International review for spatial planning and sustainable development, Vol.3 No.4 (2015), 46-56
ISSN: 2187-3666 (online)
DOI: http://dx.doi.org/10.14246/irspsd.3.4_46

Study on Regional Characteristics and Exchanges Among Regions in Fukuoka Wide Area

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Received 3 August, 2014; Accepted 12 January, 2015

Key words: Spatial strategy, Regional characteristic, Fukuoka wide area, Exchange, Self-sufficiency

Abstract: The economy of Japan has been maturing in the beginning of the 21st century. However, the decrease of population, birth rate, and increase of the aging population are proceeding rapidly especially in local cities. As a result, it will become difficult to maintain functions of communities in the future, and it is also forecasted that regional gaps between cities and villages will become large. Being based on regional characteristics, strengthening a wide area in self-sufficiency and exchanges among regions might be called for. This study aims at clarifying the changes of regional characteristics and exchanges among the regions in the Fukuoka wide area, using statistical data and personal trip survey data over the recent decade, paying attention to a new structure of a wide area including cities and villages. As a result, in the Fukuoka wide area, it was made clear that there were six groups which were classified with principal component analysis and cluster analysis, and they have spread concentrically, and become complicated in the recent decade. It might have been influenced by the changes of population distribution and household composition. Moreover, the exchanges among the regions have been broadened in the recent decade. In the Fukuoka wide area, strengthening both self-sufficiency and exchanges among the regions will become important subjects in future.

1. INTRODUCTION

The economy of Japan has been maturing in the beginning of the 21st century. However, the decrease of population, birthrate, and increase of the aging population are proceeding rapidly especially in local cities. As a result, it will become difficult to maintain functions of communities in the future, and it is also forecasted that the regional gap between cities and villages will become large. The Ministry of Land, Infrastructure, Transport and Tourism of Japan published "The grand design of 21st century national land" in 1998. In this report, it is described that the structure of national land should be changed from the structure supported by a center and dependence, to a structure supported by autonomy and interdependence. Following this, in 2008, "National spatial planning" was published. In this plan, it is suggested that a spatial plan for a wide area should be made in collaboration with national, local government, and private sector. Thinking of problems in Japan, such as regional gaps, decrease of population, birthrate, and increase of its aging population, we must consider

a new structure for a local wide area including cities and villages as a spatial strategy. Being based on regional characteristics, strengthening self-sufficiency and exchanges among regions in a wide area might be called for.

This study aims at clarifying the changes of regional characteristics and exchanges among the regions in the Fukuoka wide area, using statistical data (national population census, census of commerce, census of manufacturing industry) and personal trip surveys, paying attention to a new structure of a wide area including cities and villages.

There are some previous papers which have analyzed plural cities in wide areas of Asian countries. For example, 42 Korean cities were analyzed by using principle component analysis and cluster analysis. As a result, 42 Korean cities were classified into six groups (Mitsuyoshi & Hagishima et al., 1988).

On the other hand, from the view point of exchanges, mobility in the life of inhabitants who live in 26 Japanese cities located in the prefecture edges was analyzed by using national census data (Kanie, 1997). In Japan, populations of Tokyo, Osaka, and Nagoya regions are much bigger than local regions. 91 local small population regions were analyzed using national census data (1960-1995) from the view point of fluctuation factors (Saitou & Yamagata, 1999).

Asian capital cities recently have grown, especially Bangkok metropolis, a typical one which has been formed over a wide area. 60 districts of Bangkok metropolis were analyzed by using principle component analysis (Nishiura et al., 2011). Based on these previous papers, our paper is developed.

To this end, this paper is organized as follows. Firstly, we show the background of this paper, especially the Japanese situation. Secondly, the study area is introduced. Thirdly, the methodology is discussed. Fourthly, an analysis by using statistical data is discussed. Next, an analysis by using personal trip survey data is discussed. Finally, conclusions are drawn and some avenues for future research are discussed.

2. STUDY AREA

The study area of this paper is the Fukuoka wide area, which is one of the four areas (that is, Fukuoka area, North Kyushu area, Chikugo area and Chikuho area) of Fukuoka prefecture (see Figure 1). We chose the Fukuoka area as the study area and call it the Fukuoka wide area in this paper because this area is very important not only for Fukuoka prefecture but also for the whole Kyushu area. It includes Fukuoka, Chikushino, Kasuga, Onojyo, Munakata, Dazaifu, Koga, Fukutsu, Asakura, Itoshima City, Nakagawa, Umi, Sasaguri, Shime, Sue, Shingu, Hisayama, Kasuya, Chikuzen Town, and Touhou Village. It consists of 20 municipalities. However, Fukuoka City is extremely bigger than the others; we then divided Fukuoka City into seven wards, that is, Higashi, Hakata, Chuou, Minami, Nishi, Jyonan and Sawara wards, resulting in 26 regions being analyzed (seven wards, nine cities, nine towns and one village).

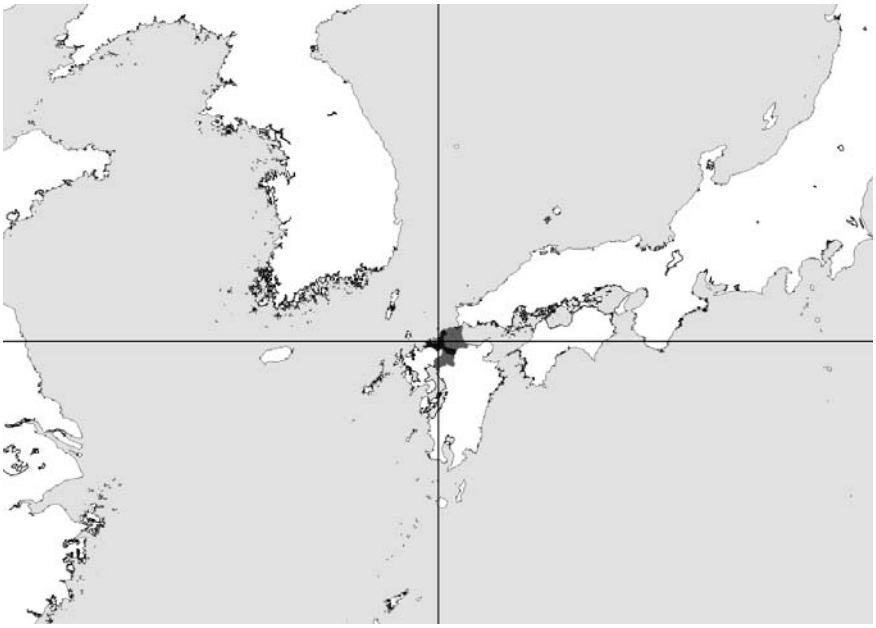


Figure 1. Study Area on Map

3. METHODOLOGY

We grasped and analyzed the changes of characteristics of regions in the Fukuoka wide area from 1995 to 2005 in principle by using the statistical data (national population census, census of commerce, census of manufacturing industry). The data were collected in 1995, 2000 and 2005. However, the census of commerce was taken in 1994, 1999 and 2004. Next, we used the third north Kyushu personal trip survey data, called 3PT (collected in 1993) and the fourth north Kyushu personal trip survey data, called 4PT (collected in 2005) in order to analyze the change of exchanges among the 26 regions (seven wards, nine cities, nine towns and one village) in the Fukuoka wide area.

3.1 Flow of analyses using statistical survey data

In this paragraph, we describe about the flow of analyses using statistical survey data.

Stage 1: We chose 18 indices to evaluate characteristics of regions from population census, census of manufacturing industry and census of commerce.

Stage 2: We analyzed these indices with principal component analysis and extracted evaluation axes in order to evaluate regions synthetically from the indices chosen in Stage 1.

Stage 3: Using scores which were obtained by principal component analysis we classified regions into six groups by using cluster analysis method.

3.2 Flow of analyses using personal trip survey data

In this paragraph, we described about the flow of analyses using personal trip survey data.

Stage 1: We removed samples of personal trip surveys where the trip number was 0 in order to grasp the exchanges among regions.

Stage 2: We extracted samples where origin and destination were both in the Fukuoka wide area and enlarged those samples by enlargement coefficients.

Stage 3: We made the OD trip table in the Fukuoka wide area by using those enlarged samples.

4. ANALYSES USING STATISTICAL SURVEY DATA

4.1 Selection of indices

Selected indices extracted from statistical data were population indices, household indices, business facility indices and so on. We selected 18 indices (see Table 1)which were transferred to proportional data or density data, except for the population and area data.

Table 1. Evaluation Index

	Index	Definition
1	Population	
2	Youth population ratio	Population of under 15 years old / population (%)
3	Productive age population ratio	Population of over 15 years old and under 65 years old / population (%)
4	Old age population ratio	Population of over 65 years old / population (%)
5	Area	
6	Population density	Population / area
7	Number of persons per household	Number of persons / number of general household
8	Nuclear family household ratio	Number of nuclear family household / number of general household (%)
9	Non-nuclear family household ratio	Number of non-nuclear family household / number of general household (%)
10	Non-relative household ratio	Number of non-relative family household / number of general household (%)
11	Single household ratio	Number of single household / number of general household (%)
12	Owned house ratio	Number of owned house / number of general household (%)
13	Public rental house ratio	Number of public rental house / number of general household (%)
14	Private rental house ratio	Number of private rental house / number of general household (%)
15	Wage house ratio	Number of wage house / number of general household (%)
16	Rental room ratio	Number of rental room / number of general household (%)
17	Enterprise density (Manufacturing industry)	Number of enterprise / area
18	Enterprise density (Commerce)	Number of enterprise / area

Source of 1～16 : National population census, 17 : Census of manufacturing industry, 18 : Census of commerce

4.2 Extraction evaluation axes with principal component analysis

In order to evaluate 18 indices synthetically, we extracted some synthetic components by using principal component analysis. The contribution value of the first principal component was 52.46% and that of the second principal component was 16.20%, the accumulated value of both was 68.66%. From this result, we judged these two principal components are important (see Table 2).

The first principal component showed bigger positive load values in the indices of population, productive age population ratio, population density, single household ratio, private rental house ratio, wage house ratio and business facility density, which were from the censuses of the manufacturing industry and commerce, and showed negative load values in the indices of the number of persons per household, the other related family household ratio and owned house ratio. Then we interpreted the first principal component as an urbanized grade criterion.

The second principal component showed positive load values in the indices of youth population ratio, nuclear family household ratio, which were from the censuses of the manufacturing industry and commerce, and showed negative load values in the indices of the old age population ratio. Then we interpreted the second principal component as the child-rearing household dwelling grade criterion.

Table 2. Principal Component Value, Eigenvalue, Contribution

Index	First synthetic component	Second synthetic component	Third synthetic component
Population	0.705	-0.221	0.568
Youth population ratio	-0.338	0.791	0.242
Productive age population ratio	0.811	0.436	0.116
Old age population ratio	-0.594	-0.721	-0.207
Area	-0.441	-0.279	0.571
Population density	0.865	-0.156	-0.097
Number of persons per household	-0.945	0.161	-0.061
Nuclear family household ratio	-0.465	0.788	0.048
Non-nuclear family household ratio	-0.823	-0.399	-0.144
Non-relative household ratio	0.558	0.160	-0.291
Single household ratio	0.923	-0.337	0.072
Owned house ratio	-0.968	-0.092	-0.111
Public rental house ratio	0.506	-0.424	0.531
Private rental house ratio	0.929	0.171	-0.033
Wage house ratio	0.676	0.359	0.157
Rental room ratio	0.571	0.162	-0.441
Enterprise density (Manufacturing industry)	0.677	-0.065	-0.415
Enterprise density (Commerce)	0.796	-0.327	-0.222
Eigenvalue	9.44	2.92	1.63
Contribution	52.46%	16.20%	9.03%
Accumulation	52.46%	68.66%	77.69%

4.3 Classification of regions with cluster analysis method

We classified 26 regions using a cluster analysis method by using principal component scores which were obtained by the principal component analysis. Distances between samples were calculated in Euclidean distances and distances between clusters were calculated with Ward method. In this analysis we had 26 regions and each region had three years' data (1995, 2000 and 2005). We used 78 samples. As a result, we could classify 78 samples into six groups (see Figure 2). Table 3 showed the names of regions, divided numbers and group numbers for each year. Next, we described each characteristic of six groups by using average values of evaluation indices (Table 4) and average values of principal components (Table 5).

Table 3. Group Composition

1995		
Region name	Number of 50 division	Number of group
Hakata ward	2	1
Chuou ward	3	
Higashi ward	1	2
Minami ward	4	
Jyonan ward	6	
Kasuga city	9	3
Onojyo city	10	
Nakagawa town	17	
Umi town	18	
Shime town	10	
Shingu town	20	
Kasuya town	22	
Nishi ward	5	4
Sawara ward	7	
Chikushino city	8	
Dazaifu city	12	
Koga city	13	
Sasaguri town	19	
Sue town	19	
Munakata city	11	5
Fukutsu city	14	
Itoshima city	16	
Hisayama town	21	
Chikuzen town	23	
Asakura city	15	6
Touhou village	24	

2000		
Region name	Number of 50 division	Number of group
Hakata ward	26	1
Chuou ward	27	
Higashi ward	25	2
Minami ward	6	
Jyonan ward	29	
Kasuga city	32	3
Nakagawa town	20	
Shingu town	38	
Kasuya town	10	
Nishi ward	28	4
Sawara ward	30	
Chikushino city	31	
Onojyo city	33	
Dazaifu city	5	
Koga city	8	
Umi town	8	
Sasaguri town	13	
Shime town	37	
Munakata city	34	5
Fukutsu city	35	
Itoshima city	21	
Sue town	11	
Hisayama town	21	
Chikuzen town	23	
Asakura city	36	6
Touhou village	39	

2005		
Region name	Number of 50 division	Number of group
Hakata ward	26	1
Chuou ward	41	
Higashi ward	40	2
Minami ward	29	
Jyonan ward	42	
Nakagawa town	48	3
Shingu town	22	
Kasuya town	32	
Nishi ward	28	4
Sawara ward	43	
Chikushino city	44	
Kasuga city	33	
Onojyo city	37	
Koga city	44	
Umi town	31	
Sasaguri town	8	
Shime town	7	
Munakata city	45	5
Dazaifu city	46	
Fukutsu city	45	
Itoshima city	47	
Sue town	34	
Hisayama town	47	
Chikuzen town	49	
Asakura city	36	6
Touhou village	50	

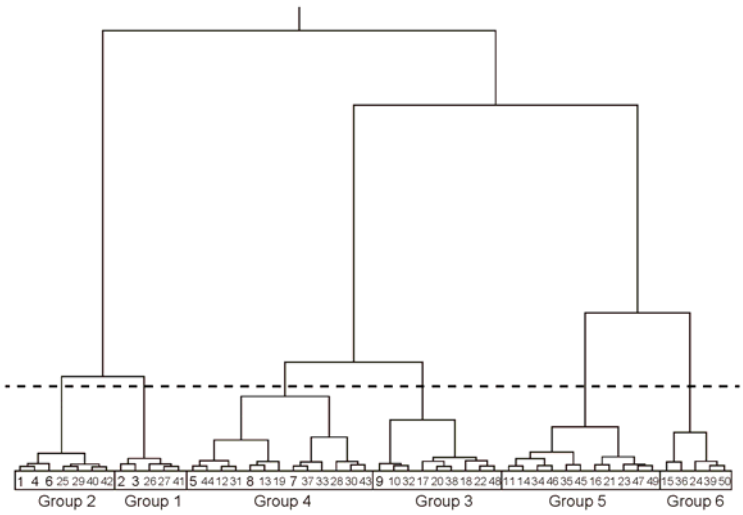


Figure 2. Dendrogram

Table 4. Average Value of Evaluation Index

1995

	Population (persons)	Youth population ratio (%)	Productive age population ratio (%)	Old age population ratio (%)	Area (km^2)	Population density (persons/km^2)	Number of persons per household (persons)	Nuclear family household ratio (%)	Non-nuclear family household ratio (%)	Non-relative household ratio (%)	Single household ratio (%)	Owned house ratio (%)	Public rental house ratio (%)	Private rental house ratio (%)	Wage house ratio (%)	Rental room ratio (%)	Enterprise density (manufacturing industry) (/km^2)	Enterprise density (commerce) (/km^2)
G1	154,458	13.19	74.52	11.83	23.31	7300.34	2.00	41.41	6.03	0.55	52.01	25.83	10.66	50.53	7.60	1.09	16.62	313.89
G2	208,139	16.04	73.09	10.54	37.11	6507.99	2.32	51.37	6.95	0.38	41.30	35.04	10.26	45.77	5.40	0.74	5.30	73.36
G3	49,730	19.54	69.99	10.36	26.85	2754.46	3.00	67.23	12.45	0.41	19.91	55.40	2.87	32.51	5.77	0.93	5.40	32.18
G4	85,721	17.64	69.71	12.44	56.33	1484.26	2.94	65.31	13.12	0.28	21.29	59.90	6.62	26.48	3.83	0.67	2.25	13.08
G5	52,872	17.48	66.52	15.96	98.60	1105.73	3.32	63.58	22.33	0.16	13.93	79.24	4.62	12.40	1.82	0.58	0.72	5.48
G6	32,855	16.59	58.98	24.43	149.33	447.68	3.53	46.07	38.71	0.06	15.15	84.72	5.39	7.08	1.68	0.51	0.77	2.56

2000

	Population (persons)	Youth population ratio (%)	Productive age population ratio (%)	Old age population ratio (%)	Area (km^2)	Population density (persons/km^2)	Number of persons per household (persons)	Nuclear family household ratio (%)	Non-nuclear family household ratio (%)	Non-relative household ratio (%)	Single household ratio (%)	Owned house ratio (%)	Public rental house ratio (%)	Private rental house ratio (%)	Wage house ratio (%)	Rental room ratio (%)	Enterprise density (manufacturing industry) (/km^2)	Enterprise density (commerce) (/km^2)
G1	166,162	11.55	74.80	13.30	23.32	7871.40	1.88	38.76	5.20	0.71	55.33	26.91	10.61	51.45	5.96	1.31	14.24	299.16
G2	212,938	14.37	72.13	13.03	37.69	6605.37	2.22	50.25	6.14	0.65	42.97	36.47	9.91	45.46	4.64	1.15	4.73	70.31
G3	52,002	18.33	69.90	11.55	30.53	2924.38	2.82	66.58	10.18	0.69	22.55	52.34	1.71	36.04	6.19	1.15	3.36	30.48
G4	86,631	16.24	69.63	13.88	49.32	2045.63	2.78	65.45	10.88	0.49	23.18	57.93	5.71	29.50	3.87	1.10	3.41	22.46
G5	50,754	15.51	66.67	17.63	84.89	1220.77	3.12	64.76	19.16	0.28	15.80	77.86	4.41	13.63	1.80	0.75	1.94	6.51
G6	32,328	14.43	57.35	28.19	149.33	433.45	3.31	47.32	34.76	0.06	17.86	83.11	5.16	8.16	1.50	0.67	0.71	2.52

2005

	Population (persons)	Youth population ratio (%)	Productive age population ratio (%)	Old age population ratio (%)	Area (km^2)	Population density (persons/km^2)	Number of persons per household (persons)	Nuclear family household ratio (%)	Non-nuclear family household ratio (%)	Non-relative household ratio (%)	Single household ratio (%)	Owned house ratio (%)	Public rental house ratio (%)	Private rental house ratio (%)	Wage house ratio (%)	Rental room ratio (%)	Enterprise density (manufacturing industry) (/km^2)	Enterprise density (commerce) (/km^2)
G1	181,406	10.70	72.15	14.25	23.32	8620.70	1.82	37.22	4.65	1.13	57.00	28.28	9.78	53.44	4.64	1.16	10.15	279.32
G2	216,504	13.57	70.43	15.30	38.09	6688.27	2.18	50.76	5.92	0.79	42.52	38.53	9.86	45.10	3.79	1.10	3.40	61.10
G3	36,035	17.47	69.00	13.50	36.01	1511.73	2.78	66.83	10.33	1.26	21.57	53.98	0.67	38.04	4.50	0.95	2.88	16.90
G4	94,922	15.86	68.19	15.59	47.60	2736.77	2.68	65.35	9.58	0.68	24.39	56.49	5.85	31.69	3.45	0.97	2.95	27.03
G5	53,957	14.23	65.73	19.99	77.00	1074.17	2.91	64.60	16.20	0.42	18.78	73.91	3.74	19.18	1.70	0.59	1.66	8.68
G6	31,067	12.67	56.22	31.07	149.33	380.00	3.16	49.34	31.90	0.26	18.50	82.55	5.85	8.74	1.22	0.64	0.65	2.62

Table 5. Average Value of Principal Component

1995

	First principal component (urbanized grade criterion)	Second principal component (child-rearing household dwelling grade criterion)
G1	20.191	-2.905
G2	10.946	-0.404
G3	0.034	3.995
G4	-2.238	1.689
G5	-9.780	0.004
G6	-14.934	-4.923

2000

	First principal component (urbanized grade criterion)	Second principal component (child-rearing household dwelling grade criterion)
G1	20.911	-4.035
G2	11.946	-1.355
G3	1.836	3.804
G4	0.336	1.398
G5	-7.902	-0.556
G6	-14.030	-6.153

2005

	First principal component (urbanized grade criterion)	Second principal component (child-rearing household dwelling grade criterion)
G1	20.261	-4.867
G2	10.965	-2.167
G3	0.626	3.319
G4	0.817	0.749
G5	-6.751	-1.320
G6	-13.483	-7.090

Group 1 was estimated as high economic activity and high density central regions because population density, business facility density (manufacturing industry and commerce) and the first principal component score were high.

Group 2 was estimated as urbanized and specialized in single household dwelling regions because of the productive population ratio, population

density, single house hold ratio, business facility density (commerce) and the first principal component score showed the urbanized grade was high.

Group 3 was estimated as intermediate density and specialized in child-rearing household dwelling regions because population, business facility density (manufacturing industry and commerce) were intermediate, and the second principal component score which showed the child-rearing household dwelling grade was high.

Group 4 was estimated as intermediate density and specialized in nuclear house hold dwelling regions because population density, business facility density (manufacturing industry and commerce) were intermediate and the nuclear household ratio was high.

Group 5 was estimated as low density and specialized in nuclear household dwelling regions because population, business facility density (manufacturing industry and commerce) were intermediate and the nuclear household ratio was high.

Group 6 was estimated as low urbanized regions, where conservative lifestyles are kept, because the other related household ratio and owned house ratio were very high and population density, business facility density (manufacturing industry and commerce) were very low.

Next, we described the relationships of two principal components and six group geographical positions by using the distribution of the six groups (Figure 3) and the changes of the scattering patterns of regions (Figure 4). Each group was distributed in the shape of the circles which shares the same center. Group 1 which was in the central position shows the highest value of the first principal component score. The greater the distance from the center becomes, the lower the first principal component score of the group becomes.

Figure 4 showed that in the changing of time (1995-2000-2005), Kasuga, Onojyou City, and Umi and Shime towns moved from Group 3 to Group 4 and Dazaifu City and Sue Town moved from Group 4 to Group 5.

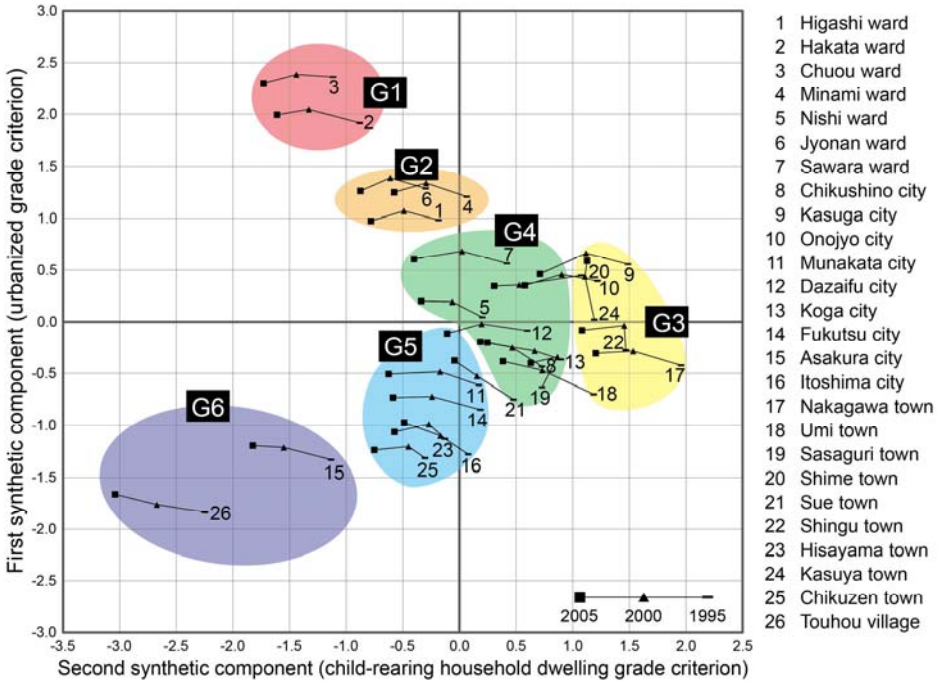


Figure 3. Geographical Distribution of Group

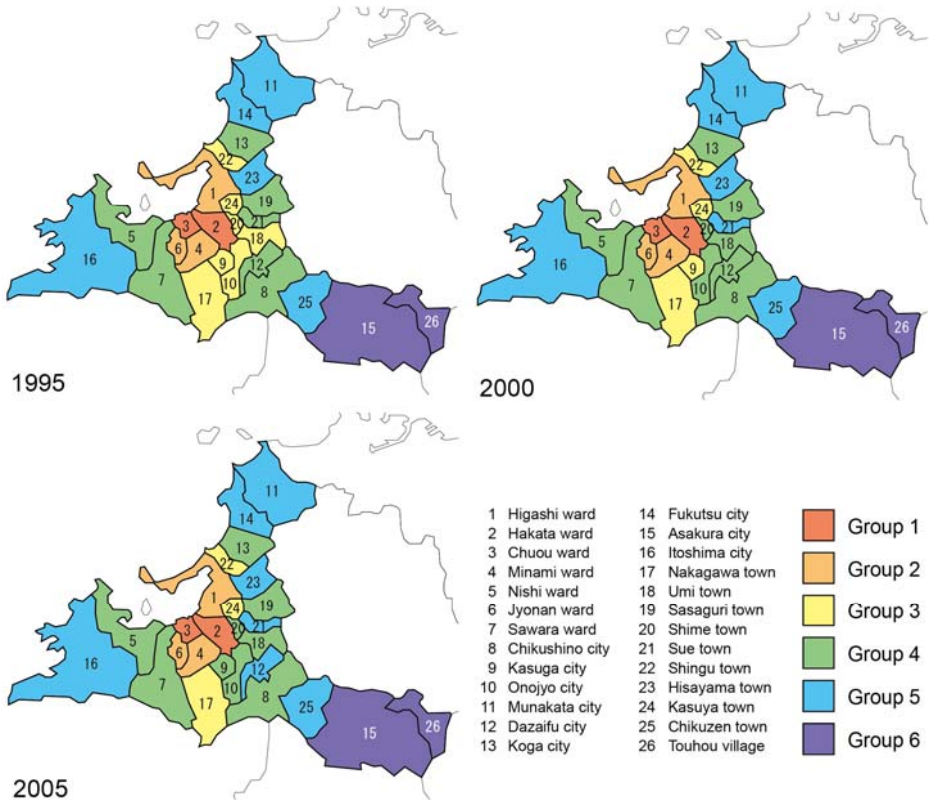


Figure 4. Change of Scattering Pattern of Region

5. ANALYSES USING PERSONAL TRIP SURVEY DATA

In this chapter, we made the OD table where values are transferred to the ratios for all in 3PT and 4PT and showed the change of exchanges among regions clear. Table 6 and Table 7 show the OD trip ratio for the sum of all generated trips of 3PT and 4PT. If the value of each cell was more than the average (1.70% in 3PT and 1.81% in 4PT), they were shown as emphasized cells. We counted the emphasized cells in each horizontal line and defined the number which showed the generation grade. In the same way, we counted the emphasized cells in each vertical column and defined the number which shows the attraction grade.

Table 6 and Table 7 show the generation grade in vertical columns, and attraction grade in horizontal lines. If Hisayama Town had an attraction grade of 1 and a generation grade of 10 it was positioned at the coordinate (1, 10), as shown in Figure 5. The region name with an underline means 4PT, otherwise the region is 3PT. In this figure, we classified 26 regions in four quadrants, that is, self sufficient type (small both in generation and attraction grade), absorbent type (small in generation grade and big in attraction grade), divergent type (small in attraction grade and big in generation grade) and central type (big both in generation and attraction grade). In the Fukuoka wide area, regions of divergent type were the most and that of absorbent type were the least. Only one absorbent type was identified, Higashi ward. It seemed that the generation grade became higher and many regions came to exchange with each other more

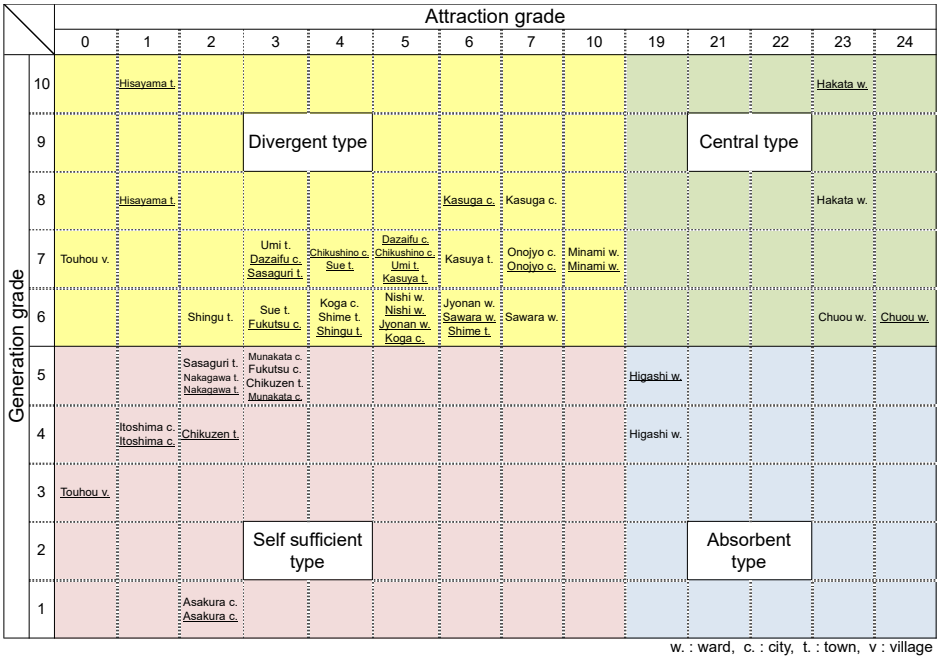
from 1993 to 2005. Sasaguri and Sue town increased in both generation and attraction grade, meaning that they strengthened their centrality grade. Toho village decreased in generation grade and changed from divergent type to self-sufficient type.

Table 6. OD Table of 3PT

	1 Higashi ward	2 Hakata ward	3 Chuou ward	4 Minami ward	5 Nishi ward	6 Jyonan ward	7 Sawara ward	8 Chikushino city	9 Kasuga city	10 Onojyo city	11 Munakata city	12 Dazaifu city	13 Koga city	14 Fukutsu city	15 Asakura city	16 Itoshima city	17 Nakagawa town	18 Umi town	19 Sasaguri town	20 Shime town	21 Sue town	22 Shingu town	23 Hisayama town	24 Kasuya town	25 Chikuzen town	26 Touhou village
1 Higashi ward	66.22	9.89	5.84	2.06	0.96	1.07	1.33	0.40	0.56	0.64	1.02	0.47	1.50	0.99	0.07	0.31	0.20	0.66	0.56	0.79	0.54	1.63	0.48	1.72	0.09	0.00
2 Hakata ward	8.13	46.63	10.55	7.53	2.79	2.46	3.80	1.41	2.87	2.86	0.90	1.36	0.85	0.66	0.25	0.80	0.86	0.78	0.53	1.58	0.54	0.45	0.20	1.02	0.19	0.00
3 Chuou ward	5.46	11.33	45.34	8.84	4.32	6.03	8.00	1.21	1.51	1.28	0.60	1.19	0.49	0.43	0.16	1.19	0.54	0.27	0.24	0.39	0.21	0.25	0.06	0.48	0.18	0.00
4 Minami ward	2.28	9.97	10.51	61.76	0.93	3.09	1.76	0.99	2.70	1.41	0.19	0.95	0.13	0.10	0.11	0.29	1.74	0.20	0.08	0.25	0.15	0.06	0.06	0.23	0.08	0.00
5 Nishi ward	1.99	6.26	8.66	1.63	62.55	2.09	9.85	0.11	0.22	0.25	0.08	0.27	0.09	0.11	0.01	5.26	0.08	0.05	0.02	0.10	0.06	0.04	0.04	0.13	0.03	0.00
6 Jyonan ward	2.24	6.61	14.40	6.00	2.34	54.19	9.63	0.46	0.57	0.46	0.24	0.52	0.13	0.17	0.06	0.71	0.39	0.05	0.13	0.29	0.10	0.11	0.04	0.11	0.05	0.00
7 Sawara ward	1.95	6.13	11.20	2.03	6.96	5.64	62.41	0.30	0.28	0.34	0.16	0.35	0.12	0.14	0.07	1.08	0.25	0.03	0.08	0.11	0.04	0.08	0.04	0.17	0.04	0.00
8 Chikushino city	1.47	6.13	4.77	3.17	0.29	0.75	0.77	61.10	2.83	3.33	0.15	10.61	0.13	0.02	0.75	0.12	0.62	0.31	0.13	0.15	0.21	0.06	0.06	0.21	1.86	0.00
9 Kasuga city	1.82	10.03	4.44	7.09	0.37	0.77	0.71	2.29	58.68	7.57	0.10	1.99	0.08	0.04	0.13	0.19	2.70	0.18	0.06	0.31	0.20	0.01	0.01	0.11	0.11	0.00
10 Onojyo city	2.00	11.34	4.63	4.02	0.47	0.79	0.87	3.07	8.68	53.42	0.12	6.37	0.11	0.14	0.26	0.05	1.18	1.00	0.15	0.45	0.23	0.09	0.02	0.24	0.30	0.00
11 Munakata city	3.69	3.84	2.28	0.52	0.15	0.36	0.34	0.05	0.15	0.19	78.28	0.15	2.44	6.00	0.00	0.11	0.09	0.06	0.12	0.03	0.13	0.80	0.07	0.16	0.00	0.00
12 Dazaifu city	2.05	6.71	5.49	3.74	0.53	0.95	1.05	12.51	2.77	7.97	0.18	51.13	0.18	0.16	0.62	0.15	0.87	0.76	0.18	0.52	0.40	0.04	0.07	0.40	0.56	0.02
13 Koga city	7.89	5.01	2.67	0.56	0.28	0.37	0.44	0.19	0.10	0.21	3.56	0.26	65.04	6.98	0.10	0.06	0.07	0.27	0.69	0.09	0.31	3.61	0.47	0.74	0.03	0.00
14 Fukutsu city	5.41	4.28	2.34	0.48	0.27	0.47	0.59	0.08	0.10	0.16	9.34	0.29	6.98	67.23	0.00	0.20	0.02	0.07	0.04	0.12	0.06	1.16	0.08	0.20	0.03	0.00
15 Asakura city	0.29	1.33	0.92	0.58	0.02	0.13	0.23	1.17	0.17	0.37	0.00	0.62	0.07	0.02	86.81	0.06	0.08	0.12	0.03	0.05	0.02	0.00	0.00	0.05	6.70	0.16
16 Itoshima city	0.99	3.42	4.23	0.87	9.29	1.09	2.89	0.07	0.19	0.09	0.08	0.12	0.07	0.10	0.03	76.22	0.07	0.05	0.02	0.01	0.00	0.07	0.00	0.05	0.00	0.00
17 Nakagawa town	1.69	7.38	4.23	11.94	0.47	1.50	1.27	1.27	7.17	2.98	0.19	1.57	0.10	0.03	0.00	0.24	56.93	0.11	0.09	0.17	0.17	0.03	0.04	0.23	0.20	0.00
18 Umi town	5.37	7.85	2.09	1.58	0.24	0.18	0.33	0.45	0.53	2.27	0.09	1.52	0.46	0.11	0.16	0.12	0.12	61.13	0.91	5.72	4.00	0.25	0.32	4.11	0.08	0.00
19 Sasaguri town	6.77	7.55	3.02	0.77	0.20	0.71	0.88	0.47	0.28	0.62	0.35	0.48	1.45	0.16	0.00	0.00	0.19	0.91	64.41	1.35	1.59	0.70	2.17	4.97	0.00	0.00
20 Shime town	5.71	13.81	3.03	1.58	0.35	1.15	0.57	0.29	0.79	1.02	0.11	0.91	0.27	0.25	0.04	0.00	0.07	6.04	0.69	52.56	6.05	0.33	0.32	3.85	0.20	0.00
21 Sue town	6.36	7.64	2.55	1.47	0.40	0.69	0.29	0.64	0.57	1.03	0.48	0.88	0.63	0.20	0.06	0.00	0.37	6.10	1.53	9.59	52.82	0.31	0.54	4.52	0.36	0.00
22 Shingu town	20.09	6.18	3.18	0.45	0.25	0.71	0.73	0.14	0.09	0.19	3.10	0.27	9.39	3.08	0.07	0.20	0.05	0.45	0.66	0.63	0.47	48.03	0.91	0.65	0.06	0.00
23 Hisayama town	13.57	7.03	2.47	1.46	0.59	0.67	0.69	0.54	0.00	0.63	0.58	0.64	2.37	0.29	0.10	0.00	0.00	0.89	5.31	2.14	1.68	2.13	51.10	5.11	0.00	0.00
24 Kasuya town	14.29	9.69	4.30	1.56	0.45	0.35	1.07	0.47	0.54	0.63	0.30	0.86	1.09	0.35	0.04	0.17	0.25	4.17	3.51	4.17	3.27	0.53	1.49	46.29	0.13	0.00
25 Chikuzen town	1.18	2.63	2.45	1.02	0.10	0.35	0.35	5.44	0.36	1.00	0.00	1.80	0.06	0.00	15.89	0.00	0.37	0.11	0.06	0.26	0.23	0.05	0.04	0.24	65.73	0.27
26 Touhou village	0.00	0.00	0.00	0.00	0.00	5.33	7.69	0.00	6.80	6.21	0.00	6.80	0.00	0.00	32.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	34.32	0.00

Table 7. OD Table of 4PT

	1 Higashi ward	2 Hakata ward	3 Chuou ward	4 Minami ward	5 Nishi ward	6 Jyonan ward	7 Sawara ward	8 Chikushino city	9 Kasuga city	10 Onojyo city	11 Munakata city	12 Dazaifu city	13 Koga city	14 Fukutsu city	15 Asakura city	16 Itoshima city	17 Nakagawa town	18 Umi town	19 Sasaguri town	20 Shime town	21 Sue town	22 Shingu town	23 Hisayama town	24 Kasuya town	25 Chikuzen town	26 Touhou village
1 Higashi ward	63.69	9.95	6.27	1.90	1.12	0.92	1.80	0.47	0.59	0.59	1.04	0.60	1.84	0.93	0.10	0.39	0.24	0.40	0.68	0.80	0.56	2.49	0.82	1.75	0.04	0.00
2 Hakata ward	9.10	42.69	11.01	7.43	3.08	2.38	4.21	1.88	3.06	2.84	1.06	1.34	0.96	0.80	0.18	0.94	1.01	1.06	0.53	1.90	0.46	0.43	0.17	1.33	0.15	0.00
3 Chuou ward	5.45	10.16	44.27	9.23	4.29	6.59	7.50	1.58	1.66	1.46	0.71	1.27	0.58	0.44	0.17	1.14	0.75	0.43	0.34	0.70	0.20	0.22	0.10	0.61	0.15	0.00
4 Minami ward	2.37	10.52	13.45	55.82	1.08	3.53	2.17	0.89	3.31	1.49	0.18	0.71	0.12	0.07	0.11	0.31	2.36	0.27	0.12	0.27	0.14	0.12	0.05	0.40	0.12	0.00
5 Nishi ward	2.05	5.88	8.21	1.49	61.23	2.42	10.74	0.13	0.19	0.26	0.06	0.33	0.06	0.08	0.07	6.01	0.19	0.07	0.07	0.23	0.03	0.03	0.01	0.13	0.03	0.00
6 Jyonan ward	2.35	6.49	18.11	6.92	3.38	46.53	10.73	0.58	0.69	0.53	0.34	0.64	0.52	0.13	0.07	0.48	0.71	0.03	0.15	0.19	0.10	0.09	0.06	0.13	0.06	0.00
7 Sawara ward	2.53	6.49	11.72	2.35	8.69	5.91	57.66	0.31	0.43	0.40	0.23	0.32	0.09	0.14	0.06	1.37	0.43	0.14	0.07	0.16	0.09	0.11	0.03	0.24	0.02	0.00
8 Chikushino city	1.57	6.23	5.34	2.04	0.23	0.80	0.60	61.12	2.46	4.18	0.10	10.10	0.12	0.14	0.78	0.06	0.56	0.58	0.13	0.19	0.07	0.05	0.10	0.20	2.27	0.00
9 Kasuga city	1.90	9.98	5.29	7.33	0.37	1.01	0.82	2.57	54.31	8.63	0.24	2.29	0.11	0.06	0.12	0.07	3.52	0.37	0.12	0.27	0.09	0.00	0.06	0.35	0.12	0.00
10 Onojyo city	1.96	10.19	5.34	3.87	0.51	0.74	1.10	4.42	9.13	52.76	0.16	5.35	0.16	0.18	0.35	0.20	1.04	0.77	0.10	0.59	0.29	0.07	0.04	0.46	0.19	0.02
11 Munakata city	3.34	3.75	2.57	0.42	0.18	0.49	0.48	0.12	0.23	0.16	77.92	0.20	2.78	5.45	0.00	0.11	0.07	0.15	0.21	0.16	0.13	0.72	0.04	0.21	0.06	0.01
12 Dazaifu city	2.53	6.63	6.75	2.78	1.00	1.08	1.19	15.32	3.42	7.40	0.29	46.45	0.51	0.14	0.73	0.32	0.76	0.87	0.25	0.30	0.39	0.05	0.08	0.27	0.51	0.00
13 Koga city	9.03	5.32	3.31	0.38	0.19	1.02	0.41	0.20	0.18	0.36	4.20	0.57	59.25	9.21	0.00	0.18	0.11	0.15	0.57	0.11	0.39	4.01	0.35	0.49	0.00	0.00
14 Fukutsu city	5.19	4.83	2.63	0.40	0.25	0.31	0.61	0.28	0.11	0.28	9.35	0.16	10.29	61.96	0.02	0.13	0.07	0.23	0.19	0.14	0.12	1.93	0.19	0.31	0.00	0.00
15 Asakura city	0.37	0.85	0.79	0.38	0.17	0.11	0.25	1.27	0.13	0.46	0.00	0.65	0.00	0.00	87.86	0.00	0.07	0.03	0.00	0.03	0.10	0.11	0.05	0.02	6.11	0.19
16 Itoshima city	1.03	2.78	3.57	0.58	9.47	0.64	2.79	0.06	0.07	0.17	0.06	0.22	0.14	0.05	0.00	78.06	0.09	0.02	0.01	0.06	0.01	0.04	0.05	0.05	0.00	0.00
17 Nakagawa town	1.70	7.28	5.37	11.48	0.69	1.50	1.73	1.06	7.59	2.12	0.05	1.05	0.16	0.05	0.15	0.23	56.75	0.38	0.03	0.15	0.10	0.00	0.00	0.21	0.17	0.00
18 Umi town	3.42	10.55	4.00	1.81	0.42	0.19	0.86	1.70	0.92	2.32	0.36	1.41	0.32	0.32	0.00	0.02	0.56	51.96	1.65	5.27	6.38	0.58	0.80	4.14	0.05	0.00
19 Sasaguri town	8.04	6.43	4.55	1.12	0.40	0.70	1.08	0.48	0.30	0.33	0.59	0.72	1.17	0.38	0.13	0.09	0.06	2.33	56.29	2.76	1.77	1.12	3.15	5.94	0.07	0.00
20 Shime town	5.96	15.29	5.42	1.77	0.55	0.60	0.80	0.52	0.80	1.00	0.40	0.30	0.34	0.22	0.00	0.13	0.20	4.49	1.71	46.44	4.51	0.61	0.35	7.59	0.00	0.00
21 Sue town	6.23	5.77	2.42	1.58	0.14	0.40	1.01	0.31	0.21	0.93	0.55	1.39	1.26	0.26	0.20	0.05	0.32	8.62	1.90	8.09	48.07	0.83	1.12	8.32	0.00	0.00
22 Shingu town	24.30	4.97	2.37	0.81	0.20	0.38	0.53	0.16	0.00	0.20	2.24	0.30	8.07	3.09	0.24	0.10	0.00	0.60	0.77	0.71	0.69	47.57	0.94	0.77	0.00	0.00
23 Hisayama town	23.82	5.68	4.40	1.38	0.25	0.79	0.57	0.76	0.38	0.78	0.57	0.52	2.74	0.49	0.00	0.55	0.00	2.75	7.52	1.99	2.68	3.03	32.39	5.94	0.00	0.00
24 Kasuya town	11.35	9.60	4.37	1.73	0.52	0.34	1.16	0.43	0.54	1.00	0.49	0.21	0.64	0.48	0.03	0.22	0.16	3.03	3.39	7.23	4.41	0.60	1.09	46.90	0.08	0.00
25 Chikuzen town	0.57	2.43	2.30	1.12	0.20	0.36	0.17	9.55	0.61	1.01	0.00	1.37	0.00	0.00	17.85	0.00	0.36	0.08	0.17	0.00	0.00	0.00	0.00	0.23	61.62	0.00
26 Touhou village	0.00	0.00	6.58	0.00	0.00	0.00	0.00	0.00	0.00	7.34	0.00	0.00	0.00	0.00	64.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.77



w. : ward, c. : city, t. : town, v : village

*Figure 5.*Generation Grade and Attraction Grade (3PT and 4PT)

6. CONCLUSIONS

In this study, we have classified characteristics of regions into six groups with principal component analysis and cluster analysis and made the changes of them clear from 1995 to 2005. Next, we have clarified the change of exchanges among regions in the Fukuoka wide area by using personal trip survey data from 1993 to 2005.

In the Fukuoka wide area, we identified six groups of regions in a circular distribution pattern and Hakata and Chuo ward were the center of these regional groups. In the decade from 1995 to 2005, some regions which were located in the intermediate band of the circular distribution pattern moved from one group to another group and the circular distribution pattern was distorted to a complicated pleated shape. As a whole, urbanization has matured and child-rearing households have decreased, resulting in the urbanized grade becaming high in many regions, however the child-rearing household living grade did not become high in any region.

In the exchanges among regions we classified 26 regions to four types and made it clear that there were many divergent types with high generation grades and low attraction grades in the Fukuoka wide area.

In addition, as a whole, the generation grades became higher and almost every region has had exchanges among more regions from 3PT (1993) to 4PT (2005).

Problems to be solved in the Fukuoka wide area might be that according to the changing characteristics of the regions and exchanges among them, from the view of wide regional planning, optimally locating main public facilities like educational and medical facilities and business facilities is important and diverse and flexible regional policies are needed. As future research, keeping analyses on changes of characteristics of regions and exchanges among regions, facility allocation and the traffic networks of the wide area might be important.

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