

Assessing Commuter Infrastructure in Urban Hubs

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Abstract—We are facing regional problems to low birth rate and longevity in Japan. Under this situation, there are some local municipalities which lose their vitality. The aims of this study are to clarify the present state of local public transportation services in local municipalities and relation between local public transportation services and population quantitatively. We conducted a questionnaire survey concerning regional agenda in all local municipalities in Japan. We obtained responses concerning the present state of convenience in use of public transportation and local public transportation services. Based on the data gathered from the survey, it is apparent that we should some sort of measures concerning public transportation services. Convenience in use of public transportation becomes an object of public concern in many rural regions. It is also clarified that some local municipalities introduce a demand bus for the purpose of promotion of administrative and financial efficiency. They also introduce a demand taxi in order to secure transportation to weak people in transportation and eliminate of blank area related to public transportation services. In addition, we construct a population model which includes explanatory variables of present states of local public transportation services. From this result, we can clarify the relation between public transportation services and population quantitatively.

Keywords—Public transportation, local municipality, regional analysis, regional issue.

I. INTRODUCTION

RAPID depopulation and aging population brought new regional issues in local municipalities in Japan. There are extremely diverse issues such as a protracted economic slump and an industry decline. Taking public transportation service as an example, almost all of local municipalities cannot provide enough public services because of a decrease in the number of users as well as shortage of funds for maintain them. These phenomena can be seen in many areas.

Regional population is intimately related to regional socioeconomic condition. Local public transportation service is one of a service for daily life. Considering these facts, how relation between local public transportation services and population is. We can offer some suggestion of regional policies in the future concerning local public transportation services by clarifying relation between these.

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There are several previous study related to local public transportation service [1], [3], [7], [8]. However, there are not enough to understand present state of local public transportation in Japan. In this situation, the aims of this study are follows. First, we clarify the present state of local public transportation services in Japan. Second, we clarify relation between local public

transportation services and population quantitatively. In order to achieve these aims, we analyze the contents shown in Fig. 1.

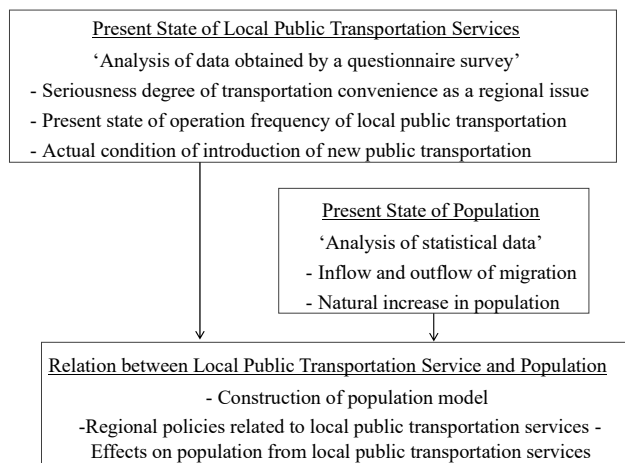


Fig. 1 Structure of paper

II. PRESENT STATE OF LOCAL PUBLIC TRANSPORTATION SERVICE FROM STAND POINT OF LOCAL MUNICIPALITIES

A. Viewpoints of Measure for Local Public Transportation Services and Summary of Questionnaire Survey

We explain the viewpoints of measure for local public transportation services in this study. International association of traffic and safety sciences said that “As for local municipalities where the public transportation services would not survive, enough local public transportation services are provided which are most required for residents living in regions in the book of ”Local transport plan developed by each region –Japanese version of guideline for developing LTP- [4]“. In many of such regions, public transportation services depend on sectors who pursuit economic profit. In Japan, many rural regions have issues corresponding to this remark. However, they have difficulties to insure equality of a moving opportunity for residents. In a broad sense, local public transportation services include not only railway or fixed-route bus, but also demand bus, taxi sharing and so on. Transportation modes excluding private cars working for residents’ travel are also becoming popular as local public transportation service.

In this study, we define the local public transportation services consisting of railway, bus and ship which are provided as traditional transportation modes. In addition, we regard demand bus, demand taxi and taxi sharing and so on as local public transportation services as well which are new public transportation services. We will carry out the questionnaire survey and analyze using data under these preconditions.

We conducted a questionnaire survey in all local municipalities of Japan in order to grasp the state of regional problems and directions of regional policies compared with data of the period of 2010. This questionnaire survey was conducted by mail in March 2014. In this survey, a response rate of 33.3% and the number of responses was 639.

B. Seriousness Degree of a Convenience in Use of Local Public Transportation as Regional Issues

Concerning regional issues in the questionnaire survey, we selected 20 items of issues in the life and convenience of transportation, and so on. and asked to what extent each municipality regards their problems using 5 categories; “5: very serious, 4: serious, 3: becoming a problem, 2: no problem, 1: no problem at all”. A distribution of serious degree of issues about convenience in use of local public transportation services are shown in Fig. 2.

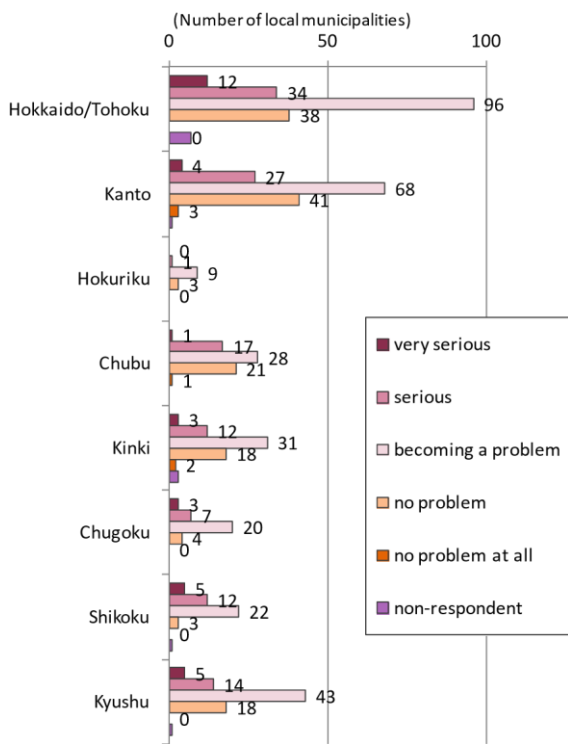


Fig. 2 The present state of transportation convenience

Areas are classified in three urban areas and five rural areas, general ways in Japan. Kanto area which includes Tokyo prefecture, Kinki area which includes Osaka and Kyoto prefectures and Chubu area which includes Aichi prefecture (Nagoya city) are regarded as urban area. We call these areas “Three metropolitan areas”. Other areas are called as rural areas.

As shown in Fig. 2, the ratio of becoming a problem in this issue is the highest percentage in all area. Some local municipalities which select item of no problem say that “Now we have some problems about local public transportation services, but these are not to say serious.” Unless they take measures for local public transportation issues, these issues may possibility turn to be serious in the regions in the near future.

C. Operation Frequency of Local Public Transportation

Concerning service frequency of local public transportation in the questionnaire survey, we selected 4 modes of transportation; “local railway, extra-regional railway, bus and ship” and asked how often these transportation services are offered, using 5 categories; “1: a few, 2: many, 3: abandon, 5: unnecessary”. Table I shows a present state of operation frequency of each transportation mode.

TABLE I
OPERATION FREQUENCY OF LOCAL PUBLIC TRANSPORTATION
“ALL OVER JAPAN”

	a few	many	abandon	nothing	un-necessary	non-responder
Local railway	308					
extra-regional railway						
bus	423					
ship	55					
Total	1,107	429				

Concerning awareness of operation frequency of local public transportation, number of local municipalities which answer a few is higher than these answer many in all transportation modes. From this result, there are many local municipalities which have a problem about operation frequency of local public transportation.

Table II shows operation frequency of local public transportation in each area which is regarded from a stand point of local municipalities.

We can see major disparity in awareness of operation frequency of local public transportation service between urban and rural areas. Concerning operation frequency of railway, there are a lot of problems in rural areas in comparison with in urban areas. On the other hand, local municipalities regard that operation frequency of bus is not enough for users in both urban and rural areas.

D. New Public Transportation Services

We can understand that there are many regions where have some regional issues related to local public transportation services. In many cases, these services are abandoned because their operation can be highly inefficient and unprofitable. This phenomenon is caused by the decreasing users and the change of the use form of the transportation facility in the user with the declining birth rate and depopulation on the background. In this situation, many ideas have been considered to ensure means of transportation according to the request of users and regional characteristics.

TABLE II
OPERATION FREQUENCY OF LOCAL PUBLIC TRANSPORTATION “EACH AREA”
The number of local municipalities answered “a few”

	local railway	extra-regional railway	bus	ship
Hokkaido /Tohoku				

	The number of local municipalities answered 'many'			
	local railway	extra-regional railway	bus	ship
Hokkaido /Tohoku				
Kanto				
Hokuriku				
Chubu				
Kinki				
Chugoku				
Shikoku				
Kyushu				
Total				

Table III shows present state of introduction of new public transportation services.

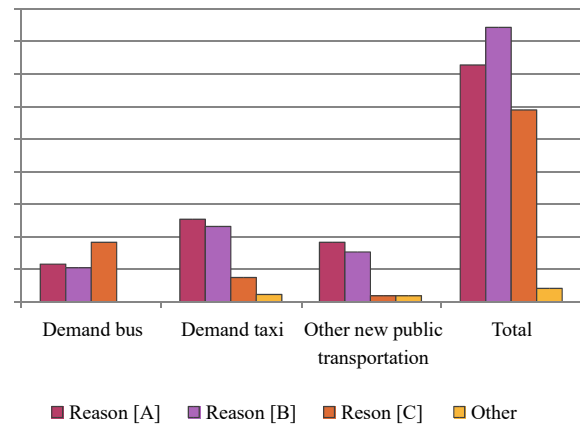
TABLE III
PRESENT STATE OF INTRODUCTION OF NEW PUBLIC TRANSPORTATION SERVICES

	demand taxi transportation	demand bus	other new public transportation	bus
Hokkaido /Tohoku				
Kanto				
Hokuriku				
Chubu				
Kinki				
Chugoku				
Shikoku				
Kyushu				
Total				

New public transportation services such as demand bus, demand taxi and so on are offered in several local municipalities. For example, types of operation are as follows; “Operation at fixed time (between home and a common destination)”, “Operation at fixed time (between bus stops)”, “Operation at required time (between home and a required destination)” and so on. Reservation method and operation time as well as types of operation are varied. Many useful ideas have been considered to ensure local public transportation services, the following are the examples. We can understand that some local municipalities provide services such as community bus, city bus and taxi subsidies.

Fig. 3 shows reasons of introduction of new public transportation services (multiple answers allowed).

(Number of local municipalities)



* Reason [A]: Promotion of administrative and financial efficiency
* Reason [B]: Securing transportation to weak people in transportation
* Reason [c]: Elimination of blank area related to public transportation services

Fig. 3 Reason of introduction of new public transportation

E. Relation between Introduction of New Public Transportation and Traffic Convenience

We clarify the relation between seriousness degree of a convenience in use of local public transportation as regional issues and presence or absence of new public transportation.

Table IV shows coefficient of correlation.

TABLE IV
COEFFICIENT OF CORRELATION RELATED NEW PUBLIC TRANSPORTATION SERVICES

	[a]	[b]	[c]	[d]	[e]
[a] worsening of convenience in use of public transportation "seriousness degree as regional issues"					
[b] introduction of demand bus	0.01	1			
[c] introduction of demand taxi	-0.10	-0.04	1		
[d] introduction of other new public transportation	-0.04	-0.08	-0.10	1	
[e] presence or absence of new public transportation	-0.08	0.37	0.55	0.51	1

From the result, there is no definite correlation between these indicators. This means that introduction of new transportation services cannot solve all issues.

III. PRESENT STATE OF POPULATION

We grasp present state of increase and decrease of population in Japan in 2014. Number of increase and decrease of population in a region consists of number of both natural increase and decrease in population (= “number of births” – “number of deaths”) and number of social increase and decrease (= “number

of inflow of migration” – “number of outflow of migration”). Fig. 4 shows population change in each area in 2014. Social increase and decrease by age group is shown in this figure. The numbers in this figure is values of number of increase and decrease in population (= “number of natural increase in population” + “number of excess inflow of population”).

Population is declining in all areas in Japan. Concerning social increase and decrease, excess inflow of migration (age 15-64) can be shown in only Kanto area which includes Tokyo prefecture. On the other hand, excess outflow of migration (over age 65) can be shown in only this area. From the results, working-age population has a tendency to move to Kanto area because of going to university or high school, getting employed, and job transfer. People have a tendency to leave from this area after retirement. Concerning natural increase and decrease in population, number of deaths is bigger than number of births in all areas in Japan recently.

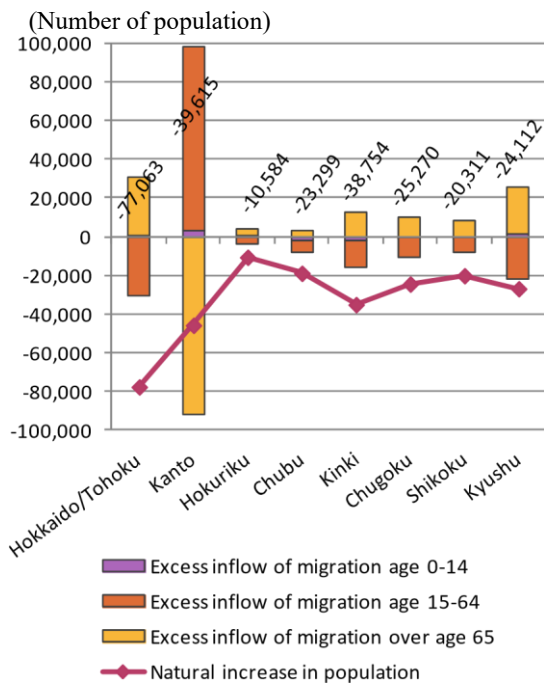


Fig. 4 Population change

IV. RELATION BETWEEN LOCAL PUBLIC TRANSPORTATION SERVICE AND POPULATION

A. Population Model

Number of population in local municipalities is affected by several matters such as socioeconomic condition. We consider that state of local public transportation services also has some effect on population in the regions. We clarify the effect on population in local municipalities from local public transportation services by constructing a model. We constructed a migration model based on the utility maximization theory [2].

In this study, we assumed a simple linear model shown as (1). Parameters of this model are estimated using data of the year 2014 [5], [6]. In order to clarify the influence of state of local public transportation services on population in local

municipalities specifically, variables which represent state of local public transportation are incorporated into the model.

$$P_i = aTC_i + bNT_i + cE_i + dTE_i + h \quad (1)$$

P_i : Population in region i ; TC_i : Worsening of convenience in use of public transportation “seriousness degree as regional issues” in region i ; NT_i : Presence or absence of new public transportation “Dummy variable” in region i ; E_i : Number of employee aged 15 and over in region i ; TE_i : Ratio of employee in the tertiary industry in region i ; a, b, c, d, h : Parameters. This model is estimated using multiple regression analysis. The estimation result is shown in Table V.

TABLE V
RESULT OF PARAMETER ESTIMATION OF POPULATION MODEL

Variable	Parameter	t-value
Worsening of convenience in use of public transportation "seriousness degree as regional issues"	-656.1	-2.3
Presence or absence of new public transportation	1,377.1	2.2
Number of employee aged 15 and over	2.1	406.7
Ratio of employee in the tertiary industry	214.1	8.0
Constant	-11,239.0	-6.6
Coefficient of determination R^2		0.997
Number of sample		

From the result, the following were clarified. It is obvious that working condition affects population in local municipalities. It is especially influenced from number of employee aged 15 and over which expresses the scale of the region. In addition, it is also influenced from ratio of employee in the tertiary industry which reflects whether the region is regarded as urban region or not.

We focus attention on the variables related to local public transportation services. It is influenced from seriousness degree of worsening of convenience in use of public transportation as regional issues. The value of parameter of it is negative, it means that population in a local municipality where has a problem related to traffic convenience. In addition, it is also influenced from presence or absence of new public transportation. Number of population in a region where introduces a new public transportation such as demand bus and demand taxi is larger than that of a region where does not introduce them. This result indicates the importance of offering local public transportation services as necessary.

B. Regional Policies Related to Local Public Transportation Service

A degree of importance of transport policy is asked in the questionnaire survey where a ‘10’ response is paramount importance. Fig. 5 shows distributions of these indexes for urban and rural regions. It means that the bigger the amount of index is the more important this policy.

From this result, there is little difference in tendency between urban and rural areas. A total of over 80% of municipalities responded that degree of importance is 1 to 5 which high importance is. We can say that the important degree of transportation policy is comparatively high in Japan.

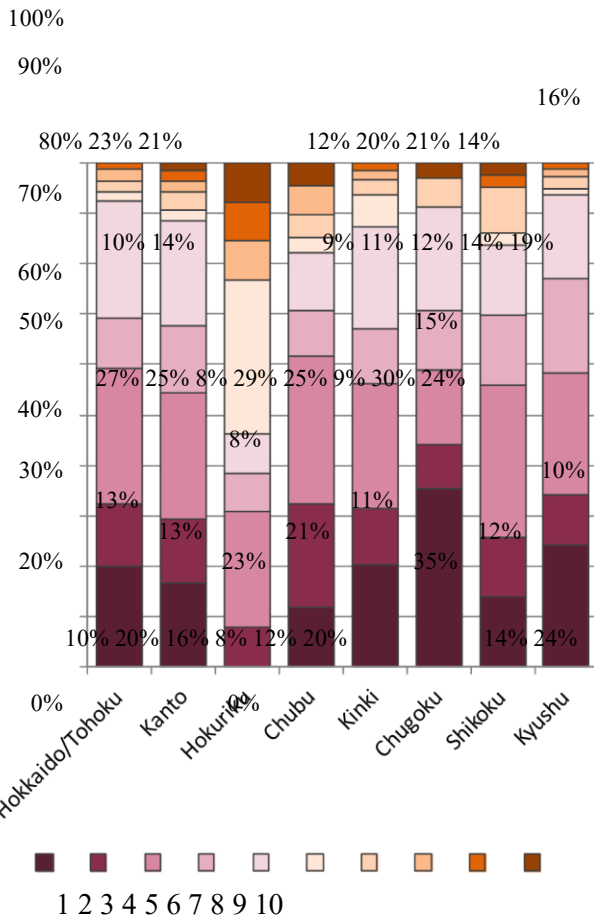


Fig. 5 Important degree of local public transportation measures

V. CONCLUSION

The aims of this study were to clarify the present state of local public transportation services in local municipalities and relation between local public transportation and population quantitatively.

Concerning the present state of transportation convenience, the ratio of becoming a problem in this issue is the highest percentage in all area. That needs some kind of countermeasure as regional policies. We focus attention on operation frequency of local public transportation services. Concerning operation frequency of railway, there are a lot of problems in rural areas in comparison with in urban areas. On the other hand, local municipalities regard that operation frequency of bus is not enough for users in many areas.

Because of depopulation and increase in the number of weak people in transportation, the number of local municipalities which offer new public transportation services has increased in rural areas. For example, these are demand bus, demand taxi and community bus. The reasons of introduction of these new public transportation services are follows. The biggest reason that some local municipalities introduce a demand bus is promotion of administrative and financial efficiency. They also introduce a demand taxi for the purpose of securing transportation to weak people in transportation and elimination of blank area related to public transportation services. We also clarify that present state of local public transportation services affect population in local

municipalities quantitatively by constructing the population model. From the result we can understand that number of population in a region where introduces a new public transportation is larger than that of a region where does not introduce them.

It is forecasted that the depopulation and aging population will progress rapidly in Japan. Under this situation, it is one of the most important issues that how we provide local public transportation services in response to the present state. The introduction of the new public transportation services is one of the most useful measures to the issues related to worsening of convenience in use of public transportation. We should continue to analyze and discuss about local public transportation services by referring to foregoing examples of similar cases

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