

**I. Introduction**

A characteristic of the last century is the continuous increase of the vehicular traffic, which is expressed differently during the whole time period.

Generally speaking, during the first decades this trend was expressed through road widening and the pressure for better road infrastructure. Afterwards, this attitude of the public was replaced from a picture: the picture of a congested road network, that results in a seriously damaged environment and depredated quality of life, covering areas from the city centers to the neighborhoods.

However, traffic calming is not a so recent developed methodology of traffic control that arises from the congested networks. It is common to say that the traffic calming concept has its routes in "Traffic in towns", a report which was published in 1963. This report tried to determine the amount of traffic that a street could carry before the environmental conditions become unacceptable.

Then, with the use of traffic management techniques, it diverted the "unwanted" vehicles from the residential network to the main road

network, in order to ensure that traffic volumes in the first are still beyond the environmental capacity. However that report did not deal with the redesign of existing streets or the implementation of physical measures to slow down traffic speeds (O'Flaherty C.A., 1997).

These issues appeared in Britain since the mid - 1980s, where techniques aiming to change the street alignment and thus its appearance, so as to influence travel patterns and the driving behavior and to improve the amenity of the surroundings, making a shift for the heavy and high speed traffic from that network, began to be more acceptable and applicable day by day. In mainland Europe planners and engineers had already achieved the control of motor vehicle use in special areas - like residential areas - by changing the streetscape, making

# A Strategy for the Implementation of Traffic Calming Schemes

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*Traffic Calming Techniques form a framework for the reallocation of road space and the promotion of manpower ways of travel, delaminating in this way the affected society in two parts: Those who are benefited from them, like pedestrians and cyclists, and the second part the motor users on which the measures imposes "problems". However, each of such projects has the potential of a unique and undeniable value, as it provides - in all cases - some "public goods", like road safety, environmental improvements, and quality of life. Having in mind the public goods, it is profound that an effort should be made so as to ensure the public will and the effectiveness of the traffic calming schemes. The answer comes through the formation of a strategy.*

*And exactly this is the aim of this paper: to propose and describe a strategy for the implementation of effective traffic calming schemes. It tries to give the boundaries of such applications and the steps that should be followed before and after the implementation. As the strategy highlights the meaning of "evaluation" in first place and "the meaning of "monitoring" in second, a description is given for the expected effects from a traffic calming scheme, distinguished them in costs and benefits.*

woonerfs, pedestrianized streets e.t.c. (O'Flaherty C.A., 1997)

For Greece, traffic calming started to gain place at 1990s. At the beginning, some simple measures to control speed (like road humps) in specific areas (residential and conservational sites) as well as pedestrianization schemes were applied in roads and sites of cities, with main objective to provide a better and safer environment for the vulnerable road users, the residents and the visitors of these areas. The meaning of the traffic calming concept as well as the application of more and more traffic calming measures became famous gradually. In this way, nowadays, traffic calming forms essential part for traffic planning of small and medium sized municipalities and additive value and self-evident application for sites of modern cities.

However, and focusing to the effectiveness of traffic calming, it is obvious that a strategy must be followed. And this is the exact objective of this paper: the formulation and description of a strategy that should be followed for the

implementation of effective traffic calming schemes. The next paragraphs are going to highlight issues that are components of such strategies.

**2. Basic concepts**

At this point it is important to give the concept of traffic calming. Traffic calming is considered to be a transport policy concept or a strategy with main objective the promotion of personal mobility and the reduction of car dependency - without compromising the accessibility needs - through the promotion of pedestrian, public and bicycle transport. But what is the meaning of the terms mobility, car dependency and accessibility?

The relation between these three parameters arises from the



consideration of the term “transport”. Transport includes all the possible ways of travel i.e. vehicle movements and other travel options like walking, cycling and transit modes in order to participate in activities or to reach desired goods. Shortening the “transport concept” and considering vehicle movements in isolation from the other ways of travel – something very common during the last decades – the result is a “transport externality” or a “public bad” that is the “car dependency”.

“Mobility” describes the personal need for movement, including in this way the use of all the available travel options, i.e. car, walking, cycling and transit modes, giving thus a wider perspective to the transport term. Although, few limitations still exist as the main objective of transport is the opportunity and ability to participate in activities or to reach desired goods i.e. accessibility. Such objectives are possible to be met through efficient policies that include the reallocation of land uses, urban sprawl e.t.c..

Thus, traffic-calming policies aim to increase mobility and accessibility, reducing the vehicle miles traveled. So, the main objectives underlying traffic calming are to:

- Reduce the higher speeds of vehicles in the traffic streams
- Create roads conditions which encourage motorists to drive more carefully
- Remove extraneous car and commercial vehicle traffic from the road being calmed
- Improve amenity and enhance the environment
- Reduce accident numbers and severity

In order to achieve the above-mentioned objectives, traffic calming policies are materialized by measures or techniques, which aim to change the horizontal and/or vertical alignment of roads in built – up areas (e.g. residential areas, shopping centers) or conservation areas (e.g. archeological sites), so as to reduce the speed of the vehicular traffic and to improve the overall traffic and environmental conditions in the considered area. In more detail, traffic calming measures try to improve road safety, to protect the pedestrians and the other vulnerable road users from the vehicular traffic, to upgrade the local street network, to create an environmental friendly and aesthetic upgraded, minimizing vehicle emissions, noise levels and visual intrusion.

Commonly used traffic calming techniques are:

- Diminished speed limits (e.g. 30km/h zones or 20mph zones) and enforcement
- Vehicle restrictions on specific roads, which involve certain type of vehicles (e.g. trucks restrictions) or users (e.g. residents permission) and woonerfs (low speed residential streets with mixed vehicle and pedestrian traffic)
- Gateways warning signs and pavement treatments, which indicate entrance in areas with “special” traffic rules and characteristics, like residential or commercial districts
- Plateau, speed tables, raised crosswalks for the accommodation of the pedestrian flow
- Median islands and curb extensions in order to narrow

traffic lanes and to reduce pedestrian crossing distances providing at the same time a safe place to stop

- Channelization islands for the traffic accommodation in a particular direction
- Speed humps, rumble strips, mini circles and roundabouts in order to control speeds and to provide safer traffic conditions
- Lane narrowing “pinch points”, horizontal shifts, chicanes, semi - diverters and street closures, which aim to create difficulties to the motorists movements and to force them to slow - down
- Bike lanes, which combine traffic lanes narrowing and cycle accommodation
- Street closures and stop signs in an effort to reduce effectively traffic flows in certain points
- “Neotraditional” street design, which aims to the creation of a traffic calming area
- Travel demand management strategies, which involve strategies to reduce car dependency, giving better public transport or creating better conditions for the movement of pedestrians and cyclists for example.

### 3. Strategies for the Implementation of Traffic Calming Measures

A traffic-calming scheme forms a solution for traffic problems identified during a traffic study and described from one or combination of two or more of the following points (Roswell Transportation Department, 2001):

1. The average speed on a residential road of the considered area is 30 mph or greater
2. The 85<sup>th</sup> percentile speed on a residential street is greater than 10 mph over the posted speed limit
3. The average daily traffic on a residential street is greater than 1000 vehicles
4. The peak hour volume on a residential street is greater than 100 vehicles
5. The number of accidents on a residential street is three or greater in one year
6. The percentage of truck traffic is 1% or more of the total vehicles counted.

Occurring one or more of the previous conditions, a traffic-calming scheme should be considered. This scheme is useful to be the output of a strategy, as in the cases of area wide traffic management and safety schemes in urban areas. Traffic calming measures in order to succeed or to increase their effectiveness should form part of a greater plan for traffic and environmental improvements in an area. Main target of this plan should be the implementation of traffic calming measures in every single road of the area in a way that does not compromise the common character of the targets for the particular area, like the speed reduction, the reduction of the number and the severity of the accidents, the environmental upgrading etc.

The process and principles that should be followed and applied respectively in such cases are (Department for Transport 1987, 1990, 2000), (Arlington County, 2000):



- Adaptation of a local area traffic-calming scheme, with common targets for the speed, the environmental conditions and the perceived level of road safety. The road network under consideration should be in line with the traffic calming strategy.
- Consideration of all road users and consultation with local people during the different stages of the process. Reducing car dependency and minimizing thus the impacts from the vehicular traffic will cause changes to the daily lives of local people. It is therefore practical and convenient to ask their contribution during all the stages of the strategy: identification of the problem, alternative solutions, and final decision. Another important aspect concerning the consultation of local people involves participation to the process of those with mobility handicaps.
- Acceptance of measures and especially from the occupants. Measures should be self - enforced in the majority of the cases; something that gives an advantage to measures involving constructions. Another way to gain the public acceptance is given to schemes when they incorporate environmental improvements into their design.
- Proper and careful design of each measure that forms part of the proposed scheme, as the effectiveness of a scheme relies on the interaction between measures, policies and strategies taken at different sites. It is crucial to ensure that working out a problem in a road will not cause a similar problem or a new one elsewhere.
- Serious consideration from the experts of the recommended guidelines for each measure and the valid national and local laws, underlying such interventions to the build environment
- Evaluation of the alternative schemes. Having wider objectives without punctual applications and results, the final choice between the alternative strategies must be the product of a careful consideration between targets and expected effects or the result of a comprehensive cost - benefit analysis.
- Implementation and continual monitoring of the scheme. In order to achieve the objectives of the proposed scheme it is vital to ensure proper implementation of the measures at first place. After the implementation monitoring the effects of the scheme is another important step for two basic reasons: to contact any revise if necessary and to form a guide of good practice for future applications.

The next paragraphs give some information about the evaluation of traffic calming schemes.

#### 4. Evaluation of the effects: Methodology

The methodology for assessing the impact of traffic calming measures is function of the targets that have been placed in order to implement them. In each case there are two basic points:

- The absolute value of the control parameter, which indicates if there exists a problem
- The change in the parameter after the implementation of the traffic calming measure, which is estimated using a cost - benefit analysis (CBA)

Both of them suggest that there must be a clear distinction between the effects of such measures and more accurate a clear definition for the costs and benefits.

#### 4.1 Benefits from Traffic Calming Measures

Economists used to define “benefits” as reduced cost, something that is very close to the reality. Considering that trying to evaluate a transport project it is common to express the impacts in monetary terms, then it is possible to say that “transport benefits” and “reduced costs” are almost consistent.

The basic benefits that result from the implementation of traffic calming measures are synopsized to the following:

- Increased road safety, as the decrease in speeds and traffic volumes results to reduction of the number and the severity of the accidents, especially of those involving pedestrians and bicyclists. Based on research results (DUMAS), a decrease of 5 km/h in travel speed gives 30% less deaths in pedestrians.
- Improved level of service for pedestrians and cyclists, or more generally for non-motorized modes
- Reduced car dependency and encouragement of movements by manpower (i.e. cycling, walking).
- Upgraded environmental conditions through the decrease of road noise and air pollution, and improvement of the surroundings’ aesthetic.
- Increased density, activity and interaction within the neighborhood, as people can meet each other in the neutral space of the lively and friendly streets. This effect of traffic calming encourages community interaction, commercial activity and discourages extreme anti-social behavior, as evoke neighborhoods.
- Increased property values for residential, refreshment and commercial uses, as such uses are attracted on streets with low or controlled traffic volumes and speeds, and pedestrian amenities.
- Diversity of land uses in areas and thus prevention of the expulsion of residential use from the city centers or the central business districts (CBD)
- Reduced suburban sprawl, as indirect impact of traffic calming scheme and direct impact of the mixed land uses.

In Greece during the recent years a number of traffic calming measures have been designed and implemented in urban areas. In Table 1 a number of traffic calming measures implemented in six (6) municipalities of Thessaloniki Greater Area in the period 1991-1999 are given.

Measure	% of Municipalities where the measures implemented
Pedestrianisation - no access	22
Pedestrianisation - limited access	22
Speed humps	5
Changing street alignment	10
Woonerf	10
Street narrowing	26
30 km zone	5

Source: Pitsiava - Latinopoulou M. et al. (2000)

**Table 1: Traffic calming measures in Thessaloniki**



An evaluation that was made for the implementation of speed humps and pedestrianization schemes gave remarkable results. Specifically, as far as speed humps are concerned on site measurements conducted in different time periods showed:

- Vehicle speed was significantly decreased by 52,3 % just after (2,5 months) the construction of the speed humps in the area
- Five years later this effect alleviated, as the speed increased by 33,3%, remaining although under the speed levels of the period before the implementation of road humps
- The level of service in the area seems to have an overall improvement

A questionnaire survey, which was also accomplished among the residents of the area, showed that:

- The majority believes that pedestrian safety has increased after the implementation of the speed humps and in the meanwhile believes that congestion and traffic volumes have been reduced.
- The opinions about traffic noise share the same portion of positive and negative reactions
- Finally, the majority believes that the cost for the implementation of road humps and traffic calming measures in general is worthwhile.

As far as pedestrianization is concerned the cases of two Greek cities - Katerini and Rhodes - where an extensive pedestrianization scheme was implemented - were evaluated. The evaluation showed that the pedestrianization resulted to an improvement of the environmental conditions. Specifically, reductions of 35%, 25% and 17,2% observed in NO<sub>x</sub>, HC, CO respectively, in the approaching area of previously congested junctions (Pitsiava – Latinopoulou M. et al. 1995).

In addition the evaluation of the impact of pedestrianization on road safety in other two medium size Greek cities – Katerini and Larisa - showed a significant reduction in the number of accidents involving pedestrians. More specifically, the reduction was 50% and 36% in the cities of Katerini and Larisa respectively. In both cases, the reduction was completely attributable to the extensive pedestrianization schemes that took place in their centers during the last decade.

#### 4.2 Costs from Traffic Calming Measures

Trying to define the term “cost” a well-understand explanation is the term “problem”. More specific, what is commonly called as problem in economic theory is described as cost. So economists define costs as benefits foregone, giving therefore a mirror - image relationship to costs and benefits. The basic costs that are expected from the implementation of traffic calming measures are:

- A fixed cost that is described as project expenses and

includes both an immediate cost for the construction and a regular cost for the maintenance of the scheme. Generally speaking it is possible to form a cost - scale for the implementation of measures that aim in the traffic balance. The scaling includes simple traffic management measures and progressively comes up to area wide traffic calming schemes or even area wide traffic prohibition schemes. The table that follows has not the exact cost of the scheme but a scaling, as it aims to be used as a guide for the applications and not as a price list.

No.	Technique	Measures
1	Traffic management	One-way streets, closures, banned turns, signing
2	Simple speed reduction measures within street (e.g. 30 km zones)	Alternate parking, pre-fab or temporary humps, build outs
3	Partial repaving and landscaping permanent measures in street	Plateau, cushions, gate effects, planting, junction treatments
4	Full reconstruction and repaving of the street plus landscaping	Shared surfaces, raised surfaces, varied materials, environmental features
5	Pedestrian areas and special treatments such as for conservation areas	Special materials (e.g. granite and stone), features, such as custom lighting, bollards e.t.c.

Source: Pitsiava – Latinopoulou M. et al. (2000)

**Table 2: Costs scaling**

- Liability claims between authorities and local societies (i.e. who is responsible for the implementation, who must have been asked before the implementation e.t.c.), although, current experience indicates that traffic calming projects do not cause significant liability claims.
- Vehicle delays and driver frustration, as an effect of traffic calming is the average motor vehicle speed reduction. Also the vehicle diversions that may be caused by a traffic-calming scheme is possible to increase the traveled distances to destinations.
- Traffic spillover on the rest road network (alternative routes) may cause an increase to the arterial traffic congestion, as the main consequence from shifting the traffic from low-volume residential street to arterial ones.
- Problems for the vehicular movements and especially for the movements of emergency and goods vehicles, as they have to use roads with special treatments and they experience the same delay with the rest traffic and maybe additional ones, as they are heavy vehicles.
- Problems for cyclists and mobility handicaps, especially where the width or the surface of the street changes, causes confusion to these two categories of road users.

Table 3 that follows present the costs and benefits from the implementation of traffic calming measures.



Benefits	Advantageous
Increased road safety	Pedestrians, cyclists and the society as a whole, due to accident reductions
Better level of service for pedestrians and cyclists	Pedestrians and cyclists
Reduction of car dependency	Society, due to the increased alternatives for travel that results to various cost savings
Environmental benefits	Residents, visitors, commercial and recreational activities
Strengthening of neighborhoods	Residents
Increase in land values	Residents and property owners
Reduction to the suburbanization rates	Society and individuals
Costs	Disadvantageous
Costs for construction and maintenance	Local governments and districts
Responsibility claims	Municipal governments
Vehicle delays	Motorists and businesses
Traffic spillovers	Residents and travelers to the residential and arterial network
Problems for emergency and goods vehicles	Drivers, people needing emergency services, public bodies
Problems for cyclists and mobility handicaps	Bicyclists and people with handicaps

**Table 2: Costs and benefits from the implementation of traffic calming measures**

**6. Conclusions**

This paper describes a comprehensive framework for the formulation of a traffic calming strategy and makes an effort to describe its effects. Giving a number of different measures that have been developed by today, defines the great variety of traffic calming schemes that could be applied. It is almost profound that traffic calming consists an effective way of redesigning the streets - inside residential and neotraditional areas - to balance the transport needs of all users: pedestrians, cyclists, public transport and motorists. However, in order to be effective, traffic calming should not cause negative effects in the greater area, such as safety reduction, congestion increase, environmental depreciation. Solving one local problem should not cause another problem to appear somewhere else (mitigation effects).

Each situation and the associated traffic-calming scheme is unique and so are its impacts. For this reason and trying to synopsize the recommended strategy, it is important in each case to select a scheme that is (Arlington County, 2000):

- The simplest solution
- The most cost-effective scheme
- The least adverse in impact
- A stand alone single measure or in combination with others
- Within the range of professional traffic management guidelines
- A contribution to the overall aesthetic and attractiveness of the area
- Legally permissible under the national and local laws

Concluding, and according to the discrete parts of the paper, if the selected scheme fulfills the previously mentioned criteria, then the public acceptance of the measures will be gained, but still the need for continual evaluation and monitoring of the scheme consists a crucial parameter for its effectiveness. Some of the impacts can be quantified or measured, but some others not, due to their nature or the inability to express the effects of a change in monetary terms, as it is the most common in use method. The evaluation and monitoring process that presented in the paper makes clear that impacts should be described both qualitative and quantitative - where possible - in order to avoid the exacerbation of inequities within local societies and outnumber the positive effects over the negative effects of traffic calming measures.

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