A proposal of the effect structure and the evaluation process for rural ITS

Kenji OKAMURA*, Seigo NASU*, Yasuhiko KUMAGAI*
Kochi University of Technology*

***ABSTRACT*:** In this dissertation, we analyze the complicated effect structure of ITS. Then, we propose outcome from rural perspective and an evaluation logic model which indicates the links between outcomes and functions of ITS, or alternate solutions.

KEYWORDS: ITS, logic model, evaluation process

1. INTRODUCTION

1.1 Objectives

Mobility in rural areas has the following features which differ from that of urban areas.

1. Narrow roads.
2. Low number of arterial high-standard motorways.
3. Sporadic public transport network.
4. Infrequent public transport.

Therefore, there is a need for a drastic improvement in infrastructure development projects such as road upgrades and enhanced public transport network. Unfortunately, Local Governments and public transport companies in rural area are in poor financial condition, and any eagerly anticipated investment in such projects may not pay off due to the small number of users.

Under such circumstances, as a more feasible solution, ITS (Intelligent Transport Systems) is expected to contribute to better & quicker services, and is a more economical solution to rural transportation issues than the previously mentioned drastic measures.

To date, the Ministry of Land, Infrastructure and Transport and local authorities such as Hokkaido and Kochi have declared the measured results of ITS as effective. The cost benefits of ITS have also been analyzed by Arimura and others. Moreover, the evaluation of rural ITS, ITS Japan have organized and illustrated the ITS method by means of a policy and administrative evaluation approach.

Thus, former studies have remained introductions for ITS activities, or effect-analyses. Due to the manner of ITS' deployment in rural areas, namely, it has been modified as one of a number of solutions to local issues, its effectiveness varies according to the area deployed. Given the unique environment and attributes of rural areas in combination with the economic situation of many project implementing bodies, it may be difficult to replicate such solutions in other areas. Therefore flexible solutions and management of policy instead of the present uniform project operation are now needed for an appropriate local management. For effective introduction and management of ITS, it is important to declare the efficacy structure and .the effect of ITS among the regionally specific problem structure.

In this dissertation, as a case study to propose an evaluation process which clearly identifies the regionally specific transportation systems and efficacy structure of rural ITS, we used "ITS offset against streetcar stops with no safety barriers", which was introduced in the unique circumstance of Kochi Prefecture. Furthermore, we analyzed the

effect of the rural ITS by means of the evaluation process, and then we looked at the challenges and future possibilities created through the evaluation of rural ITS.

1.2 Methodology

Firstly through discussions with stakeholders such as committees and preliminary surveys we developed a “recognition map” of transportation issues that represented the view of the local community. Secondly, we extracted the logical part of the problem structure from the map and built up the logic model in which issues and reasons are hierarchically organized. We also cleared out the countermeasures and function which are necessary for a logic model. This logic model method was introduced by the W. K. Kellogg Foundation, which can demonstrate the evaluation of an issue from the outcome of the function.

Thus, we linked the outcomes and outputs of the relevant transportation issues to ITS and other countermeasure in order to clarify the scope of ITS effect. Then to evaluate rural ITS we measured the effect of ITS through on-site surveys.

2. ITS AS A COUNTERMEASURE AGAINST STREETCAR STOPS WITH NO SAFETY BARRIERS

In Kochi metropolitan area, streetcars run by Tosa Electric Railway Co. Ltd. are one of the important public transport methods. However, 34 of 156 stops in Kochi Prefecture are not equipped with safety islands or safety barriers, but are flat stops with only white warning lines and colored pavement (Fig1).

At such stops, there have been many“near-miss” accidents including fatal ones between passengers and vehicles, heightening calls among passengers for immediate safety measures to be taken.

The fundamental solution to the problem of streetcar stops with no safety barriers is the improvement of physical infrastructure, for example, road extension to create enough space for the safety island. These solutions require a huge budget which would include the cost of land acquisition. Therefore in 2004, through an industry-government-academia collaboration of Kochi Prefecture, Kochi University of Technology, and a private company, a safety measure was introduced at the Higashi-shingi stop, one of the stops without safety barriers on Route 195.

The results of proceeding surveys indicates that “near-miss” accidents happened mostly because drivers did not drive safely despite the streetcar users at the stop. We drew drivers’ attention to the stop its dangers, we also secured a safety area around the stop (Fig2).

Since its introduction, the system has been rolled out to stops on National Route 195. By end of the fiscal year 2008, all the 8 streetcar stops within the line will have installed the system.

Fig1 The Streetcar Stop with No Safety Barriers

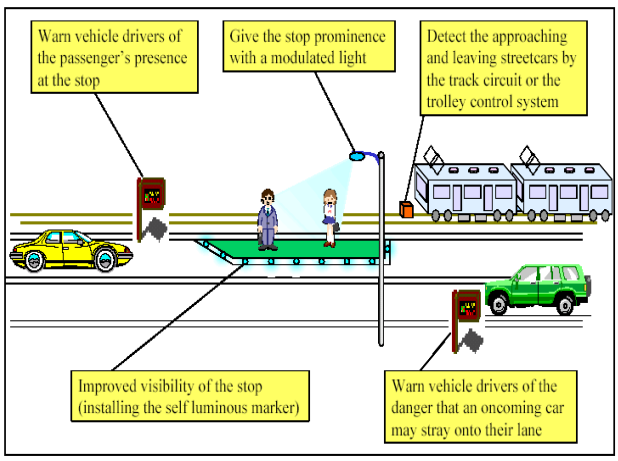

Fig2 The system Outline

3. EFFICACY ANALYSIS OF ITS ON STREETCAR STOPS WITH NO SAFETY BARRIERS

3.1 Structure analysis of efficacy of ITS

Through user surveys, on site works and interviews with the people in charge of the infrastructure we were able to identify the issues related to the stops were regionally specific and included factors such as narrow road space, and a car-oriented society, other attributes, included the age of some streetcar users (i.e. old, or very young) who are nearby residents, and the purposes of streetcar use (commuting, for example).

We then extracted the logical part from the structure of streetcar stop issues, and hierarchically displayed the outcomes from which the issues are collated. Reasons for the issues, measures which should be taken, and examples are also shown.

As a result, the streetcar stop issue was found to be composed of two outcomes, namely “the anxiety of passengers” and “the anxiety of drivers”.

Moreover, the scope of ITS were identified to affect both of these outcomes as follows:

・ITS acts to emphasize streetcar stops, which eliminates the anxiety of the drivers.

・ITS acts to emphasize streetcar stops and also improves the attentiveness of the drivers, thereby eliminating the anxiety of passengers.

In addition, in this area, ITS is the only method to eliminate anxiety of drivers due to the difficulty of securing road space and creating an unobstructed view. It is also one of few means to eliminate anxiety of passengers.

Thus, it can be said that ITS plays an important role in solving the streetcar stop issue.

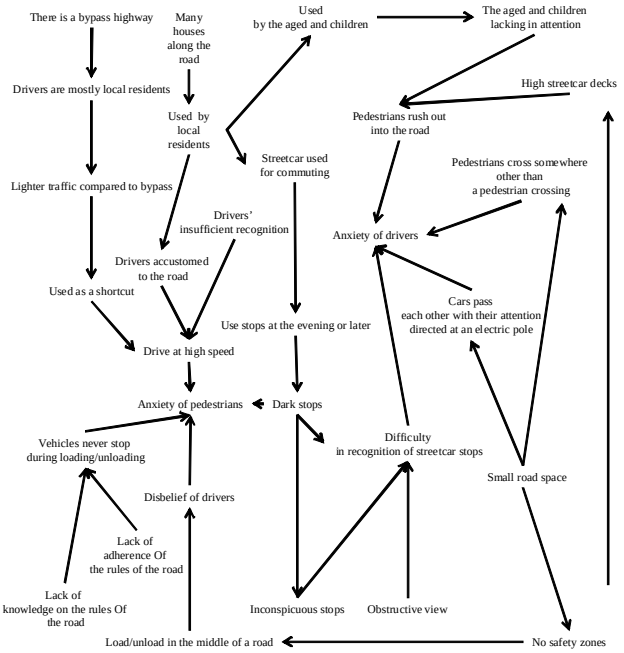

Fig3 Structure of issues with streetcar stops with no safety barriers

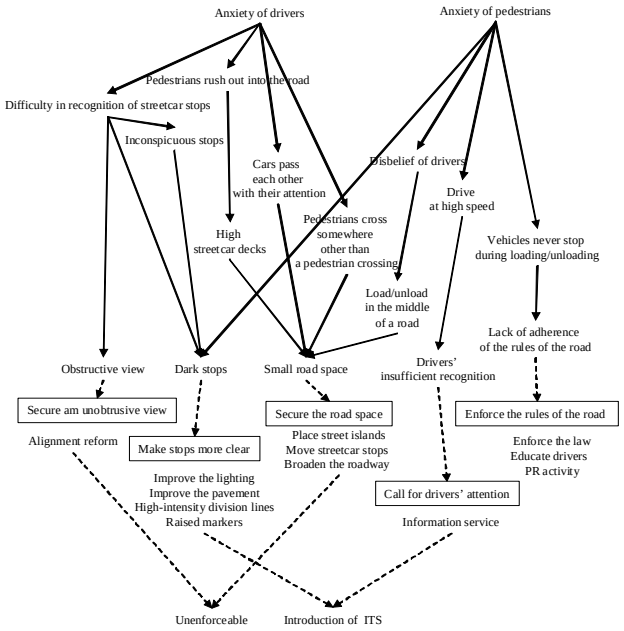

Fig4 Efficacy structure of systems for the issue of streetcar stops with no safety barriers

3.2 Verification of ITS effect

According to the efficacy structure of systems related to the issue of streetcar stops with no safety barriers as shown in Figure 4, it can be said that the direct output of ITS is to make streetcar stops more evident, and raise drivers’ awareness. Further, these

outputs are effective on the streetcar stop issue by eliminating streetcar user & driver anxiety. Therefore in order to verify the effectiveness of ITS, we have pigeonholed ITS efficiency into our outputs and outcomes through the attitude survey of streetcar users and drivers.

Table 1 and 2 show the outline of the attitude survey on streetcar users and on drivers respectively. Streetcar users are nearby residents who use streetcar on a daily basis, while drivers are local residents who drive mainly along the streetcar line on National Route 195, or people who commute to schools and hospitals near to the streetcar line.

Table1 Outline of the survey on streetcar users

Time	December, 2007
Distribution	By hand to streetcar users at stops
Response system	Mailing
Response (rate)	173 (43.7%)
Survey items	Attribute, recognizability, need, level of anxiety, etc.

Table2 Outline of the survey on drivers

Time	December, 2007
Distribution	Into the mailbox of residents on the streetcar line, etc.
Response system	Mailing
Response (rate)	293 (29.3%)
Survey items	Attribute, recognizability, level of understanding, Level of reference, needs, etc.

3.2.1 Direct outputs of ITS

Figure 5 and 6 show drivers' recognition and understanding of ITS while driving along the test area.

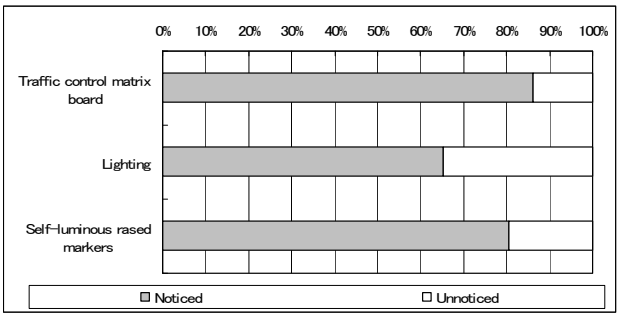

Fig5 Recognition of ITS by drivers

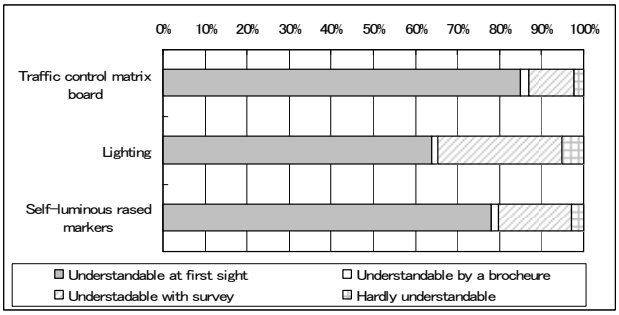

Fig6 Drivers' understanding of ITS

Traffic control matrix boards and self-luminous raised markers around the streetcar stop were recognized by 86% & 81% of drivers, respectively. At the same time, the reasons of the installation of these equipments were understood by 85% & 78% of drivers, respectively. This may show that the system was indicative of the location of stops, as well as the possibility of an encounter with streetcar users.

Figure7. shows whether the respondents refer to the information given by the system or not. If they did, their attentiveness-level is also shown.

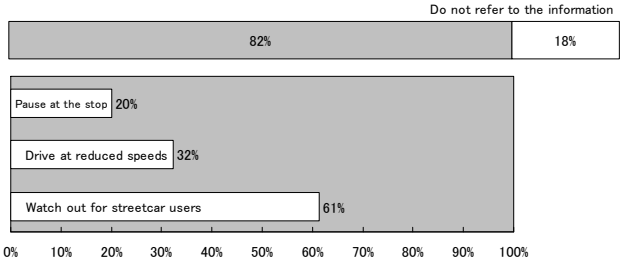

Fig7 Reference level of the drivers to the system

The system is referred to by 82% of drivers, of which 61% replied that they were attentive. That is,

50% of all drivers became attentive thanks to the system. Thus we could verify that the introduction of ITS highlighted the streetcar stops, and also improved the drivers' attentiveness.

3.2.2 Outcomes and necessity of ITS

Figure 8 shows the change in streetcar users' sense of security. Before the introduction of ITS, 61% replied that they were "very insecure" or "quite insecure". After the ITS introduction, the value decreased to 19%.

Furthermore, as for the drivers' attitude toward the system, 86.0% of them replied that they referred to ITS while driving (Fig7).

Thus we could verify that the introduction of ITS had a positive effect on the sense of security of drivers and streetcar users, which was a part of the outcomes of the streetcar stop issue.

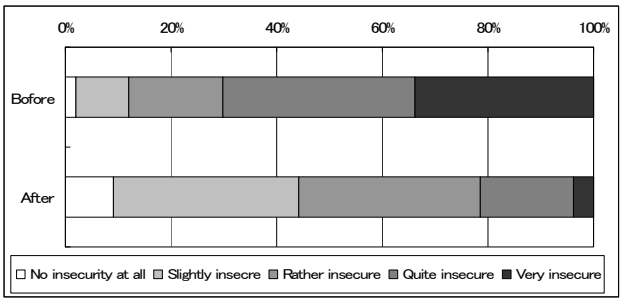

Fig8 Changes in streetcar users' sense of insecurity

Figure 9 shows streetcar users' opinions on the necessity of ITS. 91% of streetcar users replied that ITS was "necessary at all costs" or "necessary".

Figure 10 shows drivers' opinions on the necessity of ITS. 99% of drivers replied that the system was necessary.

As these results show, we could verify that ITS highlighted streetcar stops alerted drivers, and contributed to outcomes of the streetcar stop issue. Further, we found that ITS was needed by streetcar users and drivers, who were benefited from ITS.

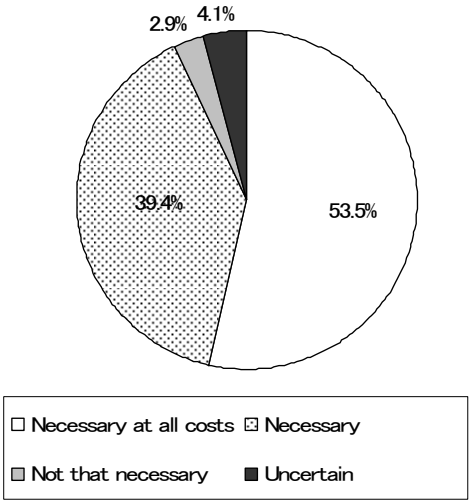

Fig9 Streetcar users' needs for ITS

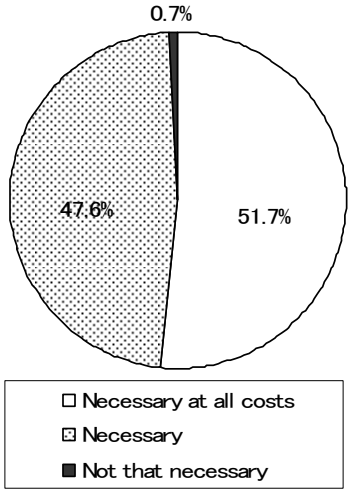

Fig10 Drivers' needs for ITS

4. CONCLUSION

We conducted a structured analysis into the efficacy of ITS using the logic models of two case studies, and also an efficacy structure analysis on ITS through attitude surveys and observational researches of real ITS users.

In the efficacy structure analysis, the relations between regionally specific road transportation issues and ITS were highlighted. At the same time, we linked the outcomes and outputs of the issues to the countermeasures in order to clarify the scope of ITS's effect. In addition, the efficiency analyses on

ITS, the partial phenomenon/effect of ITS was measured, along with the influence on the outcome.

As the result of those analyses, we have the following findings;

・Road transportation issues in rural areas are structured/concerned with the local environment and attributes.

・ITS is one of the countermeasures which affects the outcome of road transportation issues.

It is possible for ITS to become a limited countermeasure which affects certain outcomes, for example if a drastic measure such as a road repair becomes unattainable, then ITS can act effectively on road transportation issues in rural areas in difficult financial situations. It is also needed by ITS users.

Given this situation, it can be said that rural ITS affects outcomes and outputs necessary for the solution of road transportation issues in rural areas. At the same time, ITS is related with the importance of road transportation issues in local areas (Fig11).

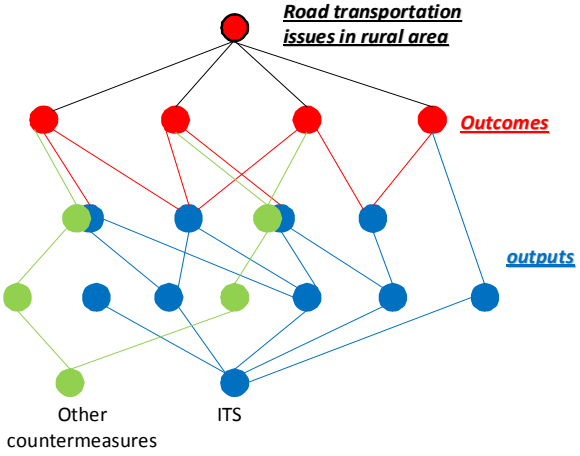

Fig11 Efficacy structure of ITS

We verified that this kind of evaluation process displayed the correlation between outcomes and outputs necessary for the solution of the issues and clarified the scope of ITS. This coincidentally indicated that the evaluation process could be utilized in function design of ITS at the stage of pre-evaluation. Furthermore, we could describe that ITS could be one of the countermeasure options in rural areas where large-scaled improvements are unrealizable.

However, this analysis failed to quantitatively measure outcomes, such as the level of contribution by ITS, for example. If we can realize the quantification of logic models, we would be able to more objectively explain the project effects and necessity of ITS.

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ACKNOWLEDGMENT

The approach introduced in this article was supported in part by a grant from Practical ITS Study Committee of Japan Society of Civil Engineers, Kochi Prefecture, Ministry of Land, Infrastructure and Transportation, and others. We are also deeply grateful to Tosa Electric Railway Co. Ltd. and many others for their support.