

## Study on Station Square Development at Hub Stations

by

Ikuo TANAKA<sup>\*</sup>, Ryouzuke ONIZUKA<sup>\*\*</sup> and Yoshinao OEDA<sup>\*\*\*</sup>

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### Abstract

At major hub stations in wide urban areas, relative changes have taken place over a long period of time between the quantity and quality of passengers and the functions of railways as a transportation system and a transportation node. However, it is often the case that no drastic review has been made about station squares. What is required from station squares in the future to improve the convenience of railway services and at the same time solve problems in fulfilling their functions as a transportation node? In this paper, methods of station square development are discussed from a practical and broad perspective, as well as in connection with the advanced development of station areas and the development of their surrounding districts. In the process, we refer to a development approach that incorporates an urban square function into the station square and also take the development of Hakata Station as an example.

**Keywords:** Major hub station, Station square, Function as a transportation node, Traffic space, Function as an urban square, Environmental space, Three-dimensional city planning

### 1. Introduction

The history of station square development in Japan shows that a station square had been seen as something like a front garden for a station before serious efforts started after World War II to develop it as a traffic square that provided connections between railways and other means of transportation. Then over time, urban transportation was transformed along with suburban development, progress in motorization, and a shift from streetcars to subways. Accordingly, the function required from the station square as a transportation node has changed.

As for recent transportation systems, with the extension of Shinkansen services to local areas and the ensuing expansion of the sphere of exchange, major hub stations clearly reflect efforts to upgrade functions of railway facilities and make advanced use of railway premises as a policy to attract more people to the station area through enhanced synergy between these efforts.

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\* General Manager, Hakata Station Construction Department, Railway Operations Headquarters, Kyushu Railway Company

\*\* Strategy Management Department, Corporate Planning Headquarters, Kyushu Railway Company

\*\*\* Associate Professor, Department of Urban and Environmental Engineering

In an age of dwindling population, the station area is socially required to serve as a new urban center to achieve a shift towards an intensive urban structure and to rebuild a city. Station squares should not be seen just as a transportation facility to handle passengers. Their development should be planned to integrate station facilities, a station building, and the downtown area around the station. And railway operators should be engaged in such development on their own initiative.

In this paper, we examine the functions required from station squares at major hub stations from the perspective of railway operations to make them more convenient and comfortable. Then using an example of JR Hakata Station development, we discuss practical methods for preparing the layout plan of the entire facility related to the station square, based on which the station area can be developed into a new urban center.

## **2. Conditions Required from Railway Stations and Roles of Station Squares**

### **2.1 Function as a transportation node (in the past and future) and design policy for “traffic space”**

Triggered by the extension of Shinkansen networks into regional core cities, station facilities functioning as a transportation hub for larger areas have been improved. This led to more frequent train services, downsizing of transportation facilities, and the development of barrier-free facilities. Also, the introduction of an IC card automatic fare system facilitates the tendency towards the concentration of ticket vending machines around ticket gates. Furthermore, ticket gates tend to be placed adjacent to two passenger traffic lines: the main traffic line and more convenient auxiliary lines. On the other hand, a recent surge in the number of foreign travelers and tourists resulted in a growing need for enhanced functions providing regional information and better personal services such as guidance in foreign languages. This posed a new challenge in that passenger services have assumed much greater importance.

Therefore, railway operators should promote development that can cater to the needs of station users, both by providing more convenient train connections between the lines they operate and enhancing the function of a station square as a transport node even further.

Needless to say, passengers are pedestrians. Therefore, it is reasonable to design the traffic space consistent with the shares of access/egress modes of transportation in strengthening its function. Any facilities plan for such space must be arranged with sufficient consideration to the shares of access/egress modes of transportation used by passengers.

At major hub stations, the shares of cars and taxis used for access/egress trips are low, while more weight is placed on public transportation. Since people transfer to another means of transportation mainly on and below the ground, the facilities for the traffic space must be located near the station and designed to minimize the crossings of pedestrian traffic lines.

Pedestrian traffic lines to other facilities near the station vary in quantities and peak hours. Thus the walk environment is designed in line with the characteristics of each of these facilities and its location. However, in reality, it is difficult to increase the area of a station square and therefore it is impossible to cram all of the functions as a transportation node into a station square. For these reasons, in designing the layout of facilities that serve as a transportation node, it is necessary to consider the shares of access/egress modes of transportation, set priorities, and decide the optimal scale. On the other hand, bus terminals and parking lots for vehicles and bicycles should be considered as inseparable from pedestrian traffic lines. In designing pedestrian traffic lines, priorities should be placed on smooth flows with less waiting time at traffic lights en route to destinations and walking comfort with fewer level changes. Also, spaces on, above, and below the ground should be utilized to form a three-dimensional network of pedestrian spaces to facilitate

pedestrian migration to/from facilities around the station

## **2.2 Functional integration of a station, a station square, and facilities in neighboring district**

As described in 2.1, railway operators are striving to make good use of the sites by shortening effective track length, reorganizing lines in low-efficient operations and reducing the total length of the station yard; promote development designed to create a multi-functional complex focusing on commercial facilities; and thus diversify their operations. The use of spaces above and below the tracks is actively incorporated into a development plan, establishing the systematic development of logistics facilities that allows a high concentration of commercial outlets. The number of railway passengers tends to slightly decline, and therefore railway operators try to enhance and increase the functions of the station area to offer people more reasons to visit the area and consequently increase the number of railway users.

The plan to develop a commercial complex can be carried out on condition that the plan is consistent with not only the layout plan of station facilities but the development plans of neighboring areas in both hardware and software aspects. Tenants of a large station building need more visitors than railway users to secure business profitability. Therefore, it is essential to improve access to the station facilities so that people visit the station building itself to enjoy various activities.

To tackle the recent phenomenon of the hollowing out of city centers and revive cities, it is necessary to create a “space bustling with activities” that facilitates the migration of people with a railway station at the center, and intensively and effectively promotes various city rebuilding projects around the station area. The station square is a core space that connects the station and the urban areas surrounding it. In addition to enhancing its function as a transportation node, as is described in 2.1, the station square is required to fulfill its “function as a square” –that is, as both symbol and gateway of a city, where information and enticement are provided.

At a major hub station, it is often the case that the neighboring district is divided into two parts on either side of the huge railway facilities. Not only concourses and public roads that connect both sides of the station but also pedestrian walkways that link the station and adjacent facilities should be built to form seamless traffic lines of pedestrians to facilitate their movement. A facility complex housed in a station building needs easy access to other facilities, and therefore sufficient attention should be paid to accessibility.

There is a concept of the functional integration of a station, a station square, and the district adjacent to the station. In reorganizing the functions of a railway station in the future, we believe that railway operators, other transport operators, municipalities and private developers that are engaged in urban area development around the station, local citizens, and business owners need to share values and a long-term perspective of community building.

## **2.3 Function as an urban square, “environmental space”, and environmental creation**

The space necessary to fulfill the station’s function as a transportation node is called “traffic space”, while the space necessary to fulfill its function as an urban square is called “environmental space”. The traffic space is a space to facilitate mobility towards facilities for access/egress traffic modes, but the environmental space is a multipurpose space mainly for pedestrians, where they not only move around but also spend some time or stay for a while, requiring an atmosphere of spaciousness. The appearance of the station building and the contrast of lighting during day and at night are among the factors that constitute the environmental space. The traffic space spreads mainly on the ground level, while the environmental space tends to have multi-layered arrangements because of its close relation with pedestrian traffic lines.

The environmental space functions as an urban center for further development of the city; a place for relaxation and exchanges such as gathering and chatting; a place for landscape formation; a place where public services are provided; and a center of disaster prevention activities. Of these five functions, the functions concerning exchanges, landscape formation, and public service provision require consideration for harmonious designs. The station square is the first place people see when they get out of the station and form their first impression of the city. However, at the same time, it is the place people use for day-to-day activities, while still experiencing seasonal changes and occasionally even festivity. Therefore, the entire space should be designed to create a timeless, dignified and refined atmosphere that strengthens people's attachment to the station area and the city.

### **3 Station Square Development**

#### **3.1 Area calculation methods for a station square**

To calculate the area of a station square, the reference area is usually computed based on an estimation of the number of people who will use the station square in the future. This estimate is obtained through studies, some of which are based on actual conditions.

Area calculation methods include function methods using the number of railway passengers as one of the variables such as the 1953 Method (Formula devised by Station Square Study Committee) and build-up methods, which work out a necessary area based on the estimated number of users of each facility, such as the 1973 Method, the Konami Method and the 1998 Method (specified in the Station Plaza Planning Guideline, 1998). The 1998 Method defines the reference area as the sum total of the traffic space area and the environmental space area. In regard to the environmental space area, it defines the ratio of the environmental space area to the area of the entire station square as an environmental space ratio. Usually 0.5 is used as the standard ratio. The method is characterized by a proactive approach to securing an adequate area for the environmental space.

Railway operators emphasize the function of the station square as a transportation node, while those who are involved in city development focus on its function as an urban space as well as a transportation node. This results in differences in opinions about the area required for the station square as well as the assignment of responsibility in deciding city planning and cost sharing. These differences can have a negative impact on not only the whole facility layout plan but daily facility management.

Therefore, it is important that both parties recognize that the area allocated for the station square must be sufficient to secure profitability for the railway operator and at the same time enhance the function of the district as a city center.

A city planning system that allows a three-dimensional use of space can secure an adequate development area for the station building. By adopting such a system and simultaneously carrying out other street development projects along with the station square development, the area actually functioning as a station square will increase. This is expected to be effective to improve the flexibility of the entire facility layout plan.

#### **3.2 Pedestrian traffic line planning**

A clear picture of the entire station area is essential in designing a traffic line on ground level. A public path that crosses the tracks to complement the central concourse can be built as a main route to link the both sides of a station. In planning a station building that also functions as a large commercial complex, the planner should try to secure pedestrian traffic lines by paying sufficient

attention to the entire facility so that people can freely move around. Traffic lines that lead passengers to their destinations can be shortened by creating a new traffic line that directly connects railway platforms and the station building by escalators and/or a new ticket close to the station building. Also, a traffic line that connects the inside of the station building and the station square through a pedestrian deck can be a comfortable route to facilities around the station.

It is important that the plan include future development to form a three-dimensional network of pedestrian pathways between the station building and the neighboring areas by linking pedestrian traffic lines at various levels. Guide signs in the station, the station square, and the adjacent districts should be prepared according to unified specifications by a body responsible for the installation and management of guide signs after the provided information is organized and edited with coordinators.

### 3.3 Direction towards multi-layered distribution of traffic lines and adoption of three-dimensional city planning

Magnetic tickets are being replaced with IC cards. In the future, it is expected that increased use of IC cards will facilitate labor and space savings around the ticket gates on the main traffic lines as well as the high concentration of passenger facilities, leading to the formation of reservoir space on the concourse. This will allow railway operators to deal with a greater concentration of passengers on hub stations without expanding station facilities.

By adopting three-dimensional city planning, passengers move between station facilities and various floors of the station building according to their purposes. Also, the barrier-free design will reduce hesitation they might feel in moving between floors, and higher accessibility will result in the formation of pedestrian traffic lines that go beyond the station building into surrounding areas. If station development by a railway operator is designed not to keep passengers within the station but to create open spaces to guide them to other areas, then all conditions will be met to create free flows of people between the station and surrounding areas. (see Fig. 1)

In summary, a facility layout plan that prioritizes pedestrian traffic lines and pedestrian space can enhance the function as a transportation node of the entire area surrounding the station.

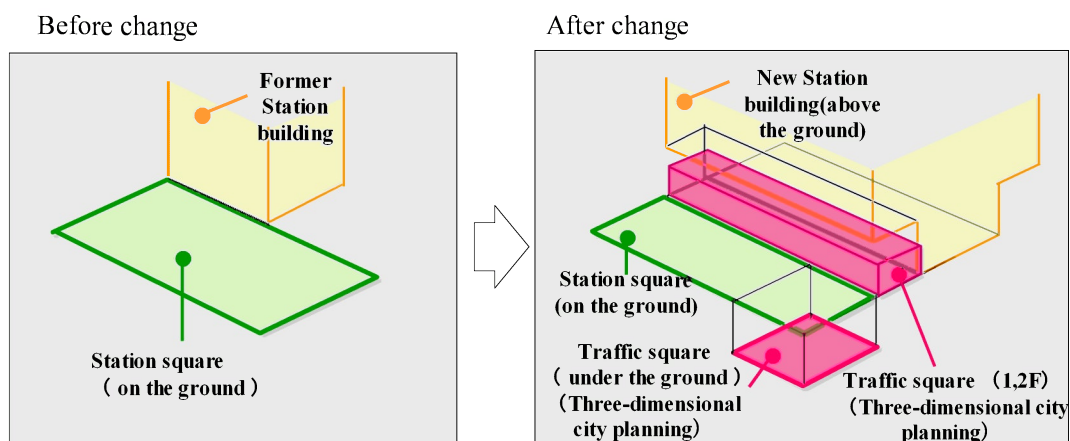


Fig.1 Outline of three-dimensional utilization plan for the station square.



#### 4. Case Study on the Development of Hakata Station

##### 4.1 Outline of Hakata Station development

##### 4.1.1 Opening of the entire Kyushu Shinkansen Line and mutual direct operation with Sanyo Shinkansen

Hakata Station opened in 1889. The present station is the station's third incarnation, to which the station was moved and began operation at the present location in December 1963 under a land readjustment project. Then with the openings of a Shinkansen line in March 1975 and the Fukuoka Subway Kuko (Airport) Line in March 1985, the station attained greater significance as a transportation node. The number of passengers increased from 70,000 in 1963 to 350,000 in 1994, but recently it has stopped growing (see Fig. 2).

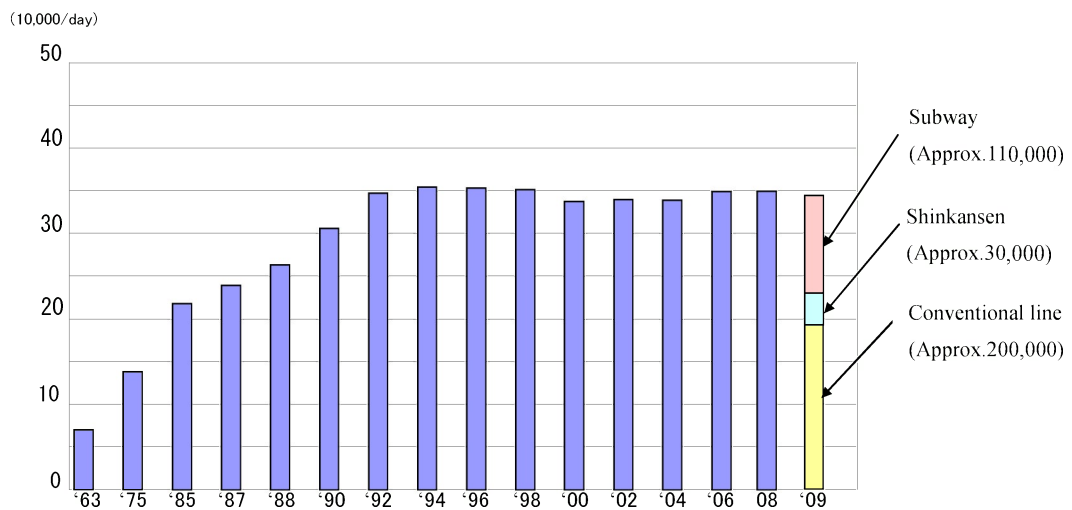


Fig.2 Number of Passengers at Hakata Station.

In anticipation of the opening of the entire Kyushu Shinkansen Line (Hakata-Kagoshima Chuo) in March 2011, facilities for conventional lines were scaled down without reducing their track capacity, and a platform with two tracks was added to the track layout of the Shinkansen. Mutual direct operation with the Sanyo Shinkansen Line is scheduled to start when the entire Kyushu Shinkansen Line is in fully operational.

##### 4.1.2 Development of the Hakata Station building

The development of a new station building, which houses the largest commercial complex in western Japan, started with the view of the simultaneous openings of the building and the entire Kyushu Shinkansen Line. With Fukuoka Airport located about 2 kilometers away from JR Hakata Station, the height of the building is restricted under the Civil Aeronautics Act. Aiming at one of the largest-scale developments possible, JR Kyushu adopted a plan to utilize the spaces above and below the tracks where there was an embankment and to allow a three-dimensional use of the station square. The total development area and the total floor area are approximately 22,000 square meters and 200,000 square meters respectively. The building is approximately 60 meters tall and 240 meters wide if it is seen from the front, with 10 stories above ground and 3 stories underground (see Fig. 3 and Fig. 4).

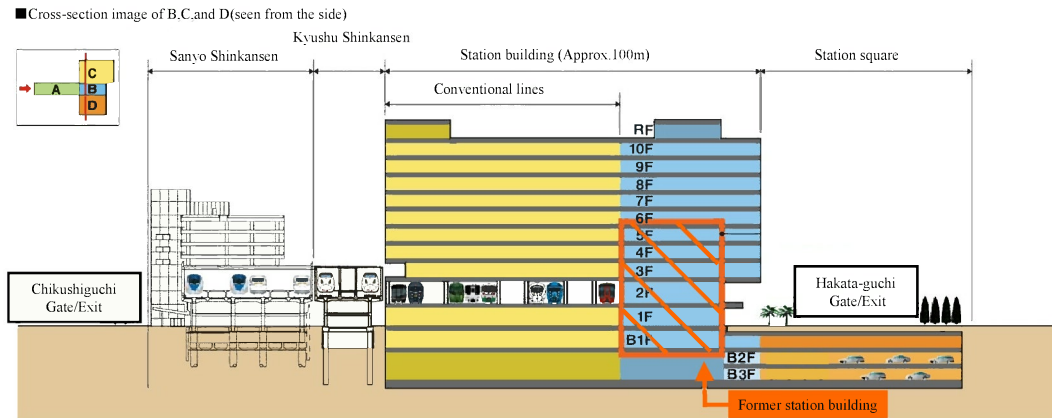


Fig.3 Area where double tracks are to be developed in the building.

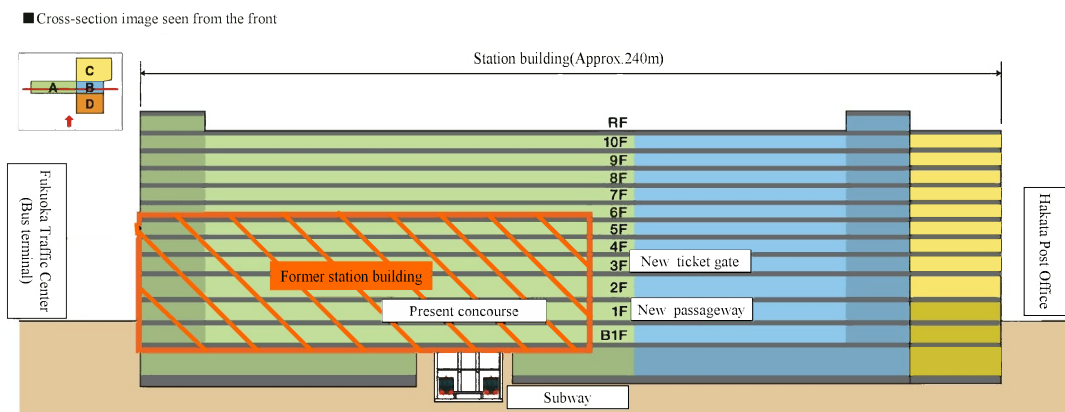


Fig. 4 Station building seen from the front.

#### 4.2 Station square area calculation and challenges posed in the development

The area of the present station square at JR Hakata Station (in front of Hakata-guchi Gate/Exit) was calculated in 1961 by using a method equivalent to the 1953 Method based on the estimate of the number of passengers in the year 1975.

On the other hand, in this development project, the number of people who would use the square in 2015 was estimated, based on which the necessary area for the station square was discussed in accordance with the 1998 Method and the area calculation standard for station square specified by Fukuoka Prefecture. **Table 1** shows a comparison of areas before and after the development.

The comparison of calculated areas reveals the following.

- 1) Due to an increase in the number of station square users, the area necessary for the square (hereinafter referred to as the “estimated area”) is larger than the present area of 15,400m<sup>2</sup>.
- 2) The area of 21,000m<sup>2</sup>, which is equivalent to the estimated area, can be secured by using a multi-story structure for the square, even though part of traffic space and a sidewalk is subject to some limitation on multi-story utilization.
- 3) An examination of the areas by function can be instructive. The area of 7,500m<sup>2</sup> is allocated as the traffic space based on the judgment that the present area is sufficient to fulfill its functions if it is efficiently used. The area of 13,600m<sup>2</sup>, which is far larger than the present area, was secured as the environmental space in light of its growing importance

**Table1** Comparison of areas.

		Present area	Estimated area when the development was discussed	Unit (m <sup>2</sup> )		
Station square (on the ground)	Transportation space	Bus stop	553.5	1,050.0	Under discussion	
		Taxi stand	934.5	300.0		
		Taxi pool	1,408.5	480.0		
		Pick-up/drop-off car park	175.5	180.0		
		Roadway	3,417.5	3,185.0		
		Parking lot	1,538.5	20.0		
		Subtotal	8,028.0	5,215.0		Rough estimate 3,100
	Environmental space	Sidewalk	4,795.0	6,260.0	2,200m <sup>2</sup> of which is used as single-story section	
		Pedestrian deck		5,862.0		
		Other facilities (landscape space, etc.)	2,577.0	4,325.5		
		Subtotal	7,372.0	16,447.5		Rough estimate 12,300
	Total		15,400.0	21,662.5	①	15,400
	2F Pedestrian deck	Sidewalk			②	1,300
	Station square (B2F)	Taxi pool, garage, etc.			③	4,400
New shopping mall (B1F)	Sidewalk (underground shopping mall)			④	1,800	

Note 1 The "present area" is the area designed and constructed in 1961 based on the estimated annual average daily traffic volume in 1975. ①~③  $\Sigma = 21,100\text{m}^2$

The number of passengers in 1961 was 59,700 and the annual average daily traffic volume in 1975 was estimated to be 150,300. ①~④  $\Sigma = 22,900\text{m}^2$

The area was calculated based on the standard formula of the Station Square Study Committee.

Note 2 The "estimated area" when the development was discussed was worked out in 2003 based on the

estimated to be 384,800 annual average daily traffic volume in 2015. The number of passengers in 2003 was 345,000 and the annual average daily traffic volume in 2015 was

The area was calculated based on the calculation standard set forth in the Station Plaza Planning Guideline (the 1998 Method) and the area calculation standard for station square specified by Fukuoka Prefecture.

Transportation space:  $3,100 + 4,400 = 7,500\text{m}^2$

Environmental space:  $12,300 + 1,300 = 13,600\text{m}^2$

### 4.3 Measures to improve pedestrian traffic lines and environmental space design

Pedestrian traffic lines are planned to allow people to go downtown west of Hakata Station through existing and new routes below the ground. Also a roadway will be built to connect Hakata Ekimae-dori Avenue and the second basement of the station square, where a taxi pool and a pick-up/drop-off car park are planned. Three-dimensional city planning was adopted to secure a pedestrian traffic line at the same level with the second floor of the station building and allow part of the station square to be used as multi-story space (see Fig. 1).

### 4.4 Creation of environmental space

The area of  $12,300\text{m}^2$  is designated as an environmental space mainly on the right side of the square, and a huge roof of approximately  $1,300\text{m}^2$  is built in the space. Green shade of deciduous broad-leaved trees and sculptures are beautifully arranged to create a space suitable as a gateway between Kyushu and Asia, as well as representing the charms of Fukuoka and Hakata. The square is to be a multi-purpose space, where not only station users but business people commuting to offices located in the adjacent areas can spend their time or meet others, and urban-style events are staged from time to time. Like Nagasaki and Kagoshima Chuo Stations, which are earlier examples of similar development, arranging an annual event schedule and organizing various events accordingly allow the station area to disseminate more information, attract more people, and create further opportunities for exchanges.

The layout plans of the entire station square (on the ground) before and after the development are illustrated in Fig. 5 and Fig. 6.



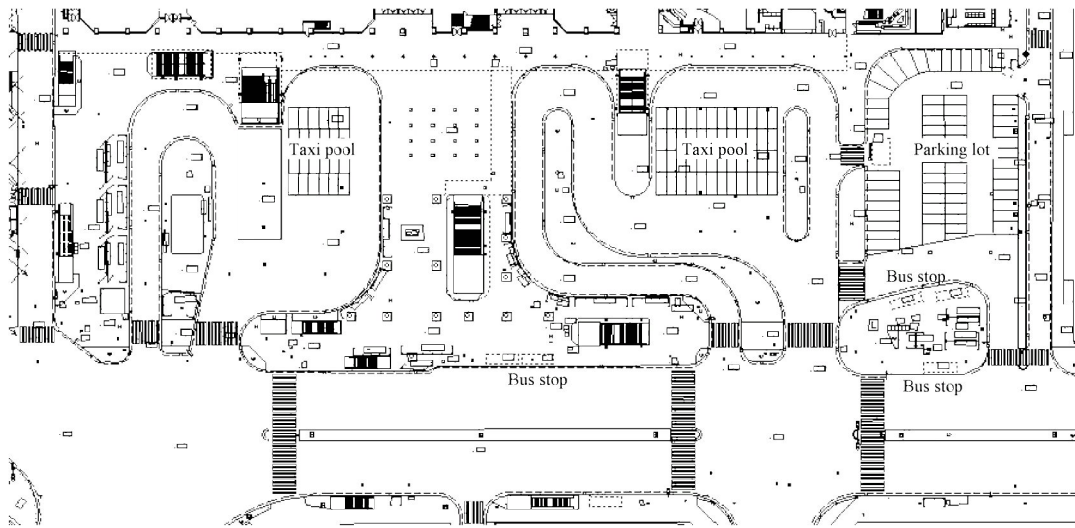


Fig.5 Station square before development(on the ground).

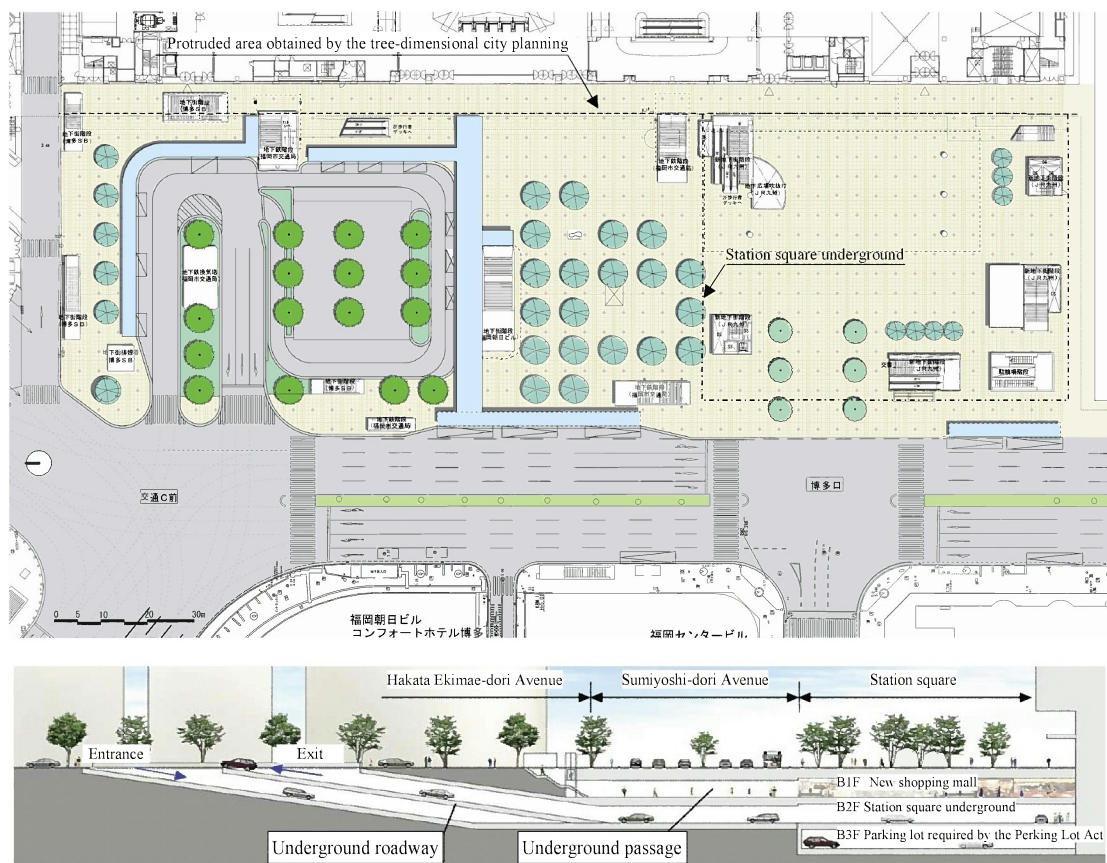


Fig.6 Station square after development.

#### 4.5 Relation between “transportation space” and “environmental space”

In the case of JR Hakata Station, pedestrian traffic lines could be formed at the level of the second and the first basement floors of the station building. Due to the priorities of the entire complex, 12,300m<sup>2</sup>, or about four-fifth of the ground area, is utilized to create a large urban space.

As a result, the transportation function of the ground area is actually reduced compared to the present level (see **Table 2**). Therefore, it is essential for road administrators and the police to take measures to better control automobile traffic and alleviate traffic congestion in the surrounding areas so that the second basement floor can sufficiently fulfill its traffic function. For instance, it will be effective to divide the traffic flowing into the station square from through traffic by adding lanes or improving traffic light control. One challenge for the railway operator and bus operators is to introduce incentives in terms of fares and guide passengers to public transportation such as trains and busses when they visit the station building and the surrounding areas.

The parking lot (pick-up/drop-off car park) was relocated to the second basement floor. However, the taxi pool remained on the ground with the same parking spaces as at present after consultation with the related taxi operators at the stage of preparing the entire facility layout plan. In the future, however, it is possible to use the space in the station square even more effectively if we can secure a place near the station where taxis can stay, and build a system for taxis to go and pick up passengers on request by fully utilizing communication tools.

**Table2** Comparison of numbers of taxi stands and parking lots before and after the station square development.

		Taxi			Parking space
		Taxi stand (pick-up point)	Taxi stop (drop-off point)	Taxi pool	Parking lot
Before development	On the ground (2 places)	6	5	73	60
After development	On the ground	3	3	72	—
	B2F	2	1	14	50

#### 4.6 Continuous effort towards station square development

In the study case, the development of the station square that faces the main conventional lines was carried out first. However, in order to achieve a balanced development of the entire area that serves as an urban center, the development of the square facing the Shinkansen lines should be started without delay. The plan must be designed based on the characteristics of Shinkansen passengers, as well as with consideration for the function sharing between the squares on both sides of the station and the smooth flow of passengers in the station facilities. The operator must be well prepared for taking a long-term perspective, correlating the development of the station with changes in the land use of the surrounding areas, incorporating prioritized functions, reorganizing existing functions, and working on the development in stages.

In consideration of future community building around Hakata Station, the “Hakata Urban Development Council” was set up. As a utility company, the railway operator has promoted and spread the notion of area management from the start of the development project in order to facilitate community building of the entire area surrounding the station along with the station development. Operational openness is always kept in mind in implementing measures to raise awareness of businesses that participate in the community building efforts and support continuous activities. The “Guideline for Hakata Urban Development” was drawn up December 2009 to share basic principles of the effort and send out information on activities to citizens.

There are various views concerning what position railway operators should take in participating in the effort for community building around the station. Personally, the authors of this paper believe that railway operators should be involved in community building activities on their own initiative. And from a long-term perspective, they should appeal to administrative offices when they need to appeal and strive as a coordinator to form a consensus among a variety of parties: not only land owners and private developers but related people in wider areas around the station.

## 6. Discussion and Conclusion

The station square of a major hub station often comes to exhibit difficulties in fulfilling its required functions over time. However, it is impossible to solve the challenges it faces all at once. Development needs to be carried out step by step over a long period of time. As a railway operator striving for better railway services and advanced use of the railway premises, we recognize that the most effective approach is coordinating the development with community building effort and moving towards concentrating urban functions on the station area.

In the case of Hakata Station development, the construction of a new Sinkansen platform and the station building development were carried out in an integrated manner while overall review of station square facility arrangement was conducted. The three-dimensional city planning enables multilevel use of the station square, creating the large “environmental space” inside of the station square. The advanced use of railway premises could improve railway convenience and enhance the function of the entire station area as an urban center. As a result, all the necessary requirements were fulfilled.

When development is carried out at a major hub station in the future, it is important to have the perspective of viewing a station square as a cure facility in order to improve the convenience of railway services while promoting the development of facilities around station as an integral part of community building.

## Acknowledgements

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