Research Regarding the Introduction of LRT as a Selective Means of Transportation: Application View Points of the Conversion from Automobile/Motorbike

Akihiro Mihoshi [1], Hiroshi Ikeda [2], Takao Yanagihara [3], and Yoshikatsu Tabata [4]

[1] *Faculty of Civil Engineering, Kinki University, mihoshi@civileng.kindai.ac.jp*
[2] *Interdisciplinary Graduate School of Science and Technology, Kinki University, hiroshi.ikeda@union-services.com*
[3] *Interdisciplinary Graduate School of Science and Technology, Kinki University, yanagiha@civileng.kindai.ac.jp*
[4] *Kokudo Jouho Kaihatsu Co.,Ltd.*

Abstract

As LRT is introduced into the city planning of many Western cities, improvements in the public transport service of an automobile-centered society are in desperate need of review in Japan also. In this research the policy of an introduction to LRT was presented to the public through a multi-staged questionnaire and the automobile / motorbike user's perception of a conversion to LRT trend was analyzed. As a single-plane introduction of LRT solely is inadequate, an overall traffic reform of public transport will become necessary. In the face of traffic problems, such an introduction of LRT as a public transport system is one of the most effective policies for the vitalization of environment and community.

Keywords

light rail transit, public transport system, park and ride, bus system, central city

1. INTRODUCTION

The application of the automobile has become something close to compulsion for many people and, as a result, our lives depend on it and, as a consequence, the service of public transport has declined. Many people believe that they need an automobile to avoid the disadvantages of not having one and, furthermore, they prefer to be in control of the operation of their transport themselves. There are many situations that require the use of an automobile because the public transport system needed for daily life is not completely assured. Also, in the event of upgrading the pedestrian environment, an increase in the number of automobile- users will be promoted even further.

A multitude of automobiles are in use at present and, even though in recent years automobile makers are wholly active in addressing environmental problems by regulating the discharge of gas and promoting a few new-style automobiles with low exhaust gas and contamination, it will take considerably longer time until completely effective changes can be made. An overall reform of the traffic system itself is inevitable. Not only improvements in the amount of traffic congestion and automobile fuel efficiency, but also an esteemed transport system has become of great importance.

2. PURPOSE AND CONTENTS OF SURVEY

The policy of an introduction to LRT was presented to a subject group of people, a section of the general public, through the use and analysis of a multi-staged questionnaire and the automobile/motorbike/moped users understanding of a conversion to LRT trend was analyzed in order to determine the best policy and method of introduction.

The points of research are as follows: (1) LRT effectiveness, (2) the public reaction to a multi-staged plan of LRT, (3) use of P&R, (4) coordination of LRT with the bus system, (5) ideal LRT cost and necessity of route to include important establishments.

The subject group consisted of people resident in areas both convenient and inconvenient for use of a bus to and from the central city.

3. LRT

LRT (light rail transit) is a medium capacity city transport system with many small compartments that runs on a track alongside the road, similar to a tramway or street car. It was named LRT with the intention of renewing the image of the American streetcar/ tramway.

4. PERCEPTION OF PUBLIC REGARDING THE INFLUENCE OF THE INTRODUCTION OF LRT

After reading an introduction of LRT, the subject group was asked which of the following points they thought would be improved by LRT: (1) environmental problems, (2) traffic congestion, (3) traffic accidents, (4) decline of central city, (5) transportation problems for aged people, a (6) improvements to the attractiveness of the city, and (7) barrier-free.

As a result of this survey, it can be seen that a large

response from the male section was LRT could contribute to improve "traffic accidents" and "traffic congestion", and also, design could make "improvements to the attractiveness of the city".

As for the female section, a large percentage thought that LRT could contribute to improve "environmental problems" and "transportation problems for aged people", with a regard to the problem in global terms, more than just a traffic problem (Figure 1).
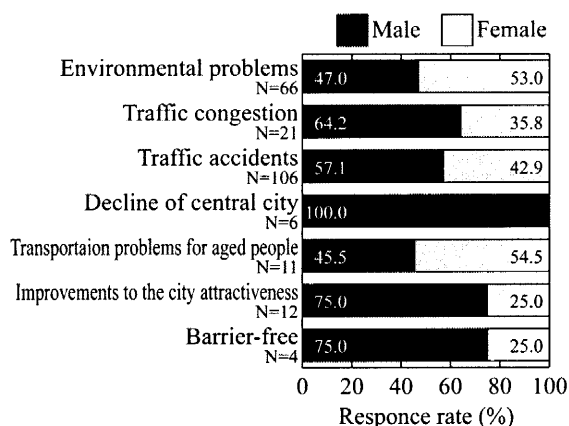

Fig. 1 Effectiveness of improvements by LRT

5. CONVERSION TREND TO LRT

The subject group was shown five stages of an upgrading policy for a conversion to LRT, with consideration given to coordination with bus systems and P&R, and also, the change from private transport to LRT for the automobile/motorbike user. The outline of the stages for upgrading is as follows:

1st stage: presentation of LRT route

2nd stage: expansion of bus route network

3rd stage: improvement of bus service

4th stage: introduction of P&R policy

5th stage: method of conversion to LRT

Figure 2 shows the results of a survey concerning the aforementioned five stages, in terms of a residential area. It shows that a large percentage of the subject group from areas C and D, which are in the area for the introduction of LRT routes, accepted conversion in the 1st
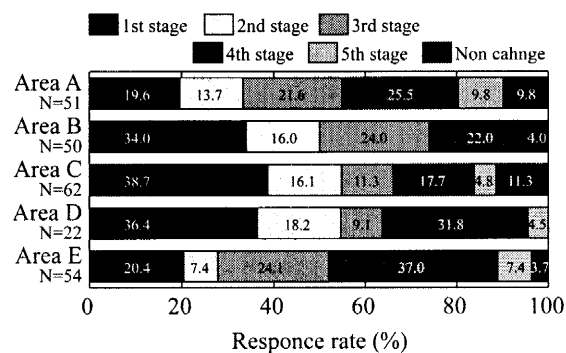

Fig. 2 Stages of conversion trend to LRT

stage. Many people from area B, which is slightly remote from the LRT route, accepted conversion in the 1st stage. In area E, which is located on a mountainside, the greatest percentage of people accepted conversion in the 4th stage. However, a comparatively large percentage of the subject group resident in other areas did not accept conversion change until the 4th stage, so it seems difficult to restrict the use of automobile completely. Also, only a comparatively small percentage of people accepted conversion in the 2nd stage, so, there is little appeal for conversion from private transport to a bus system.

As a result, the establishment of a P&R system is indispensable for people who live in the suburbs. Also, without an improvement in the basic standard of bus service, a conversion to LRT is difficult for people who live in other areas.

6. REQUIREMENTS OF COORDINATION WITH BUS

Even with the introduction of a LRT route, if supplementation by a well coordinated bus service is not possible, conversion to LRT is difficult. Therefore, the sections of the subject group who responded to the 2nd and 3rd stages were asked about requirements for coordination with bus system.

As a result, they replied that "increasing number of runs", "service hours", and "discount fee for connection", are the most important requirements for the bus service, and in regard to a connection with the public transportation system, "waiting time for connection" (see Figure 3).
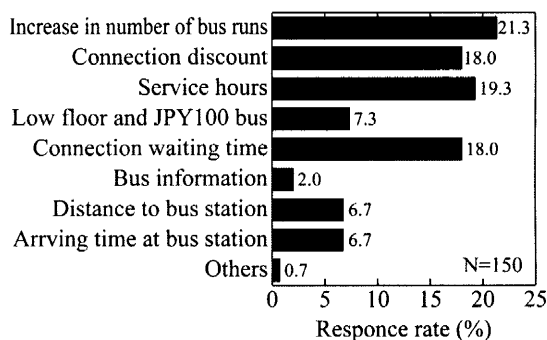

Fig. 3 Bus service situation

Figure 4 shows the results of the ideal run times for on peak and off-peak.times. The peak time was 5-7 runs, and the off peak time was 3-4 runs.

In the hypothesis that the number of runs at peak time is 7, and at off-peak time for 4 runs, Figure 5 show that 50% of the subject group wanted an increase in the number of runs at peak time and 60% at off-peak time. Therefore, with this interval in the number of runs, it will be possible for such a proportion of the public to use the bus and LRT connection.
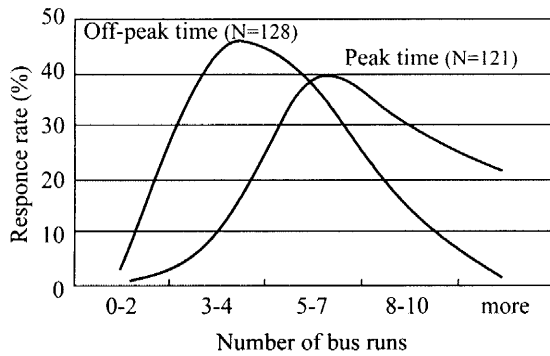
Fig. 4 Ideal number of runs for peak and off-peak times
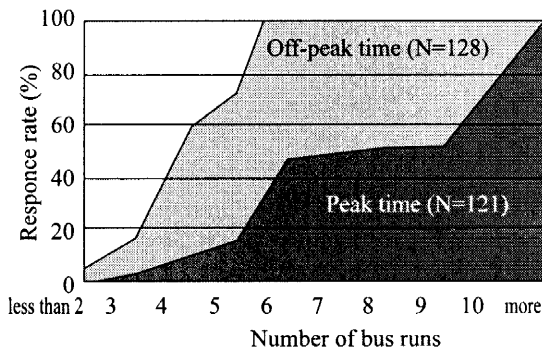

Fig. 5 Ideal number of runs for peak and off peak times (number of people)

The largest percentage of the subject group thought that 6 to 24 o'clock are the ideal service hours. Figure 6 shows the ideal service hours for bus-LRT, and it seems that the results are closely related to the current railways service hours. Also, there is the possibility that if the service hours are supported as in Figure 5, 70% of the public will be able to use the bus-LRT system.
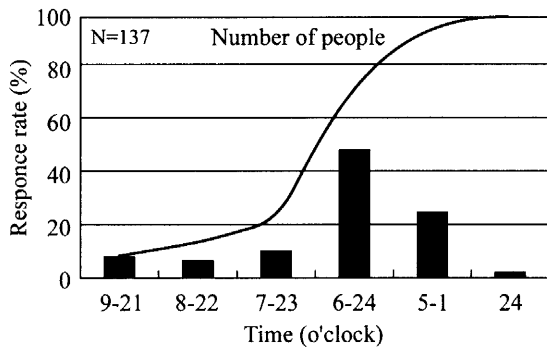

Fig. 6 Ideal service hours for bus-LRT

Figure 7 shows the subject group's response concerning the waiting time for connection. The highest percentage, 40%, is 10-14 minutes, and the next, 30%, is 4-6 minutes. The figure shows the waiting time of bus-LRT, and it is possible for 90% of the public to be able to use a connection at 4-6 minutes and 60% at 10-14 minutes. If the objective is to coordinate for a large number of people, the number of runs should be 7 at peak time and

4 at off-peak time. The service hours should be 6 to 24 o'clock in accordance with current railway service hours. Also, if the objective is to coordinate for the certainty of a larger number of customers, the waiting time for connection should be about 4-6 minutes.
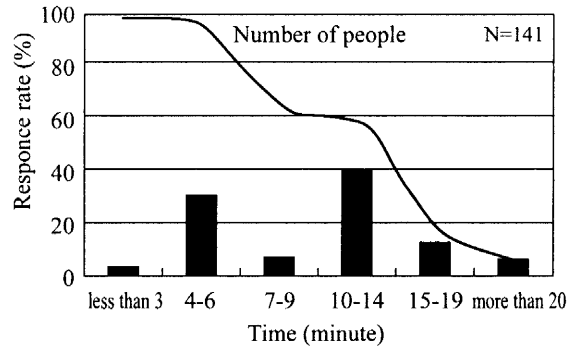

Fig. 7 Connection waiting time for bus-LRT

7. REQUIREMENTS OF P&R

P&R (park and ride) is a method of gaining access to a nearby station by automobile, and then changing to public transport facilities and commuting to the office. The time spent using an automobile is decreased, so it is kinder to the environment. Also, traffic congestion becomes non-existent because of the change to a train in the suburbs and, therefore, it is possible to arrive at the destination on schedule.

For people who reside in the suburbs and depend on private transport facilities, it is difficult to suggest using a bus. In the West, P&R is one of the most effective ways of guiding the institution of LRT for people who reside in the suburbs and require an automobile. The section of the subject group that responded at the 4th stage was asked about their requirements for a P&R system.

The results showed that the greatest response for the most important factor when using P&R was the "cost of parking". There was a significant fall in the percentage, but the next factor was the "distance from station" (Figure 8).
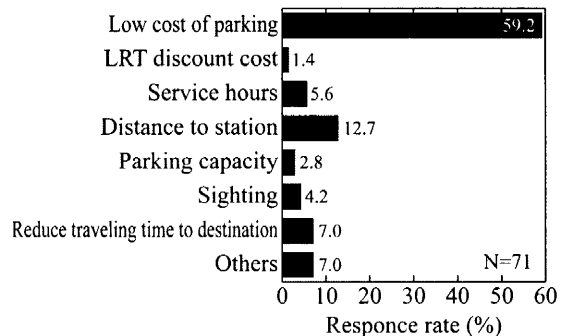

Fig. 8 Importance of institution of P&R

The subject group was asked regarding the ideal cost in terms of a one-day fixed cost. Figure 9 shows that a maximum of "JPY300" was the greatest response and the next was a maximum of "JPY1,000". In section 6, concerning the number of bus runs, almost all the subject group was able to use the system with a maximum cost of "JPY300". Also, for at least half of the subject group, the cost should be a maximum of "JPY500".
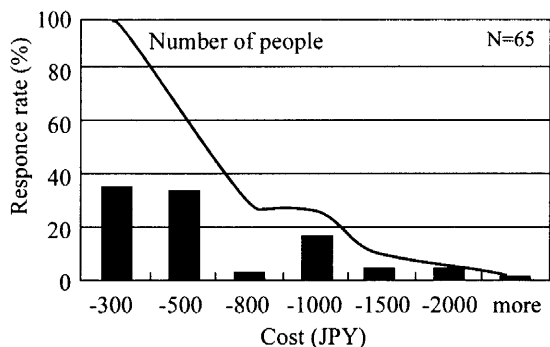

Fig. 9 Ideal parking cost

The subject group was asked regarding the ideal service hours. Figure 10 shows the result that the greatest response was for "6 to 24 o'clock", which 70% of the subject group would be able to use.
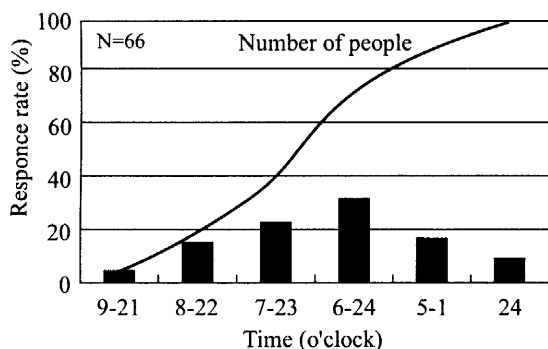

Fig. 10 Ideal service hours for parking

Therefore, the most effective factor for the institution of P&R is the parking cost. This research indicates that the cost should be a maximum of JPY500, and also it is important to coordinate with the railway service hours as well as the bus situation. The lowest response was for a "discount cost with LRT", however, it might be possible for the parking cost to be modified

8. FARE VALUE OF LRT

So far, the promotion of the utilization and the convenience of LRT as a public transportation system have been analyzed. In this chapter, a PSM analysis of the fare value was performed.

8.1 PSM analysis

In the field of market research, PSM (price sensitivity

measurement) analysis is used in order to calculate the optimal price (Figure 11). PSM analysis is a method of assessing the public's price perception [Mori, 2000]. The first step in the PSM is to ask respondents about the following four price-related issues: "too expensive", "too inexpensive", "expensive", and "inexpensive". Consequently, the following four kinds of prices can be determined: "point of marginal cheapness", "indifference price point", "optimal price point", and "point of marginal expensiveness".

Assessing the public's price perception is important for the promotion of the utilization of LRT. Therefore, the fare value of LRT was calculated by PSM analysis.
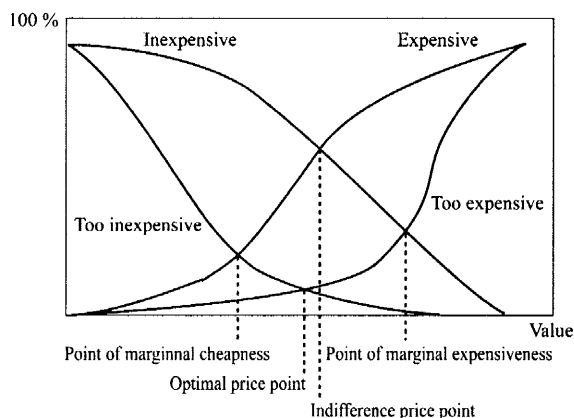

Fig. 11 Image of PSM analysis

8.2 Publics's inclination to pay in all areas

The following results were obtained from a PSM analysis of the five areas investigated at this time (Figure 12).
Point of marginal expensiveness: JPY200
Point of marginal cheapness: JPY160
Indifference price point: JPY190
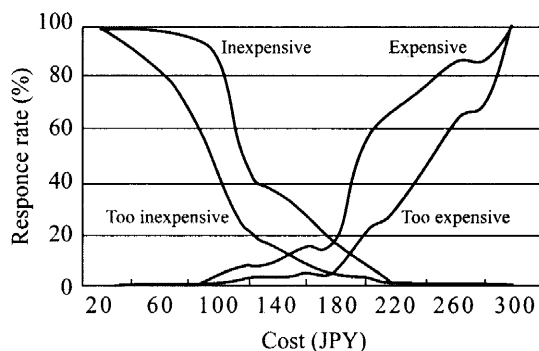Optimal price point: JPY160

Fig. 12 Estimated value of all areas

The subject group's inclination to pay in all areas is shown in Table 1.
In the areas, (area A and area B), where buses are comparatively convenient, the "optimal price point" exceeded the "indifference price point". It might be con-

Table 1 Fare value of all areas by PSM analysis

(Unit: JPY)

	point of marginal cheapness	optimal price point	indifference price point	point of marginal expensiveness
area A	180	190	145	190
area B	190	200	170	210

indifference price point < optimal price point=the area where bus traffic is comparatively convenient

area C	175	165	155	195
area D	195	180	155	205
area E	195	185	165	205
all area	190	190	160	200
average	187	184	158	201

indifference price point>optimal price point=the area where bus traffic is comparatively inconvenient

sidered that the public may pay a higher fare if the traffic environment becomes more convenient. In area C which was the lowest fare, the members of the subject group who live near to the railway station, are more inclined to go from an urban area to the central part of the city. The "point of marginal expensiveness" in all areas is lower than the bus fare (JPY220). It can be seen that the public requires a low fare because they are dissatisfied with the present bus fare. That is to say, a maximum fare of about JPY165 needs to be established in order to increase utilization of LRT in all areas.

In addition the fare system of Strasbourg in France, for example, is 7 francs (about JPY112) per time. If automobile-users utilize P&R, they can purchase a round-trip ticket for 15 francs including the parking fee, so many people use it. Therefore, it can be said that such a service is required in the promotion of the utilization of LRT.

9. ANALYSIS OF COMPARATIVE IMPORTANCE OF ESTABLISHMENTS NEAR TO LRT ROUTES

In this chapter, a method of pair-comparison is used to analyze the order of importance of establishments near to the route of LRT.

9.1 Method of pair-comparison

People make decisions by unifying various elements. AHP, (analytic hierarchy process), divides the elements of decision-making into a hierarchical structure, and compares various conflicting conceptions and elements where a measure is different. A method of pair-comparison analyzes importance by comparing each item with other items in the AHP's process.

In this study, the importance to the public concerning the following six establishments near to the route of LRT was analyzed: medical center, welfare institution, administrative centre, park, university, and commercial establishment

9.2 Importance of establishments to public

The pair-comparison matrix of each element (Table 2) was created from the difference of the average score of each item, and the weighting factor was calculated. Figure 13 shows the importance of establishments. A consistency index (C.I.) was calculated from the largest eigen value using the following (1) types. The consistency index shows a comparatively high value (Table 3).

$$C.I = \frac{(\lambda_{max} - n)}{(n-1)} \tag{1}$$

λ max: the largest eigen value
n: the number of categories
C.I.<0.15: judgmental standard of consistency index

Table 2 The pair comparison matrix of each element

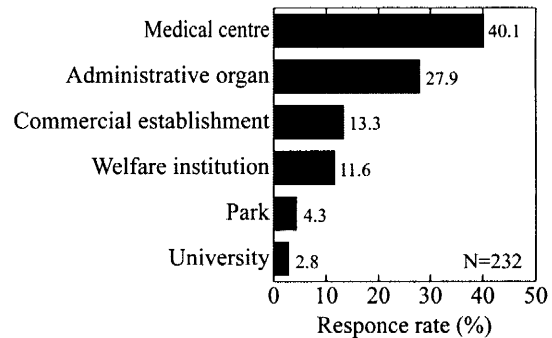|	Medical centre	Welfare institution	Administrative centre	park	university	Commercial establishment	Geometrical average	Weighting factor
dical tre	1	5	2	7	9	4	3.688927	0.400788
lfare itution	1/5	1	1/4	3	5	2	1.069913	0.116242
ninistrative tre	1/2	4	1	6	8	3	2.569797	0.279199
k	1/7	1/3	1/6	1	2	1/4	0.397893	0.04323
versity	1/9	1/5	1/8	1/2	1	1/5	0.255436	0.027752
nmercial blishment	1/4	2	1/3	4	5	1	1.222212	0.132789
						合計	9.204179	1

Fig. 13 Importance of establishments near to the route of LRT

Table 3 Consistency of importance

Establishment	Characteristic value
Medical centre	6.54692
Welfare institute	6.88414
Administrative centre	6.53414
Park	6.34905
University	6.43570
Commerce institution	6.55339
Total	39.30334
Biggest characteristic value	6.55056
Matching degree C.I	0.110111

The biggest response from the subject group concerning the importance of an establishment was "medical centre", and the next was "administrative centre". The reason that the smallest response was for "university" was because there was an extremely low number of students in the survey at this time. The fact that there were few students who responded for "university" is also of importance.

Basically, the above-mentioned establishments are important to an upgrading of the LRT line because the majority of people require the use of public institutions. However, it would be difficult to upgrade the line for each and every establishment, so it would be basically one of the references for guidelines. In this part of the survey, the overall framework of the order of priority was analyzed, and the next step should be to concentrate on the individual importance of each individual establishment, and the application of such information will increase the utilization of LRT.

10. CONCLUSION

In this research, the automobile/motorbike user's perception of a conversion trend to LRT was assessed through five stages. Even though there is negligible effectiveness in a single-phase introduction of LRT into the transportation system, an integrated introduction into an overall traffic reform will become of great importance.

In view of the present problems of urban transportation systems, the growing wave of motorization has made the central city an unsuitable place for humans. For such areas, the most important and necessary plan is for immediate reform of the public transport system and the introduction of LRT to people resident and active in the city is the most effective policy in connection with the vitalization of both environment and community.

References

Mori, Y., Simple *Marketing*, Shoeisha, 2000.