On the Possibility of Using a One-Man-Drive Vehicle: Toward a New Kind of Public Transportation*

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[Abstract]: Based on responses to questionnaires, this study investigates the possibility of using one-man-drive electric vehicles. Our survey results show that while most of those questioned were unfamiliar with the concept of the one-man-drive vehicle, 30% of respondents to whom its use was explained wanted to use it, for a sample average usage range of travel time of about 22 minutes. About 30% of respondents expected the introduction of the new vehicle to improve their opportunities to take trips for daily activities and other purposes. It was determined that the price for one-time use would be about 190 yen, almost the same as for route bus service. While elderly people and housewives would seem to be logical targets as potential users of the new vehicle system, survey results show a lack of willingness among these groups to use the one-man-drive vehicle.

[Key Words]: electric vehicle, personal vehicle, environment, new transportation mode

1 Introduction

As worries increase about global warming, no one doubts the importance of creating and maintaining a good environment. When we analyzed the social costs of cities by using a data set of 111 Japanese cities in 2005, we found the following major results (for details, see Mizutani, Suzuki and Sakai (2009)). First, the social costs of car transportation increase at an accelerated pace as city size becomes larger. Second, the construction of roads does not work to decrease the social costs of car transportation, but public transportation has a tendency, though negligible, to decrease the social costs of car transportation. Third, the largest component of the social costs of car transportation is traffic congestion, accounting for more than 50% of total social costs. Social costs due to global warming are around 5 to 10% of total social costs. Fourth, the magnitude of the social costs of car transportation is about 8.2% of

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Part of this study has been jointly carried out by Kobe University and Toyota Motors. We would like to thank the following people for valuable comments and questions: Yasuo Asakura (Kobe University), Takuya Matsumoto (Kobe University), Kenji Mori (Toyota Motors), Makoto Morita (Toyota Motors), Tetsuo Nakai (Kobe University), Hisashi Tamaki (Kobe University), and Satoru Yamamoto (Toyota Motors).

GDP. The fuel tax for car transportation in Japan covers only 15.9% of the social costs of regular car use.

Many studies suggest new policies regarding the use of new types of vehicles or new sources of energy. For example, Romm (2006) analyzes cars and fuels of the future based on a review of technological literature and on discussions with experts in the field of vehicle technology and energy analysis. Lave and MacLean (2002) explore the possibilities of the hybrid electric vehicle.

The control of car transportation is an important issue, with two main options available, the first being the imposition of fuel and environmental taxes, the second being the provision of better public transportation. In fact, the Japanese government, as Åhman (2006) states in his summary of government policy on electric vehicles, has instituted policies to encourage the development of electric vehicles. The present study explores a third option, which would be to introduce a new kind of transportation. One problem with public transportation is that, compared to private car transportation, it is inconvenient to users. To address this problem, carmakers have quite recently developed a new kind of vehicle. Toyota Motors, for example, is working on a one-man-drive electricity vehicle called the I-Real, which has the following characteristics: 1) it is easy to drive (elderly people can easily drive it), 2) it has two drive modes (a walking and a faster speed mode), 3) it emits almost no CO_2 (because it is an electric vehicle), and 4) it is relatively inexpensive. Although it is still in the development process, it is possible that this one-man-drive vehicle will provide the transportation of the future. It is the purpose of our study to investigate the possibility of introducing this kind of vehicle, by comparing it with public transportation (i.e. bus transportation).

In this study, we conduct a questionnaire survey of several groups of people and analyze the results. The main points the analysis seeks to clarify are as follows. First, will there be people willing to use the new type of electric vehicle in the future? If so, how often will people want to use it? If not, what are the main obstacles to its use? Third, how much are people willing to pay to use it? If they purchase the vehicle, how much money are people willing to pay? Fourth, what kinds of people are willing to use the new vehicle? Will elderly people find it attractive? We analyze the results of questionnaire surveys and obtain information on the possibility of introducing this new type of electric vehicle in the future.

2 Characteristics of the One-Man-Drive Electric Vehicle

Through the use of questionnaires, we investigate in this study the possibility of using the one-man-drive electric vehicle. Because it has not yet been used in Japan and the questionnaires are delivered to individuals, each questionnaire must define the on-man-drive vehicle and clarify its use. We take as a concrete example of a one-man-drive vehicle Toyota's

personal vehicle (PV), which the company calls I-REAL, but which, for the purposes of impartiality by questionnaire respondents, we refer to generically on the questionnaire as "the one-man-drive electric vehicle," or simply "the new vehicle."

We summarize the main characteristics of the one-man-drive electric vehicle as follows:

(1) Its compact, one-man size,
(2) Its lack of necessity for a driver's license,
(3) Its use being permitted on both sidewalks and a roads
(4) Its two speed modes: walking level and automobile level
(5) Its low level of carbon and noise pollution
(6) Its main use being intracity

First, the car is very small, slightly larger than an electric wheelchair. Because it is small, it occupies less space on the road, making it necessary to construct fewer roads and thus saving society money in public investment.

Second, use of the new vehicle does not require a driver's license. We make this clear on the individual questionnaires, explaining that operating the new vehicle is akin to operating a bicycle or an electric wheelchair, neither of which require licenses. Before introducing the new vehicles to real public roads, regulations will have to be worked out with regulators.

Third and fourth, the new vehicle is allowed on both sidewalks and roads, and will consequently be operable at both pedestrian and motor vehicle speeds. This characteristic will facilitate door-to-door services, in contrast to what is possible on currently available public transportation, such as buses and trains.

Fifth, being electric, the new vehicle can help improve the environment. Because oils are used to make electricity in power plants, the new vehicle is not completely free of CO_2 emissions or other air pollutants, but the new vehicle's environmental damage will be much smaller than that resulting from the use of conventional automobiles. Furthermore, the new vehicle generates almost no noise. But because a too-quiet vehicle can be dangerous to pedestrians who do not hear it coming, vehicle makers have furnished it with artificial noise, which is still much quieter than noise produced by conventional cars, buses, and trains.

Last, the new vehicle is used mainly inside the city and is not designed for intercity transportation.

Its many characteristics qualify the new vehicle to substitute for a wide range of existing transportation modes, as Figure 1 shows. It can be a walking assistant, used the way a bicycle is used for shopping at stores close to home, or it can transport workers on their daily

commutes into the city center.

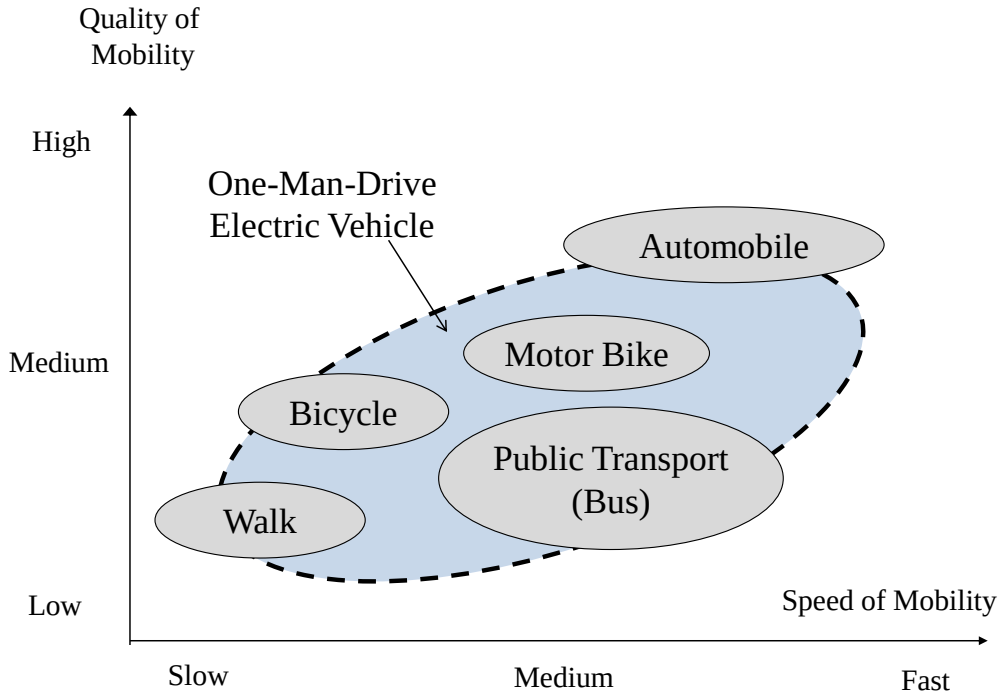

Figure 1 Potential Range for Use of One-Man-Drive Electric Vehicle

3 Potential Reduction of the Social Cost of Autos by the Use of One-Man-Drive Electric Vehicles

3.1 Summary of Estimation

The main purpose of this section is to determine the degree of potential social cost reduction due to the adoption of the one-man-drive electric vehicle, and to identify which social costs (e.g. air pollution, accidents, etc.) are most reduced. However, as mentioned above, the one-man-drive electric vehicle has yet to be used on regular roads. Therefore, we set assumptions in order to estimate the potential social cost reductions in a whole city.

The estimation equations for the social costs of automobiles are based on Mizutani et al. (2009). Setting assumptions, we modify these equations in order to estimate the potential reduction of the social cost of automobiles partially replaced by the use of one-man-drive electric vehicles. In order to calculate the potential reduction of social costs, we select 100 cities in Japan, considering both size distribution and regional variation of cities. For the estimation of social costs of automobiles, we consider vehicle types such as regular car, bus,

small truck, and truck. There are five kinds of social costs: traffic accidents, air pollution, noise, global warming, and traffic congestion. Although it is not possible to describe the details of estimation, we use empirical evidence such as actual traffic data (e.g. speed and traffic volume on roads).

3.2 Assumptions

We set up the following major assumptions for the estimation of social cost reduction.

(1) Of automobile users in a city, 20% are replaced by users of one-man-drive electric vehicles.
(2) Road vehicle capacity of the one-man-drive electric vehicles is twice as large for one-man-drive vehicles as for regular automobiles.
(3) The average number of passengers in a regular automobile is 1.3 persons.
(4) The speed of the one-man-drive electric vehicle on non-congested roads is 30km/h.
(5) Accidents: The rate of occurrence of traffic accidents is the same as that for motorbikes but the number of drivers killed or seriously injured would be reduced by half.
(6) Air Pollution: Although the one-man-drive electric vehicle does not itself pollute air, we take into account the air pollution created by the electricity producing power plant station.
(7) Noise: The one-man-drive electric vehicle produces no noise.
(8) Global Warming: We take into account the air pollution generated when the power plant station produces electricity.
(9) Congestion: We recalculate the amount of traffic volume by changing from regular cars to one-man-drive electric vehicles. In terms of size, we assume that one regular car equals two one-man-drive electric vehicles.

We would like to add to these assumptions. First, we assume that the rate of traffic accident occurrence for one-man-drive electric vehicles is the same as that for motorbikes. We consider this is a reasonable assumption because the new vehicle's mobility and size are similar to those of the motorbike. In contrast to the motorbike, however, the new vehicle has a body covering and is not as fast, reducing the likelihood of death or serious injury. As a result, the new vehicle's result for accident occurrence is a slightly worse than that of the regular automobile. Table 1 shows the accident rate for the calculation of the social costs of accidents.

As for air pollution, we consider the electricity produced for the new vehicles at the

power plant. In order to estimate the social costs of air pollution, we use research results by Ito (2002), on health damage from air pollution generated by electric power plants. Based on this research, the social costs of air pollution due to power plants is 0.32 yen/kwh. We assume that the new vehicle's electricity consumption is similar to an existing electric vehicle (Toyota COMS), which is 0.143kwh/km. With these assumptions, we find that the social costs of air pollution generated by the new vehicle are 0.045 yen/km.

Table 1 Accident Rate by Type of Damage

	One-man-drive electric vehicle	Regular automobile
Death	0.008	0.007
Seriously injured	0.101	0.076
Lightly injured	1.912	1.442
(Note): These numbers are values per 1 million vehicle-km.		

As for the social costs of global warming, a method is used which is similar to that used for air pollution. Based on Tokoro et al. (2004), we obtain the following result: the emission rate of CO_2 by the one-man-drive electric vehicle is 19.3 g/km.

It is worth noting the following point in the estimation of social costs of traffic congestion. The introduction of new vehicles could reduce traffic volumes of regular cars on regular roads. However, the mix traffic of both regular cars and new vehicles might cause congestion because of their differing speeds. We assume the average speed of new vehicles on regular roads to be 30km/h.

3.3 Estimation Results

Table 2 shows the estimation results of social cost reduction due to the introduction of a new type of car. Although these results are based on a hypothetical situation, the one-man-drive electric vehicle not having been used on regular roads, the overall effects are only limited.

First, in terms of air pollution, noise and global warming, the introduction of the new vehicles is clearly helping reduce social costs. Furthermore, while the magnitude of the reduction is not very large, the effects always hold in any size metropolitan area.

Second, as for congestion, the effects vary according to city size. In large cities (more than 1 million population), a reduction effect of about 10.6 billion yen in traffic congestion can be expected. However, in cities of medium or smaller size, congestion costs rather increase. This result is obtained mainly because of the decrease in speed brought about by mixed traffic in smaller cities.

Last, social costs due to traffic accidents increase in any size city after the introduction

of the new vehicle.

Table 2 Effect of Social Cost Reduction Due to the Introduction of a Car of New Type

City Size (population)	Case	Total	Accident	Air Pollution	Noise	Global Warming	Congestion
More than 1 million	Without	1,043.3 (100.0%)	97.7 (9.4%)	137.3 (13.2%)	19.8 (1.9%)	48.9 (4.7%)	739.7 (70.9%)
	With	1,032.6 (100.0%)	101.8 (9.9%)	136.7 (13.2%)	19.2 (1.9%)	45.7 (4.4%)	729.1 (70.6%)
	Effects	10.7	-4.1	0.5	0.6	3.2	10.6
More than 0.5 million	Without	240.4 (100.0%)	42.2 (17.6%)	42.2 (17.6%)	5.0 (2.1%)	17.9 (7.4%)	133.0 (55.3%)
	With	265.7 (100.0%)	43.7 (16.4%)	42.1 (15.9%)	4.9 (1.8%)	17.1 (6.4%)	158.0 (59.4%)
	Effects	-25.3	-1.5	0.1	0.1	0.8	-25.0
More than 0.3 million	Without	137.0 (100.0%)	24.0 (17.5%)	22.9 (16.7%)	2.8 (2.0%)	10.9 (8.0%)	76.4 (55.8%)
	With	163.5 (100.0%)	24.7 (15.1%)	22.9 (14.0%)	2.7 (1.6%)	10.5 (6.4%)	102.7 (62.8%)
	Effects	-26.5	-0.7	0.0	0.1	0.4	-26.3
Less than 0.3 million	Without	64.8 (100.0%)	11.5 (17.7%)	11.0 (17.0%)	1.3 (2.0%)	6.4 (10.0%)	34.6 (53.3%)
	With	88.5 (100.0%)	11.8 (13.3%)	11.0 (12.4%)	1.3 (1.4%)	6.3 (7.1%)	58.2 (65.7%)
	Effects	-23.8	-0.3	0.0	0.0	0.1	-23.6

(Note):
(1) Unit: billion yen
(2) These numbers are mean values in each category of city size. Total sample size is 100 cities in Japan.

4 Analysis of Possibility of Use of One-Man-Drive Electric Vehicle

4.1 A Survey by Questionnaire

The one-man-drive electric vehicle has not yet been used in the market. The main purpose of this section is to clarify what kind of people are willing to become users of this kind of new vehicle, and when they might use it. And if this new type of vehicle turns out to be unpopular, we try to identify obstacles to its wide use.

In order to clarify our purpose, we conduct a survey by questionnaire. However, because the vehicle has not yet been used in the market, simple questionnaires to isolated individuals are inappropriate. We need to familiarize respondents with the one-man-drive electric vehicle. To do so, we use the following procedure.

First, we explain the main characteristics of the one-man-drive electric vehicle including the method of driving, the performance of the vehicle (e.g. speed, capacity, etc.), and the safety level. Second, we show a short movie or the one-man-drive electric vehicle, a

three-minute video taken at a motor show, in order to present a more vivid image of the vehicle. After the video presentation, we have examinees answer the questionnaires. The total time it takes to answer our questionnaire is about 25 minutes, as we explain the main characteristics of the vehicle.

Surveys by questionnaire have been conducted a total of 15 times from April 24, 2009, to January 18, 2010. Diversified examinees consist of college students, business people, government officials, housewives, elderly people, etc. Table 3 summarizes a sample collected in these surveys. Total sample size collected in these surveys is 467. Of people surveyed, males account for about 60%. Potential targets for the use of the new vehicle are the elderly and housewives. The new vehicle would be more convenient for handicapped people than current transportation modes. We include a sufficient number of observations from these groups for the surveys by questionnaire.

Table 3 Summary of Collected Samples

Item	Category	Number of Person	Percentage
Sex	Male	275	58.9 %
	Female	192	41.1 %
	Total	467	100.0 %
Age	10 ~	40	8.6 %
	20 ~	140	30.0 %
	30 ~	100	21.5 %
	40 ~	79	17.0 %
	50 ~	32	6.9 %
	60 ~	42	9.0 %
	70 ~	33	7.1 %
	Total	466	100.0 %
Occupation	Employee	151	32.3 %
	Self-employee	1	0.2 %
	Part-time employee	7	1.5 %
	Student	174	37.2 %
	Housewife	99	21.2 %
	No job	30	6.4 %
	Others	5	1.1 %
	Total	467	100.0 %
Driver's License	Hold	351	75.5 %
	Not hold	114	24.5 %
	Total	465	100.0 %
Available Car	0 vehicle	190	41.9 %
	1 vehicle	235	51.8 %
	2 vehicles	25	5.5 %
	More than 3 vehicles	4	0.9 %
	Total	454	100.0 %

We cannot provide details of question items on questionnaires because of space limitations on the questionnaire sheets. The question items consist of three parts:

1) Individual attributes: sex, age, occupation, holding a driver's license or not, transportation means, number of automobiles, etc.
2) Current transportation situation: major transportation mode, frequency of going-out, changes in frequency of going-out in future, satisfaction with public transportation mode etc.
3) Possibility of using the new vehicle[1]: recognition, feelings about use, travel time range for use, potential contribution to the satisfaction of one's daily life, price for use and purchase, etc.

4.2 Current Transportation Situation

In this section, we summarize the current transportation situation based on the results of our survey. The major transportation modes are shown in Table 4, according to our observations.

Table 4 Major Transportation Mode

Transportation Mode	Numbers of Person	Percentage
Walk	311	23.3%
Bicycle	230	17.3%
Automobile (Driving)	190	14.3%
Automobile(Passenger)	61	4.6%
Motor-bicycle	67	5.0%
Taxi	50	3.8%
Bus	147	11.0%
Railway	268	20.1%
Others	9	0.7%

(Note):
(1) These numbers represent the number of persons choosing the transportation mode.
(2) Multiple choices are allowed.
(3) Total numbers selecting transportation modes are 1,333.

The current transportation situation is summarized in Table 5. In this study, we classify four kinds of trip purpose based on Mizuno et al. (2006) and Terada (2007), as follows:

Commuting Trip: Commuting transportation to offices or schools

Business Trip: Business transportation such as for delivery of goods or visiting customers' offices

Daily Activity Trip: Transportation for daily shopping, etc.

[1] In this study, as we mentioned earlier, the I-REAL of Toyota Motors is an example of the one-man-drive electric vehicle. The questionnaires are designed as questions for the I-REAL personal mobile. In this study, we also consider the new vehicle as possibly being "public transportation." Strictly speaking, it is important to define how the vehicle is to be used, because people's attitude to the vehicle changes, as Newman et al. (2004) show. Implicitly, we assume that the new vehicle would be used as a personal vehicle.

Free Trip: Recreation, learning activity, social activity, leisure, going to hospital, etc.

In this study, we ask each person about all four kinds of trip purposes, having each select one choice among 5 categories (almost every day, 3 ~ 4 times a week, 1 ~ 2 times a week, 1 ~ 2 times a month, zero) for each kind of trip.

Furthermore, we ask people how often they have been giving up the idea of going out because of the inconvenience of their current transportation mode. The purpose of this question is to evaluate how many people might be helped if a new vehicle were introduced. Each person selects one choice among 5 (often, once every two times, sometimes, rarely, never) in this question for each trip purpose. From this table, compared with commuting or business trip, many people have experiences of giving up going-out in the cases of daily activity and free trips.

Table 5 Current Frequency of Going Out by Trip Purpose

Item	Category	Trip Purpose			
		Commuting	Business	Daily Activity	Free
Frequency of Going-out	Almost everyday	72.0%	14.1%	17.0%	5.0%
	3 ~ 4 times a week	13.8%	17.5%	21.1%	13.9%
	1 ~ 2 times a week	3.3%	23.1%	47.5%	53.0%
	1 ~ 2 times a month	1.0%	10.9%	12.3%	25.5%
	Zero	10.0%	34.5%	2.0%	2.7%
	Total	100.0% (421 obs.)	100.0% (412 obs.)	100.0% (446 obs.)	100.0% (440 obs.)
Quit Going-out Because of Inconvenience of Current Transportation Mode	Often	0.5%	1.5%	1.9%	2.6%
	Once every two times	3.7%	2.5%	5.8%	7.0%
	Sometimes	18.8%	11.3%	35.3%	35.6%
	Rare	45.2%	40.5%	37.1%	35.6%
	Never	31.9%	44.2%	19.9%	19.2%
	Total	100.0 % (405 obs.)	100.0 % (398 obs.)	100.0 % (428 obs.)	100.0 % (427 obs.)

(Note):
The "obs." means observations.

4.3 Possible Use of One-Man-Drive Electric Vehicle

In this section, we will clarify the possibilities of use of the one-man-drive electric vehicle, for which Table 6 shows a summary of answers regarding this question. As the table shows, the new vehicle is not well known, although it was used in the Aichi Expo 2005 and is used at Chubu

International Airport. Only 7 % of total observations indicated knowledge of the new vehicle.

Despite their unawareness of the new vehicle, about 30% of respondents reported a desire to use it, for a usage range travel time of about 22 minutes as the sample average. And for daily activity and free trips, about 30% of respondents believed the introduction of the new vehicle would improve opportunities to go out. These results show that the new vehicle has potential usefulness for short distance trips for daily activities such as shopping. The price for one-time use would be about 190 yen, the same cost as for route bus service, making use of the new vehicle an attractive choice.

Table 6 Summary of the Possibility of Using the New Vehicle

Item		Category	Value
Are you aware of it?		Am aware	7%
		Have heard of it	19%
		Have never heard of it	84%
Do you want to use it?		Want to use it	29%
		Won't use it	19%
		Don't know	52%
How long willing to use it when you go out ?		Average travel time	22.4 minutes
Will your frequency of going-out increase?	Commuting	Increase	13.8 %
		Not change	85.8 %
		Decrease	0.5 %
	Business	Increase	14.5 %
		Not change	84.8 %
		Decrease	0.7 %
	Daily Activity	Increase	39.4 %
		Not change	59.5 %
		Decrease	1.1 %
	Free	Increase	37.8 %
		Not change	61.5 %
		Decrease	0.7 %
Will your life be enriched when you use it?		Improve	34.3 %
		Not change	63.6 %
		Decline	2.0 %
How much willing to pay?		For one time use	190.5 yen
		For one day rental	4,654 yen
		For purchase	280,052 yen

4.4 Who Will Use the New Vehicles?

In this section, we investigate potential users for the new vehicle, mainly to clarify whether some group would be likely users, such as elderly people and housewives with small children.

Existent transportation modes for elderly people and housewives with small children are not convenient. Private automobiles are inconvenient for elderly people because driving in crowded large cities has become dangerous and tiring for them. For wives with small children, private automobiles are bulky and difficult to find parking space for when they do daily shopping and drop their children off at kindergarten. Public transportation is inconvenient if they are, for example, required to change buses many times. It would seem that these two groups—the elderly and housewives—would be potential users for the new vehicles.

With these ideas in mind, we selected four kinds of groups: the elderly, housewives, business people, and students. We define elderly people as those over 60. Housewives are people who select "housewife" to identify their occupation. Business people are defined as people who have been employed. A person who is self-employed is included in this category. Tables 7 to 10 show the results.

As Table 7 shows, first, both elderly people and housewives have no special interest in using the new vehicle. The percentage of people in these groups who indicate a desire to use the new vehicle is almost the same as for other groups.

Second, elderly people are aware of the existence of the new vehicle, while housewives are unaware of it.

Table 7 Degree of Recognition and Willingness to Use the New Vehicle by Type of Group

Item	Category	All Sample	Elderly	Housewife	Business Person	Student
Degree of Recognition	Have known	7.3 %	11.3 %	3.1 %	11.9 %	5.2 %
	Have heard	18.6 %	22.5 %	19.4 %	25.8 %	12.6 %
	Have never known	74.1 %	66.2 %	77.6 %	62.3 %	82.2 %
	Total	100.0 % (463 obs.)	100.0 % (71 obs.)	100.0 % (98 obs.)	100.0 % (151 obs.)	100.0% (174 obs.)
Willingness to Use	Want to use	29.2 %	24.6 %	24.0 %	24.6 %	24.9 %
	Won't use	18.9 %	17.4 %	14.6 %	17.4 %	22.0 %
	Don't know	52.0 %	58.0 %	61.5 %	58.0 %	53.2 %
	Total	100.0 % (456 obs.)	100.0 % (69 obs.)	100.0 % (96 obs.)	100.0 % (69 obs.)	100.0 % (173 obs.)
(Note): The "obs." means observations.						

Table 8 shows the possibility of an increase in frequency of going-out by the introduction of the new vehicle. This table shows that elderly people would increase the frequency of going-out. Especially, for daily activity trips and free trips, almost half of elderly people indicate that the new

vehicle would increase the frequency of their going-out.

Compared with elderly people, housewives do not have such a positive impression of the new vehicle. In any category of trip purpose except commuting, housewives show the lowest values for the possibility of using the new vehicle.

Table 8 Frequency of Going-Out by Introduction of a New Vehicle by Type of Group

Item	Category	All Sample	Elderly	Housewife	Business Person	Student
Commuting	Increase	13.7 %	14.9 %	16.7 %	8.1 %	17.8 %
	Not change	85.8 %	83.0 %	83.3 %	91.9 %	81.6 %
	Decrease	0.5 %	2.1 %	0.0 %	0.0 %	0.6 %
	Total	100.0 % (429 obs.)	100.0 % (47obs.)	100.0 % (78 obs.)	100.0 % (148 obs.)	100.0 % (174 obs.)
Business	Increase	14.5 %	16.7 %	15.5 %	11.3 %	17.8 %
	Not change	84.8 %	81.0 %	83.1 %	92.9 %	81.6 %
	Decrease	0.7 %	2.4 %	1.4 %	0.0 %	0.6 %
	Total	100.0 % (420 obs.)	100.0 % (42 obs.)	100.0 % (71 obs.)	100.0 % (141 obs.)	100.0 % (174 obs.)
Daily Activity	Increase	39.4 %	46.6 %	33.7 %	36.4 %	48.3 %
	Not change	59.5 %	48.3 %	65.2 %	69.3 %	51.1 %
	Decrease	1.1 %	5.2 %	1.1 %	0.0 %	0.6 %
	Total	100.0 % (444 obs.)	100.0 % (58 obs.)	100.0 % (89 obs.)	100.0 % (140 obs.)	100.0 % (174 obs.)
Free	Increase	37.8 %	48.2 %	31.4 %	33.8 %	48.3 %
	Not change	61.5 %	50.0 %	67.4 %	66.2 %	51.1 %
	Decrease	0.7 %	1.8 %	1.2 %	0.0 %	0.6 %
	Total	100.0 % (442 obs.)	100.0 % (56 obs.)	100.0 % (86 obs.)	100.0 % (148 obs.)	100.0 % (174 obs.)

(Note):
(1) The “obs.” means observations.

According to Table 9, the elderly people feel that the introduction of the new vehicles would improve their quality of life. Their travel range is most likely 30 minutes. Possibly considering their current transportation mode, the route bus system, as inconvenient, the elderly seem to consider the new vehicles a feasible mode of transportation.

Compared with other groups, housewives feel that the new vehicle would not improve their daily life activities, and results show that they are unlikely to consider it as a new means of transportation.

Table 9 Enrichment and Possible Range of Use of the New Vehicle by Type of Group

Item	Category	All Samples	Elderly	Housewife	Business Person	Student
Enrichment of daily life	Increase	34.3 %	44.4 %	33.3 %	33.3 %	35.1 %
	Not change	63.6 %	53.7 %	65.5 %	63.3 %	63.8 %
	Decrease	2.0 %	1.9 %	1.3 %	3.4 %	1.1 %
	Total	100.0 % (440 obs.)	100.0 % (54 obs.)	100.0 % (87 obs.)	100.0 % (147 obs.)	100.0 % (174 obs.)
Travel time when one uses the new vehicle	10 minutes	26.7 %	11.8 %	20.2 %	29.0 %	28.2 %
	20 minutes	36.0 %	25.5 %	36.9 %	33.1 %	39.7 %
	30 minutes	30.9 %	45.1 %	34.5 %	31.7 %	27.0 %
	40 minutes	2.6 %	5.9 %	4.8 %	0.7 %	1.7 %
	50 minutes	0.2 %	2.0 %	1.2 %	0.0 %	0.0 %
	60 minutes	3.5 %	9.8 %	2.4 %	5.5 %	1.7 %
	Total	100.0 % (430 obs.)	100.0 % (51 obs.)	100.0 % (84 obs.)	100.0 % (145 obs.)	100.0 % (174 obs.)
	Average time	22.4 minutes	29.0 minutes	23.7 minutes	22.6 minutes	20.6 minutes

(Note):
The “obs.” means observations.

Table 10 shows people’s willingness to pay for the use or purchase of a new vehicle. This table shows that the housewife group values the new vehicle the least in almost any category. For example, the one day rental is 4,304 yen and the purchasing price is 136,353 yen. The housewives show no interest in making use of the new vehicle for a long time by purchasing and holding it. They seem to prefer to use it when needed, if the use of it is cheap enough.

As for elderly people, they do not set the purchase price as highly as the housewives do. However, they are willing to pay more than housewives or students for one-time use of the new vehicle.

Finally, we clarify the relationship between willingness to use the new vehicle and dissatisfaction with current transportation modes. Table 11 summarizes the results. This table shows that, overall, people who feel dissatisfaction with the current transportation mode are largely unlikely to change to the new vehicle. However, for daily activity trips and free trips, people who feel dissatisfaction with the current transportation mode show a tendency to want to use the new vehicle.

In free answers in this survey, important points regarding use of the new vehicle are summarized here. The most important point is safety, mentioned by 100 respondents. Other important points are convenience (61 people), function (i.e. easy to drive and equipment) (54 people), price and cost (48 people). These four points are the most important issues related to the use of the new vehicle.

Table 10 Willing to Pay for a New Vehicle by Type of Group

Item	Category	All Samples	Elderly	Housewife	Business Person	Student
How much willing to pay for one time use	0 yen	20.3 %	13.7 %	15.9 %	13.6 %	28.9 %
	100 yen	29.1 %	31.3 %	36.6 %	25.2 %	29.5 %
	200 yen	30.5 %	29.4 %	28.0 %	36.1 %	26.0 %
	500 yen	15.2 %	11.8 %	12.2 %	18.4 %	1.0 %
	1,000 yen	1.8 %	3.9 %	1.2 %	2.7 %	1.2 %
	Others	3.0 %	9.8 %	6.1 %	4.1 %	0.0 %
	Total	100.0 % (433 obs.)	100.0 % (51 obs.)	100.0 % (82 obs.)	100.0 % (147 obs.)	100.0 % (173 obs.)
	Average	190.5 yen	208.7 yen	176.6 yen	225.5 yen	167.3 yen
How much willing to pay for one day rental	4,000 yen	65.9 %	61.0 %	60.9 %	69.4 %	66.3 %
	7,000 yen	11.5 %	9.8 %	4.3 %	7.6 %	18.0 %
	9,000 yen	2.0 %	0.0 %	1.4 %	1.4 %	2.9 %
	15,000 yen	0.7 %	0.0 %	0.0 %	0.0 %	1.7 %
	Others	19.9 %	29.3 %	33.3 %	21.5 %	11.0 %
	Total	100.0 % (408 obs.)	100.0 % (41 obs.)	100.0 % (69 obs.)	100.0 % (144 obs.)	100.0 % (172 obs.)
	Average	4,654 yen	4,414 yen	4,304 yen	4,381 yen	4,987 yen
How much willing to pay for purchase	10,000 yen	8.4 %	10.3 %	10.5 %	6.7 %	8.1 %
	50,000 yen	18.4 %	13.8 %	23.3 %	16.8 %	20.8 %
	100,000 yen	34.6 %	37.9 %	38.4 %	41.6 %	31.8 %
	400,000 yen	12.1 %	12.1 %	9.3 %	17.4 %	10.4 %
	500,000 yen	7.8 %	5.2 %	7.0 %	8.7 %	8.1 %
	1,000,000 yen	5.4 %	1.7 %	1.2 %	4.0 %	11.0 %
	1,500,000 yen	1.9 %	0.0 %	0.0 %	0.7 %	4.6 %
	2,000,000 yen	0.9 %	0.0 %	0.0 %	0.7 %	1.7 %
	Others	10.6 %	19.0 %	10.5 %	3.4 %	3.5 %
	Total	100.0 % (433 obs.)	100.0 % (58 obs.)	100.0 % (86 obs.)	100.0 % (149 obs.)	100.0 % (173 obs.)
	Average	280,052 yen	169,362 yen	136,353 yen	235,764 yen	351,138 yen

(Note):
(1) Numbers in “Average” are calculated by exclusion of “Others.”
(2) The “obs.” means observations.

Table 11 Relationship Between Possibility To Use a New Vehicle and Dissatisfaction with Current Transportation Mode

Case 1: Commuter Trip		Quit Going-out Because of Inconvenience of Current Transportation Mode					
		Often	Once every two time	Sometimes	Rare	Never	Total
Do you want to use a new vehicle?	Want to use	0 (0.0 %)	1 (6.7 %)	23 (30.7 %)	57 (31.5 %)	43 (33.9 %)	124 (31.0 %)
	Won't use	0 (0.0 %)	3 (20.0 %)	6 (8.0 %)	39 (21.5 %)	27 (21.3 %)	75 (18.8 %)
	Don't know	2 (100.0 %)	11 (73.3 %)	46 (61.3 %)	85 (47.0 %)	57 (44.9 %)	201 (50.3 %)
	Total	2 (100.0 %)	15 (100.0 %)	75 (100.0 %)	181 (100.0 %)	127 (100.0 %)	400 (100.0 %)
Case 2: Business Trip		Quit Going-out Because of Inconvenience of Current Transportation Mode					
		Often	Once every two time	Sometimes	Rare	Never	Total
Do you want to use a new vehicle?	Want to use	1 (16.7 %)	2 (20.0 %)	18 (40.0 %)	45 (28.3 %)	55 (31.6 %)	121 (30.7 %)
	Won't use	1 (16.7 %)	2 (20.0 %)	3 (6.7 %)	30 (18.9 %)	38 (21.8 %)	74 (18.8 %)
	Don't know	4 (66.7 %)	6 (60.0 %)	24 (53.3 %)	84 (52.8 %)	81 (46.6 %)	199 (50.5 %)
	Total	6 (100.0 %)	10 (100.0 %)	45 (100.0 %)	159 (100.0 %)	174 (100.0 %)	394 (100.0 %)
Case 3: Daily Activity Trip		Quit Going-out Because of Inconvenience of Current Transportation Mode					
		Often	Once every two time	Sometimes	Rare	Never	Total
Do you want to use a new vehicle?	Want to use	2 (25.0 %)	10 (40.0 %)	49 (32.7 %)	45 (28.7 %)	22 (26.5 %)	128 (30.3 %)
	Won't use	1 (12.5 %)	1 (4.0 %)	25 (16.7 %)	26 (16.6 %)	24 (28.9 %)	77 (18.2 %)
	Don't know	5 (62.5 %)	14 (56.0 %)	76 (50.7 %)	86 (54.8 %)	37 (44.6 %)	218 (51.5 %)
	Total	8 (100.0 %)	25 (100.0 %)	150 (100.0 %)	157 (100.0 %)	83 (100.0 %)	423 (100.0 %)
Case 4: Free Trip		Quit Going-out Because of Inconvenience of Current Transportation Mode					
		Often	Once every two time	Sometimes	Rare	Never	Total
Do you want to use a new vehicle?	Want to use	3 (27.3 %)	10 (33.3 %)	45 (29.8 %)	48 (32.0 %)	22 (27.5 %)	128 (30.3 %)
	Won't use	3 (27.3 %)	3 (10.0 %)	25 (16.6 %)	23 (15.3 %)	23 (28.8 %)	77 (18.2 %)
	Don't know	5 (45.5 %)	17 (56.7 %)	81 (53.6 %)	79 (52.7 %)	35 (43.8 %)	217 (51.4 %)
	Total	11 (100.0 %)	30 (100.0 %)	151 (100.0 %)	150 (100.0 %)	80 (100.0 %)	422 (100.0 %)

5 Concluding Remarks

This study investigates the possibility of introducing a one-man-drive electric vehicle. While it is still too early to say that the new vehicle can be used, as there are many difficulties to be investigated and worked out. As Gjøen and Hård (2002) pointed out, new technology and

the political process are interrelated. However, we will obtain information on the possibility of introducing this new type of electric vehicle in the future.

First, as for the reduction of social costs—air pollution, noise and global warming—the introduction of the new vehicles clearly contributes to reduce social costs. However, the magnitude of the reduction is not large. In large cities (of more than 1 million in population), a reduction effect of about 10.6 billion yen in traffic congestion can be expected. However, in cities of medium or smaller size, congestion costs rather increase. This result is obtained because of the decrease in speed caused by mixed traffic in smaller cities. Therefore, while considering the introduction of on-man-drive vehicles, we must at the same time consider road policy (i.e. avoiding mixing regular cars with the new vehicles).

Second, as for the possibility of using new vehicles as we investigated through the use of questionnaires, among people unaware of the new vehicle, about 30% wanted to use it, with a usage range of travel time of about 22 minutes as the sample average. And for daily activity and free trips, about 30% of respondents indicated that the introduction of the new vehicle would improve their opportunities to go out. And at a one-time use price of about 190 yen, the cost of the one-man-drive vehicle would be about the same as for ride on the bus.

Third, we focus on elderly people and housewives as potential users of the new vehicle. However, the questionnaire results show that the percentage at which these two groups indicate they want to use the new vehicle is almost the same as for other groups.

Fourth, for elderly people, the introduction of the vehicle would increase the frequency of their going-out. Especially, in the category of daily activity trips and free trips, almost half of elderly people indicate that the new vehicle would increase the frequency of their going-out. However, the housewives do not have a positive impression of the new vehicle. In any category of trip purpose except commuting, housewives show the lowest values for the possibility of using the new vehicle.

Fifth, elderly people feel the introduction of the new vehicle would improve the quality of their life. Their most likely travel range would be about 30 minutes travel time. On the other hand, compared with other groups, the housewives feel that the new vehicle would not improve their daily life activities.

The housewife group values the new vehicle the least in almost any category. The housewives would not use the new vehicle for long time by owning it, but would prefer to use it when needed, if its use were cheap enough. On the other hand, elderly people, if they purchased the vehicle, would not value it as much as the housewives. However, when they use it once, they are willing to pay more for the new vehicle than the housewives or students are willing to pay.

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