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鉄道駅周辺地域における都市環境の経年変化に関する研究

A Study on Annual Changes of Urban Environment in Surrounding Regions of Railway Stations

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Basing on the data of land use around railway stations and subways in Fukuoka, this research selects 68 stations as the research targets, which are compared and analyzed on the distribution of land use by extracting the POSMAP data on land use with the GIS including the commerce, the house, the government and education, the transportation and the green land, etc. In addition, the data are separated with two steps of five years, that is, 0-400m radius (Step. 1) and 400-800m radius (Step. 2), which are categorized into groups according to the cluster analysis so that the characteristics of the stations can be interpreted, the changing and relationship among population, passengers and land use can also be indicated.

Keywords : Railway Stations, Urban Environment, Passengers, Cluster Analysis, Annual Changes
鉄道駅，都市環境，乗降客数，クラスター分析，経年変化

1. INTRODUCTION

1.1 Research Background

In Fukuoka city, as the development of the project of land readjustment and buildings along stations, more and more buildings are actively built by the rebuilding of stations, the situation along railway-tracks has been changing at a rapid speed. Recently years, the residential areas in the centre of a city are gradually appearing, which tendency is transferred to the suburbs of a city. Furthermore, modern society will still develop around the public traffic, thus, it is thought that peripheral urban development that centers on the train station becomes more and more important to the city planning that centers on public traffic in an environmental society in the future. With the development of large-scale retailers and specialty stores, the shutter street of shopping streets become more and more serious. The shutter street is a street which was ever made of various branch shops with many closed-down shops or offices while this used to be a busy shopping district, with the taste of a "commercial town", but now, those shops are closing down, leaving the area mostly residential now.

This research is mainly focuses on specific buildings and land use, changes of population and price of land around train stations and characteristics of railway stations. In this paper, 68 stations in Fukuoka City is compared. The research aims on analyzing the changing situation of the land use around stations in Fukuoka City, moreover, it also aims to clarify what influence has been made on stations development.

1.2 Research Aim and Research Framework

According to the background described above, this research selects 68 stations as the research target, compares and analyzes the distribution of land use, such as commerce, housing, industry, agriculture, etc., and indicates the changing and relationship among passengers, population and development of land use around railway stations in past years in order to reveal and furtherly improve the present situation and convenience of railway stations for people's life.

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This paper is consisted of five parts as follows,

Part 1 is focused on the research background, research objects, research methods and purposes;

Part 2 is formed with the selection of the target stations and investigated situations on the land use around stations;

Part 3 is consisted by analyzing the developing status and secular changes of land use around target railway stations associated with selecting special railway stations in space and time;

Part 4 is organized by the actual conditions and aging distribution of railway stations and summarizes the relationship among the population, passengers and land use around those railway stations;

Part 5 is a summary of contents of this paper, shows the analysis results and points out solution ways for problems.

2 THE OBJECTS OF THE RESEARCH AND METHODS

2.1 Research Object

Fukuoka City, which has become the subject of research, has eight lines and 68 stations in total, that is, the JR Kagoshima Line, the JR Kashii Line, the JR Chikuhi Line, the Nishitetsu Omuta Line, the Nishitetsu Kaizuka Line, and the Fukuoka municipal subway(Fig.1).

The research object that we focused on is the Fukuoka City. The annual development on 68 stations in eight routes that exist in the Fukuoka city are analyzed.

2.2 Overview of Data

Data which are used in this study are shown in the table below, that is, the data of land use and building use, which use the POSMAP (from data of land use and building use)

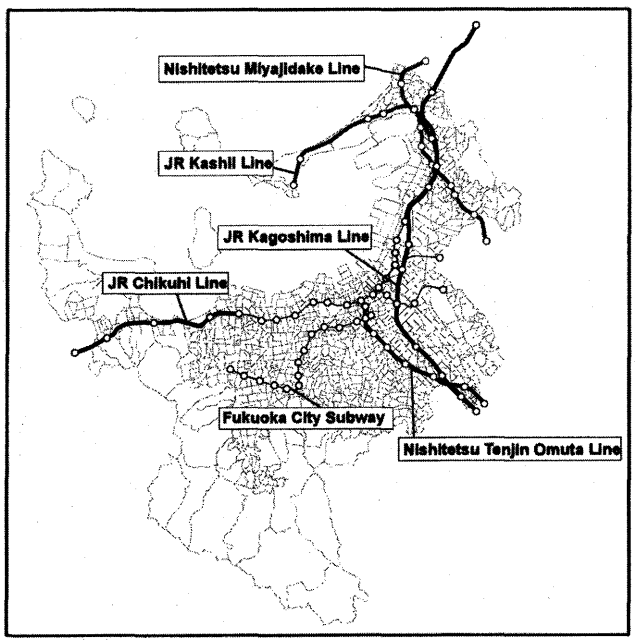

Fig.1 Outline of Object Routes and Object Stations

in the four periods of (1985, 1993, 1998, 2003,2008) at each station and the GIS (Geographic Information System) to extract each land use and building use. The data of population and number of households, which are from the census of population of Fukuoka city and in units of chome (the chome is a very special street unit in Japan, actually, the "cho" in Japanese is a kind of unit for streets; and the "me" in Japanese presents the No., so, the 1 Chome means the first Avenue) at the time of1985, 1990, 1995, 2000, 2005, 2010. The numbers of passengers, which are referred to the statistical books of Fukuoka and data of all routes of JR and Japanese western railways totaling for 36 years are collected from 1975 to 2011. The data of the Fukuoka city subway were collected up from the opening year 1981 to 2011 totaling for 30 years. The data of survey for prefectural land price and public reviewing land prices, which are from National Land Numeric Information Download Service of the homepage of the Ministry of Land, Infrastructure, Transport and Tourism, are collected up to point data of 28 years from 1983 to 2011. The data of architectural confirmation are ones of building confirmation of Fukuoka city from the year 1992 to the year 2004, totaling for 13 years. These data are all available, and then integrated by GIS.

2.3 Methods of Analysis

This research mainly focuses on changes of land use in the sphere of each station and comparison for changes on distance. The most convenient method for this research is to set station zones. There are about 1,100 chome existed In Fukuoka. In recent years, that number is increasing as the addresses are also changing. The research uses the GIS to integrate data. a geographic information system (GIS) is a "computer-based system for the integration and analysis of geographic data." It is a part of a "larger constellation of computer technologies for processing geographical data." The GIS software stores locations of features on the earth's surface to allow identification of different features on the same location. However, integration of GIS data has been more difficult, and information from the Internet and various materials is limited, so errors have been avoided as much as possible.

For the setting of stations, from January 2009, there are 74 stations in Fukuoka City (except the Shinkansen, bullet train). The goal of this research is to analyze changes of land use by urban development with a focus on the station, within walking distance of the station; the range of 800-metre (800m) radius (within a 10-minute walk) from the station is set as a station zone. In order to identify the station by using data from the railway station of GIS, the circle of 800m radius from the central point of the station is set, which is in relation to the

spatial location of chome. The step is as follows, firstly, the chome is overlap with the buffer circle; secondly, the chome should be included in the full circle of the buffer; thirdly, the center of the buffer is the station.

The service catchment area of a railway station is set from the center of the station to 800m in radius (in the range of 10 minutes on foot), firstly, analyzing the land use from the center of the station to 400m in radius (in the range of 5 minutes on foot) for catching characteristics of each station; later, making an analysis from 400m to 800m in radius for catching space characteristics of each station and the trend outside the station is also caught. Afterwards, by analyzing stages gradually, that is, within 400m in radius and radius 400m-800m (Step.2) from the center of one station (Step.1), space of each station is understood to extend spatially. The trend of the land use in the station zone is investigated in a concrete method by the cluster analysis in each investigated year (1985, 1993, 1998, 2003,2008) and each stage (Step.1, 2); finally, a change in the cluster attribute in the passing ages can be found. In addition, it is assumed that elements of the land use, the value of land, the population, and the number of passengers are combined together in order to analyze the different feature of each cluster and each cluster's changes over the years.

3.SECULAR CHANGES ON RAILWAY DEVELOPMENT OF FUKUOKA CITY

In recent years, with the land readjustment projects and stations rebuilding of the Meinohama area, the rebuilding of Kashii and Chihaya area has made stations been changing. A peripheral land use has also been changed in the same period.

3.1 Changes on Land Use around Each Station

From the year 1985 to 2008, percentage of housing has been increased dramatically from the center of the station to 400m radius, at the same time, the residential areas are also kept on developing. In addition, the relationship the percentage between agriculture and forest has been decreasing, and gradually became residential land and road land. Comparing a 400m radius with a 400m-800m radius, the percentage of commercial land is become higher and residential areas have been increasing rapidly, furthermore, regions around stations of 400m-800m radius are becoming residential areas. In addition, the percentage of government agencies, education, with respect to parks has been high within 400m from the station. Those facilities are progressing to 400m-800m radius in the center of 400m radius. Outside of the station zones, the proportion of agricultural relationship and the forest is becoming higher, but the proportion among the agriculture has been declining, residential areas and commercial land have been in an increase (Table. 1).

3.2 Typology of Cluster Analysis

Cluster analysis is the task of assigning a set of objects into groups (called clusters) so that the objects in the same cluster are more similar (in some sense or another) to each other than to those in other clusters. In other words, the cluster analysis is one way that can make things into types and provide a certain convenience for analyzing things.

This paper uses the "Euclidean distances" which is a kind of way in cluster analysis, to evaluate the distance among investigation places and defines parameters among clusters by using the "Ward" method. The ward method is one way to minimize the sum of squares of the data of the cluster. Ward's minimum variance method is a special case of the objective function approach originally presented by Joe H. Ward; he suggested a general agglomerative hierarchical clustering procedure, where the criterion for choosing the pair of clusters to merge at each step is based on the optimal value of an objective function.

This paper uses the GIS (geographic information system) to extract POSMAP of station zones (land use) by the age, usage and distance. Used variables with respect to land use

Table.1 Secular Changes of Land Use of Investigated Object Stations (%)

Category	Year	Commerce	House	Government & Education	Industry	Transporation	Park	Agriculture	Forest	Road
0~400m	1985	7.7	24.9	9.1	1.7	5.0	7.6	7.4	6.3	15.2
	1993	7.2	27.7	9.7	1.7	5.3	6.0	5.5	7.0	14.1
	1998	7.4	29.8	8.8	1.5	4.6	7.2	4.9	6.1	16.2
	2003	7.1	30.6	9.4	1.2	4.6	7.2	4.1	5.8	16.7
	2008	7.9	32.3	9.9	1.7	4.7	7.8	4.9	6.6	17.1
400~800m	1985	5.9	23.5	4.8	2.0	2.7	2.9	10.6	14.5	13.9
	1993	5.7	27.6	6.0	2.8	3.4	3.1	7.9	14.2	15.0
	1998	6.0	27.0	5.3	2.3	3.5	4.5	6.4	17.2	14.5
	2003	5.8	25.9	5.2	1.9	4.1	4.6	5.0	15.2	14.3
	2008	6.6	26.5	5.5	2.2	4.2	5.1	4.2	16.8	14.9
800m~	1985	1.9	8.6	1.8	0.7	0.8	3.1	15.3	51.1	7.8
	1993	2.0	10.5	2.2	0.9	0.8	2.4	13.6	52.2	6.3
	1998	2.4	11.8	2.2	0.8	1.4	3.2	13.2	49.4	6.8
	2003	2.3	11.6	2.2	0.7	1.6	3.3	11.8	50.9	6.8
	2008	2.5	12.6	3.1	0.6	1.5	3.1	10.6	56.8	7.2

are, "commerce", "housing", "government and education", "transportation and warehousing", "park and green land", "open space used", "open space unused", " agriculture", "forest", "water", "roads", "others" totaling 13 variables; variables with respect to building usage are "business and hotel", "commerce and entertainment", "apartment", "detached houses", "government agencies and educational facilities", "transportation and warehousing facility", "industrial facilities", "others" totaling to 8 variables, which is 21 variables in total. For each station, the data are analyzed by age and separated with two steps, that is, step.1 is 0m-400m radius, Step.2 is 400m-800m radius, (1985, 1993, 1998, 2003,2008) five age points × 2 distance categories (Step.1, 2) = 10 data (the number of samples is 1 data against 68 stations), are categorized into groups according to the cluster analysis by using the ward method for a data in order to catch changes in the categories, changes in land use and spatial characteristics of stations.

3.3 Result of Cluster Analysis

Results of cluster analysis are as follows, in step.1 it can be divided into 7 clusters; in step.2 it can be divided into 5 clusters. The number of samples between clusters has been quite biased; step.1 is a clear cluster that represents land use; as a complex situation of land use, step.2, which is not so clear than step.1, presents characteristics of land use. Based on the results of step.1 and step.2, the spatial scale around the station can be pointed out. For example, it is classified into in step.1 and is classified as C in step.2. The patterns of stations can be classified into 7 × 5 = 35. Therefore, according to the form below, the yearly characteristics and changes of categories can

Table.2 Result of Cluster Analysis

Route		Station	1985		1993		1998		2003		2008	
			Step1	Step2	Step1	Step2	Step1	Step2	Step1	Step2	Step1	Step2
Kyushu Railway	Kashii Line	Saitozaki	5	F	5	F	5	F	5	F	5	F
		Umino Nakanichi	7	D	7	D	7	D	7	D	7	D
		Ganosu	5	E	5	E	5	E	5	E	5	E
		Nata	5	E	5	E	5	E	5	E	5	E
		Wajiro	5	D	5	D	5	D	5	C	5	C
		Kashi Jingu	5	E	5	E	5	E	5	E	5	E
		Mai Matsubara	5	C	5	C	5	C	5	C	5	C
		Doi	5	D	5	D	5	D	5	D	5	D
	Kagoshima Main Line	Chikuzen Shingu	5	D	5	D	5	D	5	D	5	D
		Kyushudaimae	5	D	5	D	5	D	5	D	5	D
		Kashi	5	C	5	C	5	C	5	C	5	C
		Chihaya	3	C	3	C	3	C	3	C	3	C
		Hakozaki	5	C	5	C	5	C	5	C	5	C
		Yoshizuka	4	B	4	C	4	C	4	C	4	C
		Hakata	1	B	1	B	1	B	1	B	1	B
		Takeshita	5	B	5	C	3	C	3	C	3	C
		Sasahara	5	C	3	C	3	C	3	C	3	C
		Minami Fukuoka	5	D	5	D	5	D	5	D	5	D
	Chikuhi Line	Meinohama	3	C	3	C	3	C	3	C	3	C
		Shinoyamamoto	5	D	5	C	5	C	5	C	5	C
		Imajuko	6	E	6	E	6	E	6	E	6	E
		Susenji	6	D	6	D	6	D	6	D	6	D
Nishi Nippon Railway	Kaizuka Line	Najima	5	C	5	C	5	C	5	C	5	C
		Nishitetsu Chihaya	3	C	3	C	3	C	3	C	3	C
		Hashii Gumae	3	C	3	C	3	C	3	C	3	C
		Nishitetsu Kashii	3	E	3	C	3	C	3	D	3	C
		Kashii Harazonomae	5	D	5	D	5	D	5	D	5	D
		Tonohara	6	D	6	D	6	D	6	D	6	D
		Mitome	5	D	5	D	5	D	5	D	5	D
	Tenjin Omuda Line	Nishitetsu Fukuoka	1	B	1	B	1	B	1	B	1	B
		Yakurin	2	A	2	A	2	A	2	A	2	A
		Nishitetsu Hirao	3	C	3	C	3	C	3	C	3	C
		Takaraha	3	C	3	C	3	D	3	C	3	C
		Ohashi	3	C	3	C	3	C	3	C	3	C
		Iri	5	C	3	C	3	C	3	C	3	C
		Zayonokuma	5	D	3	D	3	D	3	D	3	D
Fukuoka Municipal Subway	Kuko Line	Muromi	5	C	3	C	3	C	3	C	3	C
		Fujido	3	C	3	C	3	C	3	C	3	C
		Nashijin	3	C	3	C	3	C	3	C	3	C
		Tenjinmachi	3	C	3	C	3	C	3	C	3	C
		Ohori Komen	2	B	2	C	2	D	2	C	2	C
		Akasaka	2	A	2	B	2	B	2	B	2	B
		Tenjinmachi	1	B	1	B	1	B	1	B	1	B
		Nakasu Kawabata	2	A	1	A	1	A	1	A	1	A
		Gien	2	A	1	A	2	A	2	A	2	A
		Higashi Bie	2	B	2	B	2	B	2	B	2	B
		Fukuoka kuko	7	D	7	D	7	D	7	D	7	D
	Hakozaki Line	Gofukumachi	2	B	2	A	2	A	2	A	2	A
		Chiyokenchiguchi	4	B	4	B	4	B	4	B	4	B
		Maidashi Kyudai	4	B	4	C	4	C	4	C	4	C
		Hakozaki Miyamae	4	C	4	C	4	D	3	D	4	D
		Hakozaki Kyudai	4	B	4	D	4	D	4	D	4	D
		Kaizuka	4	B	4	D	4	D	4	D	4	D
	Nanakuma Line	Tenjinminami	2	A	1	A	1	A	1	A	1	A
		Watanabe Dori	2	A	2	A	2	A	2	A	2	A
		Yakuin Odari	3	A	3	A	3	A	3	A	3	A
		Sakurazaka	5	C	3	C	3	C	3	C	3	C
		Reppenmatsu	3	C	3	C	3	C	3	C	3	C
		Befu	3	C	3	C	3	C	3	C	3	C
		Chayama	5	C	5	C	5	C	5	C	5	C
		Kanayama	5	C	5	C	5	C	5	C	5	C
		Namakuma	4	C	4	C	3	C	3	C	3	C
		Fukudai Mae	4	E	4	E	4	E	4	E	3	E
		Umebayashi	5	D	5	D	5	D	5	D	5	D
		Noke	5	C	5	C	5	C	5	C	5	C
		Kamo	5	C	5	C	5	C	5	C	5	C
		Jinomoru	5	D	5	D	5	D	5	D	5	D
		Hashimoto	6	E	5	E	5	E	5	E	5	E

be easily caught.

Step.1 0m~400m Radius

The features of the cluster analysis are as follows,

1. "Type of a city's centre", e.g. Hakata, Nishitetsu Fukuoka, etc.
2. "Type of business around a city's centre", e.g.Yakuin, Akasaka and Gofukumachi, etc.
3. "Type of medium density resident", e.g. Kashii, Ohashi, etc.
4. "Type of government, municipal Offices, education and public welfare", e.g. Yoshizuka, Fukushima University, etc.
5. "Type of low density resident", e.g. Wajiro, Chayama, etc.
6. "Type of resident + agriculture", e.g. Imajuku, Susenji, etc.
7. "Type of specific facilities", e.g. Umino Nakamichi, Fukuoka Airport, etc.

Step.2 400m~800m Radius

The features of the cluster analysis are as follows,

A. "Type of places near the center of a city", e.g. Yakuin, Nakasu Kawabata, etc.

B. "Type of commerce around the center of a city", e.g. Hakata, Tenjin, etc.

C. "Type of medium density resident", e.g. Chihaya, Nishijin, etc.

D. "Type of low density resident + various uses", e.g. Wajiro, Zasyonokuma, etc.

E. "Type of low density resident", e.g. Gannosu, Imajuku, etc. (Table. 2)

3.4 Features and Secular Changes of the Cluster

The features of each category are shown in Table 3 and Table 4 which can make features more obvious. Moreover, it is thought that the change in the land use is huge around stations in passing ages and the attribute of the cluster has also changed.

1) 0m-400m Radius (Step.1)

a. Land Use

In the category "the center of a city", which shows a high percentage of the "Commercial Land" and "Road". And in the vicinity of the city center, the percentage of "Green Park" has been high. It is easily to find that the "Commercial Land" tends to be decreasing, 'Residential Land", and "Land for Roads" have been increasing year by year. Furthermore, the residential and road maintenance are getting on and on. The trend of decreasing passengers has a large impact on the road maintenance(Table. 3).

b. Population and Land Price

As the "plot ratio" in the downtown has being a high density of buildings, the density of buildings are also going higher than before. However, taking a look at the population, the "Government" and "Medium-density Resident" is becoming higher in the suburbs of a city rather than "downtown of a city", and the center of a city has been full of other functions besides residential function. With respect to the land price, as it contains the bubble period, it has a sudden raise in 1993 after which it falls sharply. Population in large stations of the center of a city has been always reducing, and increasing in the suburb stations. In addition, the trend of the plot ratio can be seen within 400m from the centre of stations and the development is in progress around stations. The trend of population density is increasing rapidly in the range within 400m radius from the center of the station, at the same time, it can also be seen that the proportion of mansions is in an increase(Table. 4).

2) 400m-800m Radius (Step.2)

The features of each category are shown in Table 5 and Table 6 which can make features more obvious.

a. Land Use

In the category "the center of a city", which shows a high percentage of the "House" and "Road". And near center of a city, the percentage of "Commerce Land" has been higher. It is easy to find that the "Commercial Land" tends to be decreasing, "Residential Land "and "Land for Roads" have been increasing year by year. The trend of decreasing passengers also has a large impact on the road maintenance(Table. 5).

b. Population and Land Price

As the "plot ratio" in the downtown has being lower than it is in 0-400m, but the density of buildings are also going higher year by year. With respect to the land price, as it contains the bubble period, it has a sudden raise in 1993 after which it falls sharply. In 400-800m, the population in large stations of the center of a city has been always reducing, and increasing in the suburb stations(Table. 6).

3.5 Factors for Moving among Clusters

According to the above analysis, it can be shown that the residential quarters have made remarkable changes in the station zones. Moreover, it has been a feature that the ratio of green land is highly raising. It is also especially remarkable that the tendency of development of apartment houses is changing into more and more mansions. Furthermore, the ratio between transportation and warehousing facilities has been consistently rising.

Further speaking, the situation on changes of clusters can be clearly found according to the changing tendency. The most frequent change among clusters is in the years 1985 to 1993. One factor has been mentioned, that is, categories

Table.3 Secular Changes of Land Use of Investigated Object Stations in 0m-400m Radius (%)

Cluster	Year	Commerce	House	Government & Education	Transportation	Park	Agriculture	Forest	Road
Group 1	1985	30.4	8.5	10.8	2.3	2.8	0.1	0.0	26.3
	1993	28.9	12.0	10.8	2.6	3.5	0.0	0.0	26.4
	1998	32.8	12.0	8.1	3.0	4.8	0.0	0.0	29.2
	2003	33.1	12.5	8.0	2.6	4.3	0.0	0.0	29.2
	2008	34.2	12.6	10.2	3.2	4.4	0.3	0.2	29.9
Group 2	1985	23.6	14.1	12.3	1.7	7.3	0.8	0.2	21.8
	1993	18.3	20.0	11.7	1.3	10.4	0.7	0.0	20.9
	1998	19.8	19.8	8.7	1.9	13.4	0.5	0.0	22.2
	2003	21.5	21.1	8.8	2.1	9.0	0.6	0.0	23.3
	2008	22.6	21.3	10.5	2.3	9.9	0.5	0.0	25.6
Group 3	1985	10.6	36.3	13.0	1.8	2.0	1.4	1.3	16.5
	1993	8.3	39.6	10.6	0.8	2.1	1.5	1.9	16.6
	1998	7.9	42.4	10.4	1.1	3.4	1.1	1.0	18.8
	2003	6.6	41.6	10.4	1.1	4.9	0.7	0.9	19.7
	2008	7.8	45.3	12.6	1.3	5.6	1.0	0.8	20.1
Group 4	1985	8.3	20.5	28.6	5.7	4.1	2.0	0.4	13.5
	1993	7.8	22.6	29.0	4.6	4.1	0.9	0.3	15.3
	1998	8.7	24.0	28.6	4.4	4.5	0.8	0.2	18.3
	2003	8.1	24.1	28.9	4.4	4.4	0.6	0.2	18.7
	2008	8.7	24.7	28.2	4.4	4.2	0.8	0.3	17.7
Group 5	1985	5.6	35.2	6.2	1.7	2.7	9.9	7.0	13.2
	1993	4.9	37.4	7.1	1.4	2.0	10.6	5.4	14.5
	1998	5.2	39.8	7.0	1.4	2.5	8.6	4.8	17.4
	2003	5.2	41.4	7.6	1.4	2.3	7.4	4.4	17.7
	2008	5.5	44.6	7.7	1.4	2.4	10.9	5.2	17.2
Group 6	1985	3.1	16.4	2.0	0.4	7.8	26.6	21.1	8.2
	1993	2.8	18.0	1.9	0.3	1.3	16.5	25.9	8.8
	1998	3.2	19.8	2.0	0.4	0.9	15.3	25.8	10.6
	2003	3.3	20.4	2.2	0.6	1.0	14.4	25.7	10.7
	2008	3.2	20.1	2.1	0.4	3.2	18.3	26.8	11.2
Group 7	1985	0.3	2.3	0.4	34.2	37.4	0.2	5.4	10.2
	1993	0.9	1.5	0.8	38.8	31.5	0.1	6.0	3.5
	1998	0.5	2.2	0.5	33.7	34.8	0.1	4.0	4.7
	2003	0.7	2.2	0.3	33.8	35.1	0.1	3.7	4.9
	2008	0.6	2.3	0.2	34.5	36.1	0.1	2.3	4.4

Table.4 Secular Changes of Population and Land Price of Investigated Object Stations in 0m-400m Radius (%)

Cluster	Year	Population	Land Price	Passenger (per day)	Generation	Population Density	Plot Ratio
Group 1	1985	8,331	1,272,433	150,770	1.93	68.6	233.9
	1993	5,675	4,027,383	130,932	1.64	57.7	225.4
	1998	5,522	1,553,610	150,038	1.51	56.9	219
	2003	7,875	1,102,151	118,342	1.4	54.3	242.1
	2008	7,956	1,432,286	138,232	1.72	62.5	253.8
Group 2	1985	10,680	615,099	12,900	2.11	88	128.5
	1993	11,195	2,290,387	18,956	1.72	86.9	120.6
	1998	12,011	945,998	17,249	1.61	94.1	116.9
	2003	13,193	682,199	16,459	1.49	107.2	132.1
	2008	15,324	773,128	16,332	1.52	92.3	136.7
Group 3	1985	15,489	212,580	17,331	2.39	105.7	71.1
	1993	15,574	550,044	20,457	2.06	107.9	56.5
	1998	16,364	324,562	20,495	1.95	114.1	59.4
	2003	17,089	243,166	13,971	1.9	121.1	72.3
	2008	17,882	336,462	18,231	2.23	116.5	73.6
Group 4	1985	12,140	192,613	7,582	2.14	59.5	78.8
	1993	12,524	574,176	14,195	1.81	71.7	77.2
	1998	12,559	292,891	12,958	1.72	71.9	64.9
	2003	13,050	185,717	10,525	1.69	74.7	70.1
	2008	13,421	233,615	12,876	1.73	72.1	63.7
Group 5	1985	8,850	96,045	7,857	2.63	70.3	38.2
	1993	9,362	162,225	6,447	2.48	73.2	36.5
	1998	9,553	140,381	6,078	2.35	73.9	37.2
	2003	9,696	111,134	4,959	2.28	76	39.7
	2008	9,973	143,272	6,327	2.33	73.2	38.4
Group 6	1985	6,399	74,631	6,614	3.16	27.1	13.8
	1993	8,172	155,167	8,013	2.51	33.8	17.9
	1998	9,066	137,854	8,038	2.4	37.5	19.7
	2003	9,367	105,595	7,036	2.4	38.7	20.9
	2008	9,226	126,553	7,235	2.66	40.2	22.3
Group 7	1985	893	65,400	10,036	2.48	2.5	1.5
	1993	998	81,000	17,984	2.16	2.6	4.6
	1998	1,095	94,667	20,595	1.92	3.1	5.3
	2003	1,056	77,750	19,995	1.92	2.9	8
	2008	1,232	82,556	20,673	2.17	3.3	8.8

Table.5 Secular Changes of Land Use of Investigated Object Stations in 400m-800m Radius (%)

Cluster	Year	Commerce	House	Government & Education	Transportation	Park	Agriculture	Forest	Road
Group A	1985	24.0	20.4	10.1	2.0	3.1	0.1	0.3	22.3
	1993	21.2	22.7	10.0	1.8	2.9	0.1	0.8	23.3
	1998	23.2	23.5	8.7	2.1	5.0	0.1	0.1	24.5
	2003	22.6	24.4	9.1	1.8	4.8	0.0	0.1	24.6
	2008	25.5	23.2	9.2	1.9	5.1	0.1	0.3	26.7
Group B	1985	16.6	16.2	9.4	8.0	2.9	2.6	0.1	19.9
	1993	21.0	18.5	9.1	5.1	1.7	1.1	0.0	23.6
	1998	22.7	19.6	8.3	6.0	2.8	0.9	0.0	25.2
	2003	22.1	20.5	8.4	5.3	2.6	0.7	0.0	25.0
	2008	24.2	21.3	7.9	7.7	2.6	0.8	0.1	26.2
Group C	1985	6.5	34.6	11.8	1.7	4.0	4.3	2.4	15.7
	1993	6.4	36.6	12.3	2.1	4.5	3.0	1.8	16.4
	1998	6.7	40.0	11.1	1.5	5.6	2.6	1.5	17.5
	2003	6.4	41.4	11.5	1.3	6.0	2.1	1.3	18.2
	2008	6.2	44.6	12.7	1.8	5.5	2.2	1.2	19.8
Group D	1985	3.8	24.4	7.0	1.2	6.7	18.9	11.5	11.0
	1993	5.1	24.6	6.5	5.0	2.3	12.6	10.4	13.2
	1998	5.2	28.8	8.1	5.3	3.4	8.3	7.9	16.0
	2003	5.7	25.2	8.2	7.7	2.9	7.2	7.5	16.2
	2008	5.5	27.6	9.1	7.2	3.2	8.6	8.6	16.5
Group E	1985	1.2	10.4	4.2	0.4	6.9	7.2	36.2	18.4
	1993	1	12	7.3	0.1	4.6	6.5	48.5	6.2
	1998	1	13.1	5.1	0.2	9.1	5.8	43.2	7.1
	2003	1.2	13.6	6.9	0.2	10.1	5.2	41.1	7.9
	2008	1.3	14.2	7.8	0.3	10.9	5.8	44.2	9.6

Table.6 Secular Changes of Population and Land Price of Investigated Object Stations in 400m-800m Radius (%)

Cluster	Year	Population	Land Price	Passenger (per day)	Generation	Population Density	Plot Ratio
Group A	1985	22,894	631,905	14,830	2.09	103.5	151.9
	1993	21,606	2,989,729	18,985	1.7	92.6	158.5
	1998	23,459	1,160,477	18,134	1.61	100.3	149.6
	2003	27,043	819,150	14,732	1.51	115.6	152.4
	2008	28,662	963,256	14,988	1.82	100.8	159.2
Group B	1985	15,450	537,918	50,731	2.17	71.7	92.3
	1993	14,987	3,284,758	110,960	1.75	77.7	124.3
	1998	15,732	1,214,688	103,901	1.64	86.7	116.3
	2003	19,061	816,420	99,359	1.51	98.8	125.9
	2008	19,002	1,144,552	126,879	1.66	93.7	133.6
Group C	1985	19,947	163,003	16,798	2.57	84	54
	1993	21,371	438,222	16,355	2.25	91.1	59.1
	1998	23,016	252,776	15,876	2.18	96.2	57.2
	2003	23,805	196,913	11,623	2.08	104.3	61.5
	2008	24,606	232,663	14,667	2.53	96.5	66.7
Group D	1985	6,585	80,220	6,997	2.79	36.4	23.9
	1993	9,091	169,810	12,801	2.39	49.4	32.8
	1998	9,983	187,828	12,776	2.18	45.3	38.9
	2003	9,866	122,320	9,840	2.18	48.7	35.2
	2008	9,956	168,432	11,223	2.67	49.8	34.2
Group E	1985	7,589	105,659	3,891	2.74	19.4	8.6
	1993	8,921	132,378	4,841	2.58	22.2	10.3
	1998	8,944	120,789	4,800	2.44	22.3	11.1
	2003	9,319	94,514	4,272	2.38	23.2	11.6
	2008	9,876	113,323	4,562	2.78	24.6	12.2

of 10 stations has been changing in step.1. In addition, the clusters of 9 stations have been caught in step.2. Later, in the period of 1993 to 1998, it can be found that there are clusters of 2 stations in step. 1 and 3 stations in step.2. Furthermore, from 1998 to 2008, it can be found that there are clusters of 2 stations in step. 1 and 3 stations in step.2. In addition, some stations have shown no various changes at all. After the year of 1993, the tiny changes among clusters are also continuing, according to the above analysis, those stations which have no various changes are also keeping on developing in each group.

3.6 Characteristics of the Distribution

The distribution of stations of each cluster is a shape of a Y-looking which centers of commerce, business, medium density resident, low density resident, government, municipal offices, education and public welfare, are all in a hierarchical and classified urban structure and have a methodic land use.

Moreover, in 1985, low density resident that existed in medium density resident was very narrow; in 2003, those places that were around stations are gradually becoming the residential quarter of medium density resident and making an expansion from center of a city to outside scale.

In this chapter, by performing a cluster analysis with respect to land use around the stations, here, basing on the results of previous research, this chapter can be summarized in the following new findings,

Firstly, the changes and tend of development on railway

stations and subways of Fukuoka city have been interpreted in this chapter. As a result, most stations from 1985 to 2008 decline to changes gradually. Whereas this kind of changes tends to continue and has been confirmed in the investigation. In this situation, the land use on the commerce and housing in some stations have always been reducing which reveal a phenomenon associated with the consume progression of society, and it should be emphasized in community development activities in the future.

On the other hand, as the obvious reduction of the land use on the agriculture, green land and water in some stations, the industry facilities have been transferred into the suburbs, this situation has been a remarkable phenomenon which can be said that the decline had a significant impact on forest, green land, water and other afforestation areas in the suburbs.

4. SUBMISSION

This research mainly analyzes data of the land use by the cluster analysis method around stations in Fukuoka City. Furthermore, the features of a spatial extension around stations are also clarified. The changes of land use around stations are also analyzed specifically in this paper including their influence for the population and the land price in order to indicate characteristics of space using around stations. After the burst of the economic bubble in 1996, although the development of surrounding areas of stations is a little slower, and the stores and restaurant are in the decreasing tendency in 0m-400m zones of stations, the trend of development is still changd into the suburb regions of station zones. By representing the changes around stations in Fukuoka City, this paper is hoped to be useful for further research in future.

The specification of the directionality of a spatial extension in Step.2 by the cluster analysis (400m -800m cluster), which will be considered in a wider subject, that is, not only do the analysis by land use, but also expand it by adding the number of passenger in 400m-800m radius, the population into cluster analysis, etc. in order to find out the most important factor of influence and the degree of influence during the development of railway stations.

Moreover, according to the results of cluster analysis, the "square", "land", "population" of further land use and building applications will be analyzed further by multiple regression analysis on the base of the degree of influence for the number of customers.

After that, basing on the investigated data, an advanced research will be expanded on the forecasting of developing trend on the land use around stations. Prognostic charts of the forecasting can show a more clear variation tendency on the development of land use in future five years, ten years, even more ones which can also establish detailed information and anticipate future needs. Thus, the railway development and applications can be given a more comprehensive way to be shown. For the purpose of sustainable development, more useful and meaningful ways on developing stations and surrounding regions will be put forward to.

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