AN ANALYSIS ON ACCEPTABILITY OF AN INFORMATION PROVIDING SYSTEM FOR ROAD TRAFFIC TRAVEL TIME & ADVICE

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INTRODUCTION

By using historical data collected from probe vehicles in Toyota City, a travel time information providing system for road users has been developed (Ando and Mimura, 2010). On the other hand, many citizens have not made use of the regional ITS services supplied in Toyota (Ando, 2007). To make the travel time information providing system investment more effective, this study aims to discuss acceptability, usability, and effects before putting the system into practice by a questionnaire investigation and a monitor investigation. At first, the questionnaire investigation was implemented in 2008 to know whether similar systems had been applied by referring to a famous system in Japan (Central Nippon Expressway Company Limited) and an integrated information system in Toyota (Toyota City). Then, the monitor investigation was conducted in 2009 to know changes of the monitors' evaluation and to discuss potential directions for updating the system. This paper is to report results of the analysis in terms of both the questionnaire and monitor investigations. Finally, the conclusions summarize expectations of the users and issues to improve the system after confirming the acceptability and usability of the system.

A REVIEW OF PREVIOUS STUDIES

In Japan, a representative pioneer who developed the information search engine of travel route, travel distance, and travel time through a website should be the Japan Highway Public Corporation (JH). Since privatization, JH was regionally separated into three expressway companies: East Nippon Expressway Company Ltd. (E-NEXCO), Central Nippon Expressway Company Ltd. (C-NEXCO), and West Nippon Expressway Company Ltd. (W-NEXCO). The three new companies operate three information provision websites named by DoraPura provided by E-NEXCO, KouSokuBiyoRi provided by C-NEXCO, and RyoKin/KeiRo Search provided by W-NEXCO, respectively. One of features of these systems is that users can search for travel time information reflecting traffic congestion in the specified time zones in terms of historical data. However, according to our interview with C-NEXCO in January

2008, travel time they provide through the website is not based on historical data but just simply defining speed where traffic jam is forecasted, 30 km/h for 4-lane section and 20 km/h for 2-lane section, although the road sections where traffic jams occur and the queue lengths when traffic jams occur are forecasted on the basis of historical data in the past three years. The information of traffic accidents and intensive constructions are not included in the system.

Regarding the information contents, information not only for expressways but also for highways, urban streets, and rural roads has been provided by the Civil Engineering Research Institute for Cold Region. Furthermore, Toyota City, NAVITIME JAPAN Co., Ltd., and Google Map have included public transportation system information into their provision systems. Travel time on highways and roads provided in all these websites are based on average time from Road Timetable (Road Bureau, Ministry of Land, Infrastructure and Transport) and specified speeds in terms of number of lanes. However, the influence of traffic congestion is not considered in the systems. This may be acceptable in Hokkaido area because there is almost no traffic jam. It is, however, not satisfactory in urban areas where traffic congestion often occurs. Turning to information provision systems with consideration of the traffic congestion in terms of historical data, 46NAVI (Akita and Iwate Offices of River and National Highway) and Itsumo-NAVI (ZENRIN DataCom Co., Ltd.) can be listed here. A questionnaire of 46NAVI conducted in 2006 indicates that some users changed their departure time after they knew estimated travel time from the website, and they expected the system to be extended for other highways and roads, too. Comparing with these service websites, we added a new function to our system. The system provides information including not only travel time, fuel cost, and amount of CO_2 emission when departing at the specified time, but also the differences between the scheduled departure time and 30/60 minutes before/after. The purpose of this information is to promote people shifting travels to off-peak hours.

As the review summarized above, although many information systems have been applied in practice, there are few surveys to investigate user satisfaction and there are only a few people who try to identify real situation of making use of the systems. Therefore, this study is to investigate needs of the traffic time information providing system based on historical data and to discuss the directions for potential improvement. We have carried out two kinds of investigations. One investigation is the questionnaire for the residents in Toyota to know whether or not they are using these services. Another is the monitor investigation to find changes before and after experiencing the system.

DESCRIPTION OF THE DEVELOPED SYSTEM

The system that we have developed is divided into two parts. An input screen is shown in Figure 1. Users can choose two crossings from map or input directly as origin and destination. Then, the system allows users to choose the scheduled date and departure/arrival time from a calendar and a timetable.

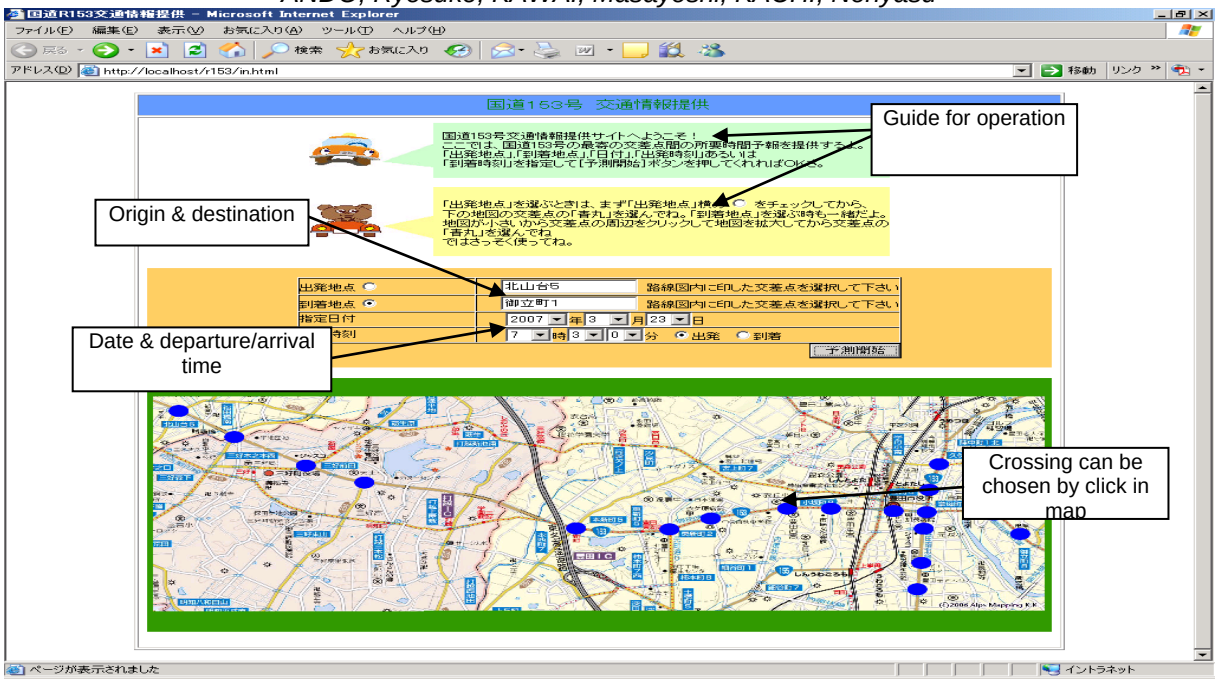


Figure 1 – Depiction of input screen

Figure 2 – Depiction of base item in output screen

To make the system for users to be intelligible and easily operated, the provided information is roughly divided into a "base item" and an "application item." The base item includes information which users want to know directly, such as travel time from the origin to the destination and travel speed of each highway section. Here, the travel speed is expressed by three colours as shown in Figure 2. Turning to the application item, we provide travel times and related information around the scheduled time inputted. The purpose is to advise users to choose a more favourable time zone to travel. The information during the time zones of

30/60 minutes before/after is provided as shown in Figure 3. Furthermore, here not only the travel times are provided, but also the differences between the advised time zone and the originally specified or appointed time zone. Moreover, an environmental indicator is proposed in the system. The indicator is expressed by a difference of the Japanese cypress conversion number from the discharge of CO_2 emissions (t/year) between the advised time zone and the originally appointed time zone.

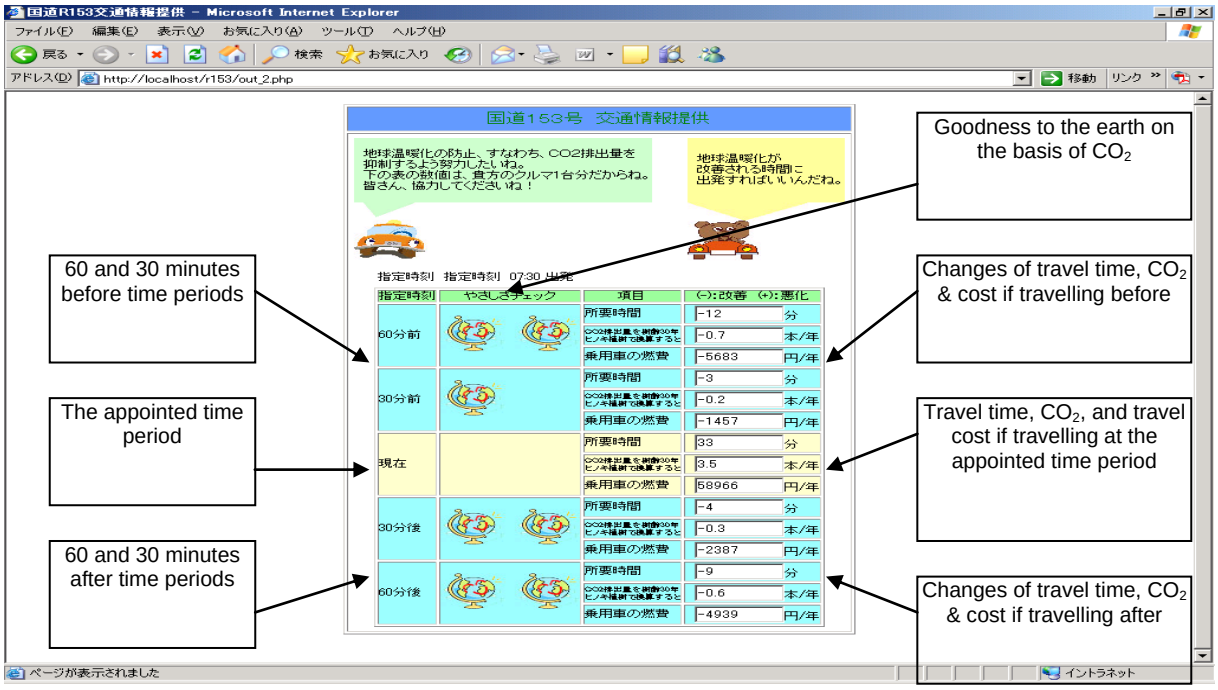


Figure 3 – Depiction of application item in output screen

ANALYSIS ON BASIS OF QUESTIONNAIRE INVESTIGATION

Outline of the investigation

The questionnaire investigation was conducted in October 2008. 5,000 residents were random extracted from all 332,789 people who are between 15 years old and 75 year old in Toyota. The target age group is decided as they can make a decision of trips by using cars or trucks. As a result, 1,199 residents returned the questionnaire sheets to us. The sample size is 1,064 being 95% reliability with 3% permissible error.

Results of the investigation

Current state of making use of the traffic information providing system

Current state of making use of the traffic information providing system and reasons for each choice are summarized in Figure 4. About 40% of people answered that they knew the service despite they made use of them or not. Only 6.3% responded they knew and used the system. The main purpose was to “drive on the shortest travel time route” and “make a travel plan”. The main purpose of 20% people who “knew and used sometimes” was to “make a travel plan” and “drive on an unfamiliar route”. These mean that the first purpose of the users is to make a travel plan. On the other hand, the main reason of 13.6% people who “knew but not using” was “search travel time by car navigation” or “go to the destination before the expected time”.

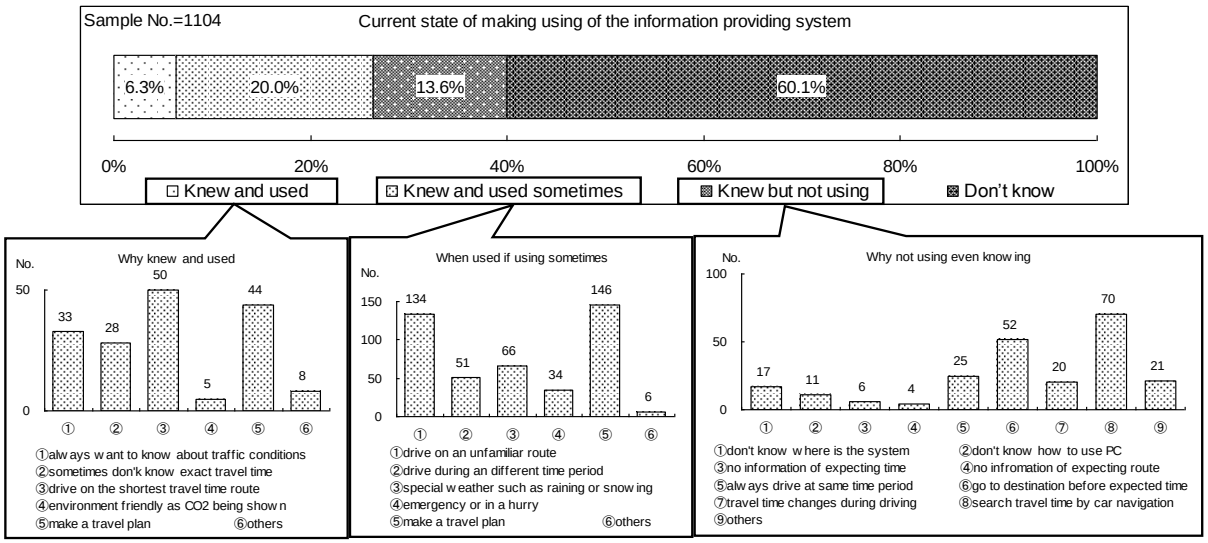


Figure 4 – Current state of making using of the information providing systems

When we focus on the people who knew and used according to age as shown in Figure 5, we can know that the age group of 40~49 and the age groups being over 60 tend to “always want to know about traffic conditions”. This result implies a special purpose of the system. The travel time provided is not only to support the users to make travel plan but also to be used as a database or a news source etc.

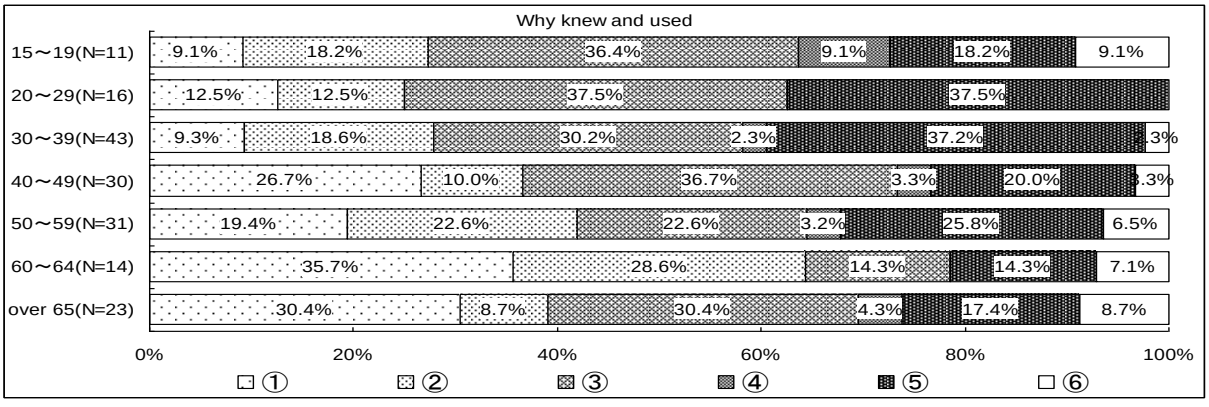


Figure 5 – Purposes by age to make use of the information providing systems (①–⑥ imply the same meanings in Figure 4)

Regarding the people who "knew but not using", as shown in Figure 6, if we see the reasons by the age groups, for many people being over 60 the reason is that they "don't know where is the system" or "always drive at same time period". They have never used the Information and Communication Technology and always tend to engage in some routing activities. Furthermore, although the age group being 15~19 years old shows the reason is that "travel time changes during driving", maybe it is because of the small sample size problem.

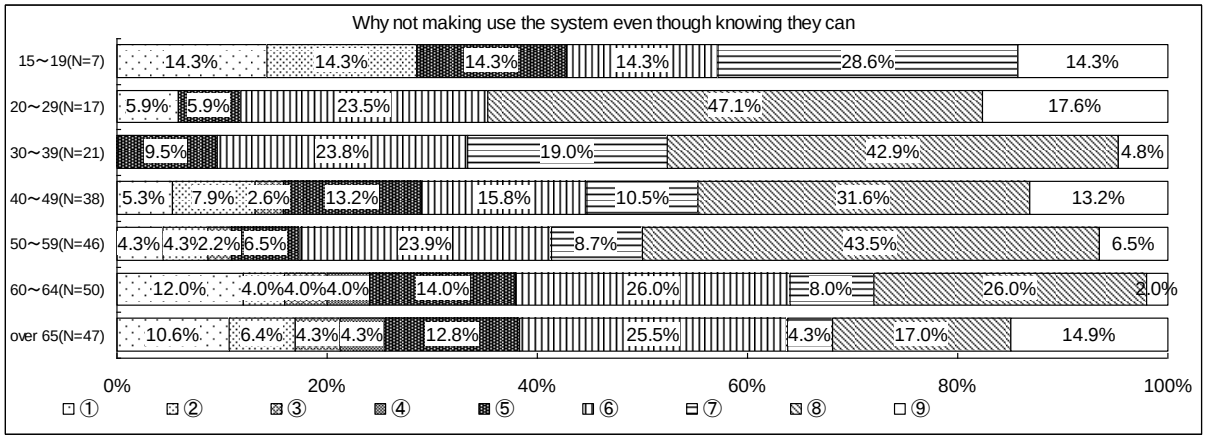


Figure 6 – Reasons by age not making use of the information providing systems but they know it (①–⑨ imply the same meanings in Figure 4)

Regarding the intention of making use of this kind of system, as shown in Figure 7, most of people under 60 years old answered they will or want to try. Only for the age group being over 65, more than 20% people answered they won't. These results indicate that the demand of such kind of system is strong. Therefore, it is convinced that the system should be developed to meet the needs of users.

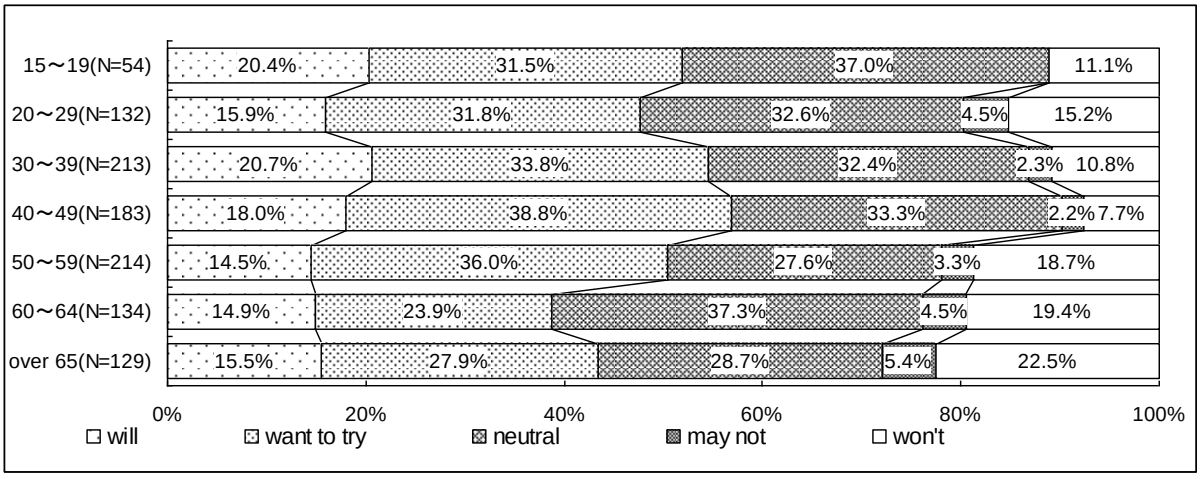


Figure 7 – Intentions by age if making use of the information providing systems in the future

Since the questionnaire was for the residents in Toyota, we made some questions in detail about a route search website Michi-Navi Toyota. The result of making using of the system is shown in Figure 8. About 80.4% answered they didn't know the system. The result indicates that activities for the promotion of the system should be undertaken by Toyota. The people who "knew and used" were only 5.5%. The reasons given by 14.1% who "knew but not

using" were "cannot use internet", "no necessary information", "information is too old" and so on. Although the reason "cannot use internet" was not caused by the system itself, the other two reasons indicate that current service should be improved.

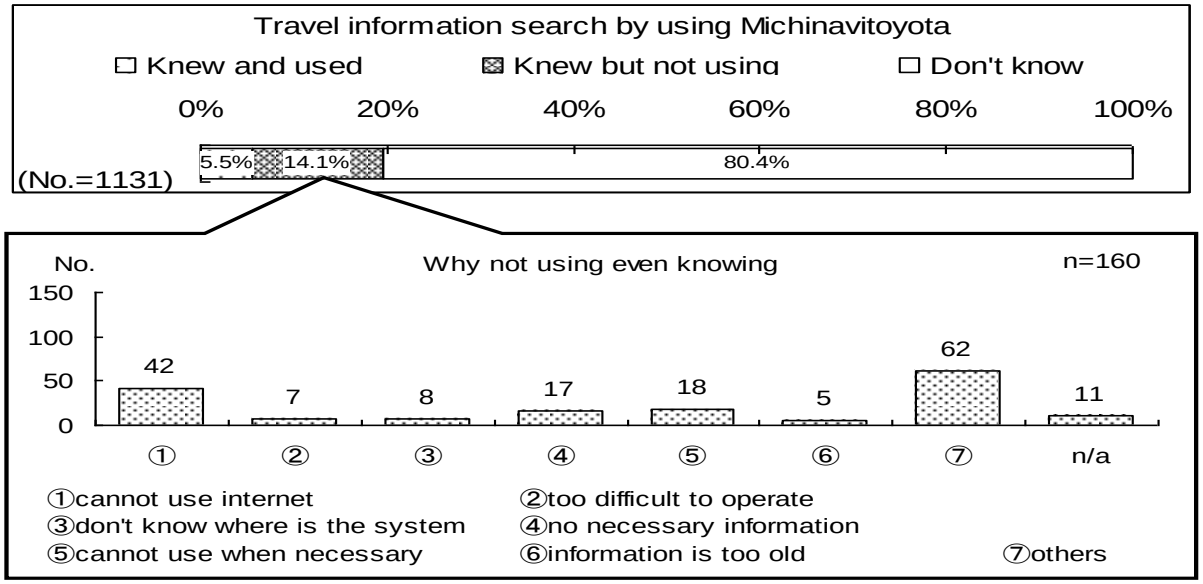


Figure 8 – Result on making use Michi-Navi Toyota to search for travel information

Evaluation by travel purpose and willingness to pay

To make an evaluation for this kind of system, we assume different situations from three viewpoints: daily activities, weekend activities, and activities with special conditions. First of all, evaluations by age on effectiveness of commuting traffic are presented in Figure 9. Individuals less than 20 years of age and over 60 have higher evaluations for the effectiveness. Although individuals between 20 to 60 years old have relatively lower evaluations, individuals made positive evaluations are still more than that of negative. Moreover, neutral evaluations show a relatively high percentage.

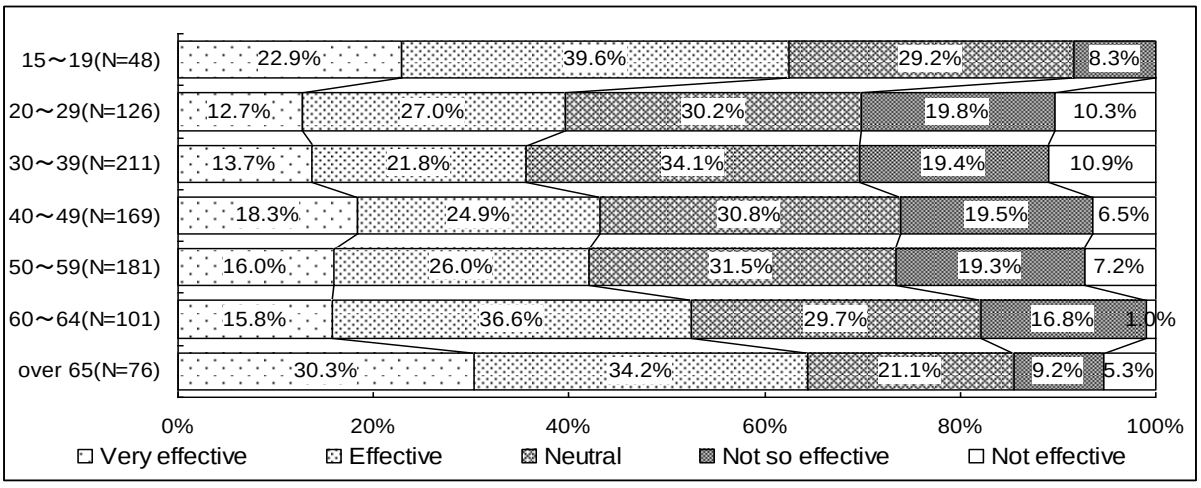


Figure 9 – Evaluations by age on effectiveness of commuting traffic

Turning to the weekend activities, Figure 10 shows evaluations by age on effectiveness of leisure traffic. All age groups show very high evaluations. Furthermore, the younger individuals are, the more positive evaluations are given.

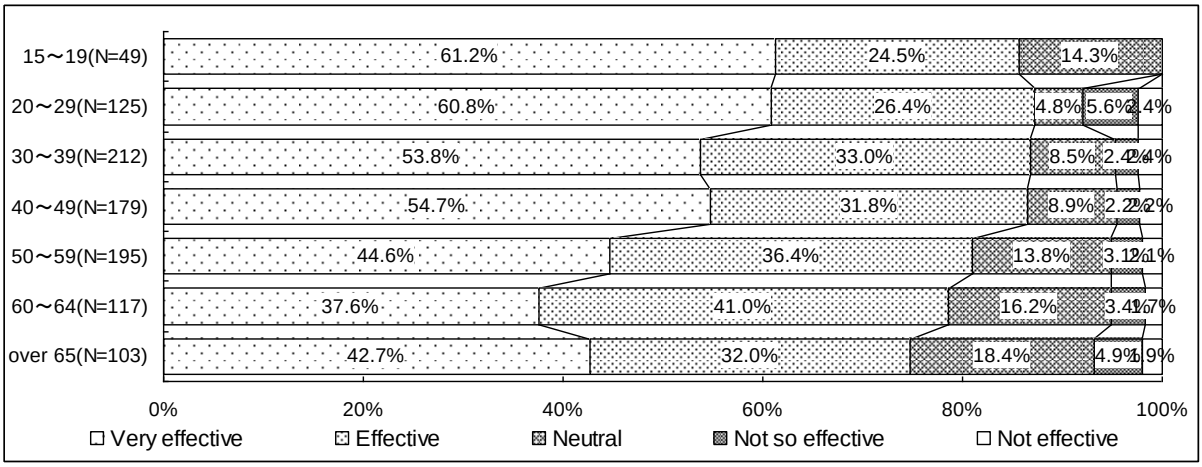


Figure 10 – Evaluations by age on effectiveness of leisure traffic

In case of bad weather conditions, as shown in Figure 11, there is almost no difference among the age groups. All people give high and positive evaluations for the effectiveness of this kind of information providing system.

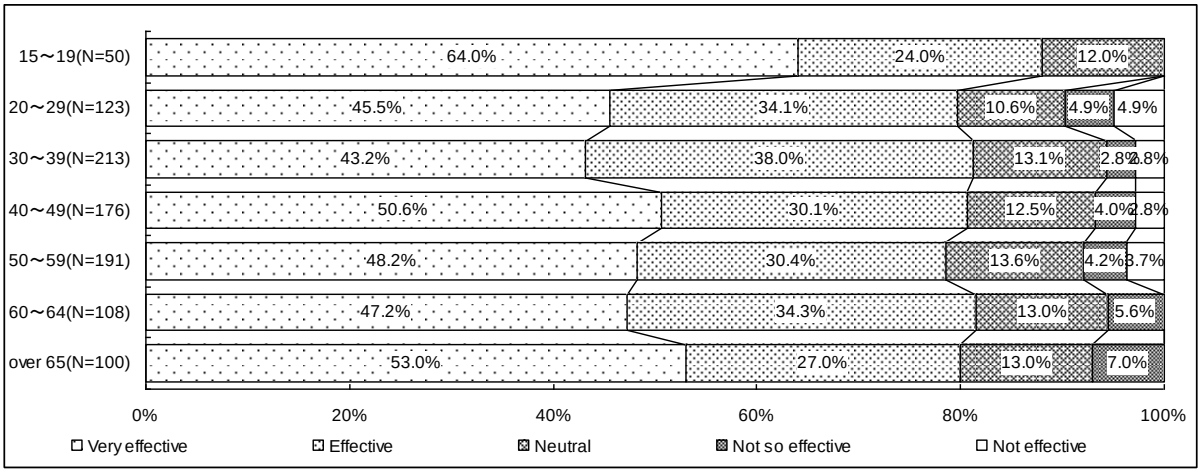


Figure 11 – Evaluations by age on effectiveness in case of bad weather conditions

Turning to the willingness to pay for making use of the system, it is indicated that all age groups but one expect the service free of charge with more than 50%. 25% to 55% people respective with the each age group tend to make some pay for the service. In particular, the youngest group and individuals between 50 and 64 years old show quite positive results. The charge may be less than 50 yen per time or less that 300 yen per month, as expressed by Figures 12 and 13 respectively. The results indicates that this kind of information providing system can be the service kept by the charge.

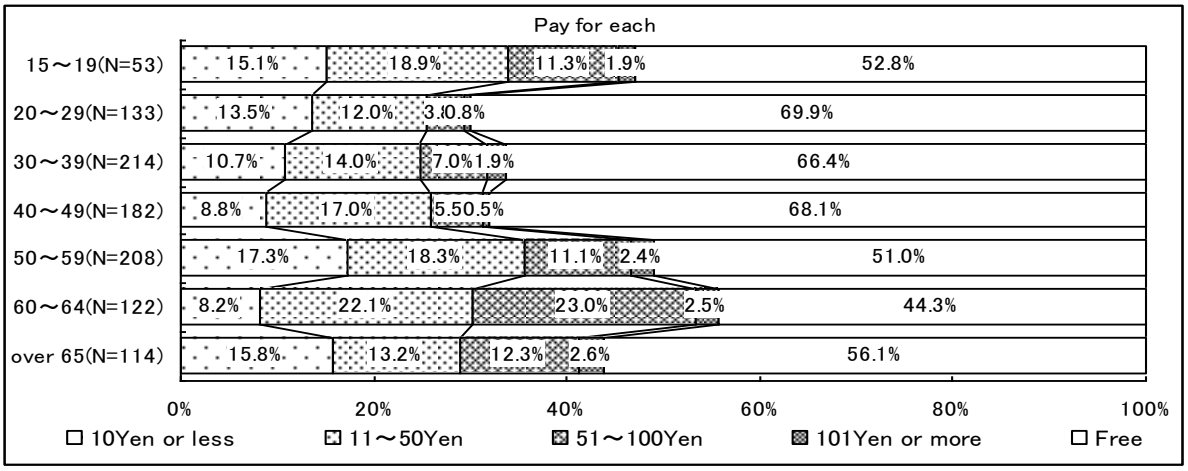


Figure 12 – Willingness to pay for each time

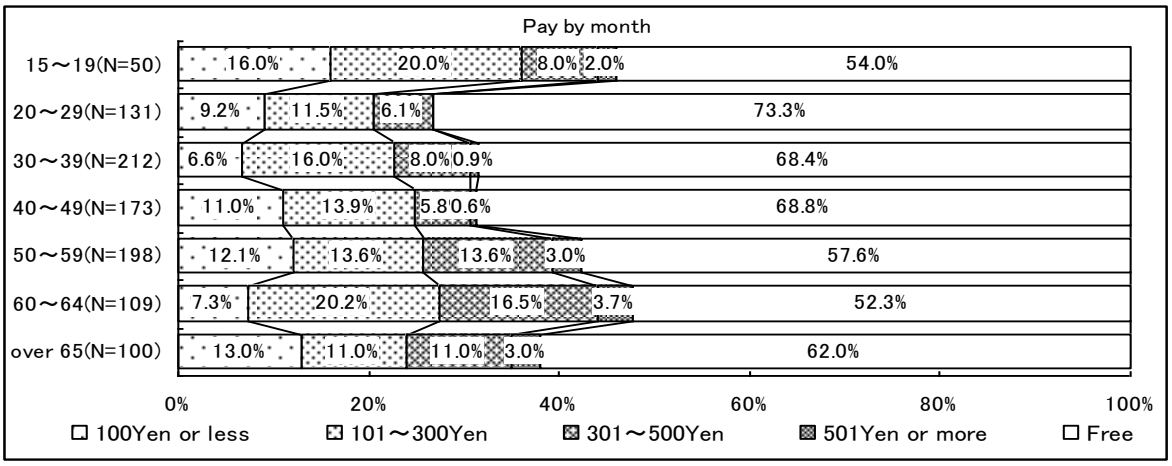


Figure 13 – Willingness to pay by month

ANALYSIS ON BASIS OF MONITOR INVESTIGATION

Outline of the monitor investigation

In order to make a revision for the developed information providing system and to make an analysis on the effect of experience, we conducted a monitor investigation after the questionnaire investigation. A call for monitors was attached in the questionnaire in October 2008. As a result, 102 persons responded to be the monitors. As the monitor investigation was finally conducted during February and March 2009, a total of 37 persons participated after adjustments of the implementation date and time. All monitors experienced the developed information providing system for travel time and advice, as described above in the last section. Then, we carried out a new questionnaire investigation to identify what changed before and after the experience.

Individual attributes of the 37 monitors are summarized in Figure 14. Although there are slightly more 30-40-years-old persons, slightly less over-60-years-old persons, and slightly more women than men if we make a comparison with the average situation obtained in the

2008 questionnaire investigation, there is no significant difference between them. Furthermore, all 37 persons have driving licenses. In addition, 35 persons, being 95% of 37 persons, that is almost same as the average situation obtained in the 2008 questionnaires survey, have their (or family) own cars.

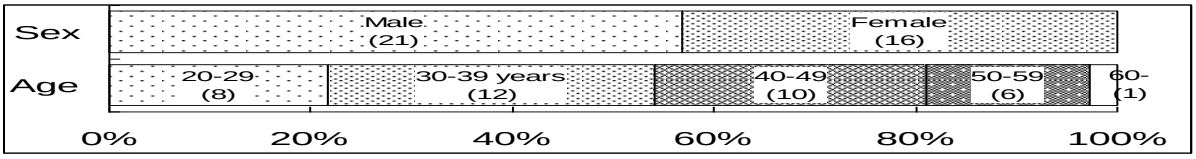
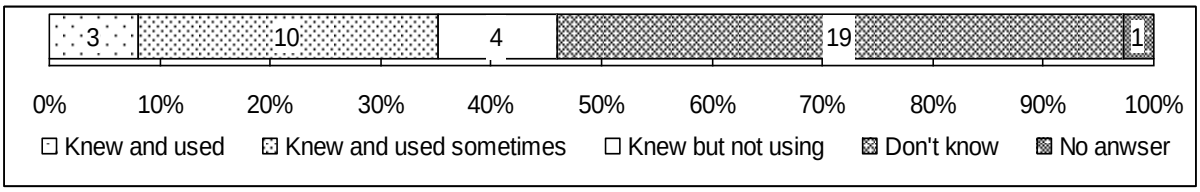


Figure 14 – Outline of the monitors

Moreover, when we aggregate the answers about usage situations of the normally known traffic information provision system based on the questionnaire investigation in October 2008, the results are summarized as shown in Figure 15. Then you can understand what shown in Figure 15 are almost same as the percentages in Figure 4. Therefore, it is concluded that these 37 monitors can be considered as the representative of residents in Toyota.

Figure 15 – Current status of monitors for making using of the information providing systems



Result of the monitor investigation

Expected effect to change the departure time for working

Regarding the question whether they are going to change the departure time to avoid traffic congestion if they can know differences of the travel time 30/60 minutes before/after the scheduled time, 21 persons being more than half of the monitors answered that they are very active or active as shown in Figure 16. Although there are still six persons answered “properly negative” and one person answered “negative”, we think the system can contribute to make people to commute during off-peak hours.

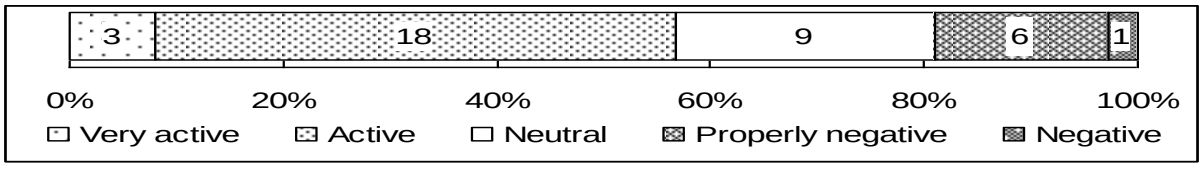
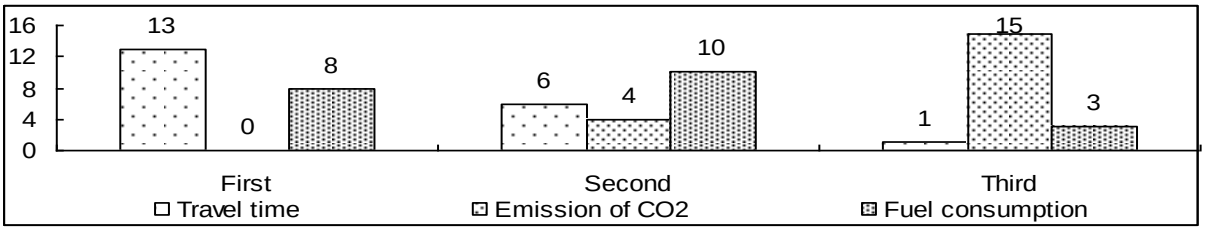


Figure 16 – Intention to change the departure time

What had made them change the mind was also asked regarding choices of “travel time”, “emission of CO_2”, and “fuel consumption”. The answers are given as shown in Figure 17. The importance of the three factors is in order of "travel time", "fuel consumption", and "CO_2 emissions", although we expected a result setting the “CO_2 emissions” with a higher priority.

This result indicates that consideration of environment being given a high priority is still very far away.

Figure 17 – Importance of factors to be considered for changing the departure time



Change of the evaluation after experiencing the system

According to the monitor investigation, the evaluations before (see Figure 18) and after (see Figure 19) experiencing the system are compared as the followings.

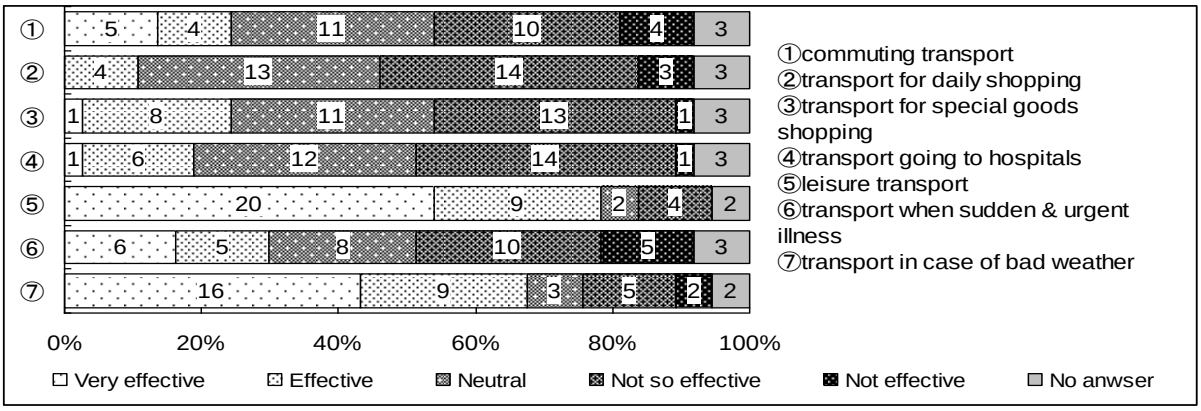


Figure 18 – Evaluation of the monitors on effectiveness before experience

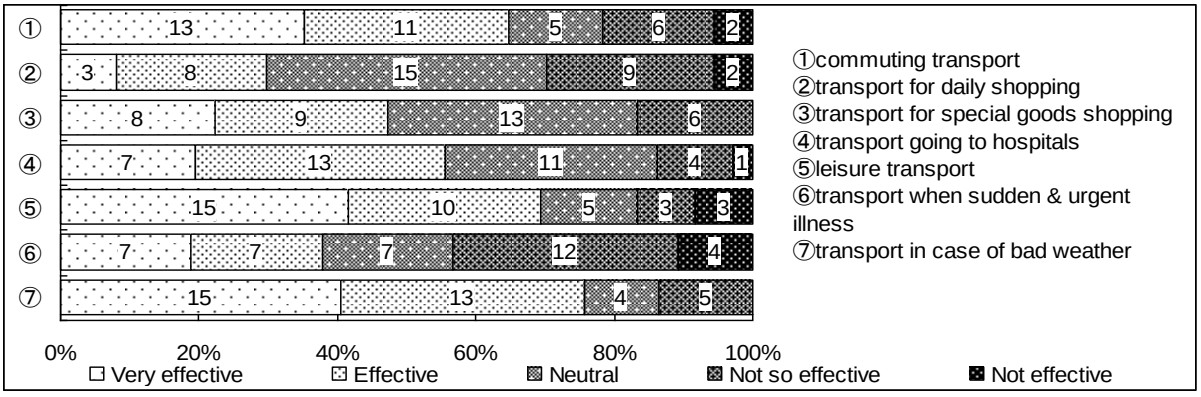


Figure 19 – Evaluation of the monitors on effectiveness after experience

It can not be found that the choice “no answer” was selected after the experience. Regarding all 7 scenes, the positive evaluations are increased while the negative evaluations are decreased but the scene “leisure transport”. Especially about the two scenes “commuting transport” and “transport going to hospitals”, the number of people who made a positive evaluation became double of that before the experience, while the number of people who

made a negative evaluation became half of that before the experience. The results indicate that the effectiveness of the information providing system for the daily activities has been understood through the experience. On the other hand, the effectiveness of the system for the weekend activities fell down. One reason may be because the monitors had already given a too high evaluation on the effectiveness for the "leisure transport" before the experience. Another reason may be because the system had not automatically given multiple routes so that it could not made them be very satisfactory.

Change of willingness to pay after experiencing the system

Regarding the willingness to pay, at first, about 90% of the monitors tend to make a payment every time when they make use of the system more than make it every month. Furthermore, as shown in Figures 20 and 21, although many people answered the service should be free of charge, the number of people who will pay increased from 6 to 9 persons, which is 1.5 times of 6 persons. One more thing making us excited is that two persons selected the choice of "51-100Yen". The results indicate that people may understand the usefulness and effectiveness through experiencing the service. Furthermore, it may not be possible to collect the charge from users to use the present system. However, the change of the monitors' answer implies that we may charge the service in the future if we can improve the system to be more satisfactory.

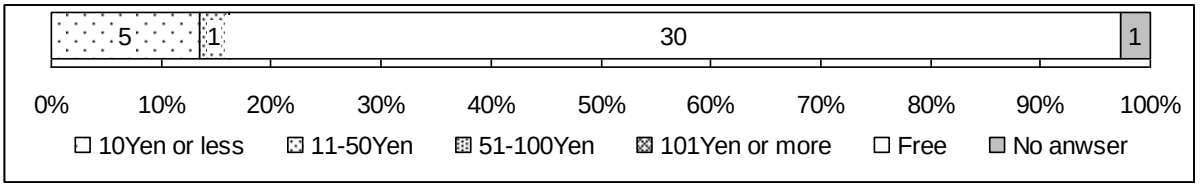


Figure 20 – Willingness to pay of the monitors for each time before experience

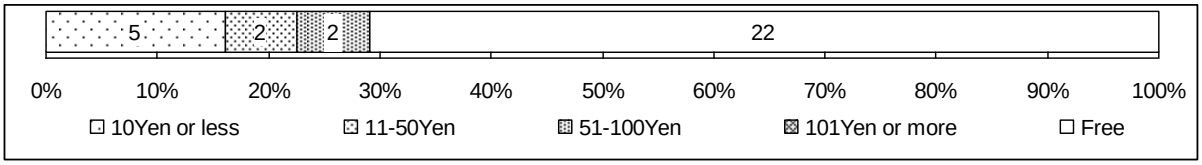


Figure 21 – Willingness to pay of the monitors for each time after experience

Direction to improve the system

The evaluation of the monitors on operations of the system is given in Figure 22. The numbers of persons who chose "very easy" and "easy" are totally 13, which is the same as that who chose "neutral". Because there is nearly 10% of persons who chose "difficult" and "little difficult", it is not considered as a satisfactory result. There are many things we should do to improve the operation of the system.

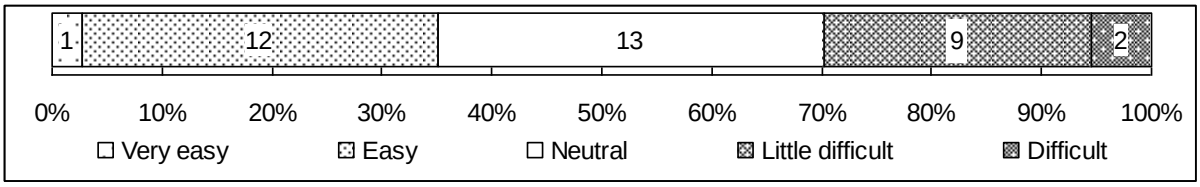


Figure 22 – Evaluation of the monitors for operation of the system

When we asked what should be added as the information to be provided, as shown in Figure 23, many monitors added “construction and regulation” and “alternative routes”. Furthermore, there is no one marked the choice of “no more”. The results imply that the existing system must be improved to meet the needs of users..

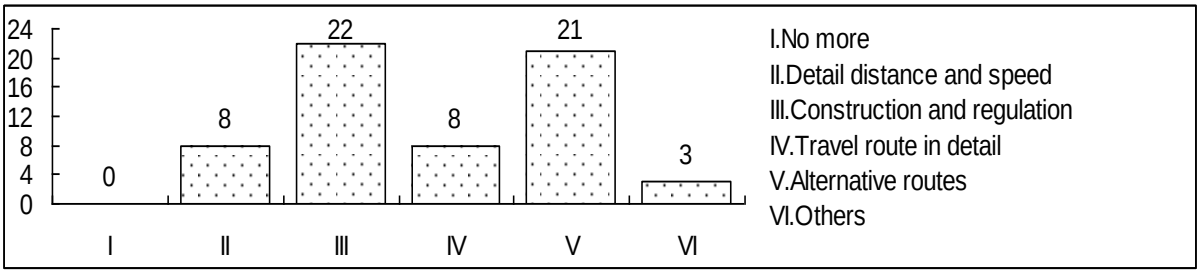


Figure 23 – Requests of the monitors for the additional information

In addition, regarding the evaluation on understandings of the information, as shown in Figure 24, the number of persons who chose “little difficult” and “difficult” was 16. This number is more than 14, which is the number of persons who chose “very easy” and “easy”.

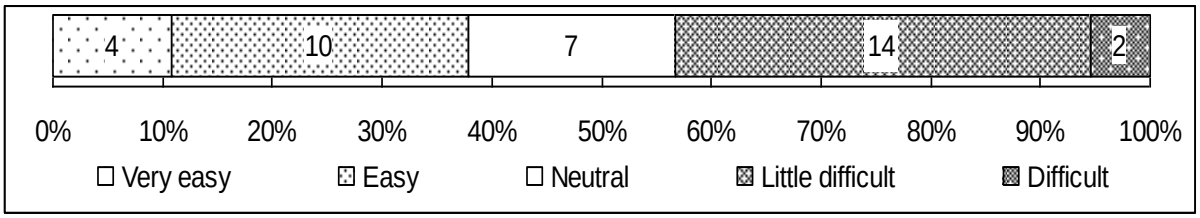


Figure 24 – Evaluation of the monitors on the understanding of the information

What had made the monitors not understanding easily are shown in Figure 25, all of them are the application item shown in Figure 3 rather than the base items in Figure 2.

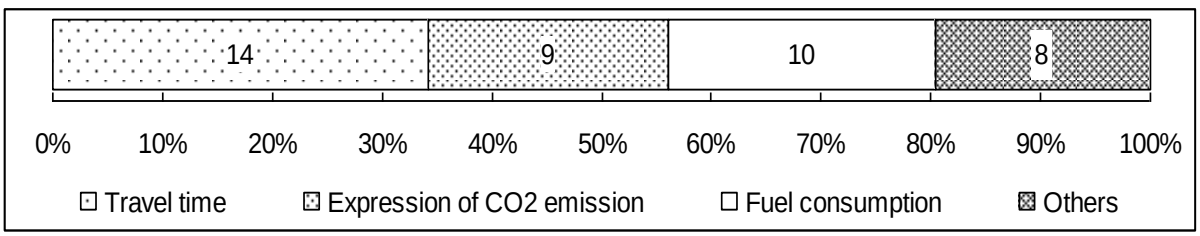


Figure 25 – Contents evaluated by the monitors being difficult understanding

As the detail requests, information before and after the specified time should not be given by 30 and 60 minutes time spans but in the much more finer time spans. Furthermore,

information should not be given by the forms of the shortened or increased time but the actual time. The information on the fuel consumption should be denoted in a trip unit or monthly instead of yearly. Moreover, the CO_2 emission should not be shown by the difficult environmental indicator but using pictures or drawings to express the image.

SUMMARY AND CONCLUSIONS

Recently, many researchers are focusing on realizing the real time traffic information system development. It is very important, we agree. However, if someone says nobody like to make use of the information system without the real time information, we will say we don't agree. Just starting from this viewpoint, we made this research. We took Toyota, which is one of the advanced ITS model cities in Japan, to be the objective area. And we made the case study by using the information providing system for travel time and advice, which was developed by us and was based on the historical data.

Regarding the intention making use of this kind of system, about half of the people answered that they tend to use while only 18% show that they would not. The results indicate that demands of this kind of system are relatively strong. Turning to the validity of the system, all age groups have highly evaluated it in case of abnormal weather conditions. Furthermore, about the usability for the pleasant activities such as leisure and travel, it is highly evaluated by all age groups except the elderly people over 60 years old. Moreover, about the usability in case of the urgent illness, more than the half except the 20-30 years-old group gave good and effective evaluations.

As explained above, the monitor investigation to analyze the use of the system has been conducted, too. 37 persons have participated in the monitor investigation carried out. The monitor investigation consists of the explanation of results of the questionnaire and the outline of the system, the experience making use of the system, and a new questionnaire.

The results of the evaluation of the system usability after experiences through this monitor investigation were compared to before. All people responded to all of the questions after the monitor investigation, although someone had not made responding to some questions before. Regarding other six scenes we listed up, much more positive (effective) answers have been given for five of them except the pleasant activities such as leisure and travel. The number of people showed that the negative answers have decreased. Related especially with two scenes of commuting and going to hospital periodically and regularly, the affirmative evaluations increased more than doubled while the negative evaluations decreased to below half. This means that the usability of the system for daily life activities has been increased through the experience. On the other hand, the evaluation in connection with the pleasant activities such as leisure and travel has been decreased. This result may be explained by high expectations before the experience and the unsatisfied point such as "more alternatives" having become clear through the experience.

Considering how to improve the system, when we investigated what should be added as output information, many monitors mentioned information on road construction and

regulation and information on multiple alternative routes. These results indicate that not only historical information but also future information such as road construction and regulation, which may affect road traffic situations, need to be provided, too. Moreover, more alternatives when roads are crowded during the specified time zone should be given not only by different time zones but also different routes.

Although there are still few users of the travel time information provision system, high needs can be predicted in the future. The real time information provision service is for the road users who are driving on roads or just before travels. The travel time information provision service on the basis of historical data is for the users who make travel plans even for many daily life scenes. Both functions can not be replaced by each other. Surely, a forecasted travel time information provision system by using both historical and real time data for any date and time zone is the most user-friendly system. However, since there is a strict restriction for the service of forecasted travel time information provision in Japan, the separate information provisions based on historical data and real time data respectively are much more realistic and effective. To realize these services widely and effectively, although there are already some existing services in the real world, it is important to carry out improvements of the developed system based on the results obtained in this study.

REFERENCES

Akita and Iwate Offices of River and National Highway, Ministry of Land, Infrastructure and Transport. Available at http://akita-road.thr.mlit.go.jp/r-46navi (in Japanese), (accessed 13 May 2010).

Ando, R. (2007). An Analysis on Recognition and Use of Regional ITS Services. Proceedings of the 14th World Congress on Intelligent Transport Systems, CD-ROM Version, 1-8.

Ando, R. and Mimura, Y. (2010). A Study to Develop an Information Providing System on Travel Time. International Journal of Intelligent Transportation Systems Research, Vol. 8, 77-84.

Central Nippon Expressway Company Limited. Available at http://kousokubiyori.jp/kousokunavi/index.html (in Japanese) , (accessed 13 May 2010).

Civil Engineering Research Institute for Cold Region. Available at http://northern-road.jp/navi/eng/index.htm (accessed 13 May 2010).

East Nippon Expressway Company Limited. Available at http://www.driveplaza.com (in Japanese), (accessed 13 May 2010).

Google Map. Available at http://maps.google.com/maps?hl=en&tab=vl (accessed 13 May 2010).

Toyota City. Available at http://michinavitoyota.jp/main/c_search.html (in Japanese), (accessed 13 May 2010).

NAVITIME JAPAN Co., Ltd. Available at http://www.navitime.com/ (accessed 13 May 2010).

Road Bureau, Ministry of Land, Infrastructure and Transport. Available at http://www.mlit.go.jp/road/user/oyakudachi/timetable.html (in Japanese), (accessed 13 May 2010).

West Nippon Expressway Company Limited. Available at http://search.w-nexco.co.jp (in Japanese), (accessed 13 May 2010).
ZENRIN DataCom Co., Ltd. Available at http://www.its-mo.com/map/?action=car (in Japanese), (accessed 13 May 2010).