

A STUDY ON THE ACCEPTABILITY OF THE ETC IN METRO MANILA AND A FRAMEWORK FOR ESTIMATING ITS ENVIRONMENTAL BENEFITS

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ABSTRACT: The benefits of using ETC instead of manual toll payment are clear. It has been observed in Philippine expressways that the average service time per vehicle with E-pass is 1.5 seconds compared to 15 seconds for manual collection. This translates to reduced traffic congestion at toll plazas, lower fuel consumption, less air pollution, and therefore less economic losses. However, the current number of E-pass subscribers is still small compared to the number of toll road users. Possible reasons are the high initial cost of subscription, infrequent use of tollways by some users, lack of information, etc. To ascertain these reasons and to understand the factors that can increase E-pass subscription, it is important to know the perception of people about the ETC. This study aims to gather people's assessment of ETC; identify factors that would make non-ETC users shift to ETC; relate socio-economic characteristics with ETC acceptability; and develop a framework estimating the environmental benefits of ETC.

Key Words: Electronic toll collection (ETC), Perception, Acceptability, Emission reduction

1. INTRODUCTION

The application of the Electronic Toll Collection (ETC) System can be found in several countries. A pioneer is Singapore with its Electronic Road Pricing (ERP) system that is used to implement congestion pricing. Japan initiated its ETC services in April 2000. Penang, Malaysia uses the "Smart TAG" for cars and the "Touch n Go Smartcard" for other vehicles. Norway uses the "Q-FREE" where tolls are charged at entry points. In the United States, applications can be found in Florida where there are 150,000 "E-pass" subscribers. In New York, Delaware, and New Jersey, subscribers use the "E-ZPass". In San Francisco, the Automatic Toll Collection (ATC) is used. The same is true for toll bridges in Louisiana, Oklahoma, and Texas.

In the Philippines the ETC System is used in the South Luzon Tollway (SLT) and the Metro Manila Skyway (MMS) linking Metro Manila with the southern provinces. This was launched in August 2000. Vehicles of ETC subscribers are fitted with transponders (commonly known as E-pass) and toll collection is done electronically. There are exclusive

E-pass lanes and the majority of the other lanes are for mixed E-pass or non- E-pass users. Initial cost is 2,200 Pesos (about 40 US\$) inclusive of 1,400 Pesos (25 US\$) for the transponder and 800 Pesos (15 US\$) worth of toll. Value preloading can be done by credit card or cash payment at designated areas. Since launching, a total of 58,000 subscribers have enrolled in the program. From January to August 2002, an average daily total of 212,680 non-ETC users (79%) and 55,335 ETC (21%) subscribers use the expressway system.

The benefits of using an ETC instead of manual toll payment are clear. It has been observed in the Philippines that the average service time per vehicle with E-pass is 1.5 seconds as compared to 15 seconds per vehicle for manual collection (Padayhag, 2002). This translates to reduced traffic congestion at toll plazas, lower fuel consumption, less air pollution, and reduced delay and therefore less economic losses. However, the current number of E-pass subscribers is still small compared to the total number of toll road users. This is clearly illustrated by the contrast between the manually operated toll gates (with long queues of vehicles being processed) and the E-pass toll gates (with swift flow of vehicles). To ascertain the reasons why some people subscribe to the ETC and why others do not and to understand the factors that can encourage more E-pass subscribers, it is important to know the perception of people about the ETC.

2. SURVEY METHODOLOGY

An ETC Perception Survey composed of an interview survey and questionnaire survey was designed with the following objectives. 1.) To gather an assessment of ETC by users and non-users; 2.) To identify factors that would make non-ETC users shift to ETC; 3.) To relate socio-economic characteristics with ETC acceptability.

Two waves of surveys were conducted in order to capture a significant representation of both ETC users and ETC non-users in the SLT/MMS tollway system.

2.1 First Survey: Questionnaire Interview survey

The Interview Survey was held on 20 and 23 November 2002 at establishments in the Petron and Shell gasoline station rest areas along South Luzon Tollway. On 20 November (Wednesday), 14 surveyors conducted an interview survey with patrons of fast-food restaurants and the convenience store of Shell gasoline station rest area from 12:00nn to 8:00pm, while 15 surveyors conducted an interview survey at Petron and Shell gas stations on 23 November (Saturday), also from 12:00nn to 8:00pm.

Each surveyor approached prospective respondents and conducted a 20-minute interview. Responses from a total of 349 samples were gathered during the survey: 158 on the first day and 191 on the second day.

2.2 Second Survey: Questionnaire Survey

The Questionnaire Survey was held in coordination with PNCC-Skyway Corporation (the operator of the Metro Manila Skyway System) from 11 to 20 February 2003 in order to capture regular tollway users (defined as those who pass by the SLT/MMS system at least 3 times a week per direction). The questionnaire used earlier was converted into a one-page

brochure to facilitate easy handling and self-administration by the respondent. A cellular phone (Nokia 3310) raffle was incorporated into the survey to promote respondent participation.

Twelve thousand (12,000) survey brochures were printed and distributed in three ways as shown in Table 1, along with return rates of validated forms.

Table 1. Survey Brochure Distribution

Mode of Distribution	Number of Distributed Survey Brochures	Number of Returned Forms
Through Entry Tollbooths	9,500	236 (2.48%)
Through Exit Tollbooths	1,500	81 (5.40%)
Through Replenishment Centers	580	32 (5.52%)
Total	11,580	349 (3.01%)

3. SURVEY RESULTS

3.1 General

From the two surveys held, the 698 respondents (349 respondents for both 1st and 2nd surveys) were classified by ETC usage and vehicle ownership as follows. “Vehicle user” is defined here as driver of the vehicle who has ties with the owner (family or friend). “Driver” is defined here as one employed by the owner of the vehicle.

Table 2. ETC Usage & Vehicle Ownership Characteristics.

ETC Usage	Owner	Vehicle User	Driver	Total	Share
User	145	57	19	221	31.66%
Non User	276	126	57	459	65.76%
Quitter	13	4	1	18	2.58%
Total	434	187	77	698	100%

3.2 Trip Information

The frequency distribution of expressway use (defined as one-way use) of respondents is shown in Figure 1.

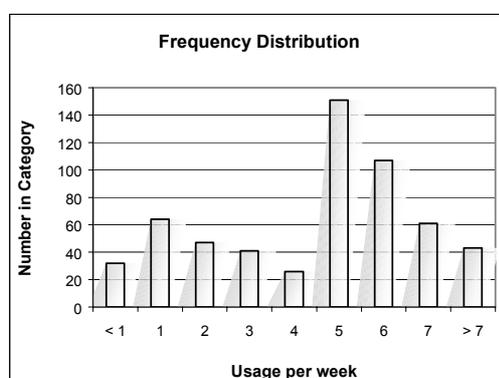


Figure 1. Frequency Distribution of Expressway Use.

3.3 Trip Purpose Characteristics

“To work” is the dominant trip purpose followed by “to home”, “private business”, and “to school”. The trip purposes are 1-To home, 2-To work; 3-To school; 4-Private business; 5-Employer’s business; 6-Medical; 7- Visitfamily/relatives;8- Leisure or recreation; 9-Accompany HH members; 10-Others. The trip purpose distribution is shown in Figure 2.

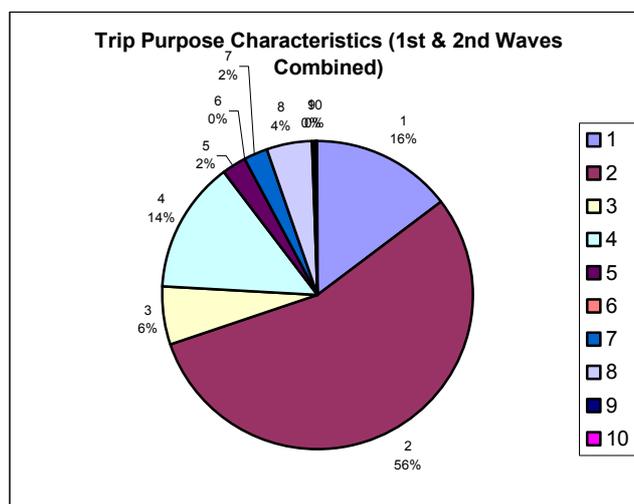


Figure 2. Distribution of Trip Purpose.

3.4 Perception

The perception on ETC is categorized according to the three groups of respondents:

- ETC users
- Non-ETC users
- ETC quitters

The perception on ETC of current users is discussed here. The reasons why respondents subscribe to ETC are as shown in Table 3. The main reasons why users subscribe to ETC is that it offers “faster” transaction. This is followed by the convenience offered by ETC.

Table 3. Reasons for Subscribing to the ETC.

Reasons for using ETC:		1 st Reason	2 nd Reason
1	Status Symbol/High tech	1	1
2	Faster	117	45
3	Safer	3	6
4	More convenient	73	98
5	Frequent use	14	18
6	Others	0	0
Total		208	168

To further improve the ETC, current users suggest the offering of toll discounts and the addition of exclusive ETC lanes. “Cheaper transponder” is also suggested by the respondents as a way to improve the current ETC. The reduction in cost of ETC in the form of lower tolls

or less expensive hardware add to its utility to users. Table 4 shows the suggestions for ETC improvement.

Table 4. Suggestions for Improving the ETC.

How ETC can become more attractive:		1 st Suggestion	2 nd Suggestion
1	Add exclusive ETC lanes	30	53
2	Stricter enforcement	16	24
3	Toll discounts	96	46
4	Cheaper transponder	43	29
5	More convenient payment	17	11
6	Others	14	12
Total		216	175

Cost is perceived to be the major deterrent why some people do not subscribe to the ETC. Another reason that discourages potential ETC users is the infrequent use or underutilization of the technology. If a user thinks that he will rarely use the ETC, then its cost will be perceived to be much higher than if it were to be more frequently utilized or enjoyed. Table 5 shows the reasons why people do not use the ETC.

Table 5. Reasons for NOT using the ETC.

Reasons for NOT using ETC:		1 st Reason	2 nd Reason
1	Dislike high tech/prefer traditional	1	12
2	Not safe	1	5
3	No information on ETC	32	28
4	Expensive initial cost	230	60
5	Infrequent use/underutilized	95	80
6	Others	66	35
Total		425	220

Table 6 shows the improvements that may convince current non-ETC users to subscribe to ETC. Most respondents perceive that they will be encouraged to use ETC if it becomes less expensive (or cheaper transponder and availability of toll discounts).

Table 6. Things that will make non-users to subscribe to ETC.

Things that will make them convert to ETC:		1 st Answer	2 nd Answer
1	Add exclusive ETC lanes	13	26
2	Stricter enforcement	10	5
3	Toll discounts	83	125
4	Cheaper transponder	178	43
5	More convenient payment	36	29
6	Others	79	29
Total		399	257

There are few former ETC users who have quit the subscription. Although comprising only 2.6% of the total sample size, it may still be interesting to note the various reasons why they have quit ETC. The survey database includes reasons like “no more ETC sponsor” in the case of those who used to drive company cars with e-pass; “erroneous debiting of toll”, “lack

of load verification or monitoring”, and inconvenience to store up load. Table 7 shows the reasons for quitting the ETC.

Table 7. Reasons for quitting the ETC.

Reasons for quitting ETC:		1 st Reason	2 nd Reason
1	E-pass is elitist	1	0
2	Infrequent use/underutilized	1	1
3	Inconvenient to store up load	4	4
4	Others	8	2
Total		14	7

Some quitters suggest that to make them subscribe again, it may be helpful to have a monthly billing report so they can easily monitor their toll payments. Another reason is if they can again find a sponsor to shoulder the costs of ETC subscription. Other improvements like toll discounts, cheaper transponder, and more convenient payment method are possible ways to convince quitters to renew their subscription. Table 8 shows the factors that will make quitters subscribe to ETC again.

Table 8. Factors that will make quitters re-subscribe to ETC

Things that will make them subscribe to ETC again:		1 st Answer	2 nd Answer
1	Add exclusive ETC lanes	2	0
2	Stricter enforcement	1	0
3	Toll discounts	3	4
4	Cheaper transponder	0	3
5	More convenient payment	3	2
6	Others	6	2
Total		15	11

For all categories of ETC usage, the general perception of the impact of the ETC in improving the expressway system is as shown in Table 9. About a sixth of the respondents “strongly agree”; about half of the respondents “agree” that the ETC has improved the expressway. About a third “disagree” to this statement. Table 8 shows people’s perception on how the ETC has improved the expressway.

Table 9. Perception on how the ETC has improved the expressways.

“The ETC has improved the condition of the expressway”		Number of responses
1	Strongly agree	100
2	Agree	305
3	Disagree	213
4	Strongly disagree	44
Total		662

Among the improvement measures that the respondents perceive to be necessary for the expressway, widening the right-of-way is considered to be the most needed. This is followed by pavement improvement and strict traffic enforcement. Table 10 shows the suggested expressway improvements.

Table 10. Suggested Expressway Improvements.

Ways to improve the expressway		1 st Answer	2 nd Answer
1	Improve signage	14	29
2	Improve lighting	29	56
3	More rest areas	5	12
4	Widen right-of-way	192	47
5	Strict traffic enforcement	100	107
6	Prompt incident management	23	50
7	Improvement pavement condition	109	115
8	Improve emergency soldiers	11	17
9	Others	38	46
Total		521	479

3.5 Socio-economic Characteristics and ETC Use

This section shows the cross-tabulation of various socio-economic characteristics and ETC usage.

3.5.1 Gender

The following chart and table show the gender and ETC usage characteristics of the respondents. The biggest category in this cross tabulation is the “male ETC non-users” comprising 52% of the concerned respondents. This is followed by the “male ETC user” which comprises 25%. Seventy-eight (78%) of all respondents are male. Of all ETC users, 75% are males. Of non-users, 80% are males.

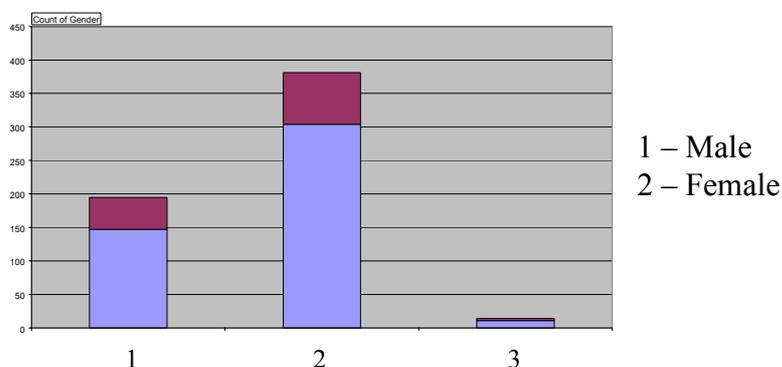


Figure 3. Gender and ETC Usage.

Table 11. Gender and ETC Usage Characteristics.

Count of Gender	Gender		
	1-Male	2-Female	Grand Total
1 – User	147	48	195
2 – Non user	304	77	381
3 – Quitter	11	3	14
Grand Total	462	128	590

3.5.2 Age

The biggest age group in the survey is the 31-40 years old segment that comprises about a third of the total number of respondents (202 samples out of 602). Of this, 71 or 35% are ETC users; 126 respondents or 62% are non-users; and a miniscule number represents the quitters. Figure 4 and Table 12 show these characteristics.

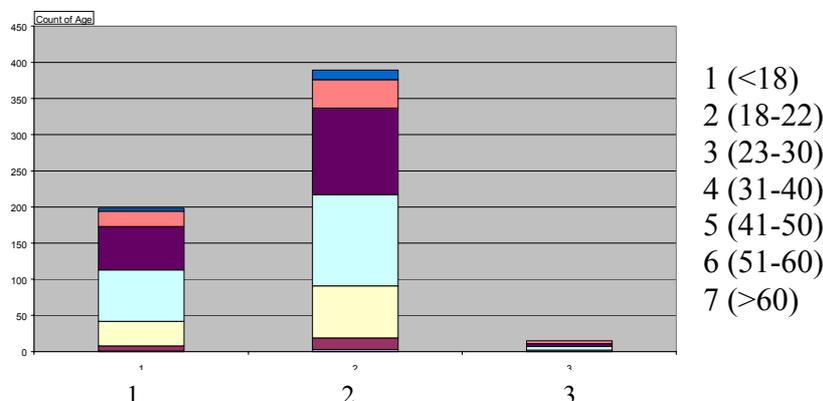


Figure 4. Age and ETC Usage.

Table 12. Age and ETC Usage Characteristics.

Age	1-User	2-Non user	3-Quitter	Grand Total
1 (<18)	1	3		4
2 (18-22)	7	16		23
3 (23-30)	34	72	2	108
4 (31-40)	71	126	5	202
5 (41-50)	60	120	4	184
6 (51-60)	21	39	4	64
7 (>60)	4	13		17
Grand Total	198	389	15	602

3.5.3 Occupation

The occupation of the biggest bulk of respondents is “6 – Private Sector Employee (Management Level)”. These respondents comprise 232 (39%) of all respondents. Of these, 42% are users; 55% are non-users; and 3% are quitters. The next biggest group is “8 – Own business enterprise, freelance” which is composed of 140 or 23% of all respondents. Table 13 shows the occupation categories. Table 14 and Figure 5 show the characteristics of occupation and ETC usage.

Table 12. Categories of Occupation.

1	Student
2	Housewife
3	No job (including retired)
4	Govt employee (managerial)
5	Govt employee (staff)
6	Private sector employee (managerial)
7	Private sector employee (staff)
8	Own business enterprise, freelance
9	Others

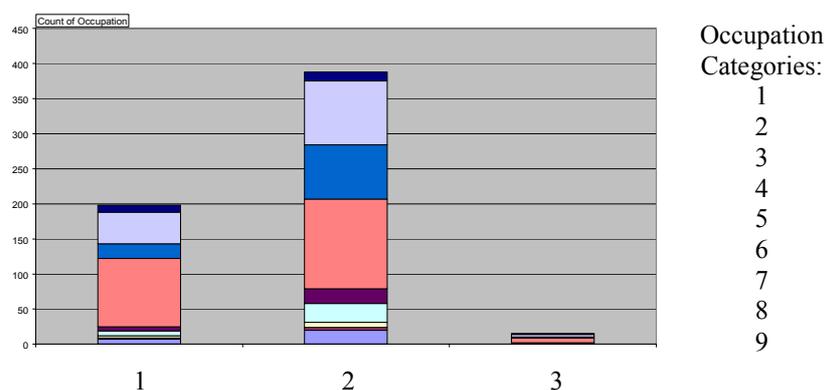


Figure 5. Occupation and ETC Usage.

Table 14. Occupation and ETC Usage Characteristics

Occupation	1-User	2-Non user	3 -Quitter	Grand Total
1	7	20	0	27
2	2	4	0	6
3	3	7	0	10
4	7	27	0	34
5	56	21	2	29
6	97	128	7	232
7	21	77	1	99
8	45	91	4	140
9	10	13	1	24
Grand Total	198	388	15	601

3.5.4 Income

Income categories are as follows as shown in Table 15. Table 16 and Figure 6 show the characteristics of monthly personal income and ETC usage.

For monthly personal income, the biggest income category is the income group number 8 with monthly personal income of 40,000 – 59,999 pesos. These respondents comprise 17% (or 99 out of 572 respondents). The income groups 4 through 8 (with monthly personal income of 10,000 to 59,999 pesos) compose 413 or 72% of all the respondents. Of these 413 samples, 134 or 32% are ETC users; 271 or 66% are non-users. Two (2%) are quitters.

Table 15. Categories of Income.

Income Categories	
1	Under 3,000 Pesos
2	3,000 – 5,999
3	6,000 – 9,999
4	10,000 – 14,999
5	15,000 – 19,999
6	20,000 – 29,999
7	30,000 – 39,999
8	40,000 – 59,999
9	60,000 – 99,999
10	100,000 – 149,999

11	150,000 – 199,999
12	200,000 – over

Table 16. Monthly Personal Income and ETC Usage Characteristics.

Monthly Personal Income Category	1 -User	2 -Non user	3-Quitter	Grand Total
1	5	10	0	15
2	6	18	1	25
3	10	40	2	52
4	15	57	0	72
5	25	67	1	93
6	26	71	2	99
7	33	46	4	83
8	35	30	1	66
9	11	17	2	30
10	5	5	0	10
11	11	8	1	20
12	4	3	0	7
Grand Total	186	372	14	572

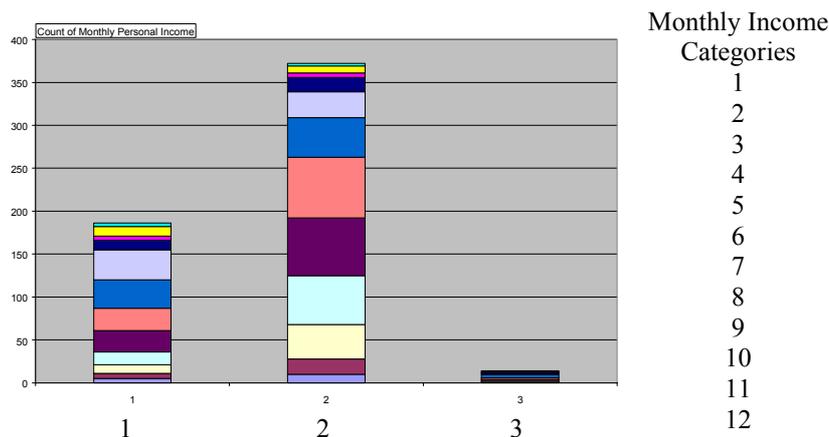


Figure 6. Monthly Personal Income and ETC Usage.

4. MODELING

4.1 Logit Modeling

Logit modeling was performed to identify significant variables that may explain the probability of ETC usage among expressway users. People’s willingness to subscribe to the ETC is considered to be influenced by the following groups of variables:

- trip attributes
- traveller characteristics
- people’s perception of ETC

These variables are shown in the figure below.

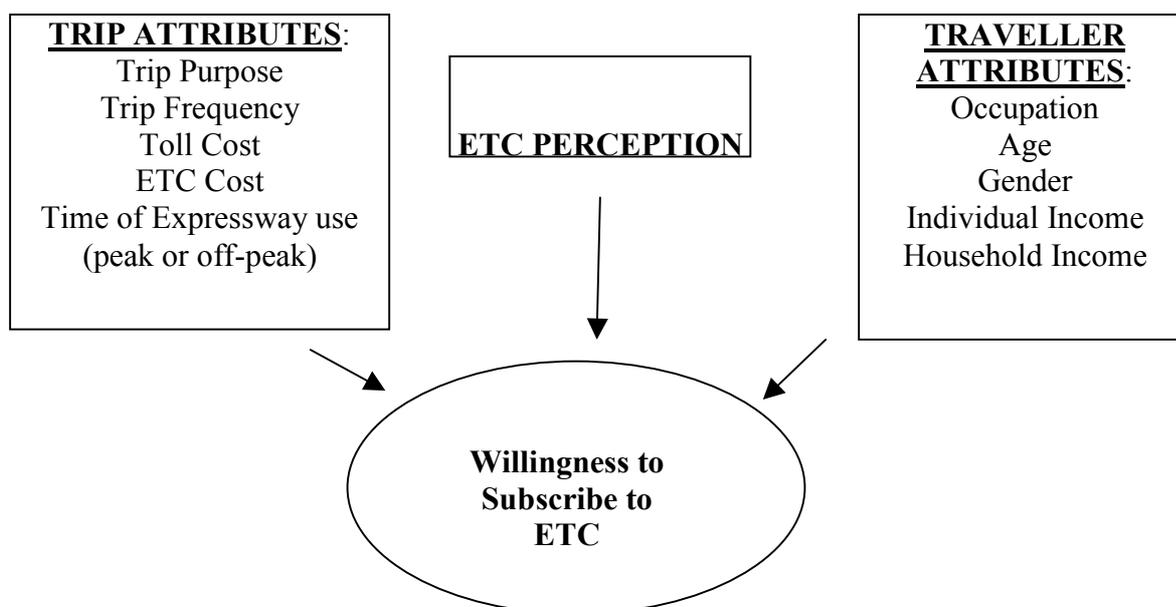


Figure 7 – Variables Influencing People’s Willingness to Subscribe to ETC

The logit model is of the form (Hensher & Button, 2000):

$$P = \frac{\exp(b_0 + b_1x_1 + \dots + b_nx_n)}{1 + \exp(b_0 + b_1x_1 + \dots + b_nx_n)}$$

Where P = probability of ETC usage
 x_i = income, trip frequency, perception of ETC's improvement of the expressway, toll paid, age, others

The table below shows the promising variables that were considered in the modeling and the a priori assumptions on the influence of the independent variables on the probability of ETC usage.

Table 17. Variables Used in the Modeling

ETC usage	1 = ETC user, 0 = otherwise
Trip Purpose (North or South)	1 = To work, 0 = otherwise
Frequency (North or South)	+
Egress Time of Day	1 = Peak time, 0 = otherwise
Toll (North or South)	+
ETC Perception (ETCAGREE)	4 = strongly agree, 3 = agree, 2 = disagree, 1 = strongly
Personal Income (PRSINC)	+
Household Income (HHINC)	+
Personal Purchase Power	+
Household Purchase Power	+
Age (AGE)	?
Gender (GNDR)	?

It is assumed that there is a higher probability of ETC usage if the trip purpose is “to work” since trips with such a purpose are usually regular and frequent thereby making ETC subscription a reasonable option. Frequency is considered to have a positive influence on ETC usage since ETC requires an amount of investment on the part of the subscriber and this investment will be considered worth it if frequency of use is high. Egress time of day is defined as the time when the motorist gets out of the expressway. Egress during peak hour means longer queues at the toll exits thereby making ETC more practical.

Higher tolls mean that motorists have to handle more cash in doing the toll transaction. Hence, ETC will provide the convenience of the not having to physically handle a lot of cash when higher tolls have to be paid. Moreover, some Filipino drivers have the “credit card” psychology; some people prefer to use the non-cash option when higher amounts have to be paid. The level of agreement to the beneficial effect of the ETC on the overall state of affairs at the expressway has a positive influence on the probability of ETC subscription. Income (personal, household, and purchasing power defined as the ratio of personal or household income to ETC subscription cost) is assumed to have a positive effect on the probability of ETC subscription.

Table 18. Logit Model

N=461	Model: Logistic regression (logit) N of 0's:319 1's:142 (ETC3-28) Dep. var: ETC Loss: Max likelihood Final loss: 236.38574877 Chi2(4)=96.575 p=0.0000				
	Const.B0	FRQ	TOLL	ETCAGR	LGPRSP
Estimate	-6.71327	0.20603	0.01519	0.97240	0.574954
Odds ratio (unit ch)	0.00121	1.22879	1.01530	2.64428	1.777049
Odds ratio (range)		21.98727	13.62705	18.48944	8.923218

	Classification of Cases (ETC3-28) Odds ratio: 6.7947		
Observed	Pred.	Pred.	Percent Correct
0.000000	294	25	92.16301
1.000000	90	52	36.61972

Hit Ratio = 75.0 %

The above model shows the most significant variable to be frequency of expressway use, amount of toll to be paid, ETC perception, and income (in the form of the log of purchasing power). Age and gender did not turn up to be significant variables.

It must be said that the current data is weak in the development of models that are policy-sensitive; the present database does not have hypothetical or stated preference information that will demonstrate how people will accept ETC subscription vis-a-vis conditions relating to price and other incentives. This weakness should be addressed as a future direction in the continuation of this research.

4. 2 Emission Reduction from ETC: An Analytical Framework

This section presents an initial framework on the potential environmental benefits of the use of ETC. It starts with the citing of an emissions model showing the effect of vehicle speed and acceleration on emissions. A framework is then proposed showing a comparison of the speed and acceleration of ETC- and non-ETC-vehicles in Japan. A similar framework is also

shown to represent the Philippine ETC system. Lastly, an integrated framework is presented illustrating the estimation of the environmental benefits of the ETC.

Speed and acceleration of vehicles have been established to have an influence on the amount of generated fuel emissions. The model of Ishida et. al (Ishida, 2002) shows the amount of particulate matter (PM in g/min) as a function of speed and acceleration of the vehicle as

$$-1.998 + 2.334E - 02Speed + 1.160E - 01Acceleration$$

follows:

where speed is in km/hr and acceleration is in km/hr/sec.

The figure below shows the speed patterns of ETC and non-ETC vehicles in Japan. ETC vehicles are required to cruise at a speed of not more than 20 kph when they go through ETC tollgates to facilitate the electronic toll payment. Non-ETC vehicles, on the other hand, are required to fully stop for the manual toll payment transaction to be completed. At past the toll gate (ETC or non-ETC) vehicles accelerate until they reach speeds that approximate the over-all average speed of the vehicles on the expressway.

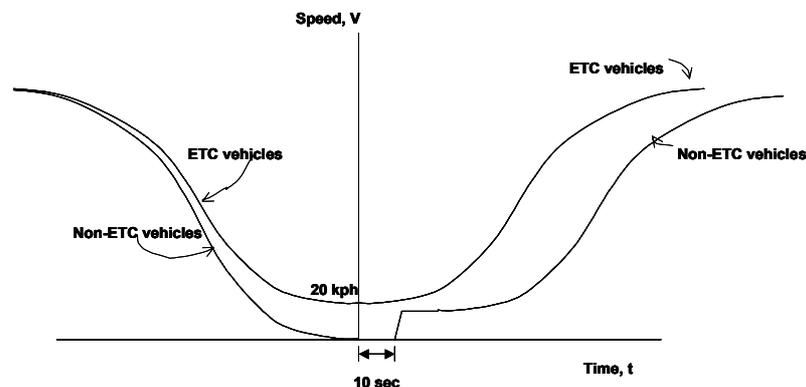


Figure 8 – Speed Patterns of ETC & Non-ETC Vehicles, Japanese Case

The figure below shows the acceleration patterns of Japan’s ETC and non-ETC vehicles as they approach and go past the toll gates. It can be seen in the figure that it is likely that non-ETC vehicles will have higher accelerations because their initial speed from the toll gate is zero (full stop) compared to ETC vehicles with initial speed of about 20 kph. Hence, there may be higher emission because of higher acceleration. Moreover, non-ETC vehicles go through an idling phase while waiting for the manual toll transaction to be completed. An average idling time of about 10 seconds have been observed in Japan.

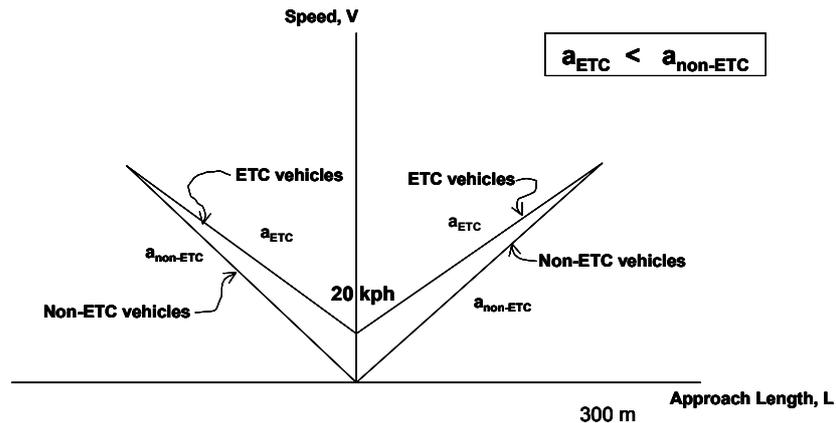


Figure 9 – Speed & Acceleration Patterns of ETC & Non-ETC Vehicles, Japanese Case

It must be noted, however, that the above statements are at present hypothetical in nature. They should, therefore, be subject to validation through actual surveys and observations. This should be done as a future undertaking of this research.

In the case of Philippine ETC, speed patterns of ETC and non-ETC vehicles may be shown as follows:

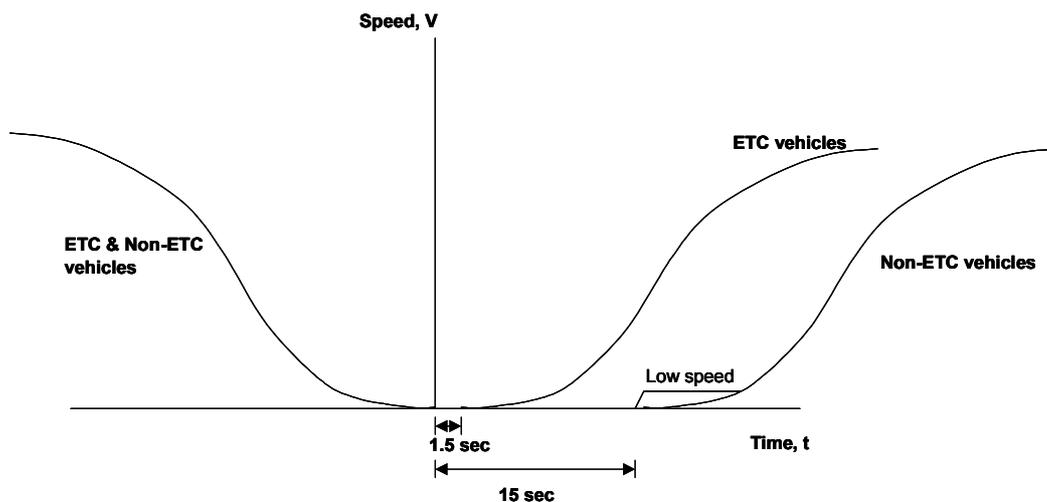


Figure 10 – Speed Patterns of ETC and Non-ETC Vehicles, Philippine Case

The Philippine ETC system is not as sophisticated as its Japanese counterpart. ETC vehicles are still required to fully stop, albeit very briefly, for the electronic transaction to be done. A boom or horizontal barrier is still used to make sure that vehicles stop at the toll gates. Surveys show that ETC vehicles require 1.5 seconds for the electronic toll collection to be completed. Non-ETC vehicles, on the other hand, take around ten times this amount, or 15 seconds for the manual toll transaction to be completed. So there is shorter idling for ETC vehicles compared to non-ETC vehicles (1.5 seconds vs. 15 seconds). There is also shorter queuing for ETC vehicles due to shorter service time. With shorter idling and queuing, emissions are less for ETC vehicles than for non-ETC vehicles.

The figure below shows a conceptual model that integrates an ETC acceptability model and an emissions model.

An ETC acceptability model shows the effect of the independent variables (trip attributes, traveler characteristics, and ETC perception) on the probability of ETC subscription. This model may be used to predict the number of probable ETC subscribers given certain conditions concerning price and other incentives. With information on probable number of ETC (and hence, non-ETC subscribers), traffic simulation can be done to estimate the resulting speeds and accelerations of the vehicles. Consequently, emission levels can be estimated using the resulting speed and acceleration values. Such an integrated model can therefore show the effect of policies on ETC pricing and other possible incentives on consequent emission levels that may result from such policies.

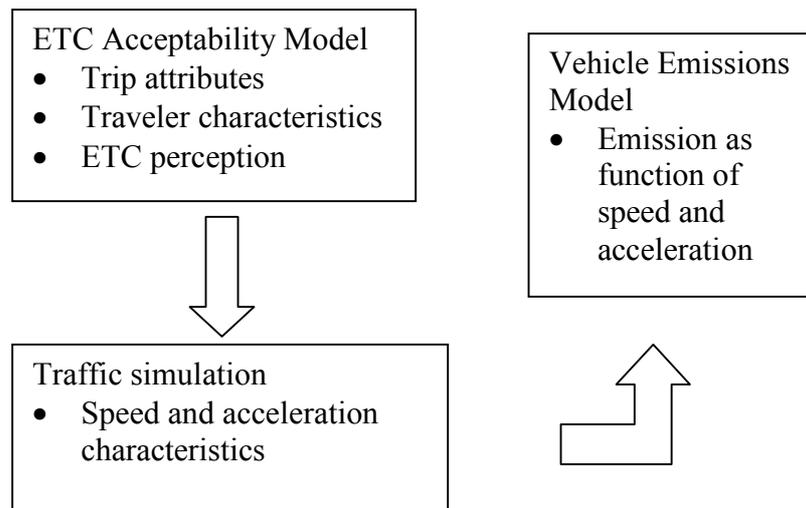


Figure 11 - An Integrated ETC Acceptability & Emissions Model

5. CONCLUSION & RECOMMENDATIONS

This paper presents the results of the survey conducted in Metro Manila to determine the perception of expressway users on the electronic toll collection (ETC) system locally known as the E-pass.

The study finds that the main reasons for subscription to the E-pass are faster tollgate processing and convenience. The most prominent suggestions for improving the E-pass are cost-related: availability of toll discounts and cheaper transponders. If these suggestions are implemented, E-pass non-users may be prompted to subscribe to the program. The surveys also reveal that the major reasons for not subscribing to the program are the high initial costs and infrequent use or underutilization of the expressway.

Furthermore, approximately two-thirds or 66% of the 698 respondents agree (or strongly agree) that the ETC has improved the operations of the expressway. This includes even those who are currently non-ETC subscribers. Among the improvement measures that the respondents perceive to be necessary for the expressway, widening the right-of-way is considered to be the most needed. This is followed by pavement improvement and strict traffic enforcement.

The study performs logit modeling to identify the factors that are significant in explaining the probability of ETC subscription. The most significant variables have been found to include frequency of expressway use, toll amount, ETC perception, and income (purchasing power).

The currently available data obtained from the surveys are bereft of hypothetical and stated preference information that may indicate people's reaction to certain policy changes such as ETC price, toll discounts, etc.. Such information can help in developing models that are powerful in showing the effect of policy variables on the acceptability of the ETC. This is considered as a future task for this research.

The study also shows a framework that illustrates the emission benefits of the ETC. Reduction in emission is expected to result from lower accelerations, shorter (or absent) queuing, and shorter (or absent) idling that may be brought about by an ETC system. The hypothetical approach should be subject to validation through empirical observation, a future task that is set for this research.

Finally, the study presents an initial modeling framework that integrates the ETC Acceptability model and an Emissions model. An ETC acceptability model shows the effect of the independent variables (trip attributes, traveler characteristics, and ETC perception) on the probability of ETC subscription and may be used to predict the number of probable ETC subscribers given certain conditions. By knowing the volume of ETC and non-ETC vehicles, resulting speeds and accelerations of the vehicles can be estimated by queue analysis. Consequently, emission levels can be estimated using the resulting speed and acceleration values. An integrated model like this can demonstrate the effect of policies on ETC pricing and other possible incentives on consequent emission levels that may result from such policies.

The study recommends the review of pricing of the E-pass subscription. A check with the expressway authorities revealed that there is a lack of in-depth market study prior to the implementation of the ETC program. With the clear findings of the survey regarding people's perception on the cost of ETC, it is suggested that the pricing scheme be revisited to determine the optimum pricing that would maximize ETC subscription and at the same time give a reasonable rate of return to the expressway operator.

It is also suggested that information on the benefits of ETC to expressway users be aggressively and creatively disseminated. After all, the best way to market a product (like the ETC) is to market its benefits.

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