EXAMINING EFFECTS OF TDM WITH TOLL DISCOUNT ON MITIGATION OF EXPRESSWAY TRAFFIC CONGESTION

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Abstract: This paper describes the results of TDM implementation with toll discount for ETC vehicles, which is intended to mitigate congestion for an uninterrupted flow section of the Tomei Expressway. As an initial trial for mitigation of congestion on Japanese intercity expressways, the TDM was implemented during the New Year period of 2007. Though traffic congestion still occurred partly because of increased daily traffic volume and insufficient shift of traffic demand from peak hours to off-peak hours, it is estimated that total delay is reduced by 35% as compared to the one predicted in case of no TDM implementation. It seems difficult to expect the shift traffic if the amount of discount is less than 1000 yens or so. Moreover, it is found from a questionnaire survey that about 50% of targeted drivers were aware of the New Year early morning discount and the induced demand was about 2%. Finally some issues are also addressed.

Key Words: TDM, measure against expressway traffic congestion, toll discount for ETC vehicles

1. INTRODUCTION

Five years have passed since November 2001 when the Electric Toll Collection (ETC) system began operation for Tomei Expressway. The utilization rate of the ETC system has increased
rapidly and it exceeded 70% as of December 2006, partly due to the introduction of late night discount, commuter discount, early morning and night discount, and the effects of fast setup service and other promotion measures. Although this ETC utilization rate usually declines during the year-end and New Year holidays, this year it increased by 9% over last year to reach around 64%. The higher utilization rate of the ETC system has largely relieved traffic congestion at toll plazas. Mitigation of traffic congestion of the mainline, however, is still an important issue for expressway operators though they have been taking both hard and soft measures to tackle it. Due to the high ETC utilization rate, it becomes possible for the operators to implement Transportation Demand Management (TDM) as an effective measure for traffic congestion of the mainline with the ETC system. This paper reports the results of TDM implementation with toll discount for ETC vehicles intended to mitigate congestion for an uninterrupted flow section of the Tomei Expressway. Prior to the TDM of toll discount with the ETC system, it has been examined that by providing traffic congestion prediction information for traffic demand concentration period of national holidays, it is possible to reduce traffic demand at peak time and thus to mitigate traffic congestion on Tomei Expressway (Okada and Usami, 2000; Usami et al., 2001). The TDM of toll discount with ETC system is the next step to provision of traffic congestion prediction information.

2. TRAFFIC CONDITIONS NEAR YAMATO TUNNEL (INBOUND)

The Yamato tunnel is located between Yokohama-machida and Atsugi (Figure 1). The annual average daily traffic of the section in 2006 is 131,000 vehicles, making this section one of the most heavily traveled and congested in the entire Tokyo metropolitan area. As a result, traffic congestion frequently occurs there on weekends and holidays. To address the traffic congestion, an auxiliary lane of 3.2km in length was added in March 2003 connecting the on-ramp of the Ebina service area (SA) along the inbound line in the Ayase area upstream of the Yamato tunnel, and vehicles equipped with LED display panels are being used to alert drivers to their speed drop before congestion occurs and, once it occurs, to provide them with information about head of congestion queue at the bottleneck in order to activate their driving behavior. Nevertheless, the congestion still occurs near the Yamato tunnel. The congestion near the Yamato tunnel is caused by speed drop due to a sag to the tunnel and subsequent upgrade section (Figure 2). Therefore, it was decided to implement TDM to help reduce or shift excessive traffic demand at peak hours by offering a toll discount at off-peak hours. As an initial trial for mitigation of congestion on expressway, the TDM was implemented during the New Year holidays of 2007.

![Figure 1 Area near the Yamato Tunnel, Tomei Expressway](image-url)
3. OVERVIEW OF A TDM SCHEME WITH TOLL DISCOUNT

3.1 Current Toll Discounts for ETC Vehicles
There are currently three types of toll discounts offered by time of day for ETC vehicles traveling on nationwide intercity expressways as follows (Figure 3):

- **Late night discount**
  - 30% discount exclusively for ETC vehicles
  - Applicable on intercity expressways from midnight to 4:00 a.m.

- **Commuter discount**
  - 50% discount exclusively for ETC vehicles
  - Applicable upon passing an entry or exit of intercity expressways in areas other than suburbs of Tokyo and Osaka from 6:00 a.m. to 9:00 a.m. and from 5:00 p.m. to 8:00 p.m.
  - Travel distance of 100 km or less per travel
  - Applicable only to one travel each in the morning and/or evening period

- **Early morning and night discount**
  - 50% discount exclusively for ETC vehicles
  - Applicable upon passing an entry or exit of intercity expressways in suburbs of Tokyo and...
Osaka from 10:00 p.m. to 6:00 a.m.
➢ Travel distance of 100 km or less per travel

3.2 Traffic Demand
It is important to know the traffic demand and excess demand at peak hours in order to mitigate traffic congestion through TDM. Figure 4 shows the traffic demand, queue discharge flow and queue length during congestion period on Jan. 2, 2006, when TDM was not implemented. The queue discharge flow and queue length were observed from vehicular detector data, and the traffic demand was calculated from the queue discharge flow and the speed of shock wave propagating upstream of the bottleneck. On that day, the traffic demand rose drastically from 9:00 a.m. and had a peak flow exceeding the pre-queue breakdown flow at the bottleneck from 10:00 am to noon, from which traffic congestion occurred. The excess demand was 350 vehicles from 10:00 a.m. to 11:00 a.m., and 245 vehicles from 11:00 a.m. to noon, for a total of 595 vehicles over two hours. The average excess demand was 6.1% of the pre-queue breakdown flow. Since bottleneck capacity drops from the breakdown flow to the queue discharge flow once congestion occurs, accumulative excess demand above the discharge flow was about 2,200 vehicles from 10:00 a.m. to 5:00 p.m., which was 7.1% of the bottleneck capacity. The traffic congestion might be mitigated if the excess demand from 10:00 a.m. to noon could be shifted to lower flow period in the early morning.

![Figure 4: Traffic demand and congestion on Jan. 2, 2006 (no TDM)](image)

3.3 Outline of the TDM Scheme
Figure 5 shows the TDM scheme (New Year specific early morning toll discount) implemented on the inbound Tomei Expressway during the New Year holidays of 2007 since heavy traffic congestion was predicted then. It was the first trial to implement TDM as a traffic congestion measure on Japanese intercity expressways.

Similar to current toll discounts, the TDM scheme is also only applicable for ETC vehicles. The time period of toll discount is set from 6:00 a.m. to 9:00 a.m. because the traffic demand in that period is low enough to accommodate the shift traffic of excess demand of the congestion period from 10:00 a.m. on and also because the discount period corresponds with the early morning period of current commuter discount to avoid complexity between the TDM
scheme and current discounts. The discount rate is set at 50%, taking the maximum rate of current toll discounts.

The target discount section for the TDM scheme was set considering that traffic congestion occurs near the bottleneck of Yamato tunnel at about 10:40 a.m. and that travel time between the bottleneck and the farthest interchange should be within of about 1.5 hours from the end of discount period to the time of occurrence of traffic congestion. Thus a maximum distance from the bottleneck is 150km and the Shizuoka was determined as the farthest interchange upstream, which is located about 140 kilometers from the Yamato tunnel. Therefore, it was decided to target ETC equipped vehicles entering the expressway between Shizuoka and Atsugi, and exiting between Yokohama-machida and Tokyo as shown in Figure 5. According to Table 1, the target discount section is expected to cover about 45% of total daily volume near the Yamato tunnel considering that the target discount section carries 75% of total daily volume at the bottleneck and percentage of ETC vehicles is estimated 60%.

The only difference between the TDM scheme and commuter discount is target discount section and restriction of travel distance. The TDM scheme has a target discount section with specific entry and exit interchanges though there is no restriction on travel distance. The commuter discount has a different target section that is west of Atsugi and has a maximum distance of 100km.

![Figure 5 Outline of New Year specific early morning toll discount on Tomei Expressway](image-url)

Table 1 Interchange-paired traffic at the bottleneck section (Jan. 2, 2006)

<table>
<thead>
<tr>
<th>Entry / Exit</th>
<th>Yokohama-machida</th>
<th>Yokohama-aoba</th>
<th>Tomei-Kawasaki</th>
<th>Tokyo</th>
<th>No. of vehicles</th>
<th>% of total daily traffic at bottleneck section</th>
<th>acc. % of total daily traffic at bottleneck section</th>
<th>No. of ETC vehicles</th>
<th>% of ETC vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atsugi</td>
<td>7,412</td>
<td>2,010</td>
<td>2,917</td>
<td>12,812</td>
<td>25,151</td>
<td>34.9%</td>
<td>34.9%</td>
<td>11,487</td>
<td>45.7%</td>
</tr>
<tr>
<td>Hatano-nakai</td>
<td>1,385</td>
<td>263</td>
<td>322</td>
<td>1,236</td>
<td>3,206</td>
<td>4.5%</td>
<td>39.4%</td>
<td>1,485</td>
<td>46.3%</td>
</tr>
<tr>
<td>Omi-matsuda</td>
<td>1,106</td>
<td>206</td>
<td>263</td>
<td>1,161</td>
<td>2,736</td>
<td>3.8%</td>
<td>43.2%</td>
<td>1,176</td>
<td>43.0%</td>
</tr>
<tr>
<td>Gotemba</td>
<td>2,195</td>
<td>566</td>
<td>592</td>
<td>2,968</td>
<td>6,321</td>
<td>8.8%</td>
<td>52.0%</td>
<td>2,836</td>
<td>44.9%</td>
</tr>
<tr>
<td>Sasano</td>
<td>716</td>
<td>188</td>
<td>204</td>
<td>1,199</td>
<td>2,307</td>
<td>3.2%</td>
<td>55.2%</td>
<td>1,103</td>
<td>47.8%</td>
</tr>
<tr>
<td>Numazu</td>
<td>1,862</td>
<td>456</td>
<td>712</td>
<td>3,725</td>
<td>6,755</td>
<td>9.4%</td>
<td>64.6%</td>
<td>2,772</td>
<td>41.0%</td>
</tr>
<tr>
<td>Fuji</td>
<td>904</td>
<td>193</td>
<td>199</td>
<td>1,362</td>
<td>2,658</td>
<td>3.7%</td>
<td>68.3%</td>
<td>1,081</td>
<td>40.7%</td>
</tr>
<tr>
<td>Shimizu</td>
<td>720</td>
<td>145</td>
<td>208</td>
<td>1,286</td>
<td>2,359</td>
<td>3.3%</td>
<td>71.5%</td>
<td>923</td>
<td>39.1%</td>
</tr>
<tr>
<td>Shizuoka</td>
<td>344</td>
<td>53</td>
<td>100</td>
<td>606</td>
<td>1,103</td>
<td>1.5%</td>
<td>73.1%</td>
<td>411</td>
<td>37.2%</td>
</tr>
<tr>
<td>West of Yaizu</td>
<td>4,937</td>
<td>1,457</td>
<td>1,610</td>
<td>11,380</td>
<td>19,384</td>
<td>26.9%</td>
<td>100.0%</td>
<td>23,273</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>21,581</td>
<td>5,537</td>
<td>7,127</td>
<td>37,735</td>
<td>71,980</td>
<td>100.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.4 Assumed Shift Rates of Traffic
Figure 6 shows the assumed shift rates of target traffic and estimated effect of the TDM scheme on alleviating traffic congestion. From the figure, it is possible to alleviate traffic congestion by about 30% with a shift rate of 15% as compared to the present situation of no TDM, and to avoid occurrence of traffic congestion with a shift rate of more than 20%. According to the results of an internet questionnaire survey conducted before the TDM implementation, 38.0% of respondents, who were asked whether they would change their originally planned arrival time at the entry interchange to early morning period from 6:00 a.m. to 9:00 a.m. if the TDM scheme were implemented on New Year holidays, replied that they would do so for traveling from Atsugi, 34.6% of respondents replied that they would do so for traveling from Gotenba, and 35.3% of respondents replied that they would do so for traveling from Numazu. Based on this response, it was expected that traffic congestion could be possibly avoided.

![Figure 6 Assumed shift rate of traffic and estimated effect of the TDM scheme](image)

3.5 Publicity Activities
In order to achieve the intended effect of the TDM scheme, it is essential to let as many road users as possible know the New Year specific early morning toll discount on Tomei Expressway. The following publicity activities were conducted in Tokyo metropolitan area and Shizuoka Prefecture:

- newspaper articles (on 10 newspapers)
- TV news (NHK and Shizuoka Broadcasting System)
- posters and leaflets (150,000 copies)
- desktop leaflets (88,000 copies)
- information guides for predicted traffic jams (20,000 copies)
- overbridge banners (14 pieces)
- website information
- town news leaflets
- newspaper ads (in Asahi Shimbun and Kanagawa Shimbun)
- posters in trains (Odakyu Line)
- internet ads
- radio commercials (K-MIX)
- highway information terminals at service areas
4. RESULTS OF THE TDM IMPLEMENTATION

4.1 Changes in Traffic Volume and Congestion
The daily traffic volume and the target traffic utilizing the TDM scheme during the three New Year holidays of 2007 are compared with those of the same day in 2006.

i) On Jan. 2, 2007, the traffic volume increased by 21% during the discount time period, but the volume of traffic congestion in km/hour increased by 19%, partly due to a 7% increase in daily traffic volume and effect of traffic accidents.

ii) On Jan. 3, 2007, the traffic volume increased by 10% during the discount time period, and the volume of traffic congestion in km/hour decreased by 34% though the daily traffic volume increased by 3%.

iii) On Jan. 4, 2007, the traffic volume increased by 8% during the discount time period, but the volume of traffic congestion in km/hour increased by 1%, partly due to a 1% higher daily traffic volume and effect of traffic accidents.

4.2 Questionnaire Survey Results
The questionnaire survey was conducted by making interviews to drivers of ETC vehicles traveling in the target discount section at Ebina Service Area (inbound) on Jan. 2 and 3, 2007, from 6:00 a.m. to noon. The main results of the survey in Figure 7 are as follows:

i) About 50% of total drivers surveyed were aware of the New Year early morning discount. Compared by the entry interchange, the percentage of awareness is highest at 72% for the drivers entering the farthest interchange of Shizuoka, and is lowest at 28% for those entering the nearest interchange of Atsugi.

ii) Among total drivers surveyed during the discount time period, about 50% changed their originally planned driving schedules and entered the expressway during the discount time period. Compared by the entry interchange, those entering Gotenba had the highest shift rate of 82%, while those entering Atsugi had the lowest of 33%.

iii) Among total drivers surveyed, 57% were for outgoing travel and 43% were for returning travel. Compared by the entry interchange, those entering Atsugi had the highest percentage of 66% for returning travel, and those entering Gotenba had the highest percentage of 53% to 68% for outgoing travel.

iv) Surprisingly, 97% of respondents replied that they would have still used the Tomei Expressway even if the New Year early morning discount had not been offered. Only seven respondents replied that they would not have used the Tomei Expressway if the discount had not been offered (i.e. induced traffic demand is 2%).

v) From the comments on the New Year early morning discount, 83% of respondents replied that the discount was effective for alleviation of traffic congestion, 92% replied that they were interested in toll discounts for easing traffic congestion, and 96% replied that they would utilize this kind of toll discount if offered in the future.

vi) Among the publicity means, Internet ads were mostly used to obtain information about the discount, accounting for 21%.

Table 2 shows the percentage of drivers who have shifted from their originally planned arrival time at the entry interchange to the discount time period (6:00 a.m. ~ 9:00 a.m.) according to the questionnaire survey results. It is seen from the table that 86% of all shift traffic are shifted from a time span of four hours (from 9:00 a.m. to 1:00 p.m.) immediately after the discount time period. The hourly shift volume from the first to fourth hour immediately after the
discount time period accounts for 13%, 38%, 14%, and 21% respectively.

Figure 7 Questionnaire survey results conducted at Ebina Service Area (inbound)

Table 2 Percentage of drivers during discount time period who have shifted from other time to discount time period from questionnaire survey results

<table>
<thead>
<tr>
<th>To</th>
<th>From</th>
<th>0:00-1:00</th>
<th>4:00-5:00</th>
<th>5:00-6:00</th>
<th>9:00-10:00</th>
<th>10:00-11:00</th>
<th>11:00-12:00</th>
<th>12:00-13:00</th>
<th>13:00-14:00</th>
<th>22:00-23:00</th>
<th>23:00-0:00</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:00-7:00</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>7:00-8:00</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>8:00-9:00</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>22</td>
<td>9</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>11</td>
<td>32</td>
<td>12</td>
<td>18</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>85</td>
<td></td>
</tr>
</tbody>
</table>

4.3 Change in Daily Time Pattern of Total Target ETC Traffic

Figure 8 shows the daily time pattern of total ETC traffic in the target discount period (entry at section from Shizuoka to Atsugi, exit at section from Yokohama-machida to Tokyo) on Jan. 2, 2007 (with TDM) compared to the same day in 2006 when TDM was not implemented. It is seen from the figure that hourly volume or percentage of total targeted ETC traffic increased during the discount time period and decreased at the following hours immediately after the discount time period. Therefore, some traffic has shifted from the peak hours of congestion to the discount time period due to the implemented New Year early morning discount.
Figure 8 Comparison of daily time patterns of total target ETC traffic between w/ and w/o TDM (Jan. 2, 2006 & 2007)

Figure 9 Amount of discount and increase in percentage of total target ETC traffic in discount period compared by entry interchanges (Jan. 3, 2007)

Figure 9 describes the amount of discount and increase in percentage of total target ETC traffic in discount period compared by entry interchanges on Jan. 3, 2007. Figure 10 plots the total daily ETC traffic volumes of the same day compared by entry interchanges. It can be seen from Figure 9 that the increase in percentage of total target ETC traffic in discount time period increases with the amount of discount as the entry interchange moves from the nearest Atsugi to the farthest Shizuoka. It seems that shift traffic could not be expected if the amount of discount is less than 1000 yens or so, and that Atsugi would have little shift traffic due to the small amount of discount of 300 – 600 yens. Therefore, in order to enhance the effects of alleviation of traffic congestion by implementing TDM in the future, it is necessary to offer greater incentives for the traffic from Atsugi that carries nearly half of the total target ETC traffic as seen from Figure 10.
Figure 10 Total daily ETC traffic volumes compared by entry interchanges (Jan. 3, 2007)

4.4 Relationship between Amount of Toll Discount and Time Shift Rate of Target Traffic
Figure 11 shows the relationship between the amount of toll discount and time shift rate of target traffic which is obtained from the TDM implementation. Here the time shift rate indicates the percentage of the total target ETC traffic that would shift from the certain one-hour period to the discount time period. For example, the time shift rate of Time-2h means the hourly shift rate from the second hour after the discount time period to the discount time period and that of Time-1-4h is the average shift rate from the four hours after the discount time period to the discount time period. It could be seen from the figure that time shift rate increases with an increase in the amount of discount.

Figure 11: Relationship between amount of toll discount and time shift rate of target traffic

4.5 Effects of the TDM on Mitigation of Traffic Congestion
The effects of the TDM on mitigation of traffic congestion are predicted by comparing the traffic congestion occurred when the TDM is implemented with the one estimated if it is not implemented. Before that, the traffic demand in case of no TDM implementation has to be
estimated from the “real” traffic demand that is also estimated from the queue discharge flow and the speed of shock wave observed from the vehicular detector data. The following assumptions are made in the estimation of the traffic demand and traffic congestion in case of no TDM implementation.

i) The induced traffic demand of 2% during the discount time period is taken into account based on the questionnaire survey results.

ii) The shift traffic volume is estimated from the increase in percentage of total target ETC traffic in discount time period as shown in Figures 8 and 9. It is then returned back to the originally planned arrival time at the entry interchange by using the percentage values in Table 2. In such a way, the demand of ETC traffic for each entry interchange is obtained.

iii) In order to predict traffic demand in case of no TDM implementation, the estimated demand of ETC traffic for each entry interchange is used to modify the “real” traffic demand at the downstream bottleneck by taking into account the travel time from the entry interchange to the bottleneck section.

iv) Traffic congestion is predicted by simply comparing traffic demand (input) and the bottleneck capacity (output) while the observed pre-queue breakdown flow and queue discharge flow are used.

Figure 12 shows the traffic demand upon implementing TDM on Jan. 2, 2007 and the estimated traffic demand in case of no TDM implementation together with the observed traffic flow downstream of the bottleneck. It is clear that some traffic has shifted from peak hours to the off-peak discount time period. Table 3 shows the estimated reduction in excess demand of congestion period at the bottleneck section due to the TDM. The daily reduction in excess demand on Jan. 2 and 4, 2007 is 795veh and 621veh respectively. The hourly reduction in excess demand at peak hour of 11:00 a.m. to noon is 5.0% and 4.5% respectively on Jan. 2 and Jan. 3, 2007. On Jan. 4, 2007, however, no reduction in excess demand is estimated because traffic congestion occurred at 4:00 p.m.

Table 3 Reduction in excess demand at the bottleneck section

<table>
<thead>
<tr>
<th>Date</th>
<th>2007/1/2</th>
<th>2007/1/3</th>
<th>2007/1/4</th>
<th>3 days total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction in excess demand</td>
<td>795</td>
<td>621</td>
<td>0</td>
<td>1,416</td>
</tr>
</tbody>
</table>

Figure 12 Estimated traffic demand in case of no TDM implementation (Jan. 2, 2007)
Table 4 lists the estimated effects of the TDM on mitigation of traffic congestion. The total delay for the whole three days is reduced by about 15,066veh h, and total cost due to delay by about 546,000USD. As a result, implementing TDM with toll discount for the whole three days has achieved 35% reduction in total delay as compared to the one predicted in case of no TDM implementation.

Table 4 Estimated effects of the TDM on mitigation of traffic congestion

<table>
<thead>
<tr>
<th>Item</th>
<th>3 days total</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No TDM</td>
<td>TDM</td>
<td>Reduction</td>
<td></td>
</tr>
<tr>
<td>Congestion time</td>
<td>30</td>
<td>29</td>
<td>1</td>
<td>3%</td>
</tr>
<tr>
<td>Max queue length</td>
<td>82</td>
<td>63</td>
<td>19</td>
<td>23%</td>
</tr>
<tr>
<td>Total time delay</td>
<td>44,512</td>
<td>29,446</td>
<td>15,066</td>
<td>34%</td>
</tr>
<tr>
<td>Total cost due delay</td>
<td>1,612</td>
<td>1,067</td>
<td>546</td>
<td>34%</td>
</tr>
</tbody>
</table>

5. SUMMARY

This paper describes the results of TDM implementation with toll discount for ETC vehicles, which is intended to mitigate congestion for an uninterrupted flow section of the Tomei Expressway. As an initial trial for mitigation of congestion on Japanese intercity expressways, the TDM was implemented during the New Year period of 2007. Though traffic congestion still occurred partly because of increased daily traffic volume and insufficient shift of traffic demand from the peak hours to off-peak hours, it is estimated that total delay is reduced by 35% as compared to the one predicted in case of no TDM implementation. It seems difficult to expect the shift traffic if the amount of discount is less than 1000 yen or so. Moreover, it is found from a questionnaire survey that about 50% of targeted drivers were aware of the New Year early morning discount and the induced demand was about 2%.

However, some issues needs to be considered. For example, Atsugi that carried nearly half of the total target ETC traffic had little shift traffic due to the small amount of discount of 300 – 600 yen. Therefore, in order to enhance the effects of alleviation of traffic congestion by implementing TDM in the future, it is necessary to offer greater incentives for the traffic from Atsugi. Other TDM schemes should also be studied for traffic congestion in Golden Week and summer peak period, and on weekends and holidays. It is believed that in the future, by further increasing awareness of the TDM scheme among the public, it would not be an unrealistic possibility to prevent occurrence of traffic congestion on Japanese intercity expressways with an effective TDM scheme.

REFERENCES
