Transportation Demand Management in the Historical Area of Istanbul: A Pilot Project of Smart Parking System

Sadayuki YAGI\textsuperscript{a}, Tamaoki WATANABE\textsuperscript{b}, Katsuhide NAGAYAMA\textsuperscript{c}

\textsuperscript{a}ALMEC Corporation, Tokyo, 162-0022, Japan
\textsuperscript{b}ALMEC Corporation, Tokyo, 162-0022, Japan
\textsuperscript{c}ALMEC Corporation, Tokyo, 162-0022, Japan

\textsuperscript{a}E-mail: yagi@almec.co.jp
\textsuperscript{b}E-mail: watanabe.tamaoki@almec.co.jp
\textsuperscript{c}E-mail: nagayama@almec.co.jp

Abstract: This paper presents the studies and processes for implementing the pilot project of Transportation Demand Management (TDM) for the historical area of Istanbul, namely, Smart Parking System (SPS), which is a parking guide system using information devices, as well as the evaluation results. SPS made it easier to find a parking space by using smart phones and parking information boards without looking/waiting for parking space. This system should also help to reduce traffic congestion in the historical area because car drivers can find a reasonable and comfortable parking space before their destination. While the results from the SPS Pilot Project suggested that it had limited impact on drivers’ choices, the Istanbul Metropolitan Municipality and other relevant organizations are working out the future activities for SPS toward continuance or expansion based on the lessons learned from this pilot project.

Keywords: Transportation Demand Management, Smart Parking System, Pilot Project, Istanbul

1. INTRODUCTION

1.1 Technical Cooperation for Transportation Demand Management

Istanbul is accommodating the largest industrial facilities in Turkey. Some major production manufacturers are in the electronics, automotive, construction, vehicle, textiles, oil products, and white goods markets. In addition to that, the City generates 55% of Turkey's trade and 22% of Turkey's Gross National Product. Around 33% of Turkey's commercial enterprises are located in Istanbul (IMM, 2005).

Population of Istanbul city is expanding rapidly in terms of its economic development. Its population of 6 million in 1986 doubled to over 13 million after a quarter of a century (DIE, 2005). The city’s registered automobiles increased 6 times over the same period and now have reached 1.7 million vehicles (TurkStat, 2012). Although the Istanbul Metropolitan Municipality (IMM) has secured most of its investment budget to the transportation sector including sea transportation, railway system, highway, and parking lots, such a rapid pace of urbanization and motorization has far outpaced the development of transport infrastructures, and negative impacts of the motorization such as traffic congestion, accidents and exhaust emission problems are becoming worse.

In Istanbul, there are so many trips generated every day. These trips are made generally by using highway, and most of the traffic consists of private vehicles. Furthermore,
the existing rail-based public transport cannot accommodate the needs of traffic demand.

Considering these pressing circumstances, with a cooperation of Japan International Cooperation Agency (JICA), a study for the Istanbul Transport Master Plan was conducted from 2007 to 2009 (JICA, 2009). Above all, a series of Transportation Demand Management (TDM) measures for the historical area of Istanbul including the world heritage have also been proposed to reduce congestion as an urgent task in terms of historical and cultural heritage preservation.

Furthermore, as part of an implementation capacity enhancement proposed for following up on the Master Plan, in response to the request of the Government of Turkey, JICA dispatched a project team to Turkey in July 2011 and the Istanbul Transportation Demand Management (iSTDM) Project started as a technical cooperation of the JICA Project Team and the Turkish Counterpart Team from the IMM (JICA, 2014). The project, which took 37 months, was completed in July 2014.

1.2 The Historical Area of Istanbul

The historical area for this project is defined as the former Eminonu district in Fatih Municipality as shown in Figure 1. It has many world cultural heritage sites, and the roads in the area are always congested because it is a high-density area with many wholesale shops of leather and clothes as well as many tourism-related facilities such as hotels, restaurants, and souvenir shops. IMM has closed some roads to vehicle traffic and pedestrianized the area to protect the historical architecture and improve the traffic environment.

![Figure 1. Historical area (former Eminonu District) and target car parks for the SPS Pilot Project.](image_url)

As one of the activities in the technical cooperation, existing transport problems and TDM plans in the historical area were clarified. The issues to be tackled with were concluded as follows (JICA, 2014):

1) Lack of traffic impact studies of the large-scale transportation projects in the
historical area such as the Marmaray rail, which connects the Asian and European sides of Istanbul, and the extension of the subway lines;

2) The historical area is/will be used as a transit area and transfer center as a result of completion of the above-mentioned large-scale projects;

3) Sea transport is not a preferred mode of transport for transportation inside the city;

4) The rail systems and other modes of transport in the historical area have not been integrated with each other;

5) Insufficient transportation facilities for pedestrians and limited mobility and accessibility for the vulnerable road users in the historical area;

6) Absence of bicycle lanes while transportation by non-motorized vehicles is a preferred mode of transport in the historical area; and

7) Insufficient parking lots in the historical area, causing overflow of illegally parking vehicles on the roads and thus hampering the road traffic.

2. ISSUES ON CAR PARKING

2.1 Social Survey

In the beginning of this project, a social survey was conducted to understand the existing traffic and transportation problems and needs as well as the perception and acceptability of TDM measures among various stakeholders of the historical area. The survey was conducted through direct interviews with the stakeholders such as residents, offices, shops, hotels and restaurants in the historical area, as well as travel agents in Istanbul. Since the survey focused mainly on the daily traffic situation in Istanbul, visitors to the historical area, who do not usually drive by themselves, were not included in the survey; however, travel agents’ views were included (JICA, 2014).

Among others, the interview survey with residents was conducted comprehensively in the historical area, and about 500 samples were selected on a random basis and interviewed. Regarding the current traffic situation, they regard traffic congestion, shortage of parking lots, and illegal parking as serious problems as presented in Figure 2. As for several conceivable TDM policies, “restriction of trucks for certain hours” and “control of illegal parking” are the policies that would be supported by the majority of the residents; whereas, the policy of “road or parking pricing in the historical area” would not be supported by the majority of the residents, as shown in Figure 3.

Meanwhile, as for selection of the most urgent problems (up to three) to be improved in the historical area, the result shows different tendencies by respondents as presented in Figure 4. That is, problems related to car parking such as shortage of available parking lots and illegal parking are not viewed as urgent problems by the traders (i.e., shops, hotels and restaurants). Their interest was rather toward problems of shortage of pedestrian space, garbage collection hours, and signalization. The historical area is mostly comprised of mixed land use. While land consumed by car parking is usually justified as providing economic benefits to retailers, allowing customers convenient access to shops, the reverse argument, in favor of removing parking in the commercial area, is often highly controversial (Lee and March, 2010). Rather than policies of parking pricing or reduction of car parking, parking management with a view to maximizing efficiency of the existing parking facility and limiting “cruising” for energy saving and congestion alleviation would be preferred to solve the problems of car parking.
Figure 2. Residents’ evaluation of traffic situation.

Figure 3. Residents’ support of conceivable TDM policies.
2.2 Parking Management in Istanbul

Various kinds of traffic management measures such as area traffic control system, traffic monitoring system, traffic information system, reversible lane system, and truck ban system are already in place in Istanbul. They are intended to improve the efficiency as well as the safety of road traffic in general.

However, though parking is one of the main causes of traffic congestion and regarded as one of the most serious issues to be tackled with as mentioned earlier, there is no clear parking management policy in the Municipality. The current practice of the Municipality is to construct as many parking spaces as possible at locations where land is available. There have been not so many researches or studies about the parking demands.

There is a new approach recently taken by the Municipality. One is the introduction of a public-private partnership (PPP) scheme to the development of parking facility on lands owned by the Municipality. The scheme is expected to accelerate the parking facility development.

In addition, there is a regulation regarding the requirement for parking space for each type of building. However, enforcement of the regulation is lax and the regulation does not function well at the moment. Thus, the problem of overflowing parking vehicles, whether legally or illegally, has been more and more serious especially in the historical area.

2.3 Recent Studies and Experiences

In terms of parking management, particularly focusing on parking guidance and information systems, while there are numerous cities where trials of parking guidance and information systems were conducted, making comparisons of the results is unreliable due to the unique characteristics of the traffic networks, parking facilities and land use patterns where the trials were implemented. The performance of those systems in terms of driver awareness, understanding and usage shows a general lack of understanding and appreciation of driver behavioral issues. Parking guidance and information systems need to be designed to give more consideration to the drivers' perspective, which is often very different from that of the traffic manager (Thompson and Bonsall, 1997).

Meanwhile, it is true that the time spent searching for free parking spaces could produce considerable environmental pollution. Information on parking availability can be a powerful
instrument for reducing these search costs. However, the case in Valparaiso, Chile led to a conclusion that improvements of some 10% in efficiency could be achieved, but only at high computational costs (Caicedo, 2010). Parking guidance is proven in many higher-income places and this study may have some potential for investigating its application in a middle-income context and also with greater than usual use of smartphone applications.

The case in Nottingham, England tested a real-time parking information system, of which survey result showed that drivers were more likely to have greater knowledge of city center car parks if they used several information sources, were active seekers of parking information, and searched for parking rather than going directly to a parking facility. In addition, it was found that drivers were more inclined to use the relatively underutilized Park-and-Ride facilities instead of the city center car parks if they received parking information from newspaper advertisements/leaflets. Overall, the parking information service in Nottingham was effective (Khatak and Polak, 1993).

The case in Oakland, California is the first transit-based smart parking project in the US at the San Francisco Bay Area Rapid Transit (BART) station. The field survey showed that only 32% of those used the parking information to decide whether to continue driving or take BART. Some key changes in participant travel behavior include: increases in BART mode share, reductions in drive alone modal share, decreased average commute time, and an overall reduction in total vehicle miles of travel (Rodier and Shaheen, 2009).

Smart parking system (SPS), which is described later, is a promising tool to improve the search process as lots grow larger. In the case of Daytona Beach, Florida, though the findings were significant and economic savings could be realized with an SPS, the costs of the system outweigh the benefits in this case. The benefits of an SPS would be magnified on a greater scale in which there were many lots to choose from (Supris et al., 2014).

3. OBJECTIVE

The overall goal of the technical cooperation project is to implement appropriate TDM measures in the historical area of Istanbul to create comfortable city environment. For this goal, a more concrete objective is to enhance the implementation capacity of Transportation Department for TDM measures in the historical area, consisting of the following three outputs:

1) Traffic characteristics of the historical area are clarified and issues on transportation planning are identified;

2) Transportation Department’s capacity is enhanced through planning, implementing, evaluating, and analyzing pilot projects of TDM measures; and

3) Experience of the pilot projects is summarized as guidelines and shared among relevant departments of IMM.

Pilot Project is a small-scale preliminary project conducted in order to evaluate its feasibility, time, cost, negative impact, and scale of effect (statistical variability). The result will also help to determine its practical feasibility and to improve upon the project design prior to the implementation of a full-scale project.

Thus, implementation of pilot projects of TDM measures plays an important role in order to create comfortable urban environment and to enhance the capacity of the Transportation Department of IMM through this project. In preparation for pilot projects of TDM measures, clarification of transportation characteristics and issues in Istanbul and its historical area is essential. Then, by implementing TDM measures in the Istanbul historical area and by conducting an evaluation survey before and after the pilot project, visible improvement is realized, thus achieving enhancement of capacities of the Transportation

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Department of IMM. This paper particularly presents the studies and processes for implementing a Smart Parking System (SPS) as a pilot project of TDM as well as the evaluation results before and after the pilot project.

4. PILOT PROJECT

4.1 Selection of a TDM Measure for Pilot Project

The pilot project of TDM has been selected through discussions among the Turkish counterpart as shown in the following steps:

1) Step 1: Discussion and sharing about TDM measures and pilot projects;
2) Step 2: Documenting all transport issues in the Istanbul historical area; and
3) Step 3: Discussion about the TDM measures as countermeasures for transport issues.

Alternative TDM measures to solve the transport issues in the historical area were listed by the Working Group, and the range of the target groups in the alternative TDM measures are analyzed as in Table 1. Finally, three pilot projects of TDM measures, namely Parking Control System, Access Control of Tourist Bus, and Illegal Parking Enforcement were short-listed. As shown in Table 2, these were examined in the following aspects: namely, innovation and novelty, availability and possibility, and coordination difficulty. After due consideration of these aspects, Smart Parking System (SPS), which is a parking guidance system using the internet, smart phones, and information boards, was selected for the pilot project.

Table 1. Range of target groups in alternative TDM measures

<table>
<thead>
<tr>
<th>Pedestrian</th>
<th>Bicycle User</th>
<th>Car User</th>
<th>Bus User</th>
<th>Railway User</th>
<th>Commuter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Control of Tourist Bus</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Automatic Vehicle Location System</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bicycle Parking Facilities</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bicycle Paths and Bicycle Lanes</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car Sharing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Illegal Parking Enforcement</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Park and Ride</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Parking Control System</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Pedestrian Zones</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public Bicycle Systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Road Pricing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Transit Signal Priority</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Transit Station Improvements</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transit Vehicle Improvements</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Traveler Information System</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
Table 2. Selection of the pilot project

<table>
<thead>
<tr>
<th>Innovation and Novelty</th>
<th>Parking information system using SMS and information board</th>
<th>Access control of tourist buses in historical area</th>
<th>Illegal parking enforcement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Routes and parking space for the tourist buses are controlled, but many buses cause traffic congestion.</td>
<td>Illegal parking causes traffic congestion, but there is no alternative parking space or access transport.</td>
<td></td>
</tr>
<tr>
<td>Availability and Possibility</td>
<td>iSPARK has the same plan and demand will be high.</td>
<td>Alternative transport mode will be required.</td>
<td></td>
</tr>
<tr>
<td>Coordination Difficulty</td>
<td>The only implementing agency is iSPARK</td>
<td>It will be difficult to coordinate with travel agencies.</td>
<td></td>
</tr>
<tr>
<td>Operability</td>
<td>High</td>
<td>Middle: it will be difficult to coordinate with travel agencies.</td>
<td></td>
</tr>
<tr>
<td>Result</td>
<td>Selected</td>
<td>Pending</td>
<td></td>
</tr>
</tbody>
</table>

4.2 Smart Parking System

4.2.1 Concept of the Smart Parking System

As drivers tend to choose nearby parking lots of their final destinations, parking lots are congested in high-density areas of offices and commercial facilities. Traffic congestion is also caused by waiting vehicles for parking, including illegal parking, and other vehicles looking around for parking lots and spaces ($O$).

The SPS introduced in the pilot project is a service that provides parking information through the Internet and smart phones, and it also operates shuttle buses for legal parking users. The SPS aims at the following effects through the parking information service that provides information about locations, availabilities, and parking fees of car parks outside the most congested area:

1) Reduce vehicles looking around for available parking lots;
2) Motivate drivers to use car parks outside the most congested area by utilizing shuttle bus service; and
3) Alleviate traffic congestion in the central area.

Figure 5 shows a basic concept of the SPS. In addition, free shuttle bus services were provided by the Municipality to operate between these car parks and the center of the city.

1) Home: Driver checks information of car parks around the destination by SMS (short message service). However, since the majority of drivers already own smart phones, for this pilot project, smart phone applications were utilized in place of SMS. That is, driver can check information of car parks through the internet or the smart phone applications.
2) On the way: Every five minutes, driver can check the updated information through smart phones.
3) Near the destination: Drivers can check the parking location through the information boards along the nearby street. Thus, they can park cars without waiting and loss.
4.2.2 Parking Information Service

In the SPS Pilot Project, parking information was provided through the following tools:

1) Website: The traffic information website, owned by IMM Transportation Department, provided information about the target car parks such as their locations and capacity (Figure 6a);

2) Smart Phones: Two applications were developed for iPhone and other smart phones (Figure 6b). The iPhone application provided information about the parking locations, parking fees, capacity, congestion situations (occupancy rates), and access to the car parks. Drivers came to be able to receive parking information by smart phones through the free service; and

3) Information Boards: Parking information boards (Figure 6c) were installed at four access points to the target area and provided information about the parking locations and real-time free spaces every five minutes.
The SPS advanced car park techniques provide the car parking authorities as well as the customers the following advantages:

1) Reduction in time spent and fuel consumed while searching for available parking space;
2) Reduction in congestion due to fewer cars driving around searching for parking space;
3) Elimination of queues entering the parking facilities because drivers will not go in when there is no parking space available;
4) Reduction in illegally parked vehicles around the parking facilities; and
5) Better distribution of the traffic flow and the parking demand over the area.

Locations for the pilot project are three car parks operated by iSPARK, which is the largest private parking operation company in Istanbul, and two car parks operated by TAVG (T-Park), which is another private parking operator. All those car parks have a relatively large capacity and are easy to access because of the locations along the main street, serving as gateway car parks to the historical area. It should also be noted that around 90% of drivers in Istanbul already have and utilize smart phones, according to the latest survey (IMM, 2014).

### 4.2.3 Shuttle Bus Service

The SPS Pilot Project introduced shuttle bus service exclusively for parking users. A circular route on the main street (Vatan Street), crossing the central area of Fatih Municipality, links five target car parks (Figure 7). Six buses were operated every 15 minutes and 20 minutes during peak hours and off-peak hours respectively.

![Shuttle bus service](image)

**Figure 7. Shuttle bus service.**
4.2.4 Public Relations

The public campaign was implemented for two weeks, followed by the implementation of the pilot project that continued for four weeks from January 2013 to February 2013. The SPS Pilot Project was announced on the IMM website. Leaflets were available on the website though IMM could not distribute them among the citizens (Figure 8) and put up posters because final approval was not obtained within IMM. Furthermore, the Turkish state TV (TNT 1) and nationwide TV (KANEL D) broadcasted the SPS Pilot Project and 12 newspapers also carried articles.

a) Advertisement on the IMM website

b) Leaflet

Figure 8. Public relations.
4.3 Implementation Procedures of the SPS Pilot Project

Figure 9 shows a basic concept of implementation procedures for the pilot project. Tasks and actual activities of the SPS Pilot Project are described as below:

1) Preparatory meetings: meetings with relevant organizations on a weekly basis to determine the contents of the pilot project (refer to earlier section) and to draft a brief implementation plan;

2) Pilot Project committee meeting: discussion on the objectives of establishing the committee and its main activities and ideas on the pilot project;

3) Approval procedures for implementation of the Pilot Project: development of the detailed implementation plan, which was approved by the Transportation Planning Directorate and Traffic Directorate as it became clear that approval from UKOME (Transportation Coordination Department) or UTK (Traffic Management Board) was not necessary this time. However, it took a long period for coordination with the relevant organizations on the parking information boards and smartphone application development;

4) Preparation for implementing the Pilot Project: discussions with the relevant organizations and preparation for the information boards, smartphone applications, and shuttle bus service. Furthermore, an opinion survey was conducted prior to the project;

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**Figure 9. Basic concept of the implementation procedures for SPS Pilot Project.**
5) Implementation of campaigns and the Pilot Project: a series of discussions on implementation methods and campaign programs, followed by announcement on the IMM website. The SPS Pilot Project was carried out for 45 days between January 15, 2013 and February 28, 2013;

6) Monitoring and evaluation: an actual illegal parking situation survey around the target car parks, and interview surveys for legal and illegal parking users. Then, the SPS Pilot Project was evaluated based on the results from monitoring activities and the evaluation surveys; and

7) Next implementation plan formulation: discussion on future activities and expansion of the SPS, and preparation of the implementation report including the results and lessons learned from the Pilot Project;

5. EVALUATION SURVEYS OF THE SPS PILOT PROJECT

5.1 Outline of the Evaluation Surveys of the SPS Pilot Project

The following three surveys were conducted before and during implementation of the pilot project to evaluate the SPS Pilot Project.

5.1.1 Opinion Survey before Pilot Project

The objective of this survey is to understand car parking user’s opinion about the existing car parking services and also to understand their behaviors when the SPS is implemented. For this, users of the target car parks for the pilot project (194 respondents) and illegal parkers around the target car parks (99 respondents) were randomly selected and interviewed on a weekday regarding the usage situation, interest in the pilot project, etc.

5.1.2 Illegal Parking Survey before Pilot Project

The objective of this survey is to understand the actual situation of illegal parking around the target car parks for the pilot project such as the number, parking duration, type of illegal parking vehicles.

5.1.3 Opinion Survey during Implementation of Pilot Project

The objective of this survey is to evaluate feasibility and impact of the pilot project. For this, users of the target car parks for the pilot project (449 respondents) and illegal parkers around the target car parks (123 respondents) were randomly selected and interviewed on a weekday regarding the usage situation, interest in the pilot project, etc.

5.2 Evaluation Survey Results from the SPS Pilot Project

5.2.1 Evaluation of the Smart Parking System

Table 3 summarizes evaluation of the SPS by parking users who knew the SPS when the interview survey was being conducted during the pilot project. This question employed a five-grade evaluation scale, setting scores from 5 to 1, with 5 being the highest/most positive score and 1 the lowest/most negative. Scores in the table are calculated by a weighted average
of the numbers of answers and the scores of the five-grade evaluation.

The evaluation of the SPS was generally positive. For a question “Would you use the SPS if the SPS is expanded to other areas in Fatih/Istanbul? (Question 1)”, more than 70% of the respondents answered “Strongly Agree”. Combined with the second positive answer “Agree”, positive answers reached 89.0%

Positive evaluation for “Accuracy of the parking information provided (Question 3)” and “Satisfaction with the parking information boards (Question 6)” were 63.2% and 50.3% respectively, provided “Strongly Agree” and “Agree” are regarded as positive evaluation. Only 26.8% of the respondents, however, positively answered for a question “Satisfaction with the shuttle bus service (Question 8)”, implying a relatively low evaluation for the shuttle bus service. In fact, most of the car park users did not utilize the shuttle bus service as explained later.

### Table 3. Evaluation of the SPS Pilot Project

<table>
<thead>
<tr>
<th>Questions</th>
<th>Strongly Agree</th>
<th>Strongly Disagree</th>
<th>Valid Responses</th>
<th>Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Use the SPS if the SPS is expanded to other areas?</td>
<td>71.9%</td>
<td>17.1%</td>
<td>5.7%</td>
<td>1.8%</td>
</tr>
<tr>
<td>2  The SPS is easily understandable.</td>
<td>51.4%</td>
<td>21.6%</td>
<td>11.9%</td>
<td>12.2%</td>
</tr>
<tr>
<td>3  Provided parking information was correct.</td>
<td>36.4%</td>
<td>26.8%</td>
<td>30.1%</td>
<td>1.9%</td>
</tr>
<tr>
<td>4  Updating frequency of parking information was satisfactory.</td>
<td>17.0%</td>
<td>22.5%</td>
<td>45.7%</td>
<td>5.4%</td>
</tr>
<tr>
<td>5  Car parks in the SPS were enough.</td>
<td>24.7%</td>
<td>33.0%</td>
<td>12.9%</td>
<td>7.5%</td>
</tr>
<tr>
<td>6  Parking information boards were satisfactory.</td>
<td>24.8%</td>
<td>25.5%</td>
<td>19.8%</td>
<td>15.1%</td>
</tr>
<tr>
<td>7  Travel time was shortened.</td>
<td>22.6%</td>
<td>12.4%</td>
<td>20.1%</td>
<td>28.8%</td>
</tr>
<tr>
<td>8  Shuttle bus service was satisfactory.</td>
<td>16.5%</td>
<td>10.3%</td>
<td>39.7%</td>
<td>16.5%</td>
</tr>
<tr>
<td>9  Use public transportation instead of shuttle buses if convenience is enhanced?</td>
<td>22.0%</td>
<td>12.5%</td>
<td>17.9%</td>
<td>13.9%</td>
</tr>
<tr>
<td>10 Use the SPS even if parking information service is charged?</td>
<td>16.5%</td>
<td>19.7%</td>
<td>16.5%</td>
<td>11.5%</td>
</tr>
<tr>
<td>11 Use shuttle buses even if the service is charged?</td>
<td>10.5%</td>
<td>15.3%</td>
<td>18.5%</td>
<td>16.7%</td>
</tr>
<tr>
<td>12 Campaigns affected parking usage.</td>
<td>6.6%</td>
<td>6.2%</td>
<td>7.7%</td>
<td>30.4%</td>
</tr>
</tbody>
</table>

Note: Scores represent the weighted average of the numbers of answers and the five-grade evaluation score.

Although negative evaluations for “Travel time was shortened (Question 7)” and “Would you use the SPS if parking information service is charged? (Question 10)” were 44.9% and 47.3% and reached nearly five out of ten respondents, more than three out of ten respondents also answered that travel time was shortened (35.0%) and they would use the
SPS even if the service is charged (36.2%).

5.2.2 Recognition Degree of the Smart Parking System

Regarding the recognition degree of the SPS during the pilot project, although it was indispensable to sufficiently announce implementation of the pilot project to potential parking users, the SPS Pilot Project was undertaken without leaflet distribution and poster advertising because the final approval inside IMM was not obtained. At some shuttle bus stops, even official signs indicating shuttle stops were not allowed to be posted and shuttle buses were not allowed to stop long enough to wait for passengers. Thus, the recognition degree of the SPS Pilot Project was actually low and only about three out of ten users, regardless of legal or illegal parking users, knew the SPS.

The most influential medium by which users received the information was the parking information boards (72.9% of the parking users who knew the SPS), and second and third media were TV (8.9%) and website (6.1%) respectively (valid responses of 280). Interview results from illegal parking users show similar tendency though percentages are different.

5.2.3 SPS Utilization

Out of 285 SPS users, only 15 respondents (5.3%) answered that they used the car park because of the SPS. Among the 15 users, three users previously parked by the roadside and four users previously used another car park.

Answers to questions “Trip purpose of parking users”, “Usage frequency of the car park”, and “Reasons for choosing the car park” were depicted in Figure 10. Regarding the trip purpose, commuting was the most common trip purpose for both legal and illegal parking users, and the share was 73.8%. Users who utilized the car parks one or more days a week take 56.3%, which indicates that more than half of the respondents used the car park on a routine basis. While up to three answers were allowed to choose, 28.8% of the users chose “There is always parking space” as a reason for choosing the car park.

Figure 10. Situation of SPS Pilot Project utilization.
c) Reasons for choosing the car park (N = 443)  

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near the destination</td>
<td>34.3%</td>
</tr>
<tr>
<td>Security</td>
<td>26.3%</td>
</tr>
<tr>
<td>Easy access</td>
<td>19.9%</td>
</tr>
<tr>
<td>Usually available</td>
<td>10.3%</td>
</tr>
<tr>
<td>Affordable price</td>
<td>8.4%</td>
</tr>
<tr>
<td>Near a station/shop</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

d) Reasons for choosing illegal parking (N = 121)  

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near the destination</td>
<td>40.6%</td>
</tr>
<tr>
<td>Legal parking lots are full</td>
<td>29.3%</td>
</tr>
<tr>
<td>Legal parking fees are expensive</td>
<td>18.4%</td>
</tr>
<tr>
<td>Always available</td>
<td>9.4%</td>
</tr>
<tr>
<td>Near a station/shop</td>
<td>2.3%</td>
</tr>
</tbody>
</table>

Figure 10. Situation of SPS Pilot Project utilization.

These results indicate that users of targeted car parks in the SPS Pilot Project utilize the car park for commuting, and tend to use it on a routine basis because they know that the car park has always enough parking spaces. It is difficult to specify whether they actually used the SPS or not from the survey results, these may be one of the reasons why existence or nonexistence of the SPS was not a deciding factor in their utilization of the car parks as mentioned before. Even for the first-time users of the car parks, the SPS was not a large factor in choosing the car park (4 out of 167 first-time users of the car parks or 2.4% utilized because of the SPS).

5.2.4 Effect of Utilizing the Smart Parking System

About changes in utilizing the SPS, although only 15 parking users utilized the car parks because of the SPS, seven users who previously had used a private vehicle/taxi changed their behavior and walked to their final destinations by utilizing the SPS and car parks. Some users’ travel time was also shortened for 20 to 30 minutes by utilizing the SPS though there were users whose travel time was longer or nearly the same. As the evaluation of the SPS was described in Table 3, there is another survey result that 35.0% of the respondents answered that their travel time was shortened (274 valid respondents).

The number of daily shuttle bus users was no more than about 30 at most and 16 on average, which apparently did not bring about a positive impact on the traffic congestion. Travel time from the car parks to the final destinations was not more than 10 minutes for the majority (89.7%) of parking users, and users who can walk to their destinations were more than nine out of ten users (94.9%).

As to why there were few shuttle bus users, it was not only because of insufficient campaigns, shuttle bus information boards, and so on, but also because of existence of many parking users who did not need to use shuttle buses as they could park at the car parks near their destinations. Some parking users also preferred walking to shuttle buses especially when traffic congestion started extending on the main street after around 2 p.m. While there was favorable evaluation of the shuttle bus service particularly from repeaters and women regarding safety and security, there was also a complaint that distances between shuttle service bus stops were too long.
5.2.5 Reasons for Illegal Parking

Reasons for choosing illegal parking were shown in Figure 9(d). While up to three answers were allowed to choose, 89.3% of users chose “Near the destination” as the first reason, which indicate that illegal parking users could illegally park near their destinations. Off-street parking may have little impact on drivers’ behavior when on-street public parking is not well managed (0). Even from the illegal parking survey, significant changes between before and during the pilot project were not observed. Illegal parking was not specifically controlled during the pilot project.

Furthermore, about 23% of users answered that legal parking fees are expensive and about 36% of users chose “Legal parking lots are full”. However, the neighboring legal parking lots were not actually full and the following measures might be necessary to promote the change in behavior from illegal parking to legal parking:

1) Strengthen regulations and penalties for illegal parking users;
2) Increase/introduce on-street parking fees;
3) Provide accurate information such as legal parking locations and free spaces; and
4) Encourage actual experience of utilizing legal parking lots.

6. CONCLUSION

This paper presented the studies and processes for implementing the pilot project of TDM as well as the evaluation results before and during implementation of the pilot project. Implementation of pilot projects of TDM measures plays an important role in order not only to create comfortable urban environment and to enhance the capacity of the Transportation Department of IMM, but also to determine its practical feasibility and to improve upon the project design towards the implementation of full-scale projects.

For the pilot project of TDM, Smart Parking System (SPS), which is a parking guide system using the internet, smart phones, and information boards, was selected after due consideration and discussion of the aspects of innovation and novelty, availability and possibility, and coordination difficulty among the Working Group. The SPS made it easier to find a parking space by using smart phones and parking information boards without looking/waiting for a parking space. This system should also help to reduce traffic congestion in the historical area because car drivers can find a reasonable and comfortable parking space before arriving at their destination. The implementation of the pilot project was for total six weeks from January 2013 to February 2013. Evaluation surveys were also made to evaluate feasibility and impact of the pilot project.

6.1 Results from the SPS Pilot Project

The evaluation survey results indicated limited effects of introducing the SPS as only three out of ten parking users knew the SPS even during the pilot project and the SPS affected only a few respondents’ decision to use car parks. Actual effects from SPS utilization are, however, confirmed such as shorter travel time and behavioral change from a private vehicle and taxi to walk to the final destination. Evaluation and expectation of the SPS users were also generally high such as anticipation of expanding the SPS to other areas of Fatih/Istanbul. Even illegal parking users showed positive interest in the SPS though the SPS did not actually lead to utilization of legal parking lots.

The SPS Pilot Project was undertaken about seven months behind compared to the original schedule, because it required longer period than initially envisioned to discuss and
coordinate for parking information boards, smart phone application, and shuttle bus services, and their setup and development. In addition to these activities, there was also a delay particularly in discussing and coordinating with relevant organizations and entities. Therefore, the project management structure is expected to be improved such as time management to schedule necessary duration for each task and working management.

However, sufficient period was secured for preparatory activities for the pilot project and relevant organizations and entities could repeatedly discuss the pilot project and share objectives and procedures of implementation of the pilot project. Though it was the first experience for IMM Transportation Department to implement the pilot project, they could enhance their understanding and consciousness through a series of activities achievements of the pilot project and its results.

6.2 Future Expansion of the Smart Parking System

After the results from the SPS Pilot project had become clear, the Transport Planning Directorate and other relevant organizations and entities discussed the lessons learned from this pilot project and are working out the future activities for the SPS toward continuance or expansion. Expected actions and improvement are shown as below. Some of these may be required for implementation of another pilot project of TDM as well.

1) Clarify maintenance and operation structure and cost sharing.
2) Add more campaigns and public relation activities (Find out possible and effective methods and coordination with relevant entities).
3) Reconsider the necessity of shuttle bus service (Discontinue the shuttle service if enough demand of users is not expected).
4) Provide illegal parking users with accurate information such as locations and available parking spaces, and encourage them to utilize legal parking lots, complying with parking rules.
5) Assure compliance with the parking rules and enforce regulations for illegal parking users together with promotion of legal parking utilization (Impose penalties and increase/introduce on-street parking fees).
6) Strengthen the project management structure (particularly time management and communication management).

ACKNOWLEDGMENT

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REFERENCES


