

***Sustainable Urban Transportation with Travel Demand Management Methods:
A Case Study for Istanbul***

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Abstract

In order to achieve sustainable cities, in addition to smart use of land, intelligent transportation systems, clean and green vehicles, it is vital to achieve social behavioral change for shifting our modes from motorized means to greener, healthier and more economic means such as walking, cycling, and public transportation. Economic, environmental, and social concerns about growth of traffic congestion have caused several mega-cities in the world and academics towards investigation and introduction of different policies and measures in urban areas. Among many options, Travel Demand Management (TDM) policies mainly aim to promote sustainable modes and increase an effective use of existing infrastructure by voluntarily controlling demand. With such circumstances, objectives of this study are as follows: (1) review existing academic, industry, governmental and non-governmental literature to examine and understand various sustainable society, sustainable development, sustainable mobility concepts, mechanisms and policies developed and tested in other parts of the world; (2) establish a framework of social behavioral change policies particularly developed and tested for urban mobility; (3) compare various mega-cities on different indicators to better understand the case of Istanbul. As a result, it was revealed that traffic congestion is worse in Istanbul compared to similar cities and management of traffic within the city implies mistakes. However, it was also seen that TDM policies offers noteworthy potential to increase use of sustainable modes and help reducing congestion levels in the city.

Keywords: TDM, Congestion, Istanbul

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Introduction

High levels of traffic congestion in urban areas like Istanbul caused cities in the world and academics towards investigations and introduction of timely and effective solutions to mitigate traffic congestion levels. Travel Demand Management (TDM) policies are one such solution. TDM policies mainly aim to promote sustainable modes such as walking, cycling, and public transportation, to eliminate the need for travel for particular trips, and to increase effective use of existing infrastructure by voluntarily controlling demand.

This paper is divided into two parts; (1) Transportation in Istanbul and (2) Mobility and Access Management. The first part overviews selected case city, Istanbul, on general highlights, transportation infrastructure, urbanization and motorization trends, and make comparisons between Istanbul and various cities in different parts of the world on different indicators to better understand the case of Istanbul. The second part establishes a framework for mobility and access management and gives brief descriptions of its components, then explain TDM as part of Mobility and Access management and provide various policies of TDM in different groups which are developed and tested in other parts of the world. Since TDM policies are very new to Istanbul, this study mainly aims to demonstrate the gap for TDM policies potential in the city to alleviate high traffic congestion levels and keep up pace with increasing motorization levels in last decades.

2. Transportation in Istanbul

As the economic, financial, and industrial center of modern Turkey, Istanbul is currently one of the largest cities in the world with a population of approximately 14 million inhabitants [4]. Istanbul is divided into two parts by the Bosphorus channel which also connects the Black Sea and Mediterranean Sea through the Marmara Sea and the Aegean Sea. The channel forms the natural boundary between Europe and Asia. In addition to this, Europe's easternmost or Asia's westernmost city, Istanbul is one of the most important gateways for trade routes between Europe and Asia from past to present. Despite of the Bosphorus channel's positive impacts on the city from many perspectives, it also complicates mobility and access within the city.

Likewise other mega-cities in developing countries, Istanbul has faced rapid urbanization and motorization in last decades in conjunction with economic growth. Population of Istanbul was just 4,7 million in 1980, it has increased to 10 million in 2000, and finally to 14 million in 2014, while the number of registered vehicles in 1980 in Istanbul was 0,2 million, it has dramatically increased to 1,25 million in 2000 and finally to 3,3 million in 2014 [12]. Although motorization rate is still low in Istanbul where there are 232 vehicles registered for 1000 people as compared with other megacities in developed world (400-500 vehicles per 1000 population), trend of motorization rates in last 10 years is alarming [36]. Figure 2.1 takes the year 1980 as base year for illustration rate of rise to show this dramatic difference in rise of population and motorization levels. It is also projected that population will increase to 17,2 million, number of vehicles in the city will increase to 4,3 million, and number of vehicles per 1000 population will increase to 252 in 2023 [14].

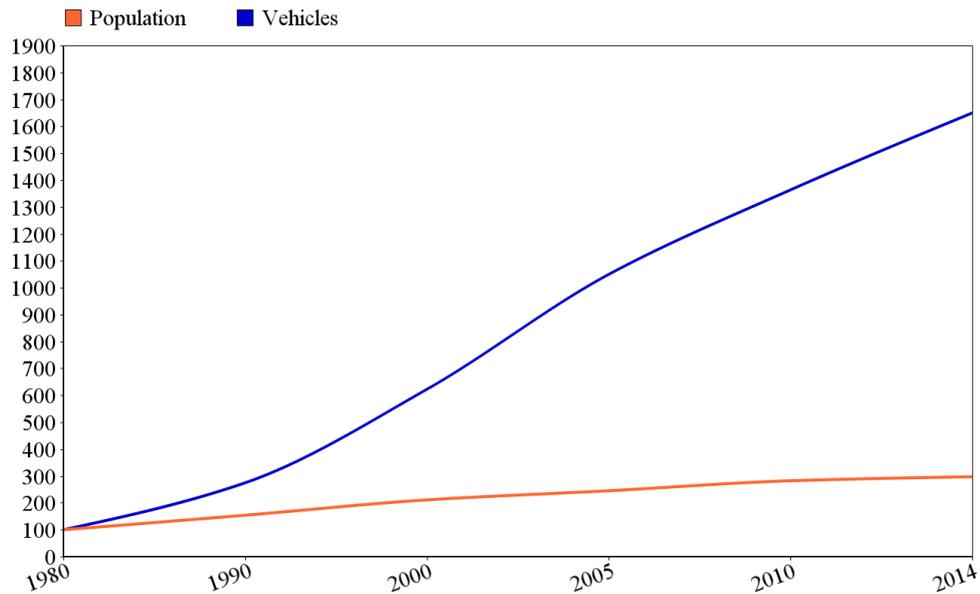


Figure 2.1: Population and Motorization Growth in Istanbul between 1980-2014 (1980=100) [12,36]

Based on the 2006 Household Travel Survey conducted by the Istanbul Metropolitan Planning and Urban Design Center (IMP) in Istanbul, the change in modal split of urban motorized travel in the period of 1987 to 2006 has been estimated and shown in Figure 2.2. According to the figure, it can be seen that the share of car has risen from %19 in 1987 to %26 in 2006 together with Company/School shuttles which has increased from 10 in 1987 to 21 in 2006. On the other hand, the share of buses has dropped from %35 in 1987 to 24 in 2006 together with respectable decrease in rate of taxi, shared taxi and minibuses. Share of railway and sea lines range at a low level between %2 and %5.

As a result, the dramatic increase in motorization rates resulted in big traffic congestion problem in Istanbul. According to a survey undertaken in 2011, participants have replied the question “What is the biggest problem in Istanbul” as traffic congestion by %31 and it is followed by population density by %21 and security by %15 [29]. Another survey as part of the Urban Age research has been undertaken to look at what residents really think about the quality of life in Istanbul [26]. According to that survey, participants have been asked “What concerns most about the city”, the result is that %55 of participants think it is traffic congestion.

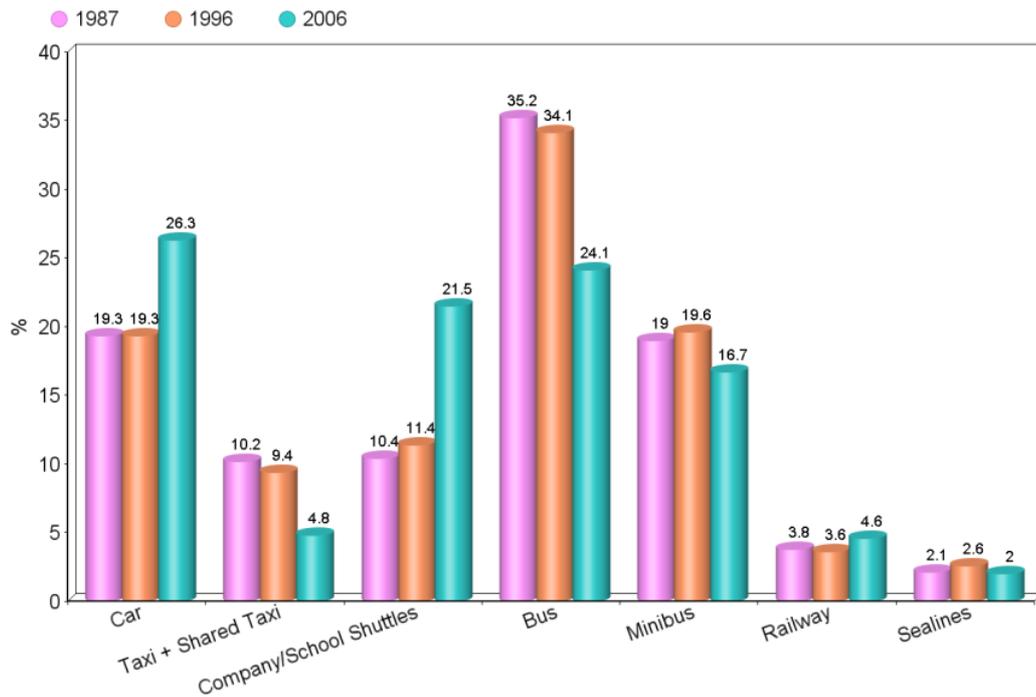


Figure 2.2 modal split of urban motorized travel in the period of 1987 to 2006 [12]

2.1. Comparisons of Istanbul and Other Megacities

As one might expect that all megacities share similarities due to extreme globalization trends, however, each city draw different patterns of urbanization and motorization with diverse spatial, economical, and social characteristics that result in specific urban experience for each city. A preliminary assessment and comparisons of various world cities on different key indicators is important to get the bottom of this urban experience. New York City from North America, Mexico City from Central America, Sao Paulo from South America, Shanghai and Singapore from Asia, London and Barcelona from Europe and finally Johannesburg from Africa have been selected in comparisons to Istanbul. The selection has been made due to representation of all parts of the world and each city sharing different spatial, economic and social characteristics. First, they have been compared on basic indicators like population, central area density and GDP (See Table 2.1). Second, they have compared on transportation related indicators such as congestion index, total infrastructure network, motorization level (See Table 2.2). Finally, they have been compared on more comprehensive indicators such as minimum wage, transport related cost indicators, and transport related purchasing power of minimum wage (See Table 2.3). The range of population of these nine cities vary from 3,2 million (Barcelona) to 24,2 million (Shanghai) while Istanbul (298,6 %) and Johannesburg (%285,4%) has faced the highest population increase since 1980. Patterns of central area densities also differ significantly. The cities representing highest densities are Shanghai (24.673 people per km²) and Istanbul (20.116 people per km²) which nearly tripled London (7.805 people per km²), and Singapore (7.418 people per km²). On the other hand, the city indicating lowest central area density, which might be considered as being more dangerous places to live, is Johannesburg (2.270 people per km²). Despite of New York City (1.210 billion \$) having the highest weight in terms of GDP, its share in the

US GDP is only %7,5 which is the second lowest in the nine cities. Cities contributing most in country GDP are Istanbul (301,1 billion \$) with percentage of 38,1 and Mexico City (411,4 billion \$) with share of %34,7. (See Table 2.1)

Table 2.1: General comparisons of various cities [13, 17, 18, 28]

City	Population in 1980 (million)	Current Population (million)	Population increase since 1980 (%)	Density (people per km ²)	GDP (billion \$)	% share in Country GDP
Istanbul	4,74	14,16	298,6	20.116	301,1	38,1
New York City	7,07	8,40	118,9	15.361	1.210,0	7,5
Mexico City	13,88	21,17	152,7	12.541	411,4	34,7
Sao Paolo	12,49	20,82	166,6	10.299	473,0	21,0
Shanghai	11,73	24,15	205,7	24.673	516,5	6,2
London	7,74	9,78	126,4	7.805	731,2	29,6
Barcelona	3,07	3,23	105,5	7.866	171,0	12,9
Johannesburg	1,55	4,43	285,4	2.270	76,0	19,8
Singapore	2,41	5,31	220,1	7.418	327,2	100,0

As mentioned in previous sections, the number of vehicles in Istanbul has increased in a more rapid trend than the population, thanks to the economic developments. The number of automobiles in Istanbul has experienced an 8-fold increase since 1980, compared to 5-fold increase in the population [12]. Although the number of cars per thousand populations is significantly lower than the most of the other large world cities, the scope of congestion problem has increased in the last years (see Table 2.2). In this manner, congestion index gives a good estimate of the degree of congestion on a normalized scale, which is calculated as follows:

$$congestion = \frac{t_{normal} - t_{free}}{t_{free}} \quad (1)$$

Where t_{free} is the amount of time spent when the roads are free (e.g., during night), and t_{normal} is the amount of time spent during a usual scenario (e.g., averaged over a large number of times sampled from various instants) over a predefined route. Looking at Table 2.2, it can be seen that Istanbul has the highest congestion index, compared to the other cities. Strikingly, number of cars per 1000 residents in Istanbul is lower than all the cities given in the table, except Shanghai and Singapore. Infrastructure comparison of these cities is made on the indicators of total metro network and total road network. While cities having the longest road network are New York City (56.516 km), Mexico City (52.749 km) and London (47.287), they also have the longest railway networks, which are London (402 km), New York City (373), and Mexico City (226,5 km), except Shanghai with total road network of 20.082 km but 538 km rail network. On the other hand, Istanbul is in the mid-range on both indicator with total road network of 32.535 km and 142 km total railway

network. The unexpected relationship between the congestion index, road and rail network and the number of cars compared to the other cities implies mistakes related to the management of the traffic.

Table 2.2: Infrastructure, life quality and congestion comparisons [7, 15, 28, 30, 35]

City	Mercer Life Quality Rank.	Congestion Index	Car ownership per 1000 residents	Total Metro Network (km)	Total Road Network (km)
Istanbul	117	0,62	152	141	32.535
New York City	44	0,26	215	373	56.516
Mexico City	120	0,54	360	226,5	52.749
Sao Paulo	115	0,46	368	74,8	28.956
Shanghai	95	0,38	73	538	20.082
London	38	0,34	645	402	47.287
Barcelona	40	0,25	470	102,6	4.551
Johannesburg	94	0,31	206	NA	2.280
Singapore	25	NA	120	152,9	NA

The comparison of the cities on quality life is also significant to analyze social welfare and life satisfactions of individuals and societies in those cities. Mercer life quality index has been used to evaluate the cities (See Table 2.2). The index consists of evaluating cities on more than 39 factors including political, social, economic environment, education, health and sanitation, natural environment, housing, consumer goods etc. which is determined according to surveys conducted in 420 different cities all over the world. The index reveals that the most livable cities among these nine cities are Singapore (ranked as 25th), London (38), Barcelona (40) and New York City (44), while the worst livable cities are Mexico City (120), Istanbul (117) and Sao Paulo (115).

Table 2.3 reveals purchasing power of minimum wage in the cities according to different mobility related indicators, while it also provide comparisons of prices of an average car, gasoline, and one way metro ticket. However, comparisons only between prices is inadequate to draw objective comparisons between cities on mobility related indicators, therefore, purchasing power of minimum wage in different cities have also been provided in the table. For example, one can purchase a new car in 138 months in Mexico City, or 141liters of gasoline, or 342 one way metro ticket by minimum wage, while in London a new car can be purchased in 14 months by minimum wage or 826 liters of gasoline or 409 one way metro tickets. On the other hand, it can be seen that one can purchase a new car in 61 month, or 172 liters of gasoline, or 397 one way metro tickets.

Table 2.3: Comparisons based on mobility indicators related to purchasing power of minimum wage [24, 28, 30]

City	Minimum wage (\$)	VW Golf or eq. car price	Gasoline (\$ per lt)	Metro ticket price (\$)	Car price / Min. wage	Min. wage / Gasoline	Min. wage / Metro ticket
Istanbul	393	24.123	2,29	0,99	61	172	397
New York City	1.400	23.000	1,05	2,67	16	1.333	524
Mexico City	130	17.982	0,92	0,38	138	141	342
Sao Paolo	310	23.914	1,25	1,38	77	248	225
Shanghai	295	25.175	1,3	0,57	85	227	518
London	1.925	26.895	2,33	4,71	14	826	409
Barcelona	620	25.462	1,97	2,67	41	315	232
Johannesbu	174	20.496	1,25	0,02	118	139	8.700
Singapore	1.000	111.865	1,71	1,44	112	585	694

As a result, Istanbul has faced uncontrollable growth at a higher rate than was anticipated in the last 30 years and this has resulted unplanned urban settlements and chronicle traffic problems unlikely from other metropolitan regions. In this manner, it was important to take a picture of Istanbul regarding traffic congestion and make comparisons with similar urban areas to find out the differences and similarities between cities. This can help to manage traffic growth in the city. Within this framework, it is also important to find appropriate successful approaches which have already been successful in other parts of the world.

3. Mobility and Access Management

There are various measurements available worldwide for any transportation management programs to meet transportations needs of an area such as building new roads, transit facilities, or managing demand, or increasing access conditions. Meyer (1998) has properly categorized these measures into three groups include supply management, land use management, and demand management [20]. Instead of developing and implementing measures from single category, applying a coordinated program including a combination of measures from three groups is necessary as a formidable solution to address long-term transport problems of urban areas, particularly mega-cities [21].

Supply Management

Of the three groups, supply management measures and strategies are the most common response policy makers and city managements have taken to come up with solutions for traffic related problems simply by supplying more. Supply management methods such as widening of existing roads, building new highways and transit facilities aim to increase the capacity of transportation infrastructure to meet the growth of traffic and transport needs. Technological solutions are also considered in

this category such as more fuel efficient, cleaner engines or new forms of road surfaces to reduce the level of traffic noise and friction related energy losses to reduce air pollution. However, these supply side measures, both building more and technology side improvements, are only effective in short-term requiring expensive investments and, in fact, generating further transport, social and economic related problems, and they are not be able to meet long-term sustainable urban mobility goals. Because it has been realized that the added road capacity makes driving more attractive, thus it increases demand to use the roads leading to further traffic related problems again [27, 19, 23].

Land-use Management

Land use means simply how the land is used, in other words, what human activities are conducted and what location is allowed for constructions. From the perspective of transportation management, knowledge of the geographical settlement patterns of social and economic activities is crucial at planning stage of transportation policies. To put simply, trip-making patterns, volumes, frequency and modal distributions are simply related to spatial distribution and use of land. It has the answers for supply management questions: how much, what type and where to supply when increasing transport capacity of a city. It is also critical for demand management when exercising control over the trip generating characteristics of the land use in an area to use for providing the resultant demand being consistent with the existing transportation infrastructure and the desired level of service.

Travel Demand Management

As discussed in previous sections of this study, automobile use has been steadily increasing at a growing rate during the past few decades. In addition, the number of passenger kilometers by private car per capita has been increasing due to aggressive growing of cities and consequently longer, more frequent working and personal trips. On the other hand, the average number of passengers traveling in the same car has been decreasing at the same time. As a result, problems related to this uncontrollable growth such as congestion, air pollution, noise, traffic accidents are continuing to rise. Besides, vehicles take up much space in urban areas, which narrow down people's living spaces. For example, many streets, which are assumed to be a habitat for many activities, are captured by traffic along with its associated problems. To arrive at a more sustainable urban transport system in the future, however, cleaner fuels and reduced car use will be necessary [32]. Technological solutions are effective at reducing the impact per vehicle and per kilometer. However, the mitigating effects of new technological solutions are not expected to keep up with the increasing growth of mobility and accessibility needs and use of various vehicle use [34]. Reduced car usage strategies are aimed at influencing people to change their behaviors to more sustainable transport modes to improve urban quality of life. Such behavioral change strategies are known as Travel Demand Management (TDM) policies.

Travel Demand Management (TDM) was defined as *“any action or set of actions intended to influence the intensity, timing, and spatial distribution of transportation for the purpose of reducing the impact of traffic”*[20]. In other respects, the primary objective of TDM policies was explained as *“to reduce the number of private vehicle*

trips while providing a wide variety of mobility options to those who wish to travel”[6]. TDM includes a broad set of policies designed to increase the attractiveness of sustainable transport modes including walking, cycling and public transport as an alternatives to travel by automobile. In other words, TDM policies aim to maximize efficiency of existing transportation system by increasing the number of passengers in a vehicle, or by influencing the time of, or need to, travel. TDM instruments rely on incentives and disincentives to accomplish these types of behavioral change by making unsustainable modes less attractive and sustainable modes more attractive.

Among many different categorization of TDM measures such as *physical* and *behavioral* or *push* and *pull* or *hard* and *soft*, we have used *push* in similar meaning with *hard* and *pull* in similar meaning with *soft* categories [33]. “Push” (hard) policies aim to decrease attractiveness of car by economic disincentives, laws and regulations, as well as modifying the objective physical environment. Examples are road tolls, congestion charging, traffic calming, increased prices of fuel and vehicle ownership, and reduction of road capacity. “Pull” (soft) policies aim to increase benefits from using other modes of travel more than car, influence individual’s awareness of the problems related to cars, and increase their knowledge for more sustainable modes of travel as alternative to car by providing economic incentives, information, education, public campaigns as well as improving physical infrastructure and service levels of sustainable modes [33,11]. Because of resulting high public opposition, being politically unfeasible and having only short-term effects, previous researches show that hard policies, that enforce change, alone do not lead to meet reduced car use targets in long-terms [10]. To illustrate this, it was found that during the world oil crisis of the mid-1970s the substantial rise in fuel prices had only a marginal effect on car use in short term [25]. In long term, higher prices have lead people to purchase smaller and more economical cars and consequently lower petrol consumption.

Thus, transportation planners, scholars, and other stakeholders have started paying serious attention to applying “soft” policies to meet desired sustainable urban transport objectives [16]. Mainstay of “soft” policy applications are an economic paradigm “utility based theory” in which travelers are generally assumed to be rational decision makers, who make choices for their travel based on how much net utility they can get out of their journey[16]. On the other hand, there are rationale advantages of car such as speed, comfort, flexibility, carrying capacity, however, there are also some subjective or emotional factors, which play significant role for changing travel behaviors through sustainable modes (public transportation, walking, and cycling) such as expressing feelings of power or superiority, or deriving enjoyment from driving, expressing their personality through type and color of car [32]. These two important aspects, utility theory and rationale and emotional advantages of car form groundings of soft policies. Different soft policy measures were identified and grouped into 10 different soft policy measures in literature which are explained below [3]. The first policy types (workplace travel plans, school travel plans, personalized travel planning, information and marketing, awareness campaigns) have been the most frequently implemented and evaluated to impact upon car use in the last decade. Although there is lack of evidence for the last categories (car clubs, car sharing, teleworking, teleconferencing, home shopping) having remarkable impacts on reducing traffic, they offer a great potential in the future to

affect traveler's behaviors as technology evolves [2]. To obtain favorable results from these measures, they should be combined in designing, policy development and implementation in order to amplify the effectiveness [9].

Workplace Travel Plan (WTP)

Nobody doubts that commuting to work by car accounts for vast majority of all car traffic in every mega-city, particularly at peak times. However, growing experience of employer travel planning programs from different countries such as the UK, Netherlands, the US, Australia etc. demonstrate that workplace travel plans offers a great potential for sustainable urban transportation as they can be highly effective at cutting the number of cars driven to work totally or at peak times, through a combination of incentives for alternative sustainable travel modes [31]. From this point of view, a work place travel plan can be described as a package of measures developed by an organization or combination of organizations, companies, municipalities and governments to accomplish more sustainable travel as making getting to and from the workplace easier, faster, more inexpensive and less harmful for employees, and reducing dependence on private vehicles and parking space [2]. Although measures would vary depending on the number of employees and stakeholders, main measures used in a typical workplace travel plan include: (1) Discounts on public transport, (2) Increased and effective spending on public transport infrastructure by offering new public bus or rail services to linking to the sites of interests such as business quarters; (3) Providing all staff with public transportation information and available promotions and discounts, (4) Offering personalized journey plans to staffs, (5) Cycling and walking initiatives (secure cycle parking, promoting cycling and walking, changing facilities and showers), (6) Co-ordinated car-sharing schemes and incentives, (7) Management of parking (restrictions to essential users, parking charges, parking 'cash out' for non-users), (8) Encouraging teleworking and teleconferencing, (9) Variations and working hour arrangements on the five day week, e.g. compressed working hours [5].

School Travel Plans (STP)

In mega-cities, millions of students and their parents go from home to school in the mornings and return home in the afternoons every day during school terms and substantial proportion of students are driven. Consequently, traffic congestion around schools has increased dramatically at peak times. This proportion has tended to increase steadily as motorization level of megacities increase at last decades. Hence, it is important to focus on these trips to make them more sustainable as promoting walking and cycling for short distances, and public transportation or dedicated school buses for longer distances through developing school travel plans (STP). In this respect, a STP can be defined as a travel plan which aims to decrease problems related to school related-congestion and traffic and to support pupils who are already travelling by more sustainable means (DfT n.d.). On the other hand, not only school travel plans are significant for reducing traffic related problems in mega-cities, but also they are helpful and crucial for children's health and wellbeing as it is desired for children to walk or cycle, which helps them to increase their daily physical activity. Well-designed school travel plans (STP) concentrate on measures to make school runs safer for walking and cycling together with awareness-raising education and campaigns, and incentives to walk or cycle such as cycle parking, fare cuts etc. A

typical STP include measurements: (1) Special walking or cycling days, (2) Walking buses or cycle trains (see Figure 3.1), (3) program for pedestrian and cycling training for children, (4) Dedicated school buses, (5) Improvement to public transportation for children, (6) Fare cuts, (7) Traffic calming, pedestrian crossing and cycle lanes around schools, (8) Offering lockers at schools [5].



Figure 3.1: A Typical Walking Bus

Personalized Travel Planning (PTP)

Recently, personalized marketing, also known as individualized marketing or one-to-one marketing has become one of the most practical strategies in the market. Basically, it means differentiating products to specific customers or customer segments according to his/her/their preferences rather than mass-marketing campaigns. The assumption behind personalized travel planning is that drivers generally have limited and inaccurate information about alternative modes, and would like to switch or use more sustainable transportation modes if they had known the available services were better. In a typical personalized travel planning application, first, all households within a target area are contacted to offer alternative travel modes, and classified in three main groups whether they are interested or they are already a user or not interested. After that, pre-surveys are conducted with interested customers to learn their current travel behaviors and sometimes (in travel blending applications) also asking them keeping travel diary for generally a week. After receiving individualized information from the travel diaries and pre-surveys, personalized information packages designed to modify behaviors have been offered to each participant. Personalized marketing strategies have been applied successfully in various fields with positive results as well as in the field of TDM under the name of personalized or individualized travel planning (PTP) at the household level and for all types of trips [1]. A typical personalized information packages may include ideal tools (ideas for changing current travel activities or time of activities), travel blending, personalized journey plans, public transportation schedules, brochures (dealing with

saving money, reducing environmental impact, making travel less stressful), Local activity guides, Loan-a-bike, free public transport tickets, and information regarding CO2 emissions their car produced, wasted time in traffic, how much money they spent etc. [2]. After a participant received his/her customized information package, participant is asked to keep post-travel diary for identifying change in travel behavior, facilitate feedback to participant and monitors program's total impact.

Marketing, Information and Travel Awareness (MITA)

Marketing, information and travel awareness applications based on targeted marketing techniques providing advice and information for alternative transport modes, and increasing public awareness for problems resulted from travel choices through campaigns. At the last decades, the concept of de-marketing emerged as a particular specialism in marketing field. While conventional marketing practices based on encouragement of demand for a product or service, on the other hand de-marketing concept based on discouragement of demand for a product or service [37]. Both marketing and de-marketing applications in the transportation field is as old as Second World War (See Figure 3.2). Marketing applications in transportation field can be easily separated into two category. First category is mainly focused on marketing of alternative transportations modes in substitution for automobile, while the second category consists of de-marketing applications for discouraging people for car usage. Applications from both categories reported evidence of reductions in car usage [2].



Figure 3.2: 'Is Your Journey Really Necessary' the UK Awareness Campaign during Second World War

Car Clubs and Car Cooperatives or Car Sharing Schemes (CC-CS)

Car clubs (in the UK) or US name 'car sharing' is a model of car rental where people rent cars for short period of time by the minute, by the hour as well as by the day [8]. Car clubs also differs from traditional car rentals in some points: 7/24 renting is available; reservation, pick up and return is all self-service; fuel costs included in the rates; users are members and pre-approved to drive; the locations of vehicles are very

easy to reach by public transportation, walking and cycling; reservation can be made by phone, websites, mobile applications or even text messages depending on company. Car clubs required membership with fees from USD30 to USD200 annually and charge by time used and distance travelled [22]. They are mostly attractive to people whose main travel modes are public transportation, walking and cycling and they only need car occasionally. Car clubs are also an alternative for owning second car for households with more than one driver. Because car clubs offers less car intensive means of urban transport by leading its members to make only necessary trips and increase usage of alternative transport modes, it has the potential for reducing car owning rates at an estimated rate of that one rental car can take the place of 15 owned vehicles (Economist 2012). In the longer term, it is estimated that growth of car clubs might reduce national car travel demand by 1.6 per cent [31].

Teleworking (Telecommuting, Teleconferencing, and Shopping from Home)

New developments within the fields of computer and telecommunication technology in recent years, -including computer networks and data systems, telephone, fax and scanner machines, electronic mail, online payment, online calling, websites, video connections etc.- offers new work and social habits to people especially workers so they can work or shop or communicate socially wherever these tools are available including home. These opportunities have led many companies, organizations and government agencies to adopt these technologies for improving services, reducing costs, reducing vehicle trips, or to achieve other objectives. In this manner, a general term, *teleworking*, has been defined as use of telecommunications to replace physical travel [5]. Specific examples of teleworking are as follows: (1) Telecommuting, (2) Satellite office or local work center, (3) Video-conferencing and Video presentations, (4) Distance Learning, (5) Tele shopping or Internet-shopping, (6) Online-Banking, (7) Electronic Government, (8) Internet Business-to-Business (B2B) [5].

Conclusion

On one hand, transportation of goods and people is vital for economic development and social life. On the other hand its negative effects, such as congestion and air pollution, risks economic development, social well-being, and most importantly sustainability of our world. Since building more roads makes driving more attractive and automobiles are unsustainable mode of mobility, it is significant to change our travel modes towards sustainable modes like public transportation, walking and cycling to mitigate this effects especially resulting from traffic congestion. Besides, increasing urbanization and motorization rates make the problem much more complicated especially in megacities. In this direction, Istanbul's traffic congestion problem is also alarming. Investments on road network and PT network do not keep up pace with traffic demand due to increasing urbanization and motorization levels. Especially during last decade, it became more chronic. In this sense, the first part overviews Istanbul on general highlights, and continue with making comparisons between Istanbul and various cities in different parts of the world on different indicators to better understand the case of Istanbul. While, the second part of this study highlights TDM policies to use existing infrastructure more efficiently, canalize people to social behavioral change for sustainable modes and alleviate unnecessary travel demand. As a result, The unexpected relationship between the congestion

index, road and rail network and the number of cars compared to the other cities implies mistakes related to the management of the traffic in Istanbul, therefore, it is suggested in this study that TDM policies should be taken into account in management level to eliminate these mistakes and to keep up pace with increasing urbanization and motorization levels in the city.

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