

**ON CLASSIFICATION OF STATIONS AND CONSCIOUSNESS OF THE
PASSENGER CONCERNING FACILITIES FOR DAILY LIFE AT THE
RAILWAY STATION IN RESIDENTIAL AREA**

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abstract: This paper is concerned with the introduction of facilities for daily life to railway stations focusing on utilizing consciousness to these facilities. First, we clarify the characteristics of railway stations and classify them into some groups of stations. Secondly, among stations which are considered to need the introduction of facilities for daily life, we select various types of stations to be investigated, and survey utilizing consciousness on facilities. Thirdly, the number of users after the introduction of facilities is estimated.

1. INTRODUCTION

Railway station functions as terminal of an area as well as an urban facility where people, goods and information are concentrated on. Railway station and its surrounding area are not merely a center of transportation; they have high potential to become urban space which forms convenience stores, grocery shops as restaurants (facilities for daily life), the open square, movie theaters, museums, culture centers and so on.

Over the years, various kinds of studies have been conducted on railway stations focusing on access modal choice, improvement of station plaza, trend of urbanization of the area. Furthermore, there have been some researches on future railway station design taking the social trends (such as information-oriented society) into consideration. However, introduction of facilities to railway stations and the ideal way of improving it based on utilizing consciousness have not been sufficiently investigated. Introduction of facilities would give a great impact on passengers as well as residents of the area; therefore, not only planner's view point but also utilizing consciousness of passengers should be taken into consideration.

This study is concerned with the introduction of facilities for daily life to railway stations focusing on utilizing consciousness to these facilities in order to meet the social needs which arise as a result of the development of the city with that railway station. First, we clarify the characteristics of railway stations and classify them into some groups of stations. Secondly, among stations which are considered to need the introduction of facilities for daily life, we select various types of stations to be investigated, and survey utilizing

consciousness on facilities. Thirdly, the number of users after the introduction of facilities is estimated.

2. CLASSIFICATION OF RAILWAY STATIONS

Before discussing the introduction of facilities for daily life to railway stations, we need to understand the current situation of railway stations of each area. In doing so, to apply this study to other stations (stations not to be selected) and to clear the meaning and limitation of this study, we deal with classified groups of stations rather than individual ones.

2.1 Classification of Railway Stations from Various Viewpoints and Their Consideration

In this chapter, railway stations are classified by their characteristics of land use, station equipment and the utilizing conditions of the passengers. Based on these classifications, relationships between each group are studied and used to re-classify them from comprehensive view point.

2.1.1 Classification of Railway Stations by Their Characteristics of Land Use around Station

73 railway stations of JR in Kyushu are selected. Component scores are calculated by principal component analysis using various areas of land use around station (business site, residential site, window of public office and facilities of station). Then, they are classified by cluster analysis using component scores. The result is shown in Table 1, and characteristics of each group and composition of land use are shown in the same table. They are classified into 4 groups; developed urban area, developing urban area, area holding industrial site around station and area holding recreation site around station from macro viewpoint of land use. Furthermore, 4 groups are subdivided into 10 groups by the proportion of business site, residential site and agriculture site. The rationality of this classification is examined by discriminant analysis.

Table 1 Classification of railway stations by their characteristics of land use around station

| Group | Sub-group | Station | Characteristics |
|---|-----------|--|---|
| The group of stations in the area where urbanization is quite progressional | | | |
| 1 | A | 1 . Hakata . 18 . Kokura . 21 . Mojiko . 69 . Oita 70 . Nagasaki . 73 . Saga | Commercial and business area |
| | B | 2 . Yoshizuka . 3 . Hakozaki . 15 . Tobata . 23 . Minamifukuoka 28 . Futsukaichi . 49 . Chikuzenmaebaru . 57 . Wakamatsu . 58 . Minamikokura 59 . Jyono . 61 . Shimosone . 68 . Kumamoto . 71 . Miyazaki 72 . Nishikagoshima | The area where the commerce, the business and the resident mix with |
| | C | 4 . Kashii . 5 . Kyusandaimae . 6 . Chikuzenshingu . 10 . Kyoikudaimae 11 . Orio . 24 . Kasuga . 25 . Onojo . 45 . Meinohama 60 . Abeyamakoen | Residential area |
| The group of stations in the area where urbanization is beginning | | | |
| 2 | D | 8 . Togo . 9 . Akama . 29 . Harumachi . 30 . Chojabaru 32 . Sasaguri . 35 . Gannosu . 36 . Nata . 38 . Kashijingu 39 . Doi . 40 . Iga . 43 . Shinbaru . 47 . Susenji 48 . Hatae . 52 . Chikuzenfukae . 56 . Fujinoki . 62 . Kuchiami 64 . Shiikoen | Developing residential area |
| | E | 27 . Haruta . 31 . Kadomatsu . 41 . Sakado . 42 . Sue 50 . Kafuri . 51 . Ikisan . 62 . Shikaya . 63 . Ishida 65 . Shii . 66 . Ishiharacho . 67 . Yobuno | Developing area |
| The group of stations which located near industrial area | | | |
| 3 | F | 12 . Kurosaki . 17 . Nishikokura . 28 . Yusu | The area where the commerce, the business and the industry mix with |
| | G | 7 . Koga . 13 . Yahata . 14 . Edamitsu . 16 . Kyukodaimae 19 . Moji . 20 . Komorie . 22 . Takeshita | The area where the resident and the industry mix with |
| | H I | 44 . Umi . 46 . Imajuku . 54 . Futajima 33 . Saitozaki . 37 . Wajiro . 55 . Okudokai | Developing residential area |
| The group of stations with recreation facilities nearby | | | |
| 4 | J | 34 . Uminonakamichi | Recreation area |

2.1.2 Classification of Railway Stations by The Station Equipment

Stations are classified to help us understand the current situation of railway station facilities. Principal component analysis and cluster analysis (same as above) are conducted using the data of JR in Kyushu. The result is shown in Table 2. They are classified into 4 groups. Furthermore, 4 groups are subdivided into 6 groups. Basically, stations are classified by the size of those and station plaza.

Table 2 Classification of railway stations by the station equipment

| Group | Sub-group | Charactristics |
|-------|-----------|---|
| 1 | a | The terminal station in Kyushu which the scale of the facilities around the station is very big |
| 2 | b | The main station of each area which the total area of the station is equal to or more than 1000 (m ²) |
| | c | The stations which the average total area of the station is 700 have 4-8 platforms. |
| 3 | d | The station with the average total area is the same as C group and there exist station squares at both sides of the station |
| | e | The stations without station staff which the scale of the facilities of the station and those around the station are small |
| 4 | f | The staitons without station square which the scale of the facilities of the station are small |

2.1.3 Classification of Railway Stations by The Utilizing Conditions of Passenger

Stations are classified to help us understand the station use such as the number of passengers and its time series data. Cluster analysis is conducted using 4 types of data (daily average number of passengers, the percentage of passengers with commuter pass (1992), growth rate of number of passengers and passengers with commuter pass (1989-1992)). The result is shown in Table 3. They are classified into 4 groups. Furthermore, 4 groups are subdivided into 11 groups.

Table 3 Classification of railway stations by the utilizing conditions of passenger

| Group | Sub-group | Charactristics |
|-------|-----------|--|
| 1 | I | The station that the passenger is equal to or more than 80,000 and the percentage of passengers with commuter pass is 60% |
| 2 | II | The stations that the passenger is equal to or more than 10,000 and the percentage of passengers with commuter pass is 40% |
| | III | The stations that the passenger and the percentage of passengers with commuter pass is small |
| 3 | IV | The stations that the passenger is equal to or more than 10,000 and the percentage of passengers with commuter pass is about 60% |
| | V | The stations that the passenger is about 7,000 and the percentage of passengers with commuter pass is 65% |
| | VI | The stations that the passenger is equal to or more than 6,000 and the percentage of passengers with commuter pass is about 75% |
| | VII | The stations that the passenger is about 3,000 and the percentage of passengers with commuter pass is 65% |
| | VIII | The stations that the passenger is less than 1,000 and the ratio of commuter pass is 65% |
| | IX | The stations that the passenger is about 1,000 and the percentage of passengers with commuter pass is 75% |
| 4 | X | The stations that the passenger is 1000-4000 |
| | X I | The stations that the passenger is 1000-2000 |

2.2 Classification of Railway Station from Comprehensive View Point Using 2 Dimensional of Cross Table

Cross-tables of 3 type of classifications which are discussed in § 2.1 are created and examined. As a result, stations are divided into 6-9 groups as shown in Figure 1-3. However, due to the limitation of space of this paper, the focus is placed mainly upon the land use and the utilizing conditions of the passengers, and stations are categorized into 9 groups.

| Equipment | | Land use | | | | | | | | | | |
|-----------|-----------|----------|--------|-----|--------|---------------|--------|---------------|-----------|-----------|---|------------|
| | | 1 | 2 | | | 3 | | | | 4 | | |
| Land use | Equipment | I | II | III | IV | V | VI | VII | VIII | IX | X | XI |
| | | 1 | A | 69 | 70.73. | | 18.21. | | | | | |
| B | | | 68.71. | | | 2.15. 49.58. | | | | | | |
| C | | | 72. | | 4.11. | 23.26. 59.61. | | | 3.57. | | | |
| 2 | D | | | | | 8.9. | | | 29 | 35.40. | | 30.38. |
| | E | | | | | 47. | | 32.36. 43.56. | 29 | 52.62. | | 48. 39.64. |
| 3 | F | | | | | | | | 67. | 41.42.50. | | 27.31. |
| | G | | | | | | | | 51.53.63. | | | 65. |
| | H | | | | | | | | 66. | | | |
| 4 | I | | | | | | | | | | | |
| | J | | | | | | | | | | | |

Note: the numbers are stations (table-1)

Fig.1 Two dimensional classification of railway stations by their characteristics of land use and the station equipment

| Passenger | | Land use | | | | | |
|-----------|-----------|----------|-----|-------------|-----------|----------------|---------------|
| | | 1 | 2 | | 3 | | 4 |
| Land use | Passenger | a | b | c | d | e | f |
| | | 1 | A | 15.73. | 18.21.70. | | |
| B | | | 68. | 2.23.26.57. | 15. | 49.58.61. | |
| C | | | | 4.11.45. | 25. | 6.24. 5.10.60. | |
| 2 | D | | | | | 29.30.35.39. | 36.38. |
| | E | | | | | 40.43.47.48. | 31.51. 63.65. |
| 3 | F | | | | | 52.56.62.64. | |
| | G | | | | | 41.42.50. | |
| | H | | | | | 53.66.67. | |
| 4 | I | | | | | | |
| | J | | | | | | |

Fig.2 Two dimensional classification of railway stations by their characteristics of land use and the utilizing conditions of passenger

| Passenger | | Equipment | | | | | | | | | | |
|-----------|-----------|-----------|----|-----|--------------------|---|---------|--------|------|----|---|-----|
| | | 1 | 2 | | | 3 | | | | 4 | | |
| Equipment | Passenger | I | II | III | IV | V | VI | VII | VIII | IX | X | XI |
| | | 1 | a | 13. | | | | | | | | |
| b | 68.69. | | | | 19. | | | | | | | |
| c | 72.73. | | | | 4.11. 2.13. 21.23. | | | 17.32. | | | | |
| 2 | d | 70.71. | | | 12. | | 7.9.59. | 45. | | | | |
| | e | | | | | | | 57. | | | | 27. |
| 3 | f | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | |
| | | | | | | | | | | | | |

Fig.3 Two dimensional classification of railway stations by the station equipment and the utilizing conditions of passenger

They are as follows:

- (1) Prefectural capital location stations in Kyushu which attract a lot of shoppers in addition to a lot of commuting visitors from the neighborhood area.
- (2) The stations that function as both of the origination station and the destination station which the accessing public transport system of the station such as the bus progresses. There are many passengers from the habitation place in the neighborhood area of suburbs.
- (3) The stations at bedroom suburb where residential sites share the main part of land use. The percentage of passengers with commuter pass is about 0.75
- (4) The stations in the area with commercial and business sites and the sites mixed with commerce, business and residential district
- (5) The stations in agriculture area stations with few and low growth rate of riderships. There will be no rapid development of the area in the future.
- (6) The residential area's stations with riderships range from 1000 to 4000 per day and high growth rate of riderships.
- (7) The stations in the area holding industrial sites with few ridership. There will be no development of the area in the future.
- (8) The stations in the area holding a great deal of recreation sites.
- (9) The stations only used for recreation trip purpose where riderships are about 250 and the percentage of passengers with commuter pass is only 0.1

Table 4 Classification of railway station from comprehensive view point using 3 dimensional cross table

| Group | Station | L | P | E | Group | Station | L | P | E |
|--------|-----------------|----|----|-----------|---------------------------------|--------------------------------|----|----|---|
| ① | Hakata | 1 | 1 | 1 | ⑥ | Sasaguri | 5 | 3 | 2 |
| | Oita | 1 | 1 | 1 | | Kyoikudaimae | 5 | 5 | 3 |
| | Kumamoto | 1 | 1 | 1 | | Nata | 5 | 5 | 4 |
| | Nishikagoshima | 1 | 1 | 1 | | Fujinoki | 5 | 5 | 4 |
| | Nagasaki | 1 | 1 | 1 | | Chikuzenfukae | 5 | 5 | 4 |
| | Miyazaki | 1 | 1 | 1 | | Ikisan | 5 | 5 | 4 |
| | Saga | 1 | 1 | 1 | | Shinbaru | 5 | 5 | 4 |
| ② | Mojiko | 2 | 2 | 1 | | Kuchiami | 5 | 5 | 4 |
| | Kurosaki | 2' | 2 | 1' | | Iga | 5 | 5 | 4 |
| | Kokura | 2 | 2 | 1 | | Shikaya | 5 | 5 | 4 |
| | Orio | 2 | 2 | 1 | | Yobuno | 5 | 5 | 4 |
| | Kashii | 2 | 2 | 1 | | Ishida | 5 | 5 | 4 |
| ③ | Jyomo | 3 | 2 | 1 | | Kafuri | 5 | 5 | 4 |
| | Koga | 3' | 2 | 1' | | Gannosu | 5 | 5 | 4 |
| | Moji | 3' | 2 | 1' | Harumachi | 5 | 5 | 4 | |
| | Yoshizuka | 3 | 2 | 1 | Sakado | 5 | 5 | 4 | |
| | Yahata | 3' | 2 | 1' | Ishiharacho | 5 | 5 | 4 | |
| | Futsukaichi | 3 | 2 | 1 | Sue | 5 | 5 | 4 | |
| | Minamifukuoka | 3 | 2 | 1 | ⑦ | Haruta | 6 | 5' | 2 |
| | Akama | 3 | 2 | 2 | | Kyusandaimae | 6 | 5' | 3 |
| Togo | 3 | 2 | 2 | Kasuga | | 6 | 5' | 3 | |
| Tobata | 3 | 2 | 2' | Kadomatsu | | 6 | 5' | 4 | |
| ④ | Takeshita | 3' | 4 | 5 | | Kashijingu | 6 | 5' | 4 |
| | Minamikokura | 3 | 4 | 3 | | Shii | 6 | 5' | 4 |
| | Kyukodaimae | 3' | 4 | 5 | | Hatae | 6 | 5' | 4 |
| | Edamitsu | 3' | 4 | 5 | | Shiikoen | 6 | 5' | 4 |
| | Shimosone | 3 | 4 | 3 | Doi | 6 | 5' | 4 | |
| | Chikuzenmaebaru | 3 | 4 | 3 | Chojabaru | 6 | 5' | 4 | |
| | Chikuzenshingu | 3 | 4 | 3 | ⑧ | Yusu | 7 | 5' | 5 |
| | Susenji | 3 | 4 | 4 | | Futajima | 7 | 5 | 5 |
| | Imajuku | 3' | 4 | 5 | | Umi | 7 | 5 | 5 |
| ⑤ | Meinohama | 4 | 3 | 1 | ⑨ | Wajiro | 8 | 5 | 6 |
| | Wakamatsu | 4 | 3 | 1 | | Saitozaki | 8 | 5 | 6 |
| | Nishikokura | 4' | 3 | 1' | | Okudokai | 9 | 6 | 6 |
| | Onojyo | 4 | 3 | 2' | | Uminonakamichi | 9 | 6 | 6 |
| | Komorie | 4' | 3 | 5 | | L : land use-station equipment | | | |
| | Hakozaki | 4 | 3 | 3 | P : passenger-land use | | | | |
| | Abeyamakoen | 4 | 3 | 3 | E : station equipment-passenger | | | | |

2.3 Classification of Railway Station from Comprehensive View Point Using 3 Dimensional Cross Table

The structural characteristics of each group which is categorized from comprehensive view point based on a 3 dimensional cross table are as follows (see Table 4):

Group1: Commuter and terminal stations

Group2: Commercial and business area's stations

Group3: Residential area's stations

Group4: Urbanization promotion area's stations which the scale of station equipment is small

Group5: Urbanization promotion area's stations with few passengers

Group6: Stations in the area without potential of development

Group7: Stations in the area with high potential of development

Group8: Stations holding industrial site around station

Group9: Stations holding recreation site around station

3. SUMMARY OF QUESTIONNAIRE SURVEY ON UTILIZING CONSCIOUSNESS OF DAILY LIVING FACILITIES

According to this classification, 11 stations in residential area are selected for a questionnaire survey of daily living facilities including convenience store, book store, coffee shop, bank, library, post office and service window of public office. The questionnaire survey data are analyzed to clear the utilizing consciousness of passengers for daily living facilities. Detail of survey includes degree of satisfaction, divided into 9 degrees, concerning facilities for daily life and their access distance, utilizing frequency of facilities and station, the access distance of the facilities around user's home and user's attribute. The investigation was done at rush hours on July from 19th to 21th, 1993. Summary of questionnaire survey is shown in Table 5.

Table 5 Summary of questionnaire survey

| Station | Group | The number of distribution | The number of collection | The collection percentage | Station | Group | The number of distribution | The number of collection | The collection percentage |
|-----------------|-------|----------------------------|--------------------------|---------------------------|--------------------------------|-------|----------------------------|--------------------------|---------------------------|
| Yoshizuka | ③ | 100 | 24 | 24.0% | Hakozaki | ⑤ | 100 | 32 | 32.0% |
| Koga | | 100 | 33 | 33.0% | Meinohama | ⑦ | 100 | 30 | 30.0% |
| Togo | | 100 | 28 | 28.0% | Kasuga | | 100 | 16 | 16.0% |
| Akama | | 100 | 26 | 26.0% | Kyusandaimae | | 100 | 23 | 23.0% |
| Minamifukuoka | | 100 | 27 | 27.0% | sum | | 1100 | 289 | 26.3% |
| Chikuzenshingu | ④ | 100 | 32 | 32.0% | Days : 1993 July 19-21 | | | | |
| Chikuzenmaebaru | | 100 | 18 | 18.0% | Method : leave-and-mail method | | | | |

4. THE DEGREE OF THE SATISFACTION OF FACILITIES FOR DAILY LIFE

The degree of the satisfaction of facilities for daily life is influenced by the access distance of the facilities, the scale and the service level of the facilities. It was clear that the correlation between the degree of the satisfaction of facilities and the degree of the satisfaction concerning the access distance of facilities is high from the result of questionnaire survey. The satisfaction functions of facilities can be established only using the access distance of the facilities based on the following assumption. That is, the user utilizes the facilities under consideration of whether they are in the nearest distance or not rather than under that of the scale and the contents of the facilities.

4.1 The Functions on The Satisfaction's Degree of The Access Distance of Facilities around Station

The distance of the facilities around station is the actual distance of the shortest route to the purpose facilities from the station surveyed by the habitation map. If we use the access distance of facilities as the only independent variable, when $r=0(m)$, $X_1=9$ (extremely satisfied), when $r=\infty(m)$, $X_1=1$ (extremely dissatisfied), and the degree of the satisfaction of facilities for daily life exponentially decreases with the distance. Thus, the satisfaction functions for the facilities (X_1) can be assumed as follows:

$$X_1 = 1.0 + 8.0 \exp(-\alpha r^\beta) \tag{1}$$

where r is the access distance of the facilities around station and α and β are parameters estimated from questionnaire survey. Then, substituting the explanatory variables, which based on user's utilizing consciousness, into the functions proposed above. The results as shown in Table 6 and Fig.4 can be obtained.

In addition to the fact that their signs of parameters are rational, multiple correlation coefficients are high and their test of significant are fine at all models. From Fig.4, it is observed that when $r=500(m)$, $X_1=3.4$, when $r=1000(m)$, $X_1=2.3$ at convenience store, and when $r=500(m)$, $X_1=3.8$, when $r=1000(m)$, $X_1=3.1$ at coffee shop. It means that the degree of the satisfaction of facilities heavily decreases if the access distance of the facilities around station become long. Hence, it is considered that these facilities are demanded to be located nearby.

And, in the case of the library and the window of public office it is seen that when $r=500(m)$, $X_1=5$ (ordinariness). Comparing with the other facilities, the degree of the satisfaction of both facilities are high. It can be said that these facilities would not be taken seriously even if the access distance of the facilities around station is far.

Table 6 The result of the satisfaction functions of the facilities around station

| The facilities | α | β | R | F-value | Judgment |
|---------------------------------|----------|---------|-------|---------|----------|
| Convenience store | 0.030 | 0.597 | 0.905 | 31.8 | ** |
| Coffee shop | 0.143 | 0.322 | 0.971 | 148.1 | ** |
| Service window of public office | 0.083 | 0.324 | 0.886 | 31.1 | ** |
| Post office | 0.105 | 0.322 | 0.881 | 23.4 | ** |
| Bank | 0.287 | 0.146 | 0.719 | 9.6 | * |
| Book store | 0.119 | 0.314 | 0.901 | 39.0 | ** |
| Library | 0.085 | 0.387 | 0.890 | 34.4 | ** |

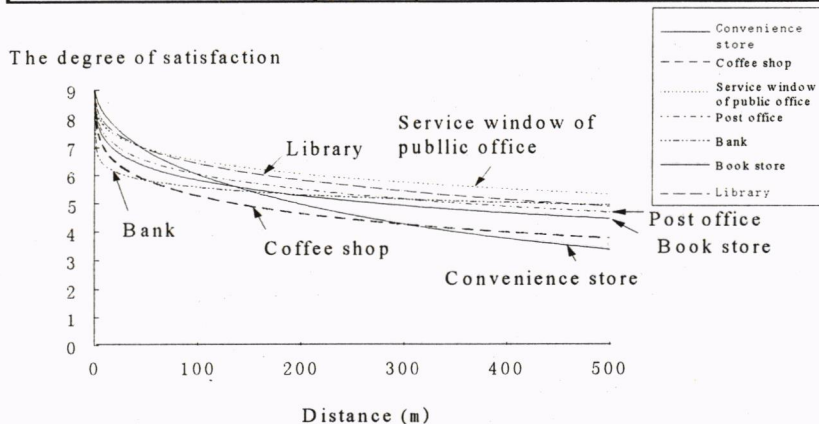


Fig. 4 The satisfaction functions of the access distance of the facilities around station

On the other hand, in the case of the bank, a very small β of 0.15 is estimated and it leads the degree of the satisfaction of the facilities to decrease. That is, the user doesn't seem to mind the access distance to the bank so much. Since the result reveals when $r=500(m)$, $X_1=5$ (ordinariness), it is supposed that the user will be satisfied if the facility exist around station. Moreover, In the case of the post office and the book store, α and β are approximately at the same values. It reveals that the consciousness of the access distance of both facilities are almost the same. And both facilities have an intermediate evaluation among those of the facilities mentioned above.

4.2 The Functions on The Satisfaction's Degree of The Access Distance of Facilities around User's Home

The access distance of the facilities around user's home is the distance of the shortest route to the purpose facilities from use's home derived from the user's answer. The reason why we assume the degree of the satisfaction of the same facilities once again is that the utilizing consciousness of the access distance of facilities around station is different from that of the access distance of facilities around user's home. The satisfaction functions of the facilities (φ_2) is assumed as follows(same as above):

$$\varphi_2 = 1.0 + 8.0 \exp(-\alpha r^\beta) \quad (2)$$

where r is the distance of the facilities around user's home and α , β are parameters estimated from questionnaire survey. Then, applying the function as shown in equation (2) by using the data for the degree of the satisfaction of each facility, which are based on user's utilizing consciousness derived from questionnaire survey, results as shown in Table 7 and Fig.5 can be obtained. From Fig.5, it reveals that if the access distance of convenience store around station becomes long, the degree of the satisfaction of facilities heavily decreases (as in § 4.1). It can be considered that these facilities are demanded to be located nearby.

On the other hand, it is noticed that β of the case of coffee shop is small. This leads to a result that the degree of the satisfaction of coffee shop heavily decreases if they are located within 1000(m) from user's home, while the degree of the satisfaction of the coffee shop decreases smaller than the others if they are located more than 1000(m) from user's home. So, we can understand that the utilizing consciousness of the access distance of facilities around station are different from those of the access distance of facilities around use's home, and the evaluation of the access distance of facilities around station are more sensitive than those around user's home.

In addition, when comparing the satisfaction functions of the access distance of facilities around user's home with those around station, α of all facilities show extremely small values while β of all facilities show big values.

4.3 The Degree of The Satisfaction of Facilities of Each Area

The station catchment area is assumed as the area of the administrative unit (the school district) based on the distributing range of the user's address derived from the questionnaire survey data and the commuter pass data. Poisson distribution is applied owing to the fact that user is randomly distributed in the area according to the distribution situation of the facilities. The probability density function of the distribution of the access distance to the nearest neighbor facilities in the area can be assumed as follows:

$$f_p(r) = 2\rho\pi r \exp(-\rho\pi r^2) \quad (3)$$

where ρ is the facility density and r is the access distance of the facilities. The satisfaction functions of facilities of each area (X_2) are constructed by the above functions and the satisfaction functions of the access distance of facilities around user's home which is

assumed that the user uses the facilities which are located in the nearest distance. It can be written as follows:

$$X_2 = \int_0^{\infty} \varphi_2(r) f_p(r) dr \tag{4}$$

Table 7 The result of the satisfaction functions of the facilities around user's home

| The facilities | α | β | R | F-value | judement |
|---------------------------------|----------|---------|-------|---------|----------|
| Convenience store | 0.008 | 0.694 | 0.988 | 157.5 | ** |
| Coffee shop | 0.065 | 0.380 | 0.981 | 115.1 | ** |
| Service window of public office | 0.009 | 0.611 | 0.936 | 28.1 | ** |
| Post office | 0.010 | 0.633 | 0.983 | 118.2 | ** |
| Bank | 0.016 | 0.565 | 0.992 | 235.0 | ** |
| Book store | 0.011 | 0.629 | 0.974 | 74.1 | ** |
| Library | 0.008 | 0.636 | 0.954 | 40.4 | ** |

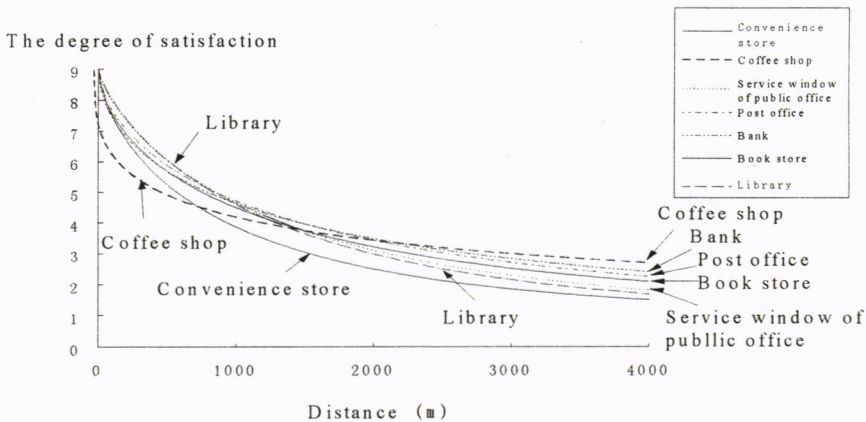


Fig. 5 The satisfaction functions of the access distance of the facilities around user's home

where $\varphi_2(r)$ is the satisfaction functions of the access distance of the facilities around user's home and $f_p(r)$ is the distribution of the access distance of the nearest facilities in the area. The density of facilities of each station is shown in Table 8.

Then, in order to obtain the satisfaction function of facilities of each area, the above equation is applied by using user's utilizing consciousness. The result is shown in Table 9. The degree of the satisfaction of all facilities range from 3 to 6, and no facility seems to be extremely satisfied. The degree of satisfaction the public office service window and the library the satisfaction is ranged from 3.0 to 4.5.

At the convenience store, the difference between the maximum and the minimum value of the degree of the satisfaction is 2.53. The difference with the degree of the satisfaction among the areas seems to be the biggest one when comparing with that of the other facilities. It is considered that this is due to the density of convenience store is quite different among the areas, and the utilizing consciousness of this facility is high.

At the library, the difference between the maximum and the minimum value of the degree of the satisfaction is 1.13. The difference with the degree of the satisfaction among the areas is small. And owing to the degree of the satisfaction of this facility among the areas is ranged from 3.5 to 4.5, the library is thought to be the facility which the user does not have interest too much. The difference between the maximum and the minimum value of the degree of the satisfaction is 1.7-1.8 and shows approximately the same value at the

facilities which exclude above two facilities.

Table 8 The facilities density of each area

| Station | Convenience store | Coffee shop | Service window of public office | Post office | Bank | Book store | Library |
|-----------------|-------------------|-------------|---------------------------------|-------------|-------|------------|---------|
| Yoshizuka | 1.681 | 4.947 | 0.032 | 0.645 | 1.660 | 1.258 | 0.063 |
| Hakozaki | 1.513 | 4.452 | 0.032 | 0.580 | 1.494 | 1.132 | 0.070 |
| Kyusandaimae | 1.076 | 1.709 | 0.032 | 0.427 | 0.823 | 0.981 | 0.047 |
| Chikuzenshingu | 0.349 | 0.436 | 0.087 | 0.262 | 0.349 | 0.262 | 0.087 |
| Koga | 0.624 | 0.702 | 0.039 | 0.234 | 0.429 | 0.234 | 0.039 |
| Togo | 0.286 | 0.364 | 0.013 | 0.117 | 0.169 | 0.221 | 0.039 |
| Akama | 0.286 | 0.364 | 0.013 | 0.117 | 0.169 | 0.221 | 0.039 |
| Minamifukuoka | 1.099 | 1.555 | 0.054 | 0.402 | 0.724 | 1.048 | 0.054 |
| Kasuga | 0.999 | 1.414 | 0.049 | 0.366 | 0.658 | 1.048 | 0.049 |
| Meinohama | 0.286 | 0.394 | 0.012 | 0.263 | 0.334 | 0.155 | 0.024 |
| Chikuzenmaebaru | 0.103 | 0.162 | 0.015 | 0.073 | 0.147 | 0.235 | 0.029 |

Table 9 The degree of satisfaction of facilities of each area

| Station | Convenience store | Coffee shop | Service window of public office | Post office | Bank | Book store | Library |
|-----------------|-------------------|-------------|---------------------------------|-------------|-------|------------|---------|
| Yoshizuka | 5.895 | 5.909 | 3.783 | 5.699 | 6.167 | 6.007 | 4.318 |
| Hakozaki | 5.810 | 5.861 | 3.782 | 5.618 | 6.101 | 5.931 | 4.401 |
| Kyusandaimae | 5.525 | 5.409 | 3.782 | 5.376 | 5.708 | 5.826 | 4.064 |
| Chikuzenshingu | 4.505 | 4.708 | 4.636 | 4.972 | 5.092 | 4.765 | 4.595 |
| Koga | 5.044 | 4.958 | 3.958 | 4.878 | 5.246 | 4.670 | 3.892 |
| Togo | 4.319 | 4.612 | 3.032 | 4.282 | 4.539 | 4.622 | 3.894 |
| Akama | 4.319 | 4.612 | 3.032 | 4.282 | 4.539 | 4.622 | 3.894 |
| Minamifukuoka | 5.543 | 5.362 | 4.226 | 5.327 | 5.620 | 5.875 | 4.171 |
| Kasuga | 5.462 | 5.315 | 4.146 | 5.250 | 5.553 | 5.875 | 4.088 |
| Meinohama | 4.320 | 4.654 | 2.955 | 4.976 | 5.060 | 4.316 | 3.468 |
| Chikuzenmaebaru | 3.363 | 4.173 | 3.138 | 3.869 | 4.428 | 4.674 | 3.646 |

The result shows that the more the station located near Fukuoka city, the bigger the degree of the satisfaction is. And at Yoshizuka and Hakozaki stations, the degree of the satisfaction of all facilities excluding the government office window, the library, the facilities with low degree of the satisfaction, are high comparatively. That means, the user seems to be satisfied with the facilities for daily life.

On the other hand, Chikuzenmaebaru station has low degree of the satisfaction of all facilities of the range from 3.0 to 4.5 and it seems that the users are dissatisfied with the facilities of daily life in the area.

5. ESTIMATION OF THE DEMAND OF THE FACILITIES AROUND STATIONS

5.1 Estimating Models of The Demand of The Facilities around Stations

When installing new facilities in the station, the consciousness of the user and the condition with construction cost and so on must be take into consideration. The most important thing is the profit when developing the facilities. When considering the profit and introducing the facilities for daily life, firstly, it is considered to estimate the amount of users of the facilities which is high correlated to the profit of the installed facilities. Needless to say, it is necessary to evaluate the profit of introduction of each facilities through the demand change of each facilities by forecasting how many uses will be attracted by the installing of facilities.

Multiple regression analysis by stepwise method were applied to estimate the amount of the attracted users of the facilities for daily life. The independent variables are the degree of the satisfaction of facilities of each area, the degree of the satisfaction of facilities around station and so on. The dependent variables are the estimated number of people who use the facilities around station based on the result of the questionnaire. And the number of people which use the facilities around station can be written as follows:

$$\text{The number of people who use the facilities around station (people/day)} = (\text{The railway ridership}/2) * (\text{The average utilizing times of the user of the facilities around station})/30$$

where the average utilizing times of the user of the facilities around station is the average utilizing times (time/month) of the user of the facilities based on the questionnaire. The established models are shown in Table 10.

In the case of the convenience store model, Y_2 and Y_3 are excluded from independent variables by stepwise method due to low correlation between both variables and the dependent variable. It leads to the fact that the more the facilities located near the station, the more the user will be attracted by the facilities. Besides, the rate which depends on Y_1 is high in this model.

In the case of the coffee shop model, the sign of Y_1 is positive, it can be explained as the same reason mentioned in the case of the convenience store model. Y_2 shows a negative value and it leads to a consideration that even if the degree of the satisfaction of the facilities of the area becomes bigger, the user are not expected to increase. That is, it is not required to be installed around the station even if the user is satisfied with the facilities around user's home. Also, we can get the same evaluation at the post office and the bank.

In the case of the service window of public office, the book store and the library, Y_1 is excluded from the model by stepwise method. It can be considered that even if the facilities are constructed near the station, the user will not increase.

Table 10 Multiple regression model for the demand of the facilities around station

| | Model of the facilities of each area | | | | | | |
|--|--------------------------------------|--------------------|---------------------------------|---------------------|---------------------|----------------------|--------------------|
| | Convenience store | Coffee shop | Service window of public office | Post office | Bank | Book store | Library |
| Y_1 (The degree of satisfaction of facilities around station) | 79.371 (6.633) | 19.531 (7.259) | | 26.898 (7.496) | 14.499 (7.956) | | |
| Y_2 (The degree of satisfaction of facilities of each area) | | -20.146 (2.286) | | -44.560 (16.782) | -41.342 (18.697) | -235.537 (20.710) | -37.175 (3.382) |
| Y_3 (The ratio of the residential area) | | -1.438 (4.048) | -0.826 (11.892) | | 0.828 (2.301) | -3.771 (1.394) | |
| Y_4 (The ratio of the commercial area) | 34.201 (6.186) | -2.935 (1.613) | 1.225 (2.576) | 2.847 (2.326) | | | -1.981 (1.073) |
| const | -410.8 | 110.8 | 53.2 | 119.4 | 202.9 | 1724.7 | 192.9 |
| R | 0.725 | 0.847 | 0.859 | 0.892 | 0.885 | 0.869 | 0.562 |

() : F-value

5.2 Application to The Object Station and The Consideration

In this section, demand estimating models of the facilities around stations proposed above is applied to forecast how many users can be attracted when these facilities are introduced into the station. In the case, the access distance of the facilities around station is regarded as 0, that is, the degree of satisfaction of the facilities for daily life around station can be supposed to be 9 (extremely satisfied). Meanwhile it is assumed that one more such

facilities increase in the area. The result of demand forecasting of the facilities is as shown in Table 11.

And the consideration concerning the result is as follows:

- (1) There are many users which use the convenience store currently in Hakozaki and Yoshizuka stations. However, the users increase only by 1.2 times after introducing the facilities into the station. Thus, it is considered that the convenience store seem to be satisfied sufficiently at these two stations.
- (2) On the other hand, the user increases by 2.6 times (300-400 persons) after the introduction of the convenience store in Koga and Kasuga station. It is considered that the convenience store is required to be introduced into these stations.

Table 11 The result of estimated demand of users of the facilities around station

| station | Convenience store | | | | Coffee shop | | | |
|----------------|---|--------------------|--|----------------------------------|---|--------------------|--|----------------------------------|
| | The degree of the satisfaction of facilities of each area | | The estimated number of user of the facilities | | The degree of the satisfaction of facilities of each area | | The estimated number of user of the facilities | |
| | present | after introduction | present | The increment after introduction | present | after introduction | present | The increment after introduction |
| Yoshizuka | 5.895 | 5.905 | 544.06 | 60.80 | 5.909 | 5.911 | 23.33 | 72.49 |
| Hakozaki | 5.810 | 5.820 | 444.64 | 100.72 | 5.861 | 5.863 | 31.84 | 51.24 |
| Kyusandaimae | 5.525 | 5.538 | 107.44 | 288.80 | 5.409 | 5.413 | 40.70 | 63.33 |
| Tikuzenshiguu | 4.505 | 4.714 | 535.43 | 31.47 | 4.708 | 4.804 | 28.26 | 71.52 |
| Koga | 5.044 | 5.099 | 265.57 | 398.81 | 4.958 | 4.986 | 39.83 | 56.69 |
| Tougou | 4.319 | 4.361 | 426.65 | 68.43 | 4.613 | 4.631 | 64.54 | 53.67 |
| Akama | 4.319 | 4.361 | 273.33 | 209.09 | 4.613 | 4.631 | 70.28 | 67.26 |
| Minamifukuoka | 5.543 | 5.584 | 436.02 | 228.02 | 5.362 | 5.379 | 28.28 | 69.90 |
| Kasuga | 5.462 | 5.503 | 179.57 | 313.46 | 5.315 | 5.332 | 11.72 | 53.18 |
| Meinohama | 4.320 | 4.358 | 342.25 | 170.96 | 4.654 | 4.670 | 118.59 | 40.53 |
| Tikuzenmaebari | 3.363 | 3.484 | 478.14 | 336.37 | 4.173 | 4.220 | 34.96 | 70.83 |

| station | Post office | | | | Bank | | | |
|----------------|---|--------------------|--|----------------------------------|---|--------------------|--|----------------------------------|
| | The degree of the satisfaction of facilities of each area | | The estimated number of user of the facilities | | The degree of the satisfaction of facilities of each area | | The estimated number of user of the facilities | |
| | present | after introduction | present | The increment after introduction | present | after introduction | present | The increment after introduction |
| Yoshizuka | 5.699 | 5.724 | 14.38 | 117.08 | 6.168 | 6.175 | 57.50 | 46.96 |
| Hakozaki | 5.618 | 5.643 | 15.09 | 115.03 | 6.101 | 6.109 | 48.16 | 69.86 |
| Kyusandaimae | 5.376 | 5.405 | 53.37 | 74.94 | 5.708 | 5.721 | 84.14 | 50.45 |
| Tikuzenshiguu | 4.972 | 5.211 | 40.24 | 102.38 | 5.092 | 5.257 | 127.83 | 32.09 |
| Koga | 4.879 | 5.008 | 66.64 | 101.68 | 5.246 | 5.309 | 97.85 | 49.86 |
| Tougou | 4.282 | 4.374 | 88.63 | 93.84 | 4.539 | 4.596 | 134.04 | 43.07 |
| Akama | 4.282 | 4.374 | 84.39 | 97.03 | 4.539 | 4.596 | 97.93 | 68.69 |
| Minamifukuoka | 5.327 | 5.428 | 86.83 | 62.74 | 5.620 | 5.667 | 130.81 | 13.54 |
| Kasuga | 5.250 | 5.351 | 42.91 | 95.85 | 5.553 | 5.603 | 100.18 | 57.97 |
| Meinohama | 4.976 | 5.013 | 37.42 | 118.09 | 5.060 | 5.087 | 101.99 | 58.72 |
| Tikuzenmaebari | 3.869 | 4.031 | 111.77 | 112.58 | 4.428 | 4.503 | 144.39 | 32.71 |

| station | Book store | | | |
|----------------|---|-------------------|--|---------------------------------|
| | The degree of the satisfaction of facilities of each area | | The estimated number of user of the facilities | |
| | present | after arrangement | present | The increment after arrangement |
| Yoshizuka | 6.007 | 6.019 | 210.38 | 26.62 |
| Hakozaki | 5.931 | 5.943 | 147.62 | 7.92 |
| Kyusandaimae | 5.826 | 5.838 | 129.34 | 48.55 |
| Tikuzenshiguu | 4.765 | 5.007 | 457.01 | 18.64 |
| Koga | 4.670 | 4.801 | 439.50 | 0.48 |
| Tougou | 4.622 | 4.671 | 431.39 | 39.51 |
| Akama | 4.622 | 4.671 | 509.76 | 8.96 |
| Minamifukuoka | 5.875 | 5.908 | 264.93 | 9.62 |
| Kasuga | 5.875 | 5.908 | 74.38 | 1.92 |
| Meinohama | 4.316 | 4.380 | 578.35 | 3.37 |
| Tikuzenmaebari | 4.674 | 4.726 | 493.32 | 22.20 |

- (3) It is observed that there are few users in the coffee shop at each station. Also, the consciousness of introducing this facilities into the station is low due to the users only increase a little after the facilities is introduced into stations.
- (4) As for the service window of public office, the user increases in 8-9 times (equal to or

more than 100 persons) after introducing the facility into Yoshizuka and Hakozaki station and it leads to the consideration that the service window of post office is required to be introduced into the station. Also, in the case of the other stations, the user increases mainly 2-3 times after the facilities are introduced.

- (5) As for the bank, the user increases by 1.1-1.5 times (40-50) after introducing the facility into stations. It means that the users are satisfied with these facilities. So, the bank is not required to be introduced into the station currently.
- (6) Since there are many users utilize the book store at the stations currently and there are just a little users increase after the facility is introduced, it is considered that there will be almost no benefit even if the book store is introduced into the station.

6. CONCLUSION

73 stations were classified from 3 viewpoints of the land use, the station equipment and the utilizing conditions of passenger. Moreover, after understanding relation between each classification which is due to the cross table, they are classified into 9 groups from comprehensive viewpoint. Regarding the stations located in the bedroom suburbs as the stations to be investigated, their consciousness of the degree of the satisfaction to the facilities for daily life were analyzed.

The result can be concluded as follows:

- (1) As an analysis of the degree of the satisfaction to the facilities for daily life, the degree of satisfaction of the convenience store fairly changes in accordance with the distribution situation of this facility of each area. And, the more the station is located near Fukuoka city, the bigger the degree of the satisfaction is.
- (2) Demand of each facility after installing the facilities into the station can be estimated after establishing the satisfaction functions of the facilities for daily life.
- (3) Estimating models of demand of the facilities around stations is applied to forecast how many users can be attracted by the introduced facilities. The result reveals that there exist big differences between each area in the case of convenience store. And the number of users of the bank and the bookstore do not seem to increase. The consciousness on the necessity of introducing of convenience store and post office window is observed to be higher than that of the other facilities.

As a further research, the relation between practical utilizing situation of the facilities at each station, the degree of the satisfaction and the user attribute is considered to be analyzed more detail based on the result mentioned in this paper. And the priority order of facility introduction based on the user's consciousness at station also needs to be decided by considering the profit of introduction of the facilities from the view point of the planner.

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