Travel Demand Management (TDM) case study for social behavioral change towards sustainable urban transportation in Istanbul

Irfan Batur\textsuperscript{a,b,⁎}, Muammer Koç\textsuperscript{b}

\textsuperscript{a} Istanbul Sehir University, Dept. of Industrial and Systems Engineering, Istanbul, Turkey
\textsuperscript{b} Sustainable Development Division, Hamad bin Khalifa University, Qatar Foundation, Education City, Doha, Qatar

A R T I C L E  I N F O

Keywords:
Sustainable transportation
TDM
Istanbul
Simulation
Survey

A B S T R A C T

In order to realize sustainable cities, it is vital to achieve and maintain social behavioral change for shifting our modes of mobility from inefficient, wasteful and motorized means to cleaner, greener, healthier and more economic means such as walking, cycling and public transportation in addition to smart use of land, intelligent transportation systems, and clean and green vehicles. This study is based on a critical review of literature in order to establish a framework of social behavioral change policies, particularly developed and tested for urban mobility and traffic congestion. First, various mega cities were compared on different sustainability indicators to better understand the case of Istanbul. Then, selected policy potentials, namely Travel Demand Management (TDM), were evaluated for Istanbul following a set of personal interview surveys aiming to reveal travel patterns of residents, their perceptions and attitudes on current transport system performance, and their opinions for possible TDM interventions in the future. We proposed a multiplicative model to process data from these surveys as inputs, which would then be used to determine travel demand. A simulation model was constructed using PTV-VISSIM tool and validated with current traffic congestion metrics obtained from field measurements in a selected district of Istanbul. Based on this validated simulation model, projections of traffic conditions in the future under different TDM scenarios were predicted with the help of determined TDM potentials obtained from the survey results. As a result of this study, it was revealed that the traffic congestion levels in Istanbul tend to become worse year by year under existing conditions, but it was also found that the TDM policies offer significant potential for reducing congestion, hence its consequent hazards, via increased use of sustainable mobility modes without the need for new infrastructure investments.

1. Introduction

People move to urban areas in search of economic advantages, educational opportunities, better health care services, and the promise of well-paying jobs among other things. As cities grow both in terms of area and population, the demand for transportation also increases as they are closely related to the choices of inhabitants with regards to choices of place for residence, work, school, and social activities. The principal supplier meeting this ever-increasing demand is passenger cars, fueled by a desire to have greater mobility, flexibility, reliability, comfort and personalization compared to other modes of transportation. These, along with ineffective use or shortage of road space, inadequate systems of alternative travel modes, and the absence of appropriate policies have led to alarming levels of congestion, air pollution, noise and land destruction, which place extensive pressures on human health and environment in urban areas, especially in mega-cities (Friman, Larhult, & Gärling, 2013; Meyer, 1997; Singh, 2005).

The experience of mega-cities in both developed and developing countries indicates that sustainable mobility means are needed to minimize dependence on personal motorization and alleviate undesired side-effects.

Travel Demand Management (TDM) can be seen as any action, strategy and policy or a set of those aimed at influencing people’s travel behavior in such a way that travel demand is reduced or redistributed in space or in time by introducing alternative mobility options while meeting the mobility needs of a region (Meyer, 1997). These measures are categorized under hard and soft policies based on utilizing different incentive and disincentive mechanisms. Increasing parking prices, tolling roads and congestion charging are examples of hard policies (Tuan Selik, 2000), while workplace and school travel plans, awareness campaigns, priority lanes for more sustainable modes and car clubs are among soft policies (Gärling & Fujii, 2009; Steg & Vlek, 1997). The implementations of these policies have indicated significant results in different parts of the world in reducing private vehicle trips and...
increasing the use of sustainable means. For example, congestion charging in London (Litman, 2006) and in Stockholm (Börjesson, Eliasson, Hugosson, & Brundell-Freij, 2012), electronic road pricing in Singapore (Tuan Seik, 2000), parking management in Portland, Oregon (Hess, 2001), and various soft policy implementations in thirty-two programs in Sweden (Richter, Friman, & Gärling, 2010). Despite of these results, there is an ongoing debate on whether hard policies alone lead to reduced car use (Stopher, 2004), and on whether soft policies have a direct effect on reduced car use (Möser & Bamberg, 2008). In parallel to this, there are many promising TDM policy interventions, especially soft policies, applied both in small and large scale cases with successful results, mostly in the developed world (Mees, 2014; Richter et al., 2010). Therefore, it is believed that TDM policies offer noteworthy potentials (Bueno, Gomez, Peters, & Vassallo, 2017; Petrunoff, Wen, & Rissel, 2016).

Many studies in the developed world indicate that the effectiveness, acceptability and political feasibility of TDM policies depends on various factors including individual characteristics such as norms and general intentions, environmental beliefs, problem awareness, willingness, perceived benefits and impacts of a measure (Beirão & Sarsfield Cabral, 2007; Bueno et al., 2017; Louise Eriksson, Nordlund, & Garvill, 2010). These factors vary across countries, societies, environments, and different age or ethnic groups. Thus far, very little research from the developing world has attempted to study these factors in the context of TDM. Hence, any attempt to study these factors in the cities of the developing world is highly beneficial for the success of any TDM policy before its implementation. Istanbul is such a place where the demand side measurements of urban transportation and short or medium term projections of traffic congestion levels have not yet been studied sufficiently. Consequently, they were excluded from the Urban Transportation Master Plan for Vision 2023 (IMM, 2011). With regard to this, this paper provides investigations on traffic congestion problems in Istanbul, Turkey, within the concept of sustainable mobility and focuses on the following research questions:

Q1. If the status quo is maintained, how will this affect future traffic congestion levels?

Q2. What additional policies should be implemented to contribute in achieving sustainable urban transportation in Istanbul?

This research will be one of the first attempts to fill this research gap in sustainable urban transportation of Istanbul literature by considering the role and the potential of TDM policies as well as projecting future traffic congestion levels in the city. A proposed multiplicative model is utilized in this study to determine the effects of the policies on travel demand. These policies include parking restriction, flexible working hours for employees, shifted and tailored working hours for different workplaces and schools, improving service level of public and active transport, active transport preference, public transport subsidy, individualized marketing tools and other such policies.

Along these lines, the objectives and scope of this study can be summarized as follows: (1) to spotlight differences and similarities of Istanbul with some other world cities in terms of their transportation issues; (2) to better understand the perception of its residents with regards to the city’s transport system, and to determine the level of their willingness to shift more of their trips from private car to public or active transport; (3) to determine potentials of the possible TDM policies to be implemented in the city and to generate different scenarios accordingly; (4) to develop a micro-simulation model to make projections for future traffic congestion levels in the city under the generated scenarios in order to better plan future of the city.

The paper is divided into five major sections. The first section introduces the problem. The next section reviews literature on sustainable urban transportation. The third section provides investigations on the case study of Istanbul. The fourth section provides detailed description of two-phase methodology: (1) evaluating potentials of sustainable transportation policies by a survey study, and (2) capturing current traffic conditions in the city to make projections under different scenarios in respective year with the help of PTV-VISSIM simulation tool. The results will then be presented before final section. The final section summarizes the key conclusion of the paper, its implications and associated discussions.

2. Literature review

A sustainable urban transportation system is an essential element of a sustainable city in helping to mitigate adverse environmental, social and economic impacts of transportation on the healthy progress and development of humans and their environment. As the need for mobility has been ever growing in urban areas, conventional solutions to meet this need, like simply adding new roads, put excessive pressure on sustainable living urban centers. According to the Center for Sustainable Transportation (Gilbert & Tanguay, 2000), a sustainable transport system has to:

- Allow the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations
- Operate efficiently, offer choice of transport mode, be affordable, and support a vibrant economy
- Limit emissions and waste within the planet’s ability to absorb them, minimize consumption of nonrenewable resources, limit consumption of renewable resources to the sustainable yield level, reuse and recycle its components, and minimize the use of land and the production of noise.

According to Awasthi, Chauhan, and Omrani (2011), research efforts devoted in the past evaluating the effectiveness of sustainable transport policies can be classified into different categories as follows: (1) life cycle analysis (Goedkoop & Spriensma, 2001; Guinee, 2002), (2) cost-benefit analysis and cost-effectiveness analysis (Beesley, Gist, & Glaister, 1983; Jonsson, 2008), (3) environmental impact assessment (Bond, Curran, Kirkpatrick, Lee, & Francis, 2001; Fischer, Wood, & Jones, 2002), (4) optimization models (Zuidgeest, 2005), (5) system dynamics models (Haghshenas, Vaziri, & Gholamialam, 2015; Tao & Hung, 2003), (6) assessment indicator models (Brown, O’Regan, & Moles, 2008), (7) data analysis (Ülengin, Kabak, & Önsel, 2010) and (8) multi-criteria decision analysis methods (Awasthi & Omrani, 2009). They have also indicated that these efforts were mostly related to evaluating physical and knowledge policies. Although these approaches are popular for evaluating sustainable transport policies, they are considered less effective for evaluating the impact of soft policies (Kho & Ong, 2015). Therefore, it is recommended that soft policies should be studied as part of a comprehensive assessment of sustainable transport policies. There are many available studies in the literature to evaluate the impact of soft policies on reducing car usage, and increasing public acceptance of sustainable policies (see Kim, Fujii, & Lee, 2013; Schmöcker, Pettersson, & Fujii, 2012).

Another classification of these policy instruments was made by Meyer (1997), who has categorized these measures into three groups namely supply management, land-use management, and demand management as illustrated in Fig. 1. Of these three groups, supply management measures (SMM) and strategies are the most common response of policy makers who have traditionally attempted to solve the problem by simply expanding existing infrastructure. Supply management methods (SMM) 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 transportation needs. The second category, land-use management (LUM), includes policies determining simply how the land is used, in other words, what human activities are conducted and which locations permit
دریافت فوری متن کامل مقاله

امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان دانلود رایگان ۲ صفحه اول هر مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات