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Would free park-and-ride with a free shuttle service attract car drivers?

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ABSTRACT

This study examines the potential of free park-and-ride facilities alongside free shuttle services on fast lanes to attract car users. The paper is based on a case study of the "fast lane", a high-occupancy toll road (HOT) to Tel Aviv, inaugurated on January 2011 in order to ease congestion at the highly congested entrance to Tel Aviv by giving priority to public transportation (busses) and high occupancy vehicles. This unique facility combines a free park-and-ride facility, a fast lane, and a shuttle service running on the fast lane. The aim of our questionnaire-based study was to determine whether this facility creates a viable alternative to private car owners as a means of transport to Tel Aviv. We also sought to identify factors that trigger private-car drivers to shift to the shuttle as a means of transport. Better understanding of these factors may potentially assist transportation experts, planners, and policy-makers in promoting new and better programs to boost public transport. Our results indicate that about 50% of the current facility users shifted from commuting by car, while most of the others shifted from other means of public transportation. Commuters from Tel Aviv's metropolitan region are the majority of potential users, and the service is mainly required during the morning rush hours. A combination of attributes, including free access to the fast lane, time saving, cost saving, and a relaxed ride, make this service attractive, but time saving is a significant predictor for using the shuttle. However, the results indicate that the facility is also attracting public transportation users to shift to multi-mode travel, where a car is used to commute to the park-and-ride facility.

1. Introduction

Some of the key challenges the world is presently facing are related to population growth and urbanization. The massive growth of cities has created major transport challenges and problems, manifested in traffic congestion in urban areas, particularly in city centers (Dijk and Montalvo, 2011). Many of the efforts to reduce congestion try to increase vehicle occupancy by inducing shifting from single occupancy vehicles (SOV) to multiple occupancy vehicles, including the various transit modes. High-occupancy vehicle lanes, high-occupancy toll lanes, and park-and-ride facilities are essential elements in attempting to decrease car use, and increase car occupancy and highway efficiency.

The first high occupancy vehicle (HOV) lane - Shirley Highway - was opened in 1969 in Virginia) Safirova et al., 2003; Fuhs and Obenberger, 2002), at first in order to create a fast lane for public transportation. However, since these lanes displayed sub-capacity during the day, soon decision makers began to open them to high-occupancy vehicles in order to motivate drivers to shift from single-occupancy vehicles to carpools. This move increased the efficiency of these fast lanes and triggered the inauguration of more HOV lanes (Fuhs and Obenberger, 2002). However, some of the HOV lanes were still being under-utilized, while the general lanes, running alongside, remained congested (Zhang et al., 2009). This led to the development of high-occupancy toll (HOT) lanes which allow single-occupant vehicles to use them upon paying a toll (Dahlgren, 1999). This toll may be dynamically set to ensure some target, such that a certain driving speed is maintained and the lane is utilized more efficiently without degrading the service for high-occupancy vehicles (Parkany, 1999).

Pricing aspects of the HOT lane have been studied with respect to pricing systems and policy, reasons for using the lane, and the effect of pricing on lane users (Halvorson et al., 2006; Chung and Recker, 2011; Fosgerau, 2011; Liu et al., 2011; Patil et al., 2011; Burris et al., 2012; and Gardner et al., 2013 to cite just a few contributions). Travel time reliability, for example, was found to create willingness to pay for using the lane. The question of the efficiency of HOT versus HOV lanes also appears widely in the literature (Poole and Orski, 2000; Obenberger, 2004; Joksimovic et al., 2005; Replogle and Funderburg, 2006; Zhang et al., 2009). Dahlgren (2002) examined various alternatives for the addition of an extra lane to an existing highway: HOV, HOT, or standard freeway, thus extending the discussion to also examine the

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advantage of an extra lane in a "regular" road in comparison with designated special lanes. His findings proposed that the extent of the delay associated with congestion should be used as an indication of the best alternative, and that studying the "nature" of the delay is a basic step in choosing the best alternative. Chu et al. (2012) focused on theoretical aspects of designing HOV lanes from the supply side in order to identify the relationship between carpooling costs and the optimal length of the HOV lane. Their findings emphasized the importance of conducting surveys to choose suitable starting points for HOV lanes. Konishi and Mun (2010) suggested that HOT lanes solve congestion more efficiently than HOV lanes, but may discourage carpooling if drivers can afford the toll. That is another aspect relevant to lane efficiency on the one hand and equity on the other.

Safirova et al. (2003) studied the HOT lane from an equity perspective. They argued that although HOT lanes are frequently discussed in terms of lanes for the "rich," the tolls that are collected can be used for the benefits of all users through investments in better public transportation and improved roads for the general public.

Park-and-ride facilities are commonly situated in urban fringe areas, enabling drivers coming from the suburbs and rural areas to park their car and switch to public transportation in order to reach urban destinations. Park-and-ride facilities, introduced in England during the 1970s, seem to offer an easy and cheap alternative to the construction of new roads. These facilities are commonly accompanied by good public transportation into the cities (Sherwin, 1998). Several papers have been published on the planning of park-and-ride facilities, as well as on the factors that influence drivers to utilize these facilities. Bos et al. (2004) investigated the importance high-quality public transportation alongside the park-and-ride facility (i.e., shuttle frequency, number of transfers, punctuality, etc.).

Van der Waerden et al. (2011) showed that travel time savings attract travelers to use park-and-ride. Sherwin (1998) concluded that the location of these facilities, congestion on the main roads to city centers, parking prices, bus fares to the city, and the quality of public transportation, all constitute important factors for the success of park-and-ride facilities. The literature reveals a lack of agreement as to whether park-and-ride facilities promote urban transportation systems. Studies conducted in the United States showed that accompanying shuttle services at park-and-ride facilities significantly increased their attractiveness (Bowler et al., 1986, and Foote, 2000). In Europe, park-and-ride facilities have generally been found to be satisfactory (e.g., Dijk and Montalvo, 2011). However, bus-based park-and-ride services, initiated in the UK (in Leicester, Oxford and Nottingham) during the 1960s, have not led to any reduction in congestion (Parkhurst, 1995; Parkhurst and Meek, 2014; Meek et al., 2009). Parkhurst hypothesized that suppressed demand had refilled the road space made available as a result of the park-and-ride facilities, thus, a congested equilibrium has been maintained. Additionally, it was also found that not all park-and-ride users commuted by car prior to the opening of the facilities; up to 40% had switched their mode from public transport services to car driving to reach the park-and-ride (Parkhurst, 2000, and Pickett and Gray, 1996). A similar survey from Melbourne supports this conclusion on prior use (Mees, 2010). Parkhurst's conclusions concerning congested equilibrium have been supported by other studies (such as Meek et al., 2009; Parkhurst and Meek, 2014). Goodwin (2003) suggested that placing park-and-ride facilities far from the city and improving public transportation are crucial in order to prevent public transportation commuters from shifting to a combination of private-car driving and public transportation.

Liao et al. (2013) argued that studying driver activity programs and full-trip chains is central to the planning of park-and-ride facilities. From the perspective of activity-based modeling, in which travel is derived from the demand to participate in activities, it is essential to take into account entire daily activity, as well as travelers' characteristics and preferences (Shiftan and Suhrbier, 2002; Shiftan and Ben-Akiva, 2011). Using two case studies, Liao et al. (2013) demonstrated

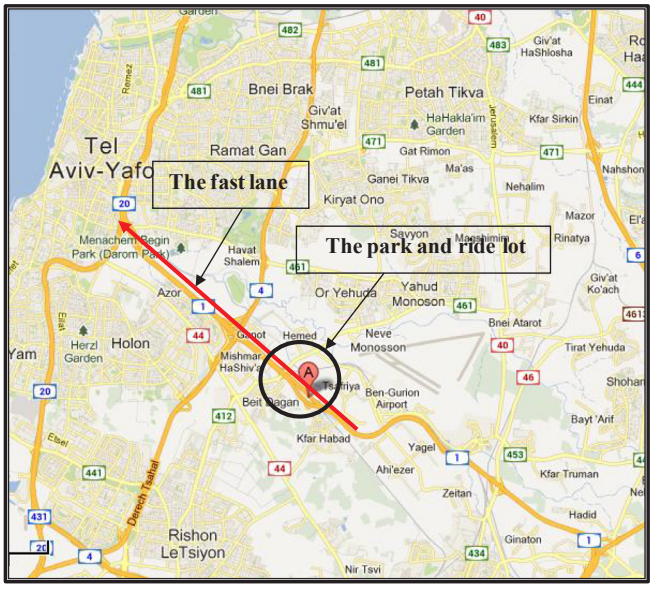

Fig. 1. HOT Lane to Tel Aviv.

that this methodology can lead to a better understanding of the potential use and impacts of park-and-ride facilities.

In light of the above described background, our study, using as a case study the HOT lane to Tel Aviv, its adjacent park-and-ride facility, and the free shuttle service to the city, examines whether the combination of these services succeeds in attracting car users, and aims at identifying the most important factors promoting travelers to switch to the facility. The next section provides more detail on the particular case study, and is followed by a description of the methodology and the survey used. Following an analysis of the results, the paper concludes with a discussion.

2. The case study

In January 2011, a HOT "fast lane" opened as a new lane on Israel's Highway No. 1, the main roadway connecting Jerusalem, the capital, and Tel Aviv, the foremost commercial center and largest metropolitan area in Israel. Fig. 1 shows the 13 km long lane. Shortly after getting on the lane there is a free park-and-ride lot with 2000 parking places. Fig. 2 shows the occupancy percentage of the facility (Correspondence with Hotze Israel Company, 2017). In 2017, the parking capacity almost reached its maximum on some days, and doubling (and at a later stage, tripling) the number of parking places is planned by adding additional levels of parking. The fast lane is free for public transportation and for HOV cars, defined as having three or four occupants, depending on the time of day. Single-occupant vehicles can use the lane by paying a toll, which is dynamically set based on the lane occupancy (currently ranging from 7 to 105 NIS, about 2–28 USD). A free shuttle service is offered from the park-and-ride facility to two areas in Tel Aviv: Kyria and Bursa (see Fig. 3), using the Ayalon, Tel Aviv's main highway, and Hashalom, one of its interchanges. The shuttle is mainly operated by minibuses, each carrying up to 15 passengers, but, due to increased demand, regular sized buses have also been added during rush hours. The shuttle operates weekdays between 06:00 to 23:00. During rush hours it has a frequency of, at least, every five minutes, and a minibus/bus will depart when it becomes full. During the rest of the day, minibus frequency is every 15 min. Travel time to Tel Aviv is approximately15 min and is steady throughout the day. The shuttle service can be reached by car, and from Jerusalem it can also be reached by bus (three lines). At this time, there are no additional public transportation services reaching the park-and-ride facility. Hence, buses from Jerusalem are an exceptional service in this facility. Based on MATAT