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Abstract

CO2 emissions in the transport sector account for about 20% of total CO2 emissions in Japan; the proportion of CO2 emissions from private cars is especially large. To reduce the environmental load in the transport sector, it is necessary to encourage the transport users to shift to sustainable transport. In this study, we developed software for mobile phones to provide environmental information, and analyzed the importance of information services toward helping achieve of sustainable transport.

To provide information services efficiently, we conducted a Web-based questionnaire to examine how people usually use mobile devices to receive information and decide a transport route. The results suggested that providing the environmental information by using the transport route guidance system via mobile phones would be more effectively promote sustainable transport. In addition, we analyzed the importance of environmental information by conjoint analysis, and demonstrated the possibility of improving transport sustainability by providing environmental information to transport users, especially older females. We also developed software to enable mobile phones to provide environmental information, and conducted a demonstration experiment for actual transport users between a specific terminal station and an event hall in Tokyo. The results showed that transport routes were often selected by using the images of transportations, and that transport users tended to decide the transport route based on fare information. It was shown that the possibility of sustainable transport being selected based on environmental information was about 10%.

1. Introduction

CO2 emissions in Japan were 1,259 million-ton in 2003 as shown in Fig. 1 [1]. The transport sector accounted for about 20% of those total CO2 emissions, with the proportion of CO2 emissions from private cars being especially large. To promote sustainable transport and hence reduce the environmental load, it is necessary to replace the use of private cars with public transport such as buses and trains. However, public transport involves many problems such as inconvenience caused by a lack of transport information.

In this study, to encourage transport users to shift to sustainable transport, we investigated the following issues.

・To provide information services efficiently, selection of an information device and a method for providing environmental information (Web-based questionnaires) [2]

・Analysis of importance of providing environmental information to transport users (conjoint analysis from questionnaire answers at an event hall) [3]

・Demonstration experiment providing environmental information via mobile phones to transport users (between a terminal station and an event hall in Tokyo)

We developed software for mobile phones to provide environmental information, and analyzed the importance of information services toward achieving sustainable transport.

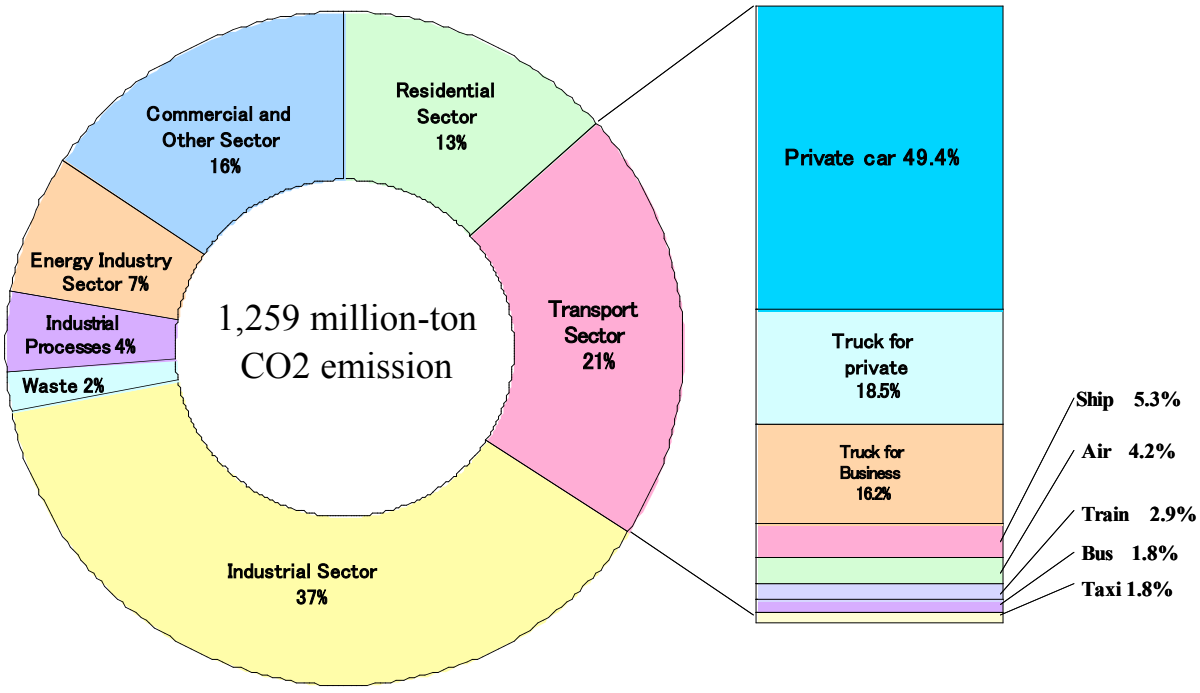

Fig. 1 CO2 emissions from each sector in 2003 and CO2 emissions from each type

of transport in the transport sector.

2. Selection of information devices and method of providing environmental information

To provide information services efficiently, it was necessary to select an information device and a method for providing environmental information, so we conducted a Web-based questionnaire to examine how people usually use mobile devices to receive information and decide a transport route. We received answers to the questionnaire from 1,089 respondents in three days.

The following answers were obtained regarding mobile devices used for receiving information; (1) Laptop computer, (2) PDA, (3) Mobile phone, (4) Do not have mobile devices. The respondents that used mobile phones were the largest, accounting for 74.4% of the total answers (see Fig. 2.).

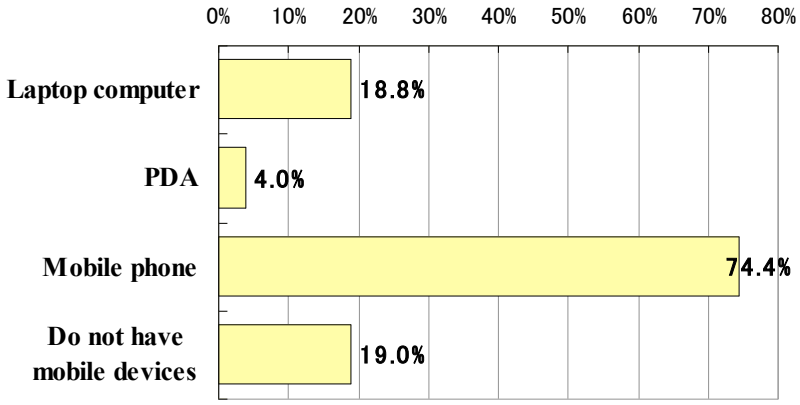

Fig. 2 Percentage of using mobile devices for receiving information.

In addition, the following answers were obtained regarding methods for deciding a transport route; (1) Route that is already known, (2) Route that uses commuter ticket, (3) Selection by using a pamphlet and guide map, (4) Confirmation by using telephone and fax, (5) Transport route guidance system (using software and Web site), (6) Advice from person who already knows a route, (7) Private car only, and others. As shown in Fig. 3, most respondents decided a transport route by using the transport route guidance system, accounting for 54.7% of the total answers.

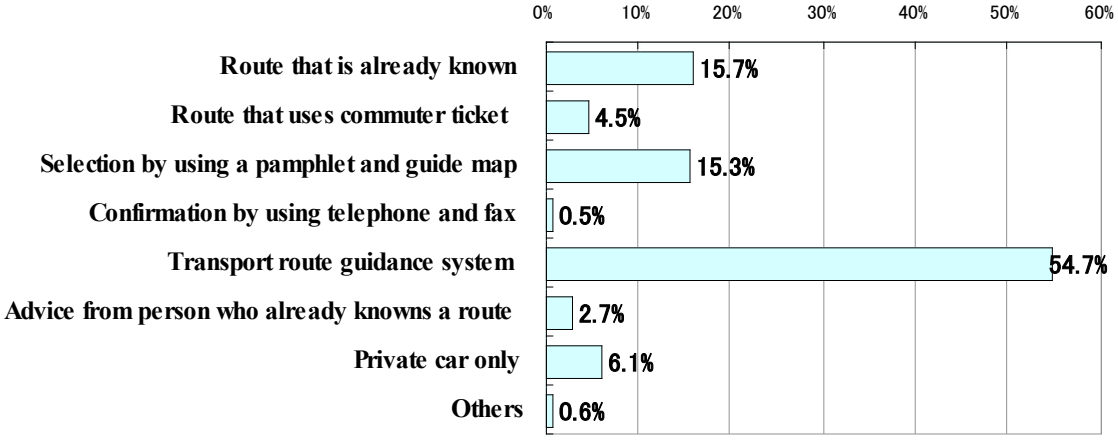

Fig. 3 Percentages of methods for deciding a transport route.

These results suggested that providing environmental information using a transport route guidance system via mobile phones would more effectively to promote sustainable transport.

3. Selection of place and data collection for demonstration experiment

We needed to select a place (transport routes) and collect related data in a demonstration experiment in which environmental information was provided by the transport route guidance system via mobile phones. The place for the demonstration experiment was selected with the following conditions; (1) Destination visited for leisure, because users were not expected to change the transport route to the route used commuting, and (2) A site that has more competing forms of transport, so that the influence of providing information related to different transport routes could be examined.

With these two conditions, we selected a place between a specific terminal station (Hamamatsucho station) and a certain event hall (Tokyo Big Sight) in Tokyo [4]. This place has six kinds of transport route; Route 1: Train A (JR line) → Train B (Rinkai line), Route 2: New transport system (Yurikamome line), Route 3: Monorail (Tokyo monorail) → Train B, Route 4: Marine transport system (Water bus), Route 5: City bus (Toei bus), and Route 6: Taxi. We researched the duration and fare for the six kinds routes, and calculated the CO2 emissions per passenger from data such as distance, fuel efficiency and occupancy related to the transport [5]. In this study, CO2 emissions per passenger in transport were selected as environmental information to be provided to transport users, because the environmental impact caused by CO2 emissions in the transport sector is especially important. The duration, fare, and amount of CO2 emissions of each transport route are shown in Table 1.

Table 1 Duration, fare, and CO2 emissions for six kinds of transport route.

		Duration (min)	Fare (Yen)	CO2 emission (g)
Route 1	Train A → Train B	34	470	245
Route 2	New transport system	35	370	262
Route 3	Monorail → Train B	28	450	181
Route 4	Marine transport system	37	400	383
Route 5	City bus	39	200	780
Route 6	Taxi	19	2,500	2,310

4. Analysis of importance of environmental information by conjoint analysis

To analyze the possibility of improving transport sustainability by providing environmental information to transport users, we clarified the importance of environmental information by conjoint analysis [6]. Conjoint analysis is a survey technology as well as an analytical method that projects consumer actions concerning a product's tangible specifications (e.g., price, functionality design, etc.) from the consumers' viewpoint by having them evaluate a specific product profile. We used the concept of conjoint analysis to analyze the importance of providing environmental information.

First, the conjoint analysis was conducted using questionnaires at an event hall, and the respondents were given transport information on the duration, fare, and amount of CO2 emissions for each transport route. The number of respondents and their ages are shown in Table 2. The attributes and levels using conjoint analysis in Table 3 were composed referring to the data of the six kinds of transport route shown in Table 1.

Table 2 Respondent's number and age.

Age	Male	Female
Twenties	61	55
Thirties	62	53
Forties	83	37
Fifties	83	20
Sixties	25	16
Total	495	

Table 3 Attributes and levels in conjoint analysis.

Attribute	Levels		
Duration	20 min	30 min	40 min
Fare	¥200	¥350	¥500
CO2 emission	400g	800g	–

We combined transport route data with 12 kinds of cards based on the design of the experiment method, and the respondents arranged 12 cards into a desirable transport route while referring to this information (shown in Fig. 4). The questionnaire answers were analyzed using conjoint analysis.

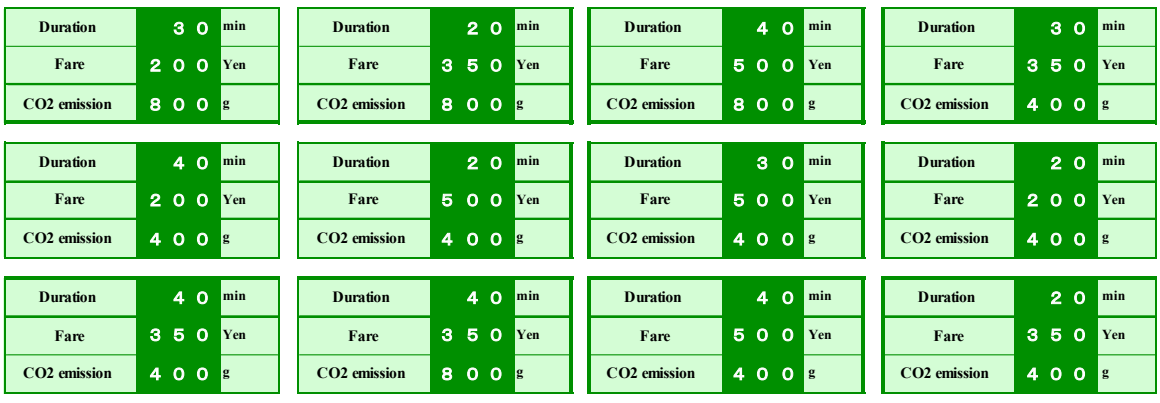

Fig. 4 12 kinds of cards used in conjoint analysis.

The results of the conjoint analysis are shown Table 4 and Fig. 5. Table 4 shows that the importance of the duration and fare in selecting the transport route was about 40%, and was larger than that of environmental information. Figure 5 shows that the importance of environmental information rose with older respondents. Moreover, it was suggested that females tended to select sustainable transport by using information services rather than males. The possibility of improving transport sustainability by providing environmental information to transport users was shown, especially among older females.

Table 4 Utility at each level and importance of each attribute.

Attribute	Level	Utility	Importance
Duration	20 min	1.45	41.0%
	30 min	0.14	
	40 min	-1.59	
Fare	¥200	1.54	40.3%
	¥350	0.11	
	¥500	-1.65	
CO2 emission	400g	0.52	18.7%
	800g	-0.52	

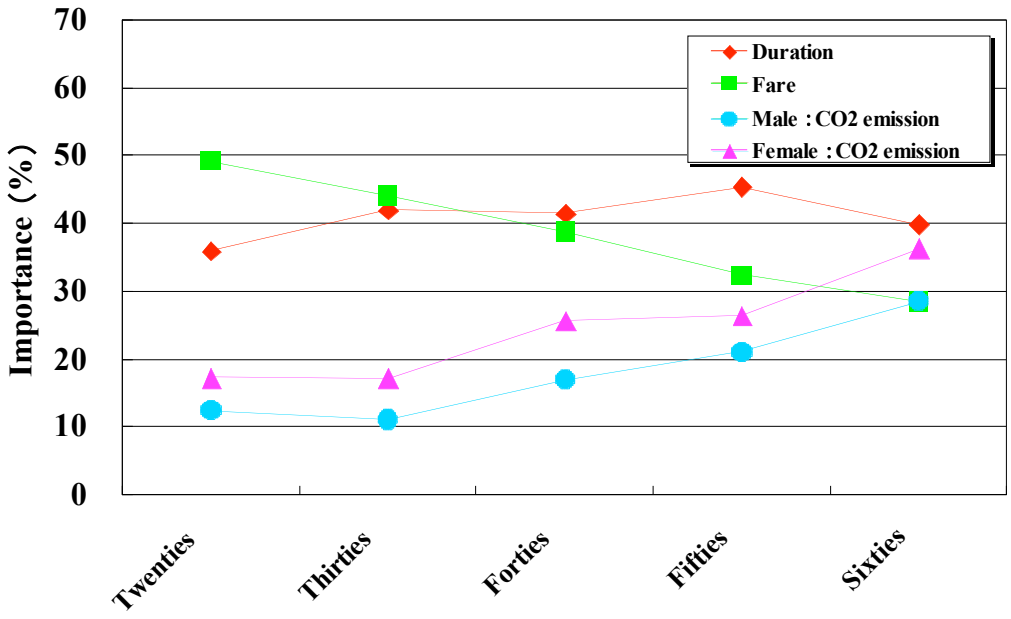

Fig. 5 Relationship between importance of transport information in selecting transport routes and respondent's age.

5. Development of software for providing environmental information

We developed software (the transport route guidance system) for mobile phones to provide environmental information, and used this system in the demonstration experiment between the terminal station and the event hall in Tokyo.

This software could provide information about the duration, fare and amount of CO2 emissions for the six kinds of transport route between the terminal station and the event hall. Figure 6 shows the display of the mobile phone for providing transport information. The transport user can search the duration, fare and amount of CO2 emissions for the six routes in real time after inputting the departure place and arrival place. The system can also display an illustration corresponding to the amount of CO2 emissions caused by transport routes, in the form of the earth becoming warmer as the amount of CO2 emissions increases (the earth's color changes from blue to red). We considered that transport users would visually understand the environmental information by using this software, despite the high importance of the duration and fare as shown by the conjoint analysis.

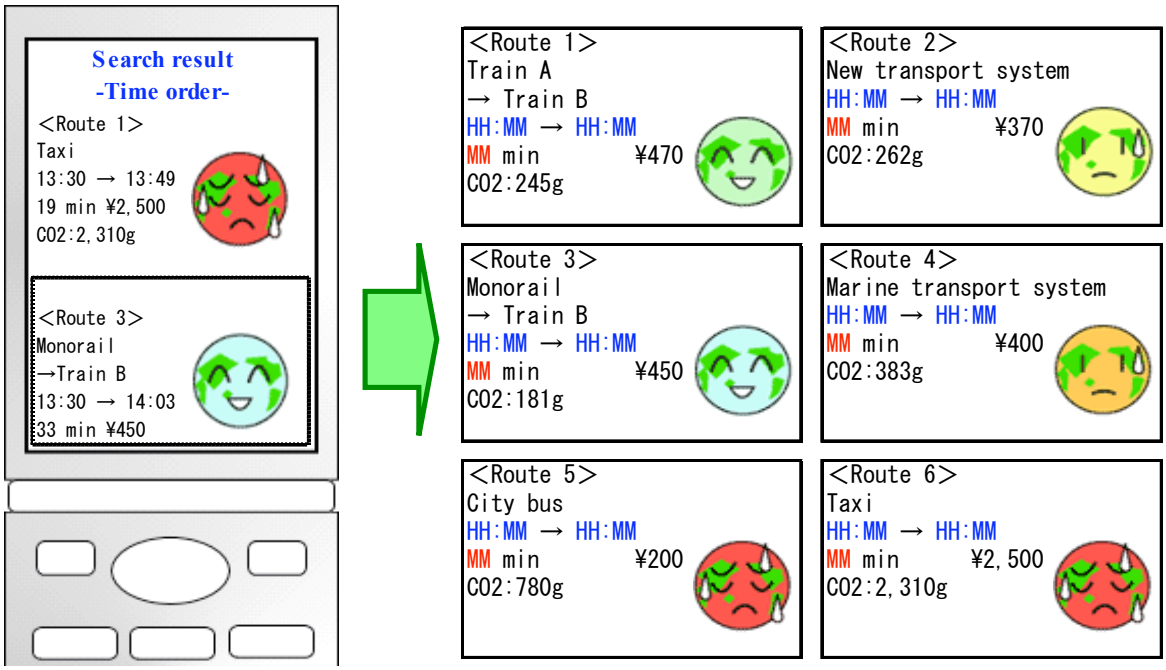

Fig. 6 Display images of mobile phone providing transport information.

6. Demonstration experiment for sustainable transport

We conducted a demonstration experiment in which we provide environmental information via mobile phones to actual transport users from the terminal station to the event hall in Tokyo. Transport users used our transport route guidance system

developed on their mobile phones, and selected a desirable transport route by referring to information provided via mobile phone. The procedure of the experiment was as follows;

(1) The respondents gathered in a conference room, and we explained how the transport route guidance system works.

(2) The respondents operated the transport route guidance system and decided a transport route between the terminal station and the event hall in Tokyo.

(3) The respondents actually traveled from the terminal station to the event hall based on the transport information provided by the system.

(4) After the respondents reached at the event hall, they answered a questionnaire about what information they had referred to and which route they would have selected without this system.

Figure 7 shows the ratio of each transport route selected by 60 respondents. It is clear that transport routes selected by transport users changed by providing information. The results shows that providing the transport information increased the ratio of selecting Route 5, because the fare of that route was the cheapest among the six routes. The percentage of selecting Route 3 with the lowest CO2 emissions was 8.3%. Further, the percentage of environmental information that the respondents referred to was 11.7%. The ratio of transport route selected based on an image of the transportation was large, and transport users tended to decide the transport route based on the fare provided as transport information. These results showed that the possibility of a sustainable transport route being selected based on environmental information was about 10%.

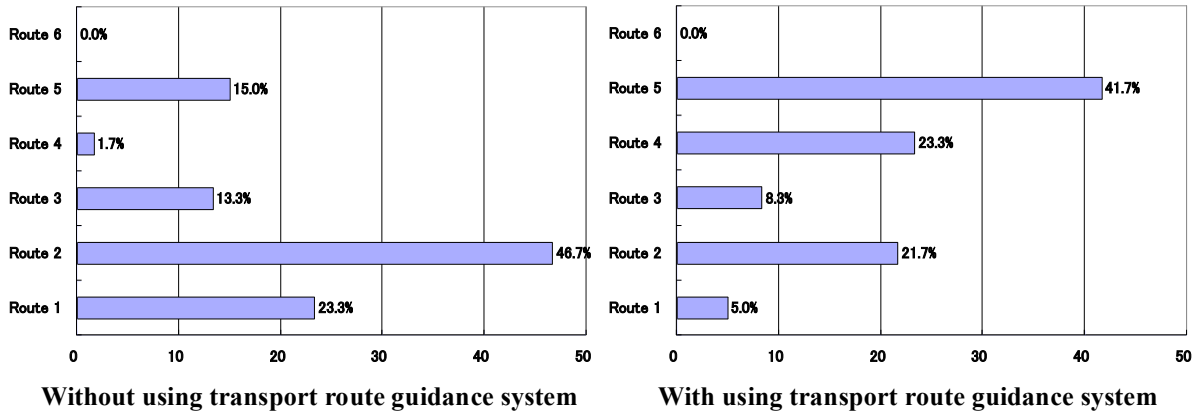

Fig. 7 Percentage of transport routes selected by the respondents.

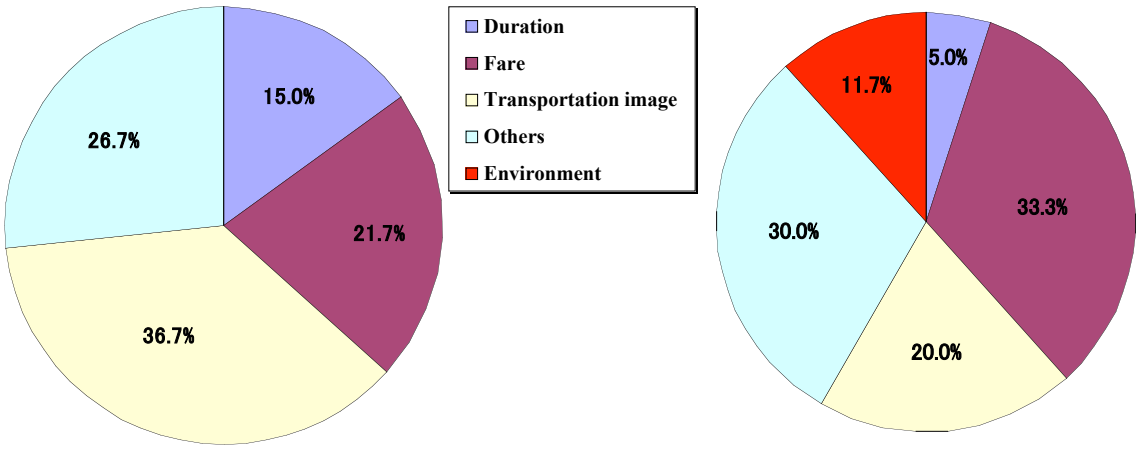

Fig. 8 Percentage of transport information that the respondents referred to.

7. Conclusions

In this study, we analyzed the importance of information services toward achieving sustainable transport, and obtained the following conclusions;

(1) Providing environmental information by using the transport route guidance system via mobile phones would more effectively promote sustainable transport.

(2) Conjoint analysis showed the possibility of improving transport sustainability by providing environmental information to transport users especially among older females.

(3) The ratio of transport route selected based on images of transportation usually was large, and transport users tended to decide the transport route based on the fare information.

(4) We conducted a demonstration experiment by using the transport route guidance system, and showed that the possibility of a sustainable transport being selected based on environmental information was about 10%.

Acknowledgement

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References

1) Ministry of the Environment (Japan), National Greenhouse Gas Inventory Report of

JAPAN, 2005.
2) K.Nakazawa, H.Ueda, T.Hashitani, Analysis of Consumer Behavior Caused by Providing Traffic Information (Ⅰ), Proceedings of The First Meeting of The Institute of Life Cycle Assessment, Japan, pp.150-151, 2005.
3) K.Nakazawa, H.Ueda, T.Hashitani, H.Tsurumi, M.Takaoka, Analysis of Consumer Behavior in Traffic Use Based on Questionnaire Survey, Proceedings of The Annual Meeting of The Society of Environmental Science, Japan, pp.110-111, 2006.
4) Tokyo Big Sight Access Map:http://www.bigsight.jp/english/access/index.html.
5) Ministry of Land, Infrastructure and Transport (Japan), White Paper on Land, Infrastructure and Transport in JAPAN, 2002.
6) Luce, R.D. and Tukey, J.W. Simultaneous Conjoint Measurement: A New Type of Fundamental Measurement, Journal of Mathematical Psychology, Vol.1, pp.1-27, 1964.