A Study on Land Development Typology of Shinkansen Station Area

CHEN　Siting

1. Introduction

1.1.Background

The Shinkansen High-Speed Rail system has played an important role in the intercity transportation in Japan. Since the first Shinkansen line connecting Tokyo - Osaka started operation in 1964, 92 stations in total have been connected by the Shinkansen network. Around the Shinkansen stations, urban development plans were carried out to improve the quality of living environment, attract investments and led population aggregation and commercial prosperity. However, in some small cities, instead of benefits, the population loss and recession became more serious after the operation of Shinkansen. Much existing research has theoretically demonstrated the integrated economic effects of the construction of the Shinkansen from perspectives of economic theory, market mechanisms, population migration and social welfare, while rarely discussing negative consequences. For cities whose Shinkansen stations are under construction or currently planned, the study on the land development around exsiting stations is of great significance.

1.2.Research Objective and Method

The purpose of this study was to comprehensively grasp the land development status of the surrounding area of all 92 Shinkansen stations. To make the discussion in this study clear, the development is defined as the process in which urban function, including commercial, business, residential, and amenity facilities, aggregate around station area and become more diverse and compact, and the development typology is defined as a description of the composition of the urban function around a station area. This research aimed to clarify the current land development typologies in the area of the 400-meter range around each of 92 Shinkansen stations, which is an area about 5-minute walk around a station and can be considered as the most station-influenced area.

As is shown in Fig.1, to depict the land development status around Shinkansen stations, 16 indexes which reflect

the development status were selected from the avaliable data source, then the principal component analysis and cluster analysis was conducted to classify the land development status of 92 station area into different typology groups, and the feature of each typology was claified. Then according to the growth raito of population and the number of employees in the past 5 years, the development tendency of the land development typologies of Shinkansen station areas was clarified.
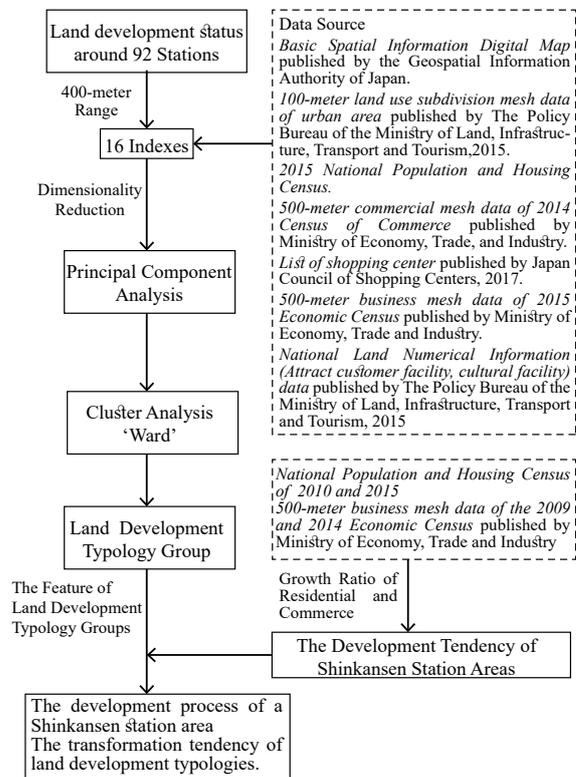

Fig.1 The Study Flow

2. Principal Components of Land Development of Shinkansen Stations Areas

The result of the Principal Component Analysis suggested that with the first four principal components, 79.8% of the information contained in the original data can be explained, as is shown in Table 1. According to the correlation of variables to the factors of the principal component analysis, the four principal components can be interpreted as follows:

Component-1 was interpreted as a commerce axis, for it is positively correlated with the number of companies,

employees, retail shops, building coverage ratio and high-rise building area, while negatively correlated with the unconstructed-related variables, which can be considered as the characteristics of a typical commerce core area.

Component-2 can be considered as a residential axis for it is highly positively correlated with population, household, and road density, while all the variables related to commerce were negatively correlated, which corresponded to the characteristics of a typical residential area of Japan.

Component-3 is highly correlated with the number of amenity facilities and the number of amenity facility, which indicates this axis depicts the amount and diversity of non-commercial amenity functions, hence, this axis can be defined as the amenity.

Component-4 is highly positively correlated with low-rise building area, and negatively correlated with dense low-rise building area, therefore, this axis describes the density of low-rise building area, which to some extent reflects the urban form of a station area.

Table 1 Correlaton of Variables to the Factors of the PCA Analysis Based on Factor Loadings

Id	Index	Comp 1	Comp 2	Comp 3	Comp 4
1	Building Coverage Raito	0.891	0.279	0.034	0.023
2	Tall Building Area	0.868	-0.143	-0.213	0.045
3	Number of Retail Shops	0.931	-0.131	-0.101	-0.033
4	Commercial Employee	0.906	-0.204	-0.222	0.039
5	Number of Companies	0.947	-0.140	-0.179	0.040
6	Number of Business Employee	0.773	-0.326	-0.174	0.153
7	Road Density	0.052	0.757	-0.088	0.169
8	Population	0.442	0.779	-0.146	-0.184
9	Household	0.531	0.691	-0.204	-0.213
10	Area of Shopping Center	0.704	-0.236	-0.358	0.044
11	Number of Amenity Facility	0.666	-0.101	0.668	0.048
12	Amenity. Type	0.669	-0.097	0.660	0.072
13	Low-rise Building Area	-0.555	0.420	0.007	0.618
14	Dense Low-rise Building Area	0.338	0.417	0.344	-0.532
15	Non-Urban Construction Land	-0.591	-0.497	-0.150	-0.480
16	Other Urban Construction Land	0.504	-0.173	0.190	0.185
	Standard deviation	2.761	1.626	1.195	1.038
	Proportion of Variance	0.476	0.165	0.089	0.067
	Cumulative Proportion	0.476	0.641	0.731	0.798
Comp1: Commerce; Comp2: Residential; Comp3: Amenity; Comp4: Density (of low-rise building area)					

3. The Land Development Typology Groups

To clarify the land development typology, the hierarchy cluster analysis was conducted based on the principal component score of 92 station areas. In this research, the Ward's minimum variance method was used. As a result, 92 station areas were classified into 6 typologies, which are A. Primitive state (15 stations), B. Low-density residential-oriented typology (35 stations), C. Intensive mixed residential-oriented typology (21 stations), D. Low-density commerce-oriented typology (8 stations), E. Dense commerce-oriented typology (7 stations), F. Integrated core typology (6 stations). The result of the classification is as shown in Table 2.

Table 2 The Land Development Typology Groups Based on the Result of Cluster Analysis

Type	Stations
A Primitive State (15)	Shin-Hakodate-Hokuto, Okutsugaru-Imabetsu, Shichinohe-Towada,Iwate-Numakunai, Shin-Hanamaki, Mizusawaesashi, Kurikoma-Kōgen, Jōmō-Kōgen, Annakaharuna, Honjōwaseda, Kurobe-Unazukionsen, Chikugo-Funagoya, Shin-Tamana, Shin-Yatsushiro, Shin-Ninamata
B Low-density Residential-Oriented (35)	Shin-Aomori, Hachinohe, Ninohe, Furukawa, Shiroishizaō, Shin-Shirakawa, Nasushiobara, Echigo-Yuzawa, Urasa, Tsubame-Sanjō, Jōetsumyōkō, Itoigawa, Shin-Takaoka, Karuizawa, Sakudaira, Ueda, Iiyama, Gifu-Hashima, Atami, Shin-Fuji, Kakegawa, Mikawa-Anjo, Maibara, Aioi, Shin-Kurashiki, Shin-Onomichi, Higashihiroshima, Shin-Iwakuni, Shin-Yamakuchi, Asa, Shin-Shimonoseki, Shin-Ōmuta, Shin-Tosu, Izumi, Sendai(K)
C. Intensive Mixed Residential-Oriented (21)	Fukushima, Utsunomiya, Oyama, Takasaki, Kumagaya, Shin-Yokohama, Odawara, Nagaoka, Niigata, Kanazawa, Nagano, Hamamatsu, Toyohashi, Shin-Ōsaka, Shin-Kōbe, Nishi-Akashi, Mihara, Hiroshima, Tokuyams, Kurume, Kagoshima-Chūō
D. Low-density Commerce-Oriented (8)	Kikonai, Morioka, Kitakami, Ichinoseki, Kōriyama, Toyama, Mishima, Kumamoto
E. Dense Commerce-Oriented (7)	Ueno, Shinakawa, Shizuoka, Kyoto, Himeji, Okayama, Fukuyama
F. Integrated Core (6)	Sendai, Ōmiya, Tokyo, Nagoya, Kokura, Hakata

1). Primitive state: The station areas in this group have extremely low values of both commerce and residential components, which indicates that these station areas are in the initial stage of development with almost no development of commercial, business or residential.

2). Low-density residential-oriented typology: This group of stations areas have relatively high value of the components of residential and amenity, while an extremely low value of commerce, which indicates this typology of station areas is highly residential-oriented. Besides, the low-rise building density axis suggests that the buildings in this group of areas were not constructed in a high-density form.

3). Intensive mixed residential-oriented typology: Station areas in this group have high values of all functional components of commerce, residential, and amenity, especially the residential, which indicates station areas in this group were intensively developed residential-oriented areas.

4). Low-density commerce-oriented typology: This group of station areas have low values of all functional components, among which the commerce is relatively higher, for which this group was considered as low-denseity commerce-oriented typology.

5). Dense commerce-oriented typology: The station areas in this group have extremely high values of commerce, while the values of residential and amenity are extremely low. Hence, this group can be considered as station areas where the commercial and business were densely concentrated while the residential and amenity were expelled from this area.

6). Integrated core typology: The values of all the functional components except residential are extrmely high, which can be considered as characteristics of station areas located in regional central cities where commercial, business and other multi-functional amenity facilities were intensively gathered.
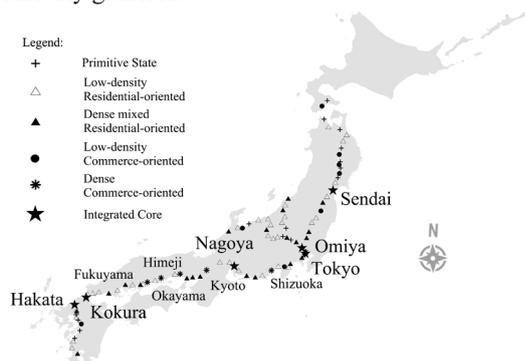

Fig.2 The Distribution of Land Development Typology Groups

The distribution of the typologies is as shown in Fig.2. It can be found that station areas of integrated core typology are always located in the major cities of Japan, and the surrounding area of stations next to an integrated core station are usually low-density residential-oriented, which indicates that the commerce power of a small city can be absorbed by the near major city with connection of Shinkansen.

Besides, the intensive mixed residential-oriented and densely commerce-oriented station areas are mostly located along the Tokaido Line and Sanyo Line which were the first two line started operation and with many regional central cities located along the line, while station areas of primitive state are mostly located at the remote area along the Kyushu Shinkansen, Hokuriku Shinkansen, and Tohoku Shinkansen North section, which can be interpreted as a manifestation that the power of the Shinkansen to promote the urban development of the station area was less significant in remote area.

4. The Development Tendency of Land Development Typologies
4.1.The Land Development of Shinkansen Station Areas in The Past 5 Years

According to the growth ratio of population and the number of employees in the past 5 years, the land development of 92 Shinkansen station areas in the past 5 years was classified into 4 groups, the result is as shown in Table 3.

Table 3 The Development Tendency of Shinkansen Station Areas

Type	Pop*	Emp*	Stations
Recession (24)	—	—	Okutsugaru-Imabetsu, Shin-Hakodate-Hokuto, Kikonai, Tokuyama, Jōetsumyōkō, Karuizawa, Itoigawa, Kakegawa, Shin-Ōsaka, Iiyama, Echigo-Yuzawa, Iwate-Numakunai, Hachinohe, Kurobe-Unazukionsen, Shin-Fuji, Fukushima, Mihara, Odawara, Nasushiobara, Mizusawaesashi, Asa, Ichinoseki, Kyoto, Shin-Iwakuni.
Residential Growth (26)	+	—	Utsunomiya, Shin-Kurashiki, Nishi-Akashi, Kōriyama, Kitakami, Shin-Onomichi, Kumagaya, Morioka, Shin-Shimonoseki, Oyama, Hiroshima, Kurikoma-Kōgen, Toyama, Shin-Kōbe, Maibara, Urasa, Shizuoka, Nagano, Shin-Ōmuta, Shiroishizaō, Mikawa-Anjō, Kurume, Shin-Shirakawa,
Commerce Growth (13)	—	+	Tokyo, Jōmō-Kōgen, Atami, Shin-Minamata, Nagoya, Toyohashi, Nagaoka, Chikugo-Funagoya, Mishima, Ninohe, Shin-Takaoka, Furukawa, Shin-Yamaguchi
Integrated Developing (29)	+	+	Sendai(K), Ueda, Aioi, Tsubame-Sanjō, Shin-Hanamaki, Niigata, Takasaki, Okayama, Fukuyama, Izumi, Shin-Yokohama, Higashihiroshima, Kagoshima-Chūō, Hakata, Shin-Tosu, Sakudaira, Kanazawa, Sendai, Shin-Aomori, Hamamatsu, Gifu-Hashima, Honjōwaseda, Shin-Tamana, Kokura, Ōmiya, Shichinohe-Towada, Shin-Yatsushiro, Annakaharuna, Kumamoto
*Pop: the growth ratio of population *Emp: the growth ratio of the number of employees			

1). Recession (24): refers to station areas where both the population and the number of employees decreased, which indicated the decline of both residential and commerce power.

2). Residential Growth (26): refers to station areas where population increased while the number of employees decreased, which suggested these station areas were losing commerce power and transforming to more residential-oriented areas.

3). Commerce Growth (13): refers to station areas where population decreased while the number of the employees increased, which suggested that these areas were transforming to more commerce-oriented areas by replacing residential with commerce.

4). Integrated Developing (29): refers to the station areas where both population and the number of the employees increased, namely, both residential and commerce were developed.

Fig.3 shows the distribution of stations with different land development in past 5 years. Most station areas along Kyushu Shinkansen Line were synthetically developed, while station areas along Hokkaido Line and Hokuriku Line kept suffering from population loss and commerce recession. This may related to the density of station, for which station areas along Kyushu Line gained population from more remote area, while the population of some station areas along Hokkaido Line and Hokuriku Line migrated to nearby central cities along the Line. Besides, most stations along Tokyo-Sendai section of Tohoku Line were becoming more residential. This may be a result of the commerce power of Tokyo and Sendai, which made the station areas between the two terminal core cities were convenient for the commute.
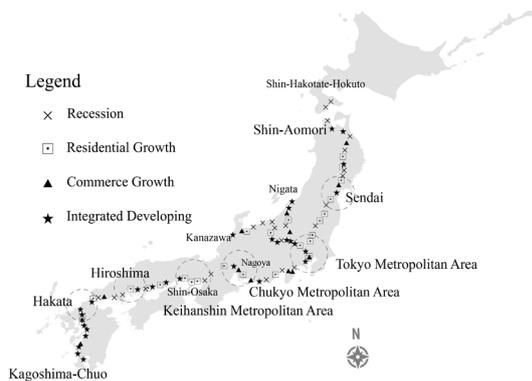

Fig.3 The Distribution of Land Development of Station Areas in Recent 5 Years

4.2 The Transformation Tendency of Land Development Typologies

As is shown in Fig.4, according to the land development in the past 5 years of each typology group, it can be found that integrated core areas has gained more commerce power, while the dense commerce-oriented areas and the low-dense commerce-oriented areas where are lack of multi-functional amenity and residential were transforming to more residential-oriented areas. And stations of the primitive state and low-density residential-oriented typology has more serious population loss and commerce recession problems than other typologies. In addition, station areas of the primitive state attracted more commerce than residential.

Accordingly, it can be concluded that while integrated core areas have enough power to maintain their commerce power and aggregate more population and commerce, most of the Shinkansen station areas of other land development

typologies were not able to retain their commerce power and were transforming to more residential areas.
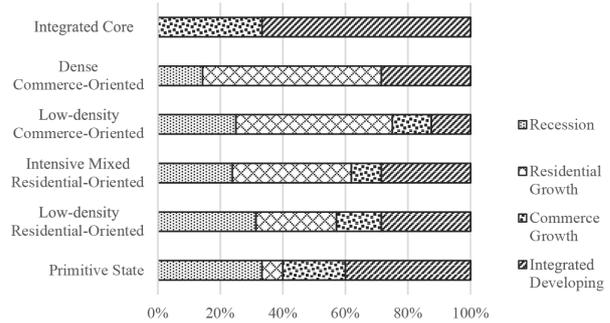

Fig.4 The Development Tendency of Land Development Typology Groups

5.Summary and Conclusion

To sum up, this research studied the land development status of 92 Shinkansen station areas. With multiple indexes which reflects the land development status, the principal component analysis and cluster analysis were conducted. As a result, 92 station areas were classified into 6 land development typology group and the characteristic of each typology group was clarified. Then, according to the growth ratio of population and the number of employees in the past 5 years, the transformation tendency of land development typologies was clarified. As is shown in Fig.5.

As a conclusion, this research clarified the current land development status and the recent development tendency of Shinkansen station areas, a remarkable thing this research found is that Shinkansen station areas have shown significant power to concentrate population, while the power to stimulate the development of commerce were much less significant.
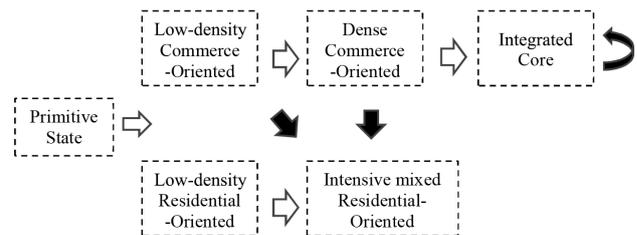

Fig.5 The Transformation Tendency of Land Development Typologies

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