ASSESSMENT OF PLATE NUMBERING SCHEME IN PUSAN: CITIZENS' PERSPECTIVE

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Abstract: This paper evaluates the 10-digit plate numbering scheme, currently being implemented as one of Transportation Demand Management (TDM) measures in Pusan, with respect to the citizens' point of view. The results of a survey conducted by The Citizen Association of Green Traffic Movement were summarized and analyzed to identify the citizens' perceptions of the scheme and to identify the influencing factors on the perceptions. It was found that citizens generally share very positive perceptions of the scheme, considering it as one of effective measures to mitigate the chronic congestion problem. But it was also shown that there are numerous barriers against its success, such as an absence of alternative modes, no substantial economic benefits, etc. The scheme thus does have a very little impact on the reduction of traffic volume on the streets. Necessary measures that can facilitate the scheme are thus suggested.

Key words: TDM, Plate Numbering, Congestion, Transit, Traffic Volume Reduction

1. INTRODUCTION

Since July 1999, Pusan Metropolitan City Government has been implementing a 10-digit plate numbering scheme as one of transportation demand management (TDM) measures. That is, cars with the plate number ending a specific number are banned to operate on a date with the same last digit. For example, a car with a plate number ending 0 is not supposed to operate on the dates 10th, 20th, 30th of the month. This scheme aims mainly at reducing traffic volume on the streets so as to mitigate the ever-worsening traffic congestion problem.

Since it is a voluntary scheme rather than a mandatory one, for this scheme to be successful, it needs citizens' collaboration. It is thus a sort of social experimentation in which all Pusanians voluntarily have to participate in one way or the other to achieve its proposed objective. To attract the citizens' attention, a participating car with a valid sticker is awarded with numerous incentives: discounted charges for public parking facilities, exemption from fees of urban expressways and city parks, as well as priority given for resident parking permits.

Though this scheme is theoretically sound and practically attractive, its real effectiveness and citizens' opinions have been neither evaluated nor identified properly. One should note that only 32% of potential candidate cars are currently with the valid sticker and that no one knows how many of them actually follow the rule of the scheme. Moreover, no attempt has

been made to find out the citizens' opinions on this scheme, so that there is no reliable source of information on which to make a rational decision for the improvement and refinement of the existing scheme.

The purpose of this paper is to evaluate the 10-digit plate numbering scheme with respect to the citizens' point of view. In particular, it aims at finding out the real effectiveness of the scheme and identifying the factors that affect the citizens' perceptions about the scheme. That is, we identify how many of car drivers with the sticker are real participants and consequently how much the scheme actually reduces traffic volume on the streets. We also find some of policy options to enhance the attractiveness and effectiveness of the scheme by examining such elements as citizens' travel characteristics and awareness on the transport system in Pusan.

This is achieved by analyzing the results of a survey performed by one of prominent Non-Government Organizations in Pusan - The Citizen Association of Green Traffic Movement (GT). The major goals of the survey were two-fold: 1) identify citizens' perception and opinions on the transport system in Pusan; 2) evaluate citizens' attitude and opinions towards the scheme. The results obtained from the survey will be analyzed mainly based on the frequencies of each variable, and only relationships among the variables proved to be significant through the Chi-Square Test will be examined.

This paper begins with a detailed description of the 10-digit numbering scheme, followed by the analyses of results of the survey and the findings from the analyses. The results of this study will provide necessary information for policy-makers and planners designing the scheme and attempting to improve the quality of TDM measures. They will be also a useful guidance for other cities of the world interested in introducing similar traffic reduction schemes.

2. DESCRIPTION OF THE SCHEME

Pusan Metropolitan City, the second largest city in Korea, is a major international port and a logistics center for southeastern coastal industrial belt as well as for northeast Asia Distribution Center. It covered an area of 849 km^2 and housed a population of 3.9 million in 2000. Over the last few decades, Pusan has experienced a rapid urbanization along with a rapid motorization process over. In particular, the number of cars has been increased by an average of 13.5% per year over the last 5 years (IPD, 2000). The result is obvious: the city is experiencing severe traffic congestion and deteriorating environment. This situation is likely to exacerbate in the near future as the travel volume on the streets continue to increase.

Pusan City has developed and implemented a number of transportation demand management measures to mitigate the negative impacts resulted from the increasing traffic volume. One of them would be the 10-digit numbering scheme to directly reduce the traffic volume on the roads and streets within the city area. Cars with the plate number ending a specific number are not supposed to operate on a date with the same last digit, except for Sundays, National Holidays and the 31st of the month.

As indicated earlier, it is a voluntary scheme, so that there is neither fine nor administrative punishment against the car drivers who do not follow the rule even with valid stickers. Instead, there are numerous incentives to the cars with the valid stickers:

- 20% discount of charge at public parking facilities.
- Exemption of toll fees for urban expressways during peak periods:
  Morning: 07:00-09:00 & Evening: 18:00-20:00
- Exemption of entrance fees for public parks
- Priority for residential parking permits and public parking

In addition to these personal incentives, the participating companies receive 20% discount of traffic impact fees. The above benefits are not applied to the cars without the sticker, and without the sticker car are not allowed to use the parking facilities located at Government buildings. Interestingly there is no specified rule that exempts certain types of vehicles from this scheme unlike other similar schemes implemented in other places of the world. For example, Metro Manila exempts emergency vehicles, taxis, delivery vehicles, Government vehicles, official media vehicles from its odd-even plate numbering scheme – Unified Vehicular Volume Reduction Program.

As of Dec. 2000, 157,318 stickers were issued, yet which is only 32% of total candidate cars in Pusan (IPD, 2000). So theoretically if the entire drivers with the valid stickers follow the rule, at most 3.2% of total daily car volume would be reduced.

3. THE SURVEY

This paper summarizes and analyzes the results of a survey conducted by The Citizen Association of Green Traffic Movement (GT). Though the survey aimed mainly at finding out the citizen's perception and attitudes towards the scheme and the opinions of participants in the scheme, it also attempted to identify the general opinions on the existing transport system in Pusan.

The survey therefore consisted of three separate parts of questionnaires: 1) citizens' opinion on the transport system in Pusan; 2) citizens' attitude towards the scheme; and 3) participating drivers' opinion on the scheme. The first and second questionnaires were given to the general public, and the third questionnaire was given to car drivers with the valid sticker, i.e., participants in the scheme. Accordingly the sample included the general public as well as car drivers with valid stickers.

In May 2000, the survey team interviewed with a total of 4,456 citizens in Pusan over a span of two weeks. Among them, 2,791 respondents were drivers with the valid sticker, the rest were non-participants. The same questionnaire was given to the entire respondents, but only participants of the scheme gave answers to the third questionnaire. The places of interview were around the Government Buildings and major traffic generators such as department stores and office complexes. Around these places interviewees were randomly selected by interviewers, and they were given mostly closed–ended questions with a few open-ended questions. The car drivers with the valid sticker were those parking their cars at the parking facilities around these places.

The questions also established the general socioeconomic characteristics of respondents, such as gender, age and employment. The breakdown of the socioeconomic characteristics of respondents is summarized in Table 1. Note that differences of total respondents among variables are due to the omissions of missing or erratic information.

Table 1. Socioeconomic Characteristics of Respondents

	Freq.	%		Freq.	%
Sex			**Age**		
			< 20	654	14.7
Male	2,336	52.9	20-40	2,552	67.5
Female	2,082	47.1	40-60	1,049	23.7
			> 60	183	4.1
Total	4,418	100.0	Total	4,438	100.0

	Freq.	%		Freq.	%
Employment			**Income/month**		
Civil servant	375	8.6			
Office worker	914	20.5	$ 800	1,078	26.3
Student	1,669	37.5	$ 800-1,600	1,885	46.0
Self-business	495	11.1	$1,600-2,400	960	23.4
Housewife	473	10.6	>$2,400	171	4.2
Etc.	425	9.5			
Total	4,351	100.0	Total	4,094	100.0

Out of the total respondents, about 52.9% are male and 47.1% female. Though the age group of 20-40 dominates the sample, it should be noted that 39.8% were in the age group of 20-29 and between 30 and 39 years of age there were 19.8%. In terms of the category of employment, the percentage of students was higher than expected, considering the daytime hours of the survey. But it should be noted that all students are attending higher than college and it may be the places of survey, most of which were around department stores. As for the economic status, most of respondents fell into the low and median income group, representing typical income distribution.

4. ANALYSIS OF SURVEY RESULTS

This section summarizes and analyzes the results of the survey performed by GT. We summarize the general opinions of respondents on the transportation system and traffic conditions in the first two subsections. In the following two subsections, the survey results associated with the numbering scheme are analyzed. Only questions related with this study were considered here.

4.1 Travel Characteristics

The survey was designed to identify the travel characteristics of the respondents, including car ownership, trip frequency and major modes of transport used because these were believed to be important elements that influence their opinions on the scheme.

Respondents were asked how many cars his/her family owns and the results are shown in Figure 1. Out of the 4,393 valid responses, 34.3% indicated that their families do not have a car, and 65.7% replied that their families own the car: 56.7% 1-car and 9.0% more than 1 car. As of Dec. 1999, 64.4% of families in Pusan owned at least one car (Pusan City, 1999), it is thus safe to say that the sample well represents the population characteristics.

The respondents were also asked to indicate a major mode of transport used for their travel, and the results are shown in Figure 2. It can be seen from the Figure that only 23.7% were choosing cars for travel, while majority of respondents (63.7%) were indicating the public transit system as a major mode of travel. It is interesting to see that most (33.6%) were using two transit modes in order to complete their desired trips. It is obvious that this large group of transit users is suffering from inconvenient transit system – paying fares for each ride, long travel time, etc.

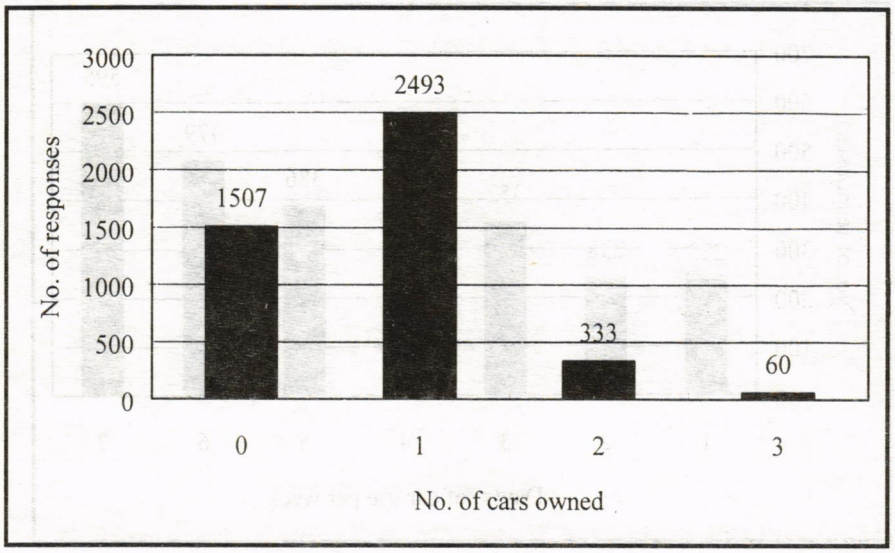

Figure 1. Family Car Ownership (N = 4,393)

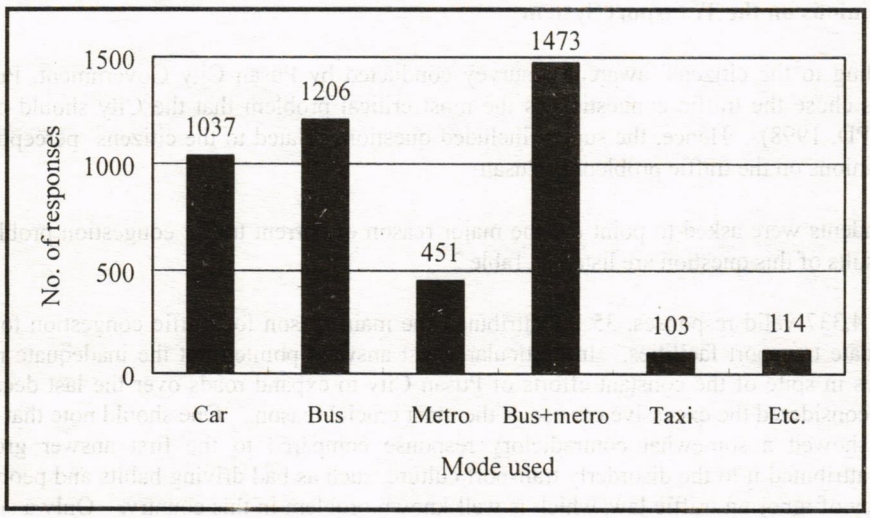

Figure 2 Major Modes of Transport Used (N = 2,858)

Since we believe the frequency of car use and the scheme are related with each other the question were asked to see how many days he/she drive the car per week and the results are illustrated in Figure 3.

As seen in the Figure, of the 2,513 valid answers, 58.2% use the car for at least 5 days, which can be considered as the group of frequent car user. Only 18.8% responded with "at most 2 days", while 23.3% use their cars for 3 or 4 days per week.

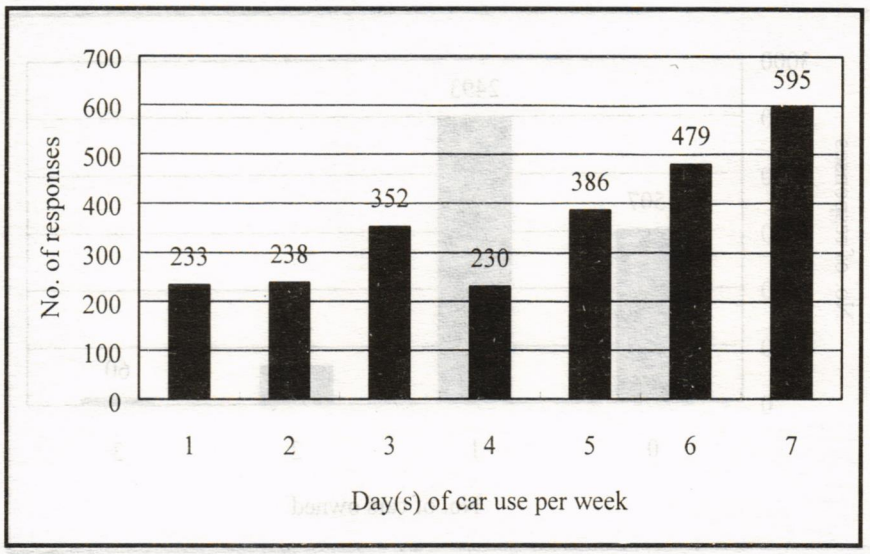

Figure 3. Frequency of Car Use per Week (N=2,513)

4.2 Opinions on the Transport System

According to the citizens' awareness survey conducted by Pusan City Government, Pusan citizens chose the traffic congestion as the most critical problem that the City should cope with (IPD, 1998). Hence, the survey included questions related to the citizens' perceptions and opinions on the traffic problem in Pusan.

Respondents were asked to point out the major reason of current traffic congestion problem. The results of this question are listed in Table 2.

Out of 4,337 valid responses, 35.1% attributed the main reason for traffic congestion to the inadequate transport facilities. In particular, most answers pointed out the inadequate road facilities in spite of the constant efforts of Pusan City to expand roads over the last decade. 31.0% considered the excessive car use as the most crucial reason. One should note that this group showed a somewhat contradictory response compared to the first answer group. 24.4% attributed it to the disorderly transport culture, such as bad driving habits and people's tendency of ignoring traffic law, which is well-known problem in this country. Only a small portion (8.1%) responded with excessive heavy trucks on the roads.

Table 2. What is a Major Reason for Traffic Congestion?

Response	Frequency	%
Lack of transport facilities	1,572	35.1
Excessive car use	1,343	31.0
Disorderly transport culture	1,058	24.4
Excessive heavy trucks	363	8.4
Etc.	52	1.2
Total	4,337	100.0

Table 3 summarizes the answers for the question of what is the most urgent measure that should be initiated in order to mitigate the traffic problem in Pusan.

Table 3. What is the Most Urgent Measure?

Response	Frequency	%
Expand roads and streets	1,400	32.8
Enhance the quality of transit service	1,161	27.2
Construct more metro lines	1,099	25.7
Reduce car traffic volume	613	14.3
Total	4,273	100.0

32.3% of respondents indicated the need to expand roads and streets facilities, while 26.7% want to have more metro lines. Note that over 50% indicated the need to enhance current public transit system – either new transit lines or improve its service quality. In addition to the present metro network (a full-section of Metro Line 1 and a half section of Metro Line 2), the other half section of the Metro Line 2 and Metro Line 3 are currently under construction, and they are scheduled to open in July 2001 and in year 2005, respectively. Besides, City's transportation plan for year 2011 includes the construction of nine new light rail transit lines within the city area (Pusan City, 1999). If these are accomplished, Pusan will have a much more comprehensive rail network.

It was attempted to see what should be done in order to deter the excessive car use, and the results are shown in Table 4.

Table 4. What Should be Done to Deter the Excessive Car Use?

Response	Frequency	%
Enhance the quality of transit service	2,058	47.9
Construct more metro lines	1,210	28.2
Expand public bus network	495	11.5
Raise gasoline price	423	2.5
Etc.	108	9.9
Total	4,294	100.0

As one can readily see, to deter the excessive driving, most of respondents pointed out the needs to improve transit services: about 47.9% indicated the need to improve the quality of transit service, 28.2% to expand metro network, and 11.5% to expand bus routes. It is interesting to see that about 10% suggested a raise of gasoline price, considering the fact that Korea is already one of countries that are charging the highest gasoline price. Note that the high-income group tends to favor raising the gas price (18%) compared to the low-income group (10%).

4.3 Citizens' Opinions on the Scheme

There were questions to identify the citizens' general opinions regarding the 10-digit numbering scheme. These include whether for or against the scheme and reasons of for or against. Using a statistical package SPSS, contingency analyses - Parson's Chi-SQ test - were also performed to identify any dependency between the responses and the other characteristics of respondents (Significant level = 0.05).

Regarding a question of whether you are for or against the scheme, out of 4,332 valid responses, about 66.6 % of respondents were in favor of the scheme, only 10.6% did not like the scheme and 22.8% did not care about the scheme. One may conclude from the results that Pusan citizens in general share a very positive perception of the existing scheme. But we have to take a careful look at the fact that a substantial portion of respondents fell into "indifference" group. Citizens in this group may not have any knowledge about the scheme or they may just ignore the scheme as one of futile efforts by Pusan City. If an appropriate action should be taken to attract more people's attention to the scheme, it should include strategies focused on this group of people.

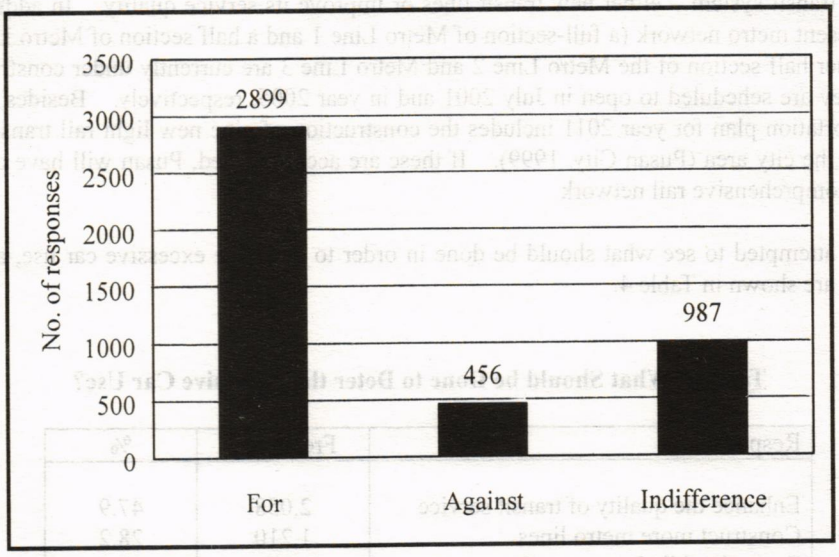

Figure 4. For and Against the Scheme (N = 4,332)

Tests of any dependency of these answers with the respondents' characteristics were undertaken. It was found that the respondents' opinions are strongly related with age, type

of job possessed, car ownership and frequency of car use (Table 5), while they are not significant with the categories of income level and gender. In other words, all these three elements, on a given condition, are related with the respondents' opinion of for or against. Categories of car trip frequency and car ownership were reconstructed into the groups of "infrequent car user (1-2 days)", "medium car user (3-4 days)", "frequent car user (5days +)", and the groups of "car-owner" and "car-not-owner", respectively.

Table 5. Results of Chi-SQ Tests

Test with	Pearson χ^2	d.f.	P
Employment	145.954	10	.000
Car trip frequency	38.21	4	.000
Car ownership	43.12	2	.000
Age	163.25	6	.000

With respect to the type of job, civil servant (73.2%) and housewife (68.0%) were more likely to be in favor of the scheme than the company personnel (63.9%) and the self-employed (64.6%). In terms of car ownership, only 6.3% of the car owned families were more likely to be against the scheme, compared to 13% of non-car owned family. This percentage was increased with the number of car owned: 16.4% of a family with more than one car against the scheme.

The relationship between car trip frequency and the attitudes were also identified as significant. It showed that the frequent group (at least 5days per week) was more likely to be against the scheme (17.4%) than the infrequent group (less than 5days per week) (9.4%). In terms of age group, it showed that the older tended to be in favor of the scheme compared to the young people. 57.1% of age under 20 group were in favor, 67.3% % of the group 20-40, and 68.8% of the age over 40 group.

Proponents of the scheme were asked why you are in favor of the Scheme, and the results are listed in Table 6.

Table 6. Why are in Favor of the Scheme?

Response	Frequency	%
Help mitigating the traffic congestion	1,839	74.3
Participate in NGO movement	246	15.5
Financial benefits	66	5.7
Etc.	56	4.5
Total	2,207	100.0

monetary

It was found that majority of participants (74.2%) agreed that their participation would help mitigating traffic congestion problem in Pusan. But it is surprising, given the monetary benefits of the scheme - to see that only 5.7% responded with "save money by participation". This can be interpreted such that the success of this scheme not necessarily depends on its monetary benefits to the participants.

Table 7 Why are not in Favor of the Scheme?

Response	Frequency	%
Business needs	134	39.6
Absence of alternative transit system	70	20.7
No significant impact on traffic volume	60	17.8
No financial benefits	50	14.8
Etc.	24	7.1
Total	338	100.0

Opponents were asked to see why they are against the scheme (Table 7). As seen, the largest portion (33.6%) of the 338 valid respondents pointed out "business needs" as a reason. Generally, this problem is considered as one of toughest barrier for the success of such traffic reduction measure as a plate numbering system. A similar scheme was adopted in Mexico City for a relatively longer period, yet the vehicle travel reductions were much smaller than projected (Goddard, 1997). Hayes attributed one of major reasons of its failure to the exemption of a large portion of vehicle used for business and professionals (e.g., doctors, salespeople lawyers, etc.)

The rest of respondents were evenly distributed to such answers as: "no available alternative modes", "No impact on existing traffic volume" and "no financial benefits". This suggests that Pusan City should take a variety of actions in order to make the scheme more attractive to the citizens.

4.4 Analyses of Responses by Sticker Holders

A total of 2,791 persons with a valid sticker of the scheme were interviewed in order to identify the real effectiveness of the scheme. The questions include whether they obey the rule of the scheme: if yes, why and if no, why. This section examines the results of the answers of car drivers with a valid sticker.

For a question of whether they presently obey the rule of the scheme, 63.6% (1,775) replied with "Yes", i.e., do not driver the car on a specified date, while 36.4% (1,016) of them answered with "No." (Figure 5) At a first glance, it appears that the scheme is being implemented successfully. Yet note that if all of candidate cars of Pusan City have the valid sticker and obey the rule, 10% of car traffic on the streets will be reduced. And also considering only 32% of the candidate car-owners are with the valid sticker, one can conclude that with this scheme the daily traffic volume reduces only by less than 2%. In other words, the scheme exerts a negligible impact on existing traffic condition.

In subsequent questions to the group of "No" response, about 11% commented that they used to obey the rule but at some point stopped to obey the rule. Its main reason was mostly due to "business needs", as will be seen later. On the other hand, 12% answered with "plan to obey the rule in the near future", pointing out that they cannot not find an appropriate alternative mode, or they find the alternative mode chosen inconvenient. Consequently they decide to continue to use their cars. It suggests that planner should pay more attention on this group in order for this scheme to be better performed.

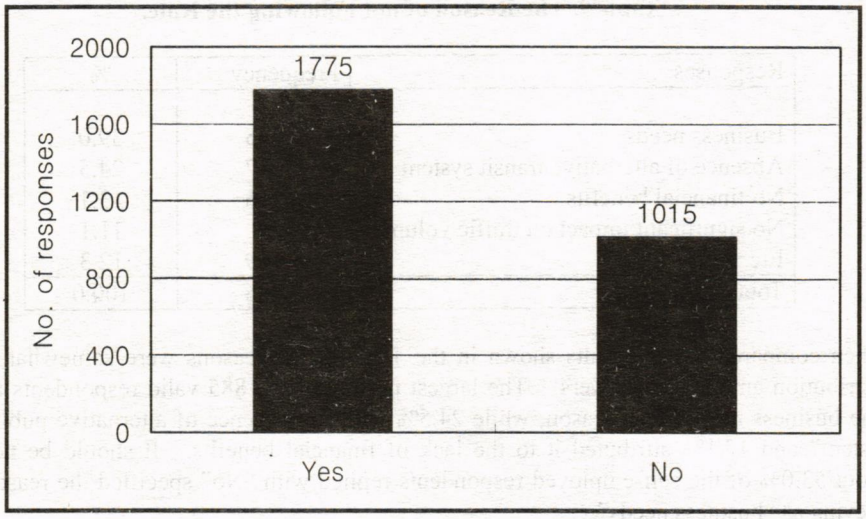

Figure 5. Do You Obey the Rule of the Scheme? (N=2,791)

The Chi-SQ tests were performed to find there was any dependency of the answer with the other characteristics of the respondents. It was found that variables of gender and income level were not significantly related with the answer. But the categories of type of job possessed and car use frequency were found as significantly related with the answer (Table 8), while the other categories such as respondent's age, income level, and gender were found as not significant.

Table 8. Results of Chi-SQ Tests

Test with	Pearson χ^2	d.f.	P
Employment	65.85	5	.000
Car trip frequency	48.12	2	.000

Civil servants (82.4%) were much more likely to obey the rule than the other groups: 64.5% office workers, 54.9% self-employed, 57.4% housewife, and 63.7% students. This is due to the fact that only participant is allowed to park his/her car at government parking facilities. As a civil servant, they should participate in the scheme in order to park his/her car at the parking facilities.

As one can readily expect in the table, the self-employed group showed the least rate of obeying the rule. It would be difficult for this group to participate in the scheme with their business cars unless there are alternative modes or other available cars for business. In terms of car use frequency, the infrequent car user group (71.5%) and the medium user group (76.5%) were more likely to obey the rule than the frequent user group (60.0%). This is also the result that we can expect.

The group giving "No" response was asked to give the reason of not obeying the rule and the results are summarized in Table 7.

Table 9. The Reason of not Following the Rule.

Responses	Frequency	%
Business needs	345	39.0
Absence of alternative transit system	217	24.5
No financial benefits	116	13.1
No significant impact on traffic volume	98	11.1
Etc.	109	12.3
Total	885	100.0

When compared to the results shown in the Table 6, the reasons were somewhat different distribution among the answers. The largest portion of the 885 valid respondents indicated "the business needs" as a reason, while 24.5% with "an absence of alternative public transit system" and 13.1% attributed it to the lack of financial benefits. It should be noted that about 53.0% of the self-employed respondents replied with "No" specified the reason of not obeying as "business needs".

It may be safe to say that policy-makers should take more attention to the answers given by this group since the respondents for this question were those who attempted to participate the scheme. As pointed out earlier, one should keep in mind that the success of the scheme requires a variety of actions: improve transit system, expand financial benefits, a careful planning for people with business needs.

The respondents with "Yes" were also asked to indicate why they do follow the rule. As seen in Table 10, majority of the valid respondents indicated that their participations would help reducing the traffic congestion in Pusan. Again only a minimal portion of people replied with the resulting economic benefits, confirming that most people did follow the rule not because of their economic gains.

Table 10. The Reason of Following the Rule.

Response	Frequency	%
Help mitigating the traffic congestion	1,331	79.6
Participate in a NGO movement	246	14.7
Financial benefits	64	3.8
Etc.	46	2.8
Total	1,672	100.0

5. CONCLUSION

As seen in the survey results, Pusan citizens generally recognize the seriousness of the transport problem as well as the needed strategies to mitigate the problem. And also the general public understands that the 10-digit numbering scheme is one of effective measures to reduce the traffic problem. It is thus clear from the above analyses that Pusan citizens, in general, share a very good perception of the 10-digit plate numbering scheme (66.6% in favor of the scheme).

It is found that the perception on the scheme varies with such respondent's characteristics as the type of job possessed, car use frequency and car ownership, while it is not significantly varied with age, gender and income level. On the other hand, the participation rate – i.e., obeying the rule of the scheme' – was found to be related with the type of job and car frequency.

The results yet indicate that the real effectiveness of the scheme - achieve the traffic volume reduction - is rather suspicious. Among the cars with the valid stickers, only 63.6% were the rule-followers. In practical sense, it can be translated such that this scheme is able to reduce the traffic volume only by less than 2% everyday. When considering the fact that theoretically maximum 10% of car traffic can be reduced, the scheme can be taken into account as having a negligible impact on existing traffic condition. To make the scheme more attractive to the citizens and thus to improve the effectiveness of the scheme, appropriate actions should be taken. In this study following actions are suggested:

First, there is a need to strengthen the City government's involvement in the scheme even though it is a voluntary scheme. So far the City has shown very passive attitude towards the scheme, only considering it as one of citizens' movements. This attitude should be reversed in order to make the scheme more effective, supporting strongly the scheme as one of TDM measures. The City should also be responsible for developing a basic plan and evaluating effectiveness of the scheme on a regular basis.

Secondly, there should be a careful study on the treatment of car users for business needs. As seen, most people do not obey the rule because of business needs.

Thirdly, the public transit system should be improved and enhanced. It is obvious that when no alternative transport system is available, only option given to the traveler would be to drive his/her car. Also in the survey many people indicated a need to expand and improve public transport system in Pusan. This could be achieved partly by restructuring the existing bus routes in a short-term basis, but in a long term more metro lines and LRT lines should be constructed.

Finally, though the survey results showed a very little effect of financial incentives on the public, it is necessary to provide more monetary incentives for the participants. Also the scheme should be more rigorously and continually publicized to the citizens through newspapers, TV, radio, even Internet and other government notices.

Though the above suggestions will clearly help facilitating the scheme, experiences of many other places adopting similar strategies show not satisfactory results in term of achieving proposed objectives. Several cities implemented or are currently implementing the plate-numbering scheme with variations in detailed methodology to achieve a better quality of urban life by reducing traffic volume and emissions. These include Santiago, Manila, Mexico City, and Bogotá. In particular, experience of Mexico City clearly indicated the difficulty of the achieving the goals through the numbering scheme (Goddard, 1999).

We should be kept in mind that there are many other Transportation Demand Management strategies that could be more effective, such as auto restricted zone (ARZ), parking pricing, pedestrian/cycling improvements, which are widely used in many other places of the world. To enhance the quality of citizens' daily life, a combination of numerous measures to restrain

the car traffic within the city area are thus required.

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