

A STUDY ON STATION SPACE MAINTENANCE OF URBAN RAILWAYS IN TOKYO METROPOLITAN AREA

Toshihiko IWAMOTO
Graduate Student
Graduate School of Environment and
Information Sciences
Yokohama National University
79-5 Tokiwadai, Hodogaya-ku, Yokohama,
240-8501 Japan
Fax: +81-45-339-4031
E-mail: d04tb001@ynu.ac.jp

Fumihiko NAKAMURA
professor
Graduate School of Environment and
Information Sciences
Yokohama National University
79-5 Tokiwadai, Hodogaya-ku, Yokohama,
240-8501 Japan
Fax: +81-45-339-4033
E-mail: nakamura@cvg.ynu.ac.jp

Tsutomu YABE
Research Associate
Graduate School of Environment and
Information Sciences
Yokohama National University
79-5 Tokiwadai, Hodogaya-ku, Yokohama,
240-8501 Japan
Fax: +81-45-339-4031
E-mail: yabe@cvg.ynu.ac.jp

Abstract: Urban railway companies in Tokyo Metropolitan area were directing their efforts toward increasing transport capacities, relieving congestion, shortening travel times and expanding railway network. Therefore, relatively higher degree of punctuality, reliability in safety, and high frequency encourage a large number of passengers to use railways. Through the development of urban railways, the station became the core of urban planning. However, the densely built-up area around station in urban railways is very poor compared with the number of passengers. In addition, it has been discussed that “station space” which includes station, station plaza and the district around station is quite unsatisfactory for passengers and users. In this paper, the authors aimed to pay attention to the station space maintenance on which the railway entrepreneur, the administration, and the private organization have worked up to now, and to confirm the relation between the station space and its evaluation by station space users.

Key Words: urban railway, station space, satisfaction rating evaluation

1. INTRODUCTION

After the Second World War, Japan has been making a high growth, which has brought about the gravitation of population toward large cities, the expansion of urban districts and large-scale housing developments in the suburbs. Under this situation, urban railway companies were directing their efforts toward increasing transport capacities, relieving congestion, shortening travel times and expanding railway network. Therefore, relatively higher degree of punctuality, reliability in safety, and high frequency encourage a large number of passengers to use railways. It goes without saying that urban railways are important parts of urban infrastructure that support daily life of people and economic activity in Tokyo Metropolitan area.

Through the development of urban railways, the station became the core of urban planning. However, the densely built-up area around station in urban railways is very poor compared

with the number of passengers. In addition, it has been discussed that “station space” which includes station, station plaza and the district around station is quite unsatisfactory for passengers and users in local communities. In the background, there is the fact that the undertaker who builds and manages each facility is different. Furthermore, the reason is that passengers and users are not satisfied with “station space” although “station space” is the greatest public space in urban districts.

In this paper, we aim to pay attention to the station space maintenance on which the railway entrepreneur, the administration, and the private organization have worked up to now in urban railways in Tokyo Metropolitan area, and to confirm the relation between the station space and its evaluation by station space users. First we took the line of Tokyu Corporation as a study area and looked back on the history of the station space maintenance, and then grasped the current state of the station space maintenance. After having classified the station space, we considered the result of awareness survey by station space users.

2. OUTLINE OF INVESTIGATED LINES

As research lines, we selected six main lines of Tokyu Corporation located in the southwest district of Tokyo Metropolitan area (Figure1). The total extension of the lines is 91.7 kilometers and the number of stations is 86. Heavily patronized by commuters, the Tokyu railway network served as many as 968 million passengers in 2002. There are two major trunk lines, such as the Toyoko line and the Den-en-toshi line. Each line has over one million passengers per day, connecting Tokyo and Yokohama.

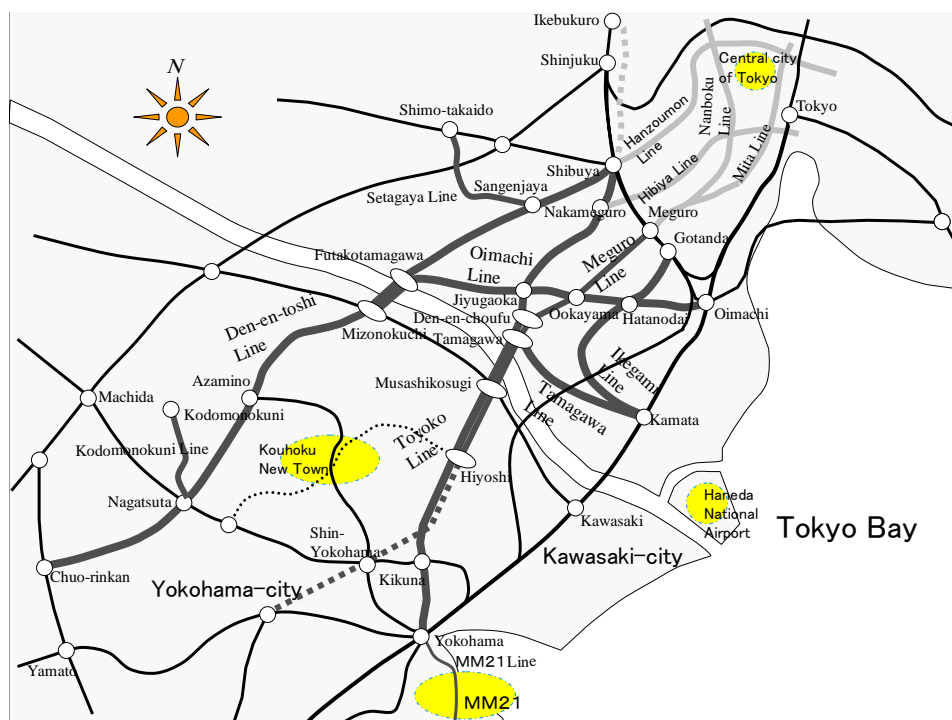


Figure 1. Location of Investigated Lines

Table 1 shows line name, section, length of line, the number of stations, the number of passengers carried per day, and the opening fiscal year. The Den-en-toshi line was planned as a main transportation connecting Tama Den-en City, being maintained by the new town

development of suburbs of postwar days, directly with the central city of Tokyo. In 1996 it opened between Mizonokuchi and Nagatsuta. Extension works were carried out step by step by 1984. Moreover, the Den-en-toshi line between Shibuya and Futako-tamagawa is underground was designed to directly connect with the Hanzomon line of Tokyo metro. It began operation in 1977. Other lines are old lines maintained in 1920's excluding the Den-en-toshi line.

Table 1. Outline of Investigated Lines

Line Name	Section	Length (km)	Station Number	Average Passenger per day in 2002 (thousand)	Opening Fiscal year
Toyoko Line	Shibuya-Yokohama	24.2	21	1,074	1926(Tamagawa-Yokohama) 1927(Shibuya-Tamagawa)
Meguro Line	Meguro-Musasikosugi	9.1	11	233	1923(Meguro-Tamagawa) 1926(Tamagawa-Musashikosugi)
Den-en-toshi Line	Shibuya-Chuorinkan	31.5	27	1,069	1927(Futakotamagawa-Mizonokuchi) 1966(Mizonokuchi-Nagatsuta) 1977(Shibuya-Futakotamagawa) 1984(Nagatsuta-Chuorinkan)
Oimachi Line	Oimachi-Futakotamagawa	10.4	15	327	1927(Oimachi-Ookayama) 1929(Ookayama-Futakotamagawa)
Ikegami Line	Gotanda-Kamata	10.9	15	207	1923(Kamata-Yukigayaotsuka) 1928(Yukigayaotsuka-Gotanda)
Tamagawa Line	Tamagawa-Kamata	5.6	7	132	1923
Total		91.7	86	—	

3. HISTORY OF STATION SPACE MAINTENANCE

The appearance of the station space started at the same time as opening the railway, and the station and the station space have changed in relation to closeness. In this paper, the station space is defined as the space that comprises station, station plaza, and the district around station. The station space is an important space, which improves the convenience of the change between the railway and other transportation in Tokyo Metropolitan area where the railway traffic develops. At the same time it is a face of the town, and the public space in which quite a lot of people gather. Originally, the station space, which should become the core of the town, is the one to be maintained in premeditation. However, because the entrepreneur and the manager in each facility are different, the cooperation of the time axis and facilities in the maintenance of the station space is not settled. Therefore, being not able to demonstrate the function as the core of the town enough is a current state. Here, the history of the station space maintenance is divided roughly into eight as shown in Table 2, and the feature is described as follows.

Table 2. History of Station Space Maintenance

Era	Notes
1920s-	(1) Space maintenance at that time of line opening
1950s-	(2) Space maintenance for economic growth period in postwar days
1960s-	(3) Space maintenance at that time Den-en-toshi line opening
1980s-	(4) Making the station Information base
	(5) The second maintenance in the Den-en-toshi line
1990s-	(6) The second maintenance in underground station
	(7) Space maintenance by railway large-scale improvement
2000s-	(8) Space maintenance integrated with large-scale commercial facilities

3.1 Space Maintenance at That Time of Line Opening

Large damage was caused to an existing urban area in Tokyo Metropolitan area by the Great Kanto Earthquake, which had come in 1923. This became an opportunity, the population moved to the Tokyo southwest part suburbs, and the housing lot development and the railway maintenance of suburbs progressed. At Den-en-chofu Station on the Toyoko line, a European style station, a radial street, and the station plaza were especially maintained, and they played a symbol role of the town.

Moreover, in 1930's the station building was constructed on the adjacent site in Shibuya station, which was the base station in the line. As a result, the terminal where the department store had been established as an annex was maintained for the first time in Tokyo Metropolitan area.

3.2 Space Maintenance for Economic Growth Period in Postwar Days

The plan and the maintenance policy concerning the station plaza were provided in the war damage revival plan after the Second World War had ended. And, the maintenance of the station plaza of the main terminal such as Shibuya and Yokohama was advanced. Jiyugaoka station on the Toyoko line was promptly revived after the war, and the station plaza with the rotary was maintained.

In addition, the population rapidly concentrated from after the war to the high economic growth period in Tokyo Metropolitan area, and the congestion became aggravated around the station. Therefore, the urban planning decision of the station plaza to aim to cancel the traffic jam was conducted, and the station plaza and the station building were maintained in the terminal station which had been connected with Japanese National Railways such as Shibuya, Meguro, Gotanda, and Kamata. The stations other than connected station with Japanese National Railways only maintained a space necessary for the approach, which connected the station and the town for the pedestrian. On the other hand, the traffic plaza for bus was maintained in Hiyoshi Station and Tsunashima Station on the Toyoko line where there were a lot of bus users.

3.3 Space Maintenance at That Time Den-en-toshi Line Opening

Situated in the sprawling Tama hills southwest of Tokyo, just 15 to 35 kilometers from Mizonokuchi Station to Chuo-rinkan Station on the Den-en-toshi line. Stretching over four cities, Kawasaki, Yokohama, and Yamato cities in Kanagawa prefecture, and Machida city in Tokyo. The railway entrepreneur has gone in this area unifying city planning and the railway maintenance of place along railway in 1960's. The site around the station was secured by the land substitution of the readjustment of town lots business when the route was maintained, and the station plaza from which the bus and the taxi use, etc. as the access means of the station were considered was maintained. Not only the plaza of traffic processing, and it exists in the motto making the plaza for man when it undertakes the space maintenance. The symbol tree and the monument were arranged in the space around the station, and the space formation that the station combined with the station plaza was done. Moreover, because the railway entrepreneur oneself maintained the station plaza in railway site, the urban planning decision has not been received.

3.4 Making the Station Information Base

The new attempt as follows was executed in 1980's. Generally a station was a mere street point for movement. The attempt was to convert a station into the space gathered by the local populace and the station user. In brief, it was that the station changed the base of local information and service. Therefore, "Tecoplaza" which had the overall service function to offer the region the place of the community was set up at the main station. Tecoplaza service center was new attempt to provide a diverse range of services to support the various facets of urban living. It provided a complete range of services, from sales of train and bus commuter tickets, consultation on housing, relocation and door-to-door delivery services, sales of admission tickets, all the way to travel arrangements. At the same time, it worked on making to public and the service function improvement of the station as the administrative service corner and the post office were established in the station premises.

3.5 The Second Maintenance in the Den-en-toshi Line

The convenience of the railway network drew a great number of passengers; the resulting rose in population and business activity to serve residents led to even more growth in railway traffic. In 1980's the department store and the commercial establishment, etc. were maintained around the base station in the Tama garden city. As a result, a united space was formed with the station and the station plaza that had already been maintained. The railway entrepreneur provided excellent living environments through a well thought-out placement of shopping, educational, and cultural facilities. Each station on Den-en-toshi line is equipped with shopping facilities that support residents' daily life.

Moreover, maintenance of station plaza widening was executed at the station where a lot of bus users existed as the area served by a railway station expanded. About Aobadai Station, the urban planning decision of station plaza was conducted and the station plaza was expanded in the site of railway and road. In addition, the advanced use for the space was achieved by constructing the station as a structure with the business complex including the station facilities. Similarly, the artificial ground was set up in overhead space of the railway, and the station plaza was maintained again as a joint project of the railway entrepreneur and the administration at Ichigao Station.

3.6 The Second Maintenance in Underground Station

Because the region for constructing the underground was highly urbanized, it was impossible to purchase the site for a new railway line. The railway was inevitably maintained under the road, and therefore, there were many cases that only the exit of the station was established on the ground. In general, the station space of underground became a narrow-minded station space.

On the other hand, in the case of Sangenjaya Station and Yoga Station on the Den-en-toshi line the space maintenance cooperated with a redevelopment project and a private large-scale development business was executed. In those projects facilities maintained were as follows: a redevelopment building connected directly with the station, a free passage where the development area and the station connected continuously, a public open space and a traffic plaza for bus. Moreover, these projects were characterized by considering the continuousness in facilities and the spectacle.

3.7 Space Maintenance by Railway Large-scale Improvement

The station space was maintained by also to the large-scale improvement construction of the railway like the project of increasing from two to four tracks and the continuous overpass business, etc. The facilities like the station plaza, bicycle-parking space, the commercial establishment, and the station building, etc. were maintained in the district around the station after the railway was made underground or was made elevated. It contributed to the community formation in the region. In the case of Den-en-chofu Station on the Toyoko line, the old station that had been the symbol in the town was restored after the railway improvement. Furthermore, in the case of Hiyoshi Station on the Toyoko line, after the station was rebuilt underground, the railway entrepreneur took advantage of overhead space by erecting the station building (Picture 1). In this project the free passage of 24 hours opening to connect the town was established in the station premises, and it contributed to urban planning in the region.



Picture 1. Station Space at Hiyoshi Station

3.8 Space Maintenance Integrated with Large-scale Commercial Facilities

In recent years, there was a unique case focusing on the convenience of a road traffic access and the location near the station. In the case of Minami-Machida Station on Den-en-toshi line, the shopping center of open mall type was maintained around station. The aim of this project was to activate the district around station in the suburbs, which was not developed well. The bustle space combined the station with large-scale commercial facilities is formed there.

4. CLASSIFICATION OF STATION SPACE

It is necessary to understand the current state of the station and its surrounding area before we analyze the user's awareness in the station space. In that case, making the function of the station space a pattern and catching systematically enable to apply the station other than the investigation object. When the station space was classified, the cluster analysis was conducted by using nine variables, such as station structure and average passengers per day/commercial form around station, etc. The analysis was executed by the Ward method of the Euclid square distance, and the dendrogram like Figure 3 was obtained. As a result, the station space was classified into eight groups as shown in Table 1. The feature and the name of each group are as follows.

Table 3. Classification of Station Space

Group	Station Space Type	Station Number
A	Terminal station type	7
B	Underground station type	5
C	Transfer station type	5
D	Base station type	10
E	Outskirts station type	8
F	Semi-base station type	11
G	Suburb station type	4
H	General station type	36

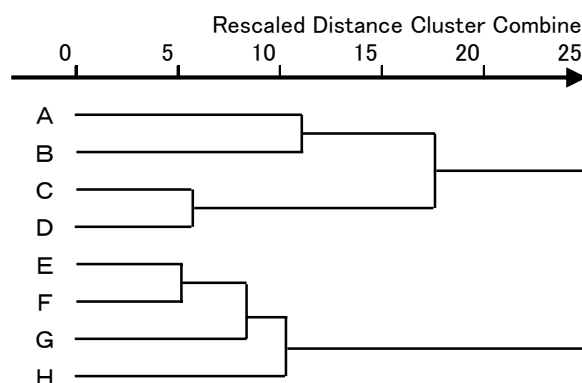


Figure 2. Dendrogram Using Ward Method

A (Terminal station type): For terminal station type, the number of station users is considerably large, and the station is origin-destination in the line. The station of this type has the terminal function of the line and is the transfer station with other lines. Therefore, the station plaza is maintained as transportation node, and most of the access road to the station is trunk roads. Around the station are bustling high buildings and large-scale commercial facilities, etc.

B (Underground station type): For underground station type, the average number of passengers getting on and off per day is 50,000 people or more, and there are a lot of station users. The station of this type is the subway station located in the outskirts region of city centre. Because the station is maintained under the trunk road, station space is a narrow-minded. Moreover, because the surrounding area of the station is urbanized, maintaining urban infrastructure facilities of the station plaza etc. is quite difficult.

C (Transfer station type): For transfer station type, the average number of passengers getting

on and off per day is about 100,000 people or more, and the station is base in the line. And there are considerably a lot of station users as the transfer station with other lines. The station plaza is maintained as transportation node, and large-scale commercial facilities and the shopping street exist together around the station.

D (Base station type): For base station type, the average number of passengers getting on and off per day is about 40,000 people or more, and the station is base in the line. There are comparatively a lot of station users; moreover, the station plaza is maintained as a traffic plaza. The feature is that bus user's ratio is high as the access transportation to the station. Large-scale commercial facilities and the shopping street exist together around the station.

E (Outskirts station type): For outskirts station type, it is located in the outskirts region of city centre. There are comparatively a lot of station users, too. However the surrounding of the station is urbanized, because the station plaza is not maintained, the majority of the access transportation to the station is walking. The shopping street exists around the station.

F (Semi-base station type): For semi-base station type, the majority of the access transportation to the station is walking though the station plaza is maintained as transportation node. Therefore, the average number of passengers getting on and off per day is about 40,000 people or less and the number of station users is comparatively few. Medium-scale commercial facilities and the shopping street exist together around the station.

G (Suburb station type): For suburb station type, it is located in the suburbs of the line, and the average number of passengers getting on and off per day is about 25,000 people or less. The station square with the open space for the pedestrian is maintained, and there are various means as for the access transportation to the station. The majority of surrounding area around the station is a residential district.

H (General station type): For general station type, the average number of passengers getting on and off per day is about 25,000 people or less. Because the station plaza is not maintained, the majority of the access transportation to the station is walking. The shopping street and the residence exist around station.

5. EVALUATION OF STATION SPACE BY USER

5.1 Awareness Survey of Station Space

Judging the result of classification in the preceding chapter, group H (General station type) that composed a comparatively small-scale station space was excluded from the awareness survey. According to this classification, 8 stations shown in Table 3 were selected for awareness survey from group A to group G. Table 4 shows the outline of station and station plaza in 8 stations to be surveyed.

The survey was conducted to the station space user by the facing answer method with the investigator. We divided survey days into weekday and holiday to avoid bias of answerer's attribute. Moreover, we collected survey votes considering the difference of sex and the age group. The survey asked the purpose to use the railway, the use frequency and the satisfaction rating evaluation about station space, station, station plaza and the district around station. We collected 943 answers in total.

Table 4. Outline of the Station and Station Plaza

Group	Station Name	Average Passenger per day (2003)	Modal share (%)				Station Plaza	
			Walking	Motor-cycle	Bus	Car	Traffic plaza	Open space
A	Shibuya	418,009	71.8	9.2	14.9	4.1	Yes	Yes
B	Sangenjaya	110,543	90.2	7.3	1.4	0.5	No	No
C	Jiyugaoka	120,329	80.1	8.9	9.4	1.2	Yes	No
D	Tama Plaza	60,306	60.9	5.4	27.0	6.7	Yes	Yes
D	Aobadai	104,511	49.5	9.0	34.1	6.1	Yes	No
E	Gakugeidaigaku	63,668	89.0	8.9	1.8	0.0	No	No
F	Den-en-Chofu	33,194	86.9	4.6	4.3	3.5	Yes	Yes
G	Tsukushino	13,237	74.9	9.3	6.9	7.7	No	Yes

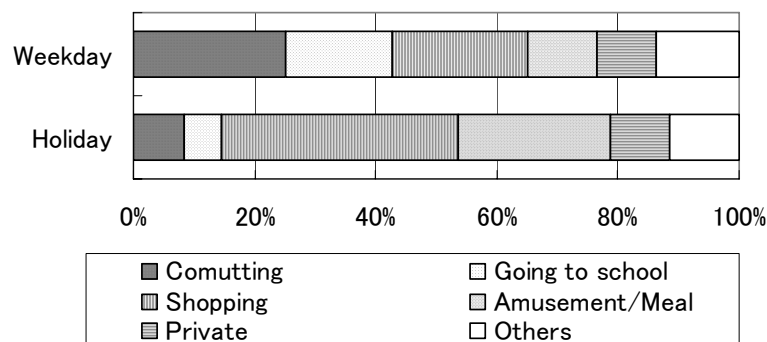


Figure 3. The Purpose to Use Railways

Figure 3 shows the purpose to use railways on weekday and holiday. As a result we can see that commuting, going to school, and shopping are 60 percent or more of the purpose to use railways on the weekday. On the other hand, we can see that shopping and the amusement/meal are 60 percent or more on holiday. There is a big difference in the action characteristic on the weekday and holiday.

5.2 Consideration of User Evaluation in Station Space

Here, to clarify the relation between the overall evaluation in the station space and the evaluation of individual facilities, the survey result was arranged. The survey asked the satisfaction rating of the station space, the station, the station plaza, and the district around station by five stages ("Satisfaction": 2points, "dissatisfaction": -2points), and the satisfaction rating score was calculated by averaging the score in each facilities of each station. Table 5 shows the result and the number of survey votes in each station.

As a result, when we pay attention to the satisfaction rating score of the station space, we can see that the score of Tama Plaza, Aobadai in group D, Den-en-chofu in group F and Tsukushino in group G is relatively high. For group D and group G there is a feature that the railway entrepreneur maintained the station and the station plaza in premeditation when the railway line opened. It can be said that the cooperation of station and station plaza go well because one entrepreneur maintained them. In addition, for Den-en-chofu in group F, the station space was maintained again by the railway large-scale improvement, and as a result

station space users evaluate the effective maintenance of the facility such as the station plaza and the commercial establishment, etc. in overhead space of the railway.

Table 5. Satisfaction Rating Evaluation in Station Space

Group	Station Name	Number of Survey Votes	Station Space	Station	Station Plaza	The District around Station
	Entire 8 Stations	943	0.37	0.35	0.22	0.18
A	Shibuya	116	0.00	-0.27	-0.28	-0.18
B	Sangenjaya	120	0.27	0.27	0.20	0.25
C	Jiyugaoka	121	0.29	-0.04	0.06	0.40
D	Tama Plaza	118	0.52	0.50	0.53	0.38
	Aobadai	124	0.53	0.74	0.32	0.12
E	Gakugeidaigaku	110	0.02	0.23	-0.58	-0.17
F	Den-en-Chofu	110	0.82	0.84	0.86	0.56
G	Tsukushino	124	0.47	0.52	0.54	0.03

On the other hand, for Shibuya and Jiyugaoka, the satisfaction rating evaluation of the station and the station plaza has lowered compared with other station spaces. In these stations, it is caused with low satisfaction rating evaluation that numerous railway users and the capacity shortage of facilities space interfere to a smooth movement. Similarly, the satisfaction rating evaluation of station plaza has lowered in Sangenjaya of underground station type and Gakugeidaigaku of outskirts station type because the station plaza is not maintained enough by the space restriction around the station.

Next, for the district around station, the evaluation of the space where a commercial function is compactly settled around the station such as Den-en-chofu and Jiyugaoka has risen. Oppositely, the evaluation of the space where a commercial integration is thick and the user accumulates in the limited narrow area such as Shibuya and Gakugeidaigaku has lowered. When we notice the overall satisfaction rating evaluation of the station space, we can classify the station space into four stations with high score and four stations with low score. It seems that the difference of the classified station space is whether each facility is maintained as one body and continuously or not.

From the above, it is considered that there is a moderate congestion level of the space that the station space user can use comfortably, and it is closely related to the space evaluation. Moreover, it can be said that it is effective to plan each facilities where the station space is composed as one body to improve the overall satisfaction rating evaluation of the station space.

6. CONCLUSIONS

In this paper, we investigated the history of station space maintenance in six lines of Tokyu Corporation which was one of urban railways in Tokyo Metropolitan area and conducted awareness survey to confirm the relation between the station space and its evaluation by station space users. As a result of analysis of satisfaction rating evaluation by users, it turned out that it is effective to maintain each facility considering the spatial and functional integration for the improvement of the overall satisfaction rating evaluation of the station space.

For the achievement of a comfortable and convenient station space for users, it is necessary to discuss the ideal way of premeditated maintenance and management which comprises the station, the station plaza, and the district around the station without cracking to an existing idea which has separately treated each facility. In the research in the future, we need to analyze the evaluation structure in the station space focusing on user's action characteristic and the evaluation of an individual item, and we will propose the policy theory of the station space maintenance in urban railways.

REFERENCES

a) Books and Books chapters

Tokyu Coroporation (1972) **50 years History of Tokyu Corporation**, Taisho Publishing (In Japanese)

Ogiwara J., Miyata M. and Sekita K. (2001) **Retrospect of Tokyu Railway**, Taisho Publishing (In Japanese)