Freeway and three smaller (but still significant) roads crossing Kifisou Avenue and also linking the suburbs to the city center, namely Iera Odos, Athinon Avenue and P. Ralli Avenue. Kifisou Freeway has a length of about 25km and is used not only for trips from the Western suburbs, but also for trips from the Northern suburbs (at its northern end) and for trips from the Southern suburbs (at its southern end). It must be noted that no analysis of the P. Ralli Avenue was not made due to infrastructure problems on the day.

*Kifisou Freeway – direction towards the south*

During the morning peak-hour period, there is a 45 minutes early start with an about 30% traffic flow increase. This is only evident from the northern end of the Freeway until its crossing with the roads linking Kifisou Freeway to the city center. In the northern part of the Freeway extra congestion is evident from 08:00, when traffic flow decreases by about 20%, time occupancy increases by about 30% and average speed decreases by about 30%. As the Freeway gets southern, the magnitude of this phenomenon decreases (though it is still evident), indicating that a significant percentage of the increased traffic flow at the northern end used the Acharnon Avenue to reach the city center (the ATMC does not have any loops in that specific Avenue to estimate the traffic data changes). During the other two peak-hour periods, extra congestion is only observed in that part of the Freeway close to the city center and only during the evening peak-hour period.

*Kifisou Freeway – direction towards the north*
In this direction, extra congestion is observed in the morning peak-hour period only in that part of the Freeway between its crossings with the arterial roads connecting the Southern suburbs to the center and its crossing with Athinon Avenue. Hence, drivers from the Northern suburbs preferred other arterial roads (namely Poseidonos Avenue in conjunction with Syggrou Avenue) instead of Kifisou Freeway. The values of the traffic data are similar to those in the opposite direction.

During the other two peak-hour periods, extra congestion is observed mainly in the afternoon peak-hour period. There is a slight traffic flow increase, time occupancy increases by about 20% and average speed decreases by about 30%.

_Athinon Avenue – direction towards the city center_

In the western part of the Avenue, during the morning peak-hour period, there is an about 15% increase in traffic flow starting from about 60 minutes before the typical peak-hour period, but during the typical peak-hour period traffic flow remains unchanged because the road operates at its capacity level. The remaining traffic data values do not change substantially. Downstream of its crossing with Kifisou Freeway (where Athinon Avenue collects the traffic from the Freeway heading towards the city center), the picture changes. The peak-hour period starts 45 minutes in advance with an increase in traffic flow by about 20%. After 07:30, extra congestion is evident resulting in an increase in time occupancy by about 40% and a decrease in average speed by about 30%. During the other two peak-hour periods, there is no substantial change in the traffic data values for the western part of the Avenue, but closer to the city center, there is extra congestion evident in the evening peak-hour period.
Athinon Avenue – direction towards the west

During the morning peak-hour period, in that part of the Avenue between the city center and Kifisou Freeway, there is an about 20% increase in traffic flow before the start of the typical peak-hour period, but during the typical peak-hour period there is no change in the traffic data values. In the remaining part of the Avenue, there is no statistically significant change.

In the part of the Avenue between the city center and Kifisou Freeway, during the other two peak-hour periods, extra congestion is observed in the afternoon peak-hour period resulting in substantial changes in the values of time occupancy and average speed (by about 30%), whilst during the evening peak-hour period, traffic flow increases by about 20%, but no changes are evident in the other traffic data values. In the western part of the Avenue, there is no statistically significant change in the traffic data values.

Iera Odos – direction towards the city center

In the morning peak-hour period, there is a 30 minutes earlier start of the morning peak-hour period and the increased traffic is about 25%. Traffic flow remains increased during the peak-hour period by about 20%, but it does not result in any substantial change in the values of time occupancy and average speed indicating that the total traffic flow is still below the capacity level of the road. No changes in the traffic data values were found during the other two peak-hour periods.

Iera Odos – direction towards the west

No traffic data changes are found during the three peak-hour periods indicating that the drivers did not choose to use this road more on that day than on a typical Thursday.
3.5 City Center

The city center of Athens is served by thermal buses (ETHEL S.A.), electric bus network (ILPAP S.A.), electric railway (ISAP S.A.) and METRO (AMEL S.A.). The road network in the area involves many arterial roads, the most frequently used ones being Basililissis Sofias, Panepistimiou (one way street towards the city center), Stadiou (one-way road towards the suburbs), Alexandras Avenue and Peiraios.

*Basilissis Sofias Avenue and Alexandras Avenue (direction towards the city center), Panepistimiou*

During the morning peak-hour period of a typical Thursday, these roads operate well below the capacity level. On the day of the strike, there is a considerable increase in the traffic flow (by about 50%) for about 60 minutes before the start of the typical peak-hour period. This increase is substantially lower (by about 20%) during the typical peak-hour period resulting in small changes in time occupancy and average speed. Moreover, the peak-hour period does not finish later than typical.

During the other two peak-hour periods, no substantial change in the traffic data takes place, since no considerable amount of traffic is heading towards the city center during that time.

*Basilissis Sofias Avenue and Alexandras Avenue – direction towards the suburbs*

During the morning peak-hour period the picture is the same as in the opposite direction. During the other two peak-hour periods, extra congestion is evident. Traffic flow decreases by about 60% for a period of 60 minutes resulting
in an increase in time occupancy by about 40% and a decrease in average speed by about 40%.

*Stadiou*

During the morning peak-hour period, the picture is the same as described for the previous roads. During the other two peak-hour periods, there is an increase in traffic flow (by about 25%), which results in an increase in time occupancy (by about 30%) and a decrease in average speed (by about 15%), but it does not result in extra congestion, due to the fact that the road still operates below the capacity level.

*Peiraios – direction towards the city center*

Peiraios is heavily affected by the strike, because it is the road where the traffic flow coming from all the arterial roads from the Northern Suburbs is merging. During the morning peak-hour period, there is an earlier start of about 75 minutes and extra congestion is evident after 07:30. The traffic flow decrease is about 50%. At the same time, time occupancy increases by about 60% and average speed decreases by about 40%. Moreover, the peak-hour period finishes later by about 75 minutes.

During the afternoon peak-period extra congestion is slightly evident, but it is considerably greater during the evening peak-hour period. More specifically, during the evening peak-hour period, traffic flow decreases by about 40% resulting in an increase in time occupancy by about 60% and a decrease in average speed by about 40%. The traffic pattern in Peiraios is illustrated in Figure 5:

**FIGURE 5 Changes in Traffic Data in Peiraios – Direction towards the City Center**
During the morning peak-hour period, there is a small increase in traffic flow and a statistically insignificant change in the values of time occupancy and average speed. During the other two peak-hour periods, extra congestion affects the road heavily. More specifically, the two peak-hour periods can not be segregated and the decrease in traffic flow starts 30 minutes after the start of the peak-hour period. The decrease in traffic flow reaches the 80% value resulting in an also dramatic increase in time occupancy (by about 80%) and a decrease in average speed by about 30%. Moreover, the peak-hour period finishes later by about 75 minutes.

CONCLUSIONS

The Athens transport network was heavily affected by the transit strike. The number of trips cancelled due to the absence of Public Transport and due to the participation in the strike can not be estimated, but the different transportation characteristics of the day have certainly led to a change in the typical traffic patterns. Due to the fact that Athenians do generally prefer using their cars to Public Transport, the effect of that strike was not as massive as it could have been if Athenians were more transit-dependent.

All the arterial roads linking the suburbs to the city center were affected and in all cases there was one particular arterial road that produced the most substantial changes in the traffic data. These arterial roads were Kifisias Avenue in the Southern Suburbs, Syggrou Avenue in the Northern Suburbs and Peiraios Avenue due to the Western Suburbs. The City Center seemed to suffer heavy
traffic congestion due to the fact that all the excess traffic of the Suburbs merged in the roads of the City Center. This phenomenon was evident in the direction towards the city center during the morning peak-hour period and in the opposite direction during the afternoon and evening peak-hour periods.

Due to the transit strike, there was an earlier start of the morning peak-hour period ranging from 45 to 75 minutes, which values are close to the ones estimated from similar studies (Coindet, 1998; Lapierre, 1998). People preferred to go to work earlier to avoid the expected excess traffic. The percentage of the traffic flow increase ranged from 30% to 40%.

Depending on whether the resulted traffic flow was above or under the capacity level of the road, it either led to the extra congestion (more congestion than on a typical day) or not (in the cases where the extra traffic flow could be accommodated by the road capacity). This extra congestion was evident for about 30 to 60 minutes after the start of a typical morning peak-hour period. In that period, traffic flow decrease ranged from 20% to 50%, time occupancy increase ranged from 15% to 30% and average speed decrease ranged from 20% to 40%. These data resulted in longer queues and greater travel times. These values were lower in the afternoon and evening peak-hour periods, because traffic was more widely spread through time.

Due to the previously described phenomenon, in many roads, there was also a considerable late finish of the peak-hour period compared to a typical one. Due to the excess traffic and the extra congestion caused by it, it took more time for vehicles to travel to their destination. This late finish was about 30 minutes long. This phenomenon was evident especially in the morning and in the evening peak-hour periods and wherever evident in the afternoon peak-hour period, it did
not lead to any segregation between the afternoon and the evening peak-hour periods.

The impact that this strike had on traffic could be used as reference for future strikes in Athens and in other similarly sizes cities (allowing for cultural differences). The changes in traffic patterns could be taken into account to design traffic management measures to be used in cases of transit strikes in order to minimize the effect that the absence of Public Transport has on traffic.

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### TABLE 1 Average Daily Number of Passengers per Public Transport Organization

<table>
<thead>
<tr>
<th>Public Transport Organization</th>
<th>Average Number of Passengers</th>
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<tbody>
<tr>
<td>ETHEL S.A.</td>
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<tr>
<td>ILPAP S.A.</td>
<td>304,312</td>
</tr>
<tr>
<td>ISAP S.A.</td>
<td>400,000</td>
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<tr>
<td>AMEL S.A.</td>
<td>560,000</td>
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<td>TRAM S.A.</td>
<td>40,000</td>
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<td>PROASTIAKOS S.A.</td>
<td>9,000</td>
</tr>
<tr>
<td><strong>Total Number of Passengers</strong></td>
<td><strong>2,651,689</strong></td>
</tr>
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FIGURE 2 The Extra Congestion Traffic Pattern
FIGURE 3 Excess Traffic Flow Accommodated by Road Capacity
FIGURE 4 Traffic Pattern in Kifissias Avenue – Direction towards the City Center
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