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Air pollution

PLANNING OF A TRANSPORTATION STUDY FOR THE IMPROVEMENT OF URBAN TRAFFIC AND ENVIRONMENT

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Abstract. The new General Transportation Study (GTS) of Thessaloniki (1997-1999) covers the Thessaloniki Metropolitan Area (TMA). The old data base (GTS in 1988) have been reassessed and enriched and new surveys have been conducted aiming at the upgrade of the old sample in addition to a new sampling performed specifically to define trip characteristics, transport data, travel behaviour and travel demand attributes. The GTS also includes roadside surveys, traffic counts surveys, stated preference surveys, traffic accidents surveys, parking characteristics surveys, etc. The GTS analyses and properly examines the transportation problem in more than 30 municipalities and communities in TMA. This paper attempts to present the study methodology and some results correlated with the air pollution.

Keywords: trips, traffic, transportation planning, urban environment.

AIMS AND BACKGROUND

Traffic and environmental problems characterise the majority of urban areas all over the world. The situation in Greek cities, and especially in Athens and Thessaloniki, is rapidly worsening during the last two decades. More specifically, such problems in Thessaloniki Metropolitan Area (TMA) first appeared in the early '80s. TMA has nowadays reached a total population of about 1 000 000 inhabitants presenting a small increase (average yearly increase in the area of 0.6%) during 1981-1991. The butterfly-shaped urban area is densely built and the highway infrastructure offers limited solutions to bypass the area via major thoroughfare streets. Recent studies in TMA have estimated that travel demand (either for bypassing or passing through the city centre) has climbed up almost 70% over the period of the years 1988-1997. The majority of the central area arterials are now considered as "congested" mainly due to limited excess capacity given the increased volumes and the valuable space taken by parked cars.

The first effort to conduct a general transportation study was initiated by the Organisation for the Master Plan and Environmental Protection of Thessaloniki

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(OMPEPT) in 1988[1]. That study included a detailed household survey with 9237 questionnaires in order to investigate the daily made trip characteristics like trips' origins and destinations, selected transport mode, trip purpose, travel time, etc. It also included an extensive roadside survey (33 177 questionnaires), traffic counts at 50 basic intersections, special surveys for the taxis and school buses, and investigation of parking characteristics in the central area. OMPEPT also initiates and finances many short-term traffic management studies in various municipalities/ communities in TMA, having as main objective the overall improvement of the quality of life and the environment for residents and visitors. The data base produced from the 1988 study had to be updated, reassessed and enriched. Therefore a new study was started in October 1997[2], initiated again by OMPEPT. The methodology and first results of this study are presented herein below.

EXPERIMENTAL

The new General Transportation Study (GTS) of Thessaloniki (1997-1999) covers the TMA (almost 1100 km^2) and includes more than 30 municipalities and communities. The TMA area was divided into 7 major sectors and 316 traffic zones. The 7 sectors of the GTS are: 1) commercial centre of the city including three municipal districts, 2) city centre including two municipal districts, 3) east part of the city, 4) north-east part, 5) north-west part, 6) west part and 7) surrounding area. GTS consists of 6 stages (Table 1) and 13 major survey campaigns, and activities (Table 2).

Table 1. Stages of the General Transportation Study (GTS)

1. Data collection and update procedures	4. Determination and evaluation of alternative transport infrastructure and transport policy scenarios
2. Data analysis procedures	5. Elaboration of the selected scenario
3. Development and calibration of mathematical models	6. Detailed examination of the selected scenario for the first five-years period (up to year 2004)

All the data selected within the framework of the GTS were input in specially designed data bases in order to be fully utilized by various software packages. Special attention was paid to the use of GIS technology (Geographic Information Systems) throughout the project. It must be mentioned at this point that OMPEPT has already the cartographic background of the TMA in a GIS environment. The scale of the maps required within the framework of the GTS varies from 1: 10 000 to 1:2000 depending on the theme of each map and on the reference area. More specifically the scales of the maps required within the framework of the study are: 1) road network: 1:10 000, 1:5000, 1:2000, 2) traffic volumes: 1:10 000, 1:5000, 3) land use system: 1:10 000, 1:5000, 4) public transport: 1:10 000, 1:5000, 1:2000, 5) parking: 1:2000, 6) traffic accidents: 1:10 000, 1:5000.

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Table 2. Surveys and activities of the General Transportation Study (GTS)

1. Roadside surveys including the completion of 26 899 questionnaires	8. Survey on the collection and analysis of all traffic accident data
2. Home interviews surveys including the completion of 3342 questionnaires	9. Traffic counts surveys at 100 basic intersections of the road network
3. Stated preference survey including the completion of 905 questionnaires	10. Travel time surveys along specific road axis
4. Survey on population and employment	11. Surveys on the geometric and functional characteristics of the basic road network
5. Surveys on the characteristics of the public transport system	12. Preparation and assessment of the necessary transport planning models
6. Survey on the characteristics of the system	13. Formation — evaluation of a fine-tuned complete and long-term development and policy plan
7. Survey on the parking system characteristics	

One of the basic objectives of the study is the development, adaptation and installation at the OMPEPT premises of a system within which the following operations will be available:

- Integrated and user-friendly management of files and databases related to TMA.
- Relation of the databases with the geographical data.
- Presentation of all processed data in an easy to understand (user-friendly) way.
- Representation of the networks of public transport and the rest of the traffic.
- Examination of the interaction between the land use and the transport system.
- Estimation of the future trip characteristics (e.g. number of trips, distribution).
- Estimation of the future number of trips per transport mode and per part of the transport network for the various alternative scenarios concerning the development of the transport infrastructure.
- Evaluation of specific indices concerning the evaluation of the alternative transport scenarios and policies. Special attention is given to the environmental impacts and especially to the air pollution.

Special training courses will take place for the personnel of OMPEPT which will be involved in the operation and maintenance of the new system.

The model which was developed within the framework of the GTS comprises of the trip generation model, the trip distribution model, the model split and the trip assignment model. The forecasting period for the model is 15 years and three time periods are examined (year 2004, year 2014 and period after the year 2014).

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The formation of the alternative transportation scenarios for the TMA was based on the data collected in the first stage of the GTS and also on the findings and proposals of traffic and environmental management studies which were carried out in the study area over the last decade. Data on the following issues were also used within the framework of the formation of the alternative scenarios:

- Existing and future trends for the development of the TMA.
- Objectives, directions and proposals of the Law for the Master Plan of the TMA.
- Transport and environmental planning plans of OMPEPT.
- Town planning measures concerning the land use system in TMA.
- Transport and other infrastructure projects which are under consideration or construction in TMA.
- Role of Thessaloniki in Northern Greece and the Balkans.

Therefore, all alternative scenarios include transport infrastructure plans and transport policies, which are compatible and serve the goals of the ongoing or under study major transport infrastructure projects in the TMA like the Thessaloniki metro system and the Thessaloniki underwater bypass tunnel.

Within the scope of all proposed alternative scenarios the following points were taking into account:

- Improvement of the urban environment and the quality of life for both residents and employed in the study area.
- Strengthening the role of public transport (including all means of Public Transport like buses, metro system, tram, mini buses, seaway transport etc.).
- Implementation of public transport priority measures like bus lanes (introduction of new bus lanes and extension of existing ones) and appropriate modifications in traffic signal system.
- Design and implementation of restraint measures for the use of private cars in the city centre and residential zones.
- Design and implementation of an integrated on-street parking policy and construction of parking stations.
- Promotion of use of bicycles and other environmental friendly transport modes.
- Promotion of on foot trips.
- Design of the appropriate infrastructure for the safe and unobstructed movement of pedestrians in general, and especially the movement of children, elderly people and people with special needs.
- Design of a new-decentralised-structure of the city.
- Avoidance of imposing external costs (due to traffic) to various groups of the population (in accordance with the Green Bible of DG VII of the EU).

The evaluation of the alternative scenarios examined in the framework of GTS was based on different criteria like those presented in Table 3.

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Table 3. Criteria for the alternative scenarios evaluation of the General Transportation Study (GTS)

1. Environmental impacts	5. Traffic delays
2. Infrastructure cost	6. Accessibility level
3. Operation cost	7. Parking system characteristics
4. Road network level of service	8. Traffic safety level

RESULTS AND DISCUSSION

Some of the most important outcomes of the General Transportation Study (GTS) realized in Thessaloniki Metropolitan Area are presented below.

The trip distribution per mode (% of daily trips) is: 30.5% with private car (as driver), 10.1 % with private car (as passenger), 27.5% by bus, 4.2% by taxi, 18.3% on foot (more than 10 min walking time), 1% with light track, 0.4% with track, 0.2% with bicycle, 4.6% with motorcycle.

From the comparison of the above results with the results of the similar study which took place in 1988 it arises that the use of private car was increased by 20% while the use of public transport was reduced by 25% during the last decade. The car occupancy in TMA was also increased from 177 / 1000 inhabitants to 253 / 1000 inhabitants during the same period. The total number of daily trips in TMA is 1 600 000 of which around 25% have their origin or destination in the city centre. Ten years before the respective total number of trips was 1 350 000.

Parking is one of the problematic elements of the traffic system in TMA. According to the results of the GTS the average walking time from the parking position to the final destination is less than 3 minutes for the 94.7% of the drivers, between 3 and 5 min for the 4.0% of the drivers and between 5 and 10 min for the 1.3% of the drivers. According to the results of a recent research project[3] more than 10 000 vehicles in the Thessaloniki city centre are found parked on-street every day at non-parking places. It is known that illegal parking has a serious impact on traffic situation since it affects the capacity of the road, and therefore it is a cause for traffic delays. These delays contribute to increased fuel consumption and atmospheric pollution. It was found[4] that the unobstructed vehicle movements in intersections — due to elimination of the illegal parking phenomenon — results to a reduction of CO emissions from 39% to 77%. The situation becomes worst in the case where delays occurred at bus stops. These delays quintuple the CO emissions from every obstructed vehicle and almost double the CO emissions from all vehicles along the examined road.

The spatial distribution of passenger cars from the point of view of cars ownership is different in the 7 sectors of TMA. The higher values of the car ownership appear in the east and north-east part of the city (sectors 3,4) and the lower values appear in the west part (sector 6). During the morning peak hours, when the cold starting of cars and consequently the higher NO_x emissions occur — which are determinant for the NO_2 average concentrations — the city centre sectors (1,2) produce the higher NO_x emissions[5].

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The traffic composition and the traffic volumes in TMA have changed dramatically during the decade 1988-1997. The total number of trips has increased by 19% but the average trip time of the passenger cars remained almost the same.

The vehicle fleet size in TMA has been increasing but the shift of the fleet composition in favour of new technology passenger cars and the improvement of the fuel quality led to the decreasing trends for some primary air pollutants and stabilising or increasing trends for the secondary photochemical pollutants[6-8].

The experience of the implementation of various traffic management measures in the central areas of Greek cities shows a significant reduction in the values of NO_x — nitrogen oxides, HC — hydrocarbons and CO — carbon monoxide[9-11]. Such policies will be tested within the framework of the GTS of Thessaloniki and the formation of a comprehensive transportation master plan. The results will be available during the year 2000.

CONCLUSIONS

The new General Transportation Study (GTS) of Thessaloniki (1997-1999) covers the Thessaloniki Metropolitan Area (TMA). The GTS includes roadside surveys, traffic counts surveys, stated preference surveys, traffic accidents surveys, parking characteristics surveys, etc. Some of the most important outcomes of the GTS are:

The use of private car was increased by 20% while the use of public transport was reduced by 25% during the last decade. The car occupancy in TMA was also increased from 177/1000 inhabitants to 253/1000 inhabitants during the same period. The total number of daily trips in TMA is 1 600 000 of which around 25% have their origin or destination in the city centre. Ten years before the respective total number of trips was 1 350 000. Parking is one of the problematic elements of the traffic system in TMA. The vehicle fleet size in TMA has been increasing but the shift of the fleet composition in favour of new technology passenger cars and the improvement of the fuel quality led to the decreasing trends for some primary air pollutants and stabilising or increasing trends for the secondary photochemical pollutants.

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