SHifting to alternative models to reduce
PT-surveying cost burden by downsizing the data

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Abstract: The shift of travel demand policies from the conventional supply oriented policies to management oriented policies has made the effectiveness of conventional trip-based modeling approaches, which still dominates the practice, questionable. In addition to this, the increasing finical burden of the conventional PT-surveying is making the sustainability of the model doubtful. The attempts so far to reduce the cost mainly focused on finding alternative surveying methods and techniques. In this paper, however, we investigate how shifting to alternative models, tour-based model in this case, may contribute in reducing the cost burden of the conventional PT-surveying approach. We will also investigate future prospect of this approach.

Key Words: Trip-based modeling, cost burden reduction, tour-based models.

1. INTRODUCTION

The challenges that conventional trip-based models are facing include increasing person-trip (PT) surveying cost, to collect necessary data to implement the model, and declining responding rates of the surveys. The cost burden mainly comes from the fact that conventional trip-based models require large size data representative of the zones which the analysis is based on. The decline in willingness to participate in travel surveying is also making the reliability of the surveys questionable.

The shift in travel demand policies from the conventional supply oriented policies to management oriented policies is also making the effectiveness of conventional modeling approaches, which still dominates the practice, questionable. Contemporary policies are environmental oriented with primary objective of bringing about efficiency and environmental friendly transportation system. As the conventional trip-based models relay on statistical correlation, and lack behavioral-foundation, they fail to grasp the complex travel behavior that may arise from implementing Travel Demand Management (TDM) or Mobility Management (MM). Even though some attempts were made to enhance conventional trip-based models, they couldn’t eliminate the fundamental problems of the system. However, new models (tour-based/activity-based models) that overcome conventional trip-based models have been developed.

There have been also various efforts to reduce the travel survey cost burden. However; the
focus has been mainly on changing the surveying system. The new models have great potential in reducing the cost, and defining the future prospect of the PT-surveying.

1.1 Objective

This paper is to explore how shifting to tour-based models could contribute in addressing the challenges that that the conventional trip-based models are facing. We propose a tour-based model linking all daily travel decisions, and applicable with ordinary PT-data. Using the proposed model, we examine the prospect of reducing data size without making significant compromises in the output. This is important as it wouldn’t only address the huge data cost burden that conventional models are criticized for, but also the limitation of the conventional models in addressing contemporary policies. We also look at the main drawbacks of the PT-surveying, with feasible amendments of the surveying system, so that it may applied to evaluate contemporary and emerging travel behavior trends and efficient are discussed.

2. REVIEW ON COST REDUCTION APROACHES

Traditionally travel surveying has been conducted in-person by home-visiting in face-to-face form. Though this method is considered the most complete, its high cost along financial constraints are making growing number of institutions to reconsider the approach. As mentioned in the introduction, as a solution to the cost burden alternative surveying methods have got wider attention. Conducting the survey by telephone, mail, internet or a combination of them, which may reduce the cost considerably, have been considered as options. The National Travel Survey in the Netherlands shifted from the home-visiting survey to that of CATI (Computer Aided Telephone Interview) and mail in 1985 to reduce the cost (Henk and Ger, 2000). U.S. National Household Travel Survey (NHTS) too, CATI was introduced in 1983.

In Japan, even though analyses indicate that the cost of home-visiting survey could be reduced by more than 50% by switching to mailing system, it has yet to be materialized in any of the major practical travel surveys (Morio et al. 2007). One of the major concerns in shifting to the mailing surveying method lies in the return rates which may become as low as 10%-35% (Moriguchi Shoichi, 2009).

Reducing data sample size is another important option with greater potential of alleviating the data cost burden that should be considered. The surveying may cost as much as 4000Yen (Morio et al. 2007) per household or up to 1700 Yen per respondent. Therefore, the potential of reducing the financial burden by shifting to models applicable with smaller data size, without any significant compromises in the result is worthy of consideration.

Shifting toward discrete choice models may overcome the large data size issue with the conventional trip-based models. However, the failure to address contemporary polices, due to unrealistic
assumptions which the conventional models are based on, would remain as an issue (Goran Jovicic, 2001). Therefore, it is essential to assess the potential of the alternative models, which are able of evaluating management oriented policies, to address the cost burden. In the following section, we explore how tour-models may contribute in reducing the data cost burden by reducing the sample size.

3. COST REDUCTION USING TOUR-BASED MODEL

3.1 Specifications of the Model
The basic concept of the model is based on the framework developed by Ben-Akiva (1996). The model consist of two major parts as shown in Figure 1: travel patterns, and tours. Travel patterns are characterized by the number of the daily tours. It is assumed that a traveler would make a decision of whether to make a single-tour, multiple-tours or a tour with sub-tour/s

Based on the behavioral hypothesis that travelers make choices about tour with less important activities conditional on decisions about a tour with more important activities of a travel pattern, the tier between the tours are divided. Primary tour of the pattern is decided based on a priority order of activities, work being at the top. The tier is separated based on the duration of the activities if the tours’ main purposes happen to be the same.

The tour consists of tour destination, tour type, time of day and tour mode choice models. Tour type is composed of combinations of main purposes and number of intermediate stops (activates). Work (including school), maintenance and discretionary are the main purpose categories used. The latter two main purposes are combined as shopping for estimation. To avoid the large choice set, we reduced the destination choice set to eight feasible alternatives: five of them from the nearest ten zones to the departure zone, and the rest three randomly from the rest of the 66 zones the study area is made up of. Time of day is divided into peak and off peak periods, and tour type is categorized into three based on the main activities and intermediate stops (activities). Mode choice is modeled for public transport (bus and train) and automobiles (drive alone and shared ride).

To demonstrate the change due to reducing the size of the sample, we used primary tour data part. We estimated the model as nested logit using sequential method, decomposing the choice probabilities into marginal and conditional probabilities, for full and half of the data samples.

3.2 Data
The data we used is a typical PT-data, from Kofu city area of Japan. The household and person trip survey was conducted in 2005 by the prefecture for travel behaviors and regional transpiration studies and plans, including forecasting the travel demand of the city area. The survey includes 17,391 households with 42,118 members of 5 years old and above

3.3 Estimation and Results
The estimation result shows that both, full and half, samples keep the same trend. The sign of the parameters remained unchanged for each variable in all models of both samples. The logsum parameters, which imply the interlinkage of decisions, remained within the valid range too.

The parameters for all generic (logsum excluded), socio-demographic and specific constant variables of all models, other than that of tour type models, don’t show significant differences. The estimation result of mode choice (Table 1), time of day (Table 2) and daily travel pattern estimation result (Table 4) shows that there is no significant difference in all of the parameters.
However, variations are observed in the logsum parameters of the destination choice models and in some of the parameters for tour type models.

Table 1: Mode choice models estimation

<table>
<thead>
<tr>
<th>No.</th>
<th>Variables</th>
<th>Full Sample</th>
<th></th>
<th></th>
<th>Half Sample</th>
<th></th>
<th></th>
<th>t-stat.</th>
<th>of differences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Parameters</td>
<td>Std. error</td>
<td>t-stat.</td>
<td>Parameters</td>
<td>Std. error</td>
<td>t-stat.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>worker dummy: train</td>
<td>-1.870</td>
<td>0.079</td>
<td>-23.63</td>
<td>-1.798</td>
<td>0.113</td>
<td>-</td>
<td>15.89</td>
<td>-0.454</td>
</tr>
<tr>
<td>2</td>
<td>worker dummy: bus</td>
<td>-1.812</td>
<td>0.097</td>
<td>-18.69</td>
<td>-1.742</td>
<td>0.138</td>
<td>-</td>
<td>12.61</td>
<td>-0.631</td>
</tr>
<tr>
<td>3</td>
<td>worker dummy: auto-shared auto per driving license: train</td>
<td>-1.707</td>
<td>0.038</td>
<td>-45.06</td>
<td>-1.677</td>
<td>0.054</td>
<td>-</td>
<td>31.32</td>
<td>-0.362</td>
</tr>
<tr>
<td>4</td>
<td>auto per driving license: bus</td>
<td>-0.227</td>
<td>0.051</td>
<td>-4.42</td>
<td>-0.223</td>
<td>0.074</td>
<td>-3.00</td>
<td>-0.039</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>auto per driving license: Shared-auto cost(yen): public tran.(PT)</td>
<td>-0.752</td>
<td>0.076</td>
<td>-9.96</td>
<td>-0.673</td>
<td>0.107</td>
<td>-6.28</td>
<td>-0.976</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>constant: train</td>
<td>-2.744</td>
<td>0.098</td>
<td>-18.72</td>
<td>-1.893</td>
<td>0.140</td>
<td>-</td>
<td>13.54</td>
<td>0.296</td>
</tr>
<tr>
<td>7</td>
<td>constant: bus</td>
<td>-1.479</td>
<td>0.120</td>
<td>-4.47</td>
<td>-0.753</td>
<td>0.169</td>
<td>-4.45</td>
<td>1.326</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>constant: shared-auto</td>
<td>0.351</td>
<td>0.046</td>
<td>3.43</td>
<td>0.101</td>
<td>0.064</td>
<td>1.57</td>
<td>1.245</td>
<td></td>
</tr>
</tbody>
</table>

The probability to choose each alternative is estimated using the estimated results of the samples. As shown in Table 3, differences of probabilities for each choice in both samples are less than 2% for mode and time of day choice models.
Table 2: Time of day choice models estimation

<table>
<thead>
<tr>
<th>No</th>
<th>Variables</th>
<th>Full Sample</th>
<th>Half Sample</th>
<th>t-stat. of differences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Parameters</td>
<td>Std. error</td>
<td>t stat.</td>
</tr>
<tr>
<td>1</td>
<td>logsum term</td>
<td>0.4573</td>
<td>0.107</td>
<td>4.28</td>
</tr>
<tr>
<td>2</td>
<td>worker dummy: peak time</td>
<td>2.6676</td>
<td>0.100</td>
<td>26.58</td>
</tr>
<tr>
<td>3</td>
<td>worker dummy: on/off-peak</td>
<td>2.0736</td>
<td>0.066</td>
<td>31.54</td>
</tr>
<tr>
<td>4</td>
<td>age below 30 dummy: peak</td>
<td>1.8083</td>
<td>0.076</td>
<td>23.71</td>
</tr>
<tr>
<td>5</td>
<td>below 30 dummy: **on/off-peak</td>
<td>1.4863</td>
<td>0.073</td>
<td>20.28</td>
</tr>
<tr>
<td>6</td>
<td>Constant: peak:</td>
<td>-1.198</td>
<td>0.057</td>
<td>-21.08</td>
</tr>
<tr>
<td>7</td>
<td>Constant: on/off-peak</td>
<td>-0.3204</td>
<td>0.044</td>
<td>-7.34</td>
</tr>
</tbody>
</table>

** On/off-peak: involve peak and off-peak periods

Sample size= 17850
L(0)= -18452
L( \beta )= -16738
\rho^2 = 0.092898
\bar{\rho}^2 = 0.092519

Sample size= 8861
L(0)= -9194
L( \beta )= -8282
\rho^2 = 0.09921
\bar{\rho}^2 = 0.09845

Table 3: Differences in average probabilities for mode and time of day choice models of full and half samples (based on estimated parameters)

<table>
<thead>
<tr>
<th>Mode choice</th>
<th>Sample size</th>
<th>Difference (%)</th>
<th>Time of day choice</th>
<th>Sample size</th>
<th>Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Train</td>
<td>4.29</td>
<td>4.27</td>
<td>0.481</td>
<td>32.70</td>
<td>32.80</td>
</tr>
<tr>
<td>Bus</td>
<td>2.69</td>
<td>2.73</td>
<td>-1.647</td>
<td>50.03</td>
<td>49.61</td>
</tr>
<tr>
<td>Shared-auto</td>
<td>27.88</td>
<td>28.20</td>
<td>-1.138</td>
<td>17.26</td>
<td>17.59</td>
</tr>
<tr>
<td>drive alone</td>
<td>65.14</td>
<td>64.80</td>
<td>0.523</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4: T-test for the difference of parameters of full and half sample

<table>
<thead>
<tr>
<th>Variables</th>
<th>t-stat</th>
<th>Variables</th>
<th>t-stat</th>
<th>Variables</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>logsum term</td>
<td>-</td>
<td>logsum term</td>
<td>2.74</td>
<td>logsum term</td>
<td>0.25</td>
</tr>
<tr>
<td>Worker dummy: work with intermediate stops</td>
<td>2.21</td>
<td>population/km2</td>
<td>0.00</td>
<td>HHN*: single tour</td>
<td>-</td>
</tr>
<tr>
<td>worker dummy: work without intermediate stops</td>
<td>2.61</td>
<td>The work force/km2</td>
<td>0.00</td>
<td>HHN: multiple tour</td>
<td>-</td>
</tr>
<tr>
<td>HHN*: work with intermediate stops</td>
<td>0.27</td>
<td>Employees/km2</td>
<td>-</td>
<td>Constant: single tour</td>
<td>0.14</td>
</tr>
<tr>
<td>HHN: work without intermediate stops</td>
<td>0.30</td>
<td>Number shops/km2</td>
<td>-</td>
<td>Constant: multiple tour</td>
<td>0.37</td>
</tr>
<tr>
<td>constant: work with intermediate stops</td>
<td>2.15</td>
<td>Built-up area/km2</td>
<td>-0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>constant: work without intermediate stops</td>
<td>1.76</td>
<td>periphery zones dummy</td>
<td>0.95</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*HHN: household number

For tour type models too, there is no change in the sign of parameters and the logsum parameter remains significant and within the valid range after the data size was reduced by half. However, as shown in Table 4 significant difference is seen in some of the parameters: logsum, worker dummies and constant variables. In destination choice too, the logsum parameters indicates the existence of significant difference. As the logsum of the upper tier of the model system is affected by the parameters of the lower model, the significant difference in parameters of the tour type choice modeling may have resulted in the variation in the logsum parameters of destination choice models. The probability to choose each alternative which is calculated based on the estimated parameters of the models of the full and half both samples is shown in Table 5. The differences of probabilities for each alternative are not more than 3.4% for the tour type and travel pattern models.

Table 5: Differences in average probabilities for tour type and travel pattern choice models of full and half sample (based on estimated parameters)

<table>
<thead>
<tr>
<th>Tour type choice</th>
<th>Sample size</th>
<th>Differ-</th>
<th>Travel pattern choice</th>
<th>Sample size</th>
<th>Differ-</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full-%</td>
<td>Half-</td>
<td></td>
<td>Half-</td>
<td>Half-</td>
</tr>
<tr>
<td>work with intermediate stops</td>
<td>54.56</td>
<td>53.80</td>
<td>1.063</td>
<td>Single tour</td>
<td>83.33</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>83.62</td>
</tr>
<tr>
<td>work without intermediate stops</td>
<td>18.39</td>
<td>18.40</td>
<td>-0.033</td>
<td>Multiple tours</td>
<td>11.23</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.13</td>
</tr>
<tr>
<td>Non work with no stops</td>
<td>27.05</td>
<td>27.63</td>
<td>-2.121</td>
<td>Tours with sub-tours</td>
<td>5.44</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.26</td>
</tr>
</tbody>
</table>
4. FUTURE PROSPECT OF PT-SURVEYING

Conventional PT-surveys were basically designed to forecast the long-term travel demand trends due to socio-economic and demographic changes. Therefore, the main content of the survey includes household and personal attributes beside the trips characteristics. Even though the content of the PT-surveys is basic and important, it falls short of the information necessary to analyze some of the contemporary and emerging travel behavior trends. Therefore, it obviously fails to address contemporary or emerging travel behavior trends. Major weakness of the conventional PT-surveying includes declining response rates, lack of information on at home activates, and aggregation as explained below.

4.1 Declining Responding Rates

One of the challenges that PT-surveys, and travel surveys in general, are facing is the decreasing of willingness to participate. This is not a Japanese only phenomenon, rather a global issue. The Dutch National Travel Survey recorded continuous decline in responding rates, and the Dutch experience is worthy of discussion.

As shown in Figure 3 there was significant decline in the respond rate of the Dutch National Travel Survey from 1985 to 1998. In general, the response rate dropped to 35% in 1998 compared to the 51% of the 1985. Excluding the incomplete data, the effective response rate of the 1998 survey got below 30%. This decline made the representativeness and reliability of the data questionable (Henk and Ger, 2000).

To overcome this series problem and encourage the survey participation, the Dutch National Travel Survey system was redesigned. The basis for the new survey system was reducing the burden on the respondents to encourage their involvement. As a preliminary investigation the German New KONTIV Design (NKD), developed by the institute Socialdata in Munich that has been implemented successfully in several countries was adopted (Brog W., 2009).

Before the redesign

Introduction letter
Household questionnaire (CATI)
Diaries (mail)
Reminder (mail)

After the redesign

Introduction letter
Questionnaire (mail)
Response motivation (tel.)
Reminder (tel. and mail)
Follow-up surveys if necessary

Figure 2: Procedure of the Dutch National Travel Survey before and after the redesign

The questionnaire was made as simple as possible in the new design. For example, with the new questionnaire the respondents were no more supposed to be bothered with definitions (pre-coded answers) or questions that would only apply to a small part of the population, and they could even answer questions in their own words.

Procedurally, the main change was in the application of the telephone. In the new Dutch travel survey design, telephone is used to get the motivation of the respondents to participate.
and not to collect household data as shown in Figure 2. The result of the pilot study was encouraging, as more than 70% of the households approached using the new procedure responded in 1999, and the response rates were also similar in the subsequence years (Figure-3).

The Dutch experience highlights how respondent-oriented questionnaire may help in overcoming the tendency of increasing unwillingness to participate in travel surveys. Surveying techniques should be updated so that they may adjust to the attitude of the respondents. The receptiveness of the survey system should be taken into account in designing future surveys, making the surveys user-friendly by shifting the burden as much as possible from the respondents.

4.2. Revising the PT-Surveying

Conventional PT-surveys were basically doesn’t include activities which don’t involve trips. This limits the applicability of the data for activity-based models, which are founded on the principle that travel would be conducted if the utility of accomplishing an activity with travel surpasses that of doing without travel. In another word, the data can’t be used to grasp the trade-off between at home and out of home activities. As a result, several contemporary and emerging travel behavior trends and transport policies can’t be analyzed with this data. The impact of Information and Communication Technology (ICT) on travel behavior, responses to the implementation of policies like flexible work scheduling, congestion pricing and measures to bring about travel behavior changes (Mobility Management) are some, among others, that can’t be analyzed effectively with the conventional data. The new technology has enabled diversity array of activities to be undertaken through personal computers and wireless technologies, like e-commerce and tele-commuting. Decision process of the daily activity pattern may change in such a way that individuals can plan and execute without the advance preparation for their activities. Therefore, to address some of the contemporary and emerging travel behavior trends, the PT-survey should be revised to include activities conducted without travel.

Moreover, only discrete part of time, mainly in departure and arrival forms, is included in the PT-surveying. This is because time is mainly considered as an attribute of trips not activities. PT-surveys are also zone based and often large area is assumed to be a point, resulting in aggregate bias. The idea that decision makers organize and conduct their activity facing temporal and spatial constraints is fundamental principles of activity-based models (Hagerstrand, 1970). There are many contemporary policies which need the analysis of activity distribution in time and space. To address such policies data with high spatial and temporal resolutions is required.
4.2.1 Innovative Surveying Methods along Shift in Modeling Approaches

Contemporary and emerging complex travel behavior trends make comprehensive data inevitable. It is difficult to collect compressive data, which includes all the activities with their distribution in time and space, necessary to analyze this complex travel behavior by conventional PT-surveying methods.

However, it is very interesting to note that the very same technology contributing to the emerging complex travel behavior trends carries great potential of solutions. The advancement of wireless tele-communications along with global positioning system (GPS) and the spread of their usage have expanded the applicability of these devices for household travel surveys (Buliung and Kanaroglou, 2006). The advancement of technology has made collection of more accurate, detailed and even continuous data collection possible. This provides a tremendous opportunity to overcome the shortcomings of conventional PT-surveys.

Probe-person surveying method is a typical example of data collection methods based on emerging technologies. Mobile assisted probe-person survey (Hato et al., 2006) enables collecting more accurate, real time and continuous data than the conventional methods. The timing and route choice information would be automatically recorded and the traveler has to choose departure and destination categories as well as the mode from the menu of the mobile phone at departure. Since then, the devise has been updated in attempts to decrease the burden on the respondents by recording more information automatically through sensors (Hato, 2009).

Considerable development has been made in developing innovative surveying technologies (Sasaki and Nishii, 2007). However, the application of such devises is so far limited to small scale projects, as it would be costly if it is applied in large scale surveys, like PT-surveys for conventional modeling. Therefore it’s important to consider shifting to models, like the one we proposed, which may yield acceptable result with smaller data sample size. This would make the application of innovative surveying methods more feasible for large scale travel survey projects, besides addressing wider range of transport policies than the conventional models.

4.2.2 Longitudinal Surveys

The growth in motorized mobility has come at the cost of increasing its environmental and social consequences: in terms of pollution, traffic congestion and safety (Erling, 2007). To achieve sustainable mobility and to control the adverse consequences of the growing mobility, various countries have shown increasing interest in mobility management.

Even though MM description may slightly vary by country, the general objective of MM is to shape the attitude and the behavior of decision makers toward sustainable transport modes voluntarily. “Soft” measures like information or communication are the basic tools of MM programs (Werner, et al., 2004).

MM programs have been implemented In Japan also, mainly in the form of travel feedback form since 1999 (Taniguchi, et al., 2007). There have been similar European initiatives to study how information and communication technology may influence the travel behavior and to reduce reliability on automobiles (Tyler, 2003): INPHORMM (Information and Publicity Helping the Objective of Reducing Motorized Mobility) and its successor TAPESTRY (Travel Awareness, Publicity and Education supporting a Sustainable Transport Strategy in Europe).

To effectively influence the mobility of decision makers, it is inevitable to understand the determining factors of the mobility and how they affect the mobility. MM policies can be effectively evaluated by closely monitoring and evaluating the changes specific groups show in response to the implementation of MM measures.

Moreover, travel behavior is dynamic by nature, as decision makers may anticipate the new situation or adopt it. PT-surveys, which are cross-sectional, are static as they are used to
compare the behavior of different people at a single point in a time and infer how the behavior may change in the future. Therefore, longitudinal data survey in which the mobility of a given group is monitored for a given period of time is important to study the dynamic nature of travel behavior and how the behavior may change over time. The increasing interest in achieving sustainable mobility through changing the travel behavior would only emphasize the need for panel surveys for longitudinal data.

6. CONCLUSION

We have investigated the prospect of reducing data cost burden of conventional PT-surveying by shifting modeling approach. For this purpose, we proposed a tour-based model and examined how the result of half of the sample size would vary from that of the full sample. With few exceptions, no significant differences were observed between the full and half sample results. Travel behavior trends remained the same after the reduction, and the choice probabilities were similar for both samples. This suggests the possibility of reducing the sample size without compromising in the result, and as a result decreasing the PT-surveying cost burden.

Declining respondent rate has become a series issue in travel surveying in various countries. PT-surveying is not an exception in this regard. Various analyses suggest that making the questionnaire respondent-oriented may help to overcome this problem. The burden on the respondents should be decreased and the surveying system should be designed taking into account the attitude of the respondents. Keeping questions as simple as possible and avoiding pre-coded answers and definition, with the possibility of the respondents to answer in their own terms should be considered to encourage the participation.

Travel behavior is getting more complex, and so is the response to implementation of contemporary policies, which may require continuous data over time and space for effective evaluation. The advancement in technologies, however, has shown promising signs in providing such comprehensive data. The major obstacle in using new the technologies in conventional models is their dependency on huge data, which makes the application method costly. Therefore, the transition of conventional models to more behaviorally realistic models, like tour-based models, could not only enable the models address contemporary and emerging policies, but also make the application of emerging technologies to collect data more viable as they require smaller data to implement them.

The increase in motorized mobility with its environmental consequences highlights the importance of achieving sustainable mobility. To realize this, changing the attitude and travel behavior of the people is necessary. Therefore, MM policies planned to bring about environmental friendly travel behavior trends are getting wider attention. Evaluation of MM policies requires analyzing the changes observed overtime, which the cross-sectional survey like PT-data fail to grasp. Therefore, the attempts to introduce panel surveys in consistent way should be strengthened.

REFERENCES


