

USER BEHAVIOR IN A STATION AREA SPACE OF A LOCAL CITY CENTER –A CASE STUDY OF THE OZAKI STATION IN HANNAN CITY

*Yasutomi Sakuma¹, Kohki Yoshikawa² and Yuko Minami³

¹Faculty of Systems Engineering, Wakayama University, Japan,

²Seilin & Company, Japan,

³Kaizuka City, Japan

*Corresponding Author, Received: 15 June 2023, Revised: 26 Dec. 2023, Accepted: 28 Dec. 2023

ABSTRACT: Local governments develop appropriate location plans to promote forming station-front spaces in compact cities to create lively city centers. However, plans clarifying the trends and movements of station users are limited. Understanding user behaviors and trends is necessary to meet local needs. Three surveys were conducted around the Ozaki Station in Hannan City, Osaka Prefecture, as a case study. The case study investigated station users' staying behavior based on video camera recordings, circulation using a behavior tracking survey, and parking space usage using an observational field survey. The results showed that people who stayed in front of the Ozaki Station used areas conducive to staying and with little interference from passersby. They spent an average of approximately 4 min in the station area. On the north side, 94.6% of the people used the front space of the station on their way home. On the south side, 36.5% entered a store or facility for purchasing. Parking space occupied 77.3% of the underused land around the station, and 41.5% of the parking space had a parking ratio of 30% or less. In conclusion, this study found that the area around the Ozaki Station could become a commercial, recreational, or leisure center rather than a mere transit point. Therefore, utilizing underused parking spaces and creating public lingering areas have become primary concerns.

Keywords: Local City Center, Open Space, Staying Behavior, Circulation Behavior, Parking Space

1. INTRODUCTION

In Japan, compact city policies are being promoted with the expansion of the automobile industry. Commercial centers have been developed before railway stations and along the main roads.

Spaces in front of railroad stations in downtown areas of regional cities becoming mere transit points for station users have become a primary concern. The station areas are no longer as vibrant as they were once. In addition, the amount of underutilized land, such as vacant lots and houses, has increased.

Many cities are implementing projects to transform public spaces into human-centered areas. For example, the Hokomichi Project, a system for improving pedestrian convenience road systems established in 2020 to build lively and dynamic roads [1], was designated for 109 routes in Japan (as of March 31, 2023).

What role should station areas in a central city play in the expanding automobile society of regional cities? The actual situation requires further investigation to answer this research question.

Previous studies have investigated various aspects of station areas, including station area front spaces, staying and circulation behaviors, and parking lot usage.

Toki et al. [2] conducted a study on using station plazas through time-differentiated use for space in front of stations. They presented a utilization model

based on the relationship between the space in front of stations and their usage patterns. Kotaki et al. [3] clarified the actual situation of station plazas and the factors contributing to insufficient capacity by focusing on station plazas at the central stations of regional cities. Iwamoto et al. [4] analyzed user demands and evaluations of station area spaces and revealed that developing station area spaces did not sufficiently reflect user awareness.

For research on staying behavior, Yamaguchi et al. [5] focused on the space in front of a station integrating commercial facilities. They clarified the relationship between staying behavior and commercial facilities.

For research on circulation behavior, Takahashi et al. [6] analyzed the circulation behavior of visitors through a tracking survey in the area surrounding the Shimokitazawa Station. They found that a higher store density resulted in more frequent store visits. Akazawa et al. [7] analyzed the actual circulation behavior of visitors and inter-store structures along shopping streets with increased chain stores in metropolitan areas. They clarified that drugstores generate considerable circulation behavior among themselves, and an increase in chain stores may limit the inter-store structures of shopping streets.

For research on parking lot usage, Murakami et al. [8] revealed a visitor attraction effect resulting from parking lot development based on a case study around a station at the Yamagata Shinkansen bullet

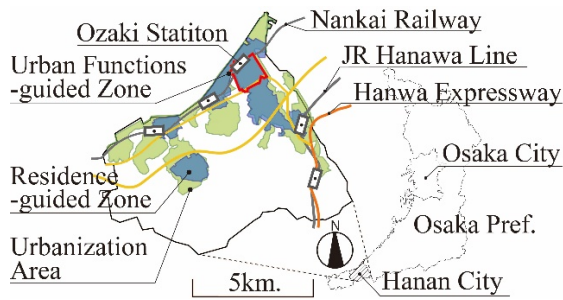


Fig. 1 Map of Hannan City (Created by the author based on the Hannan City Location Normalization Plan [10])

train line extension. They suggested the potential to enhance the value of railway stations by increasing customer visits to station buildings and the surrounding shopping streets.

This study clarifies the function of the station area based on three surveys of actual usage: staying behavior, circulation behavior, and parking lot usage.

This study focused on the Ozaki Station in Hannan City, Osaka Prefecture. A case study on the space in front of a station in the central area of a regional city was conducted. Three surveys were conducted in front of the Ozaki Station: 1) understanding station users' staying behaviors based on video camera images, 2) understanding station users' circulation behavior through tracking, and 3) understanding the actual usage of parking spaces around stations based on parking space surveys. Therefore, this study clarifies the role of the space in front of a station in the downtown area of a regional city. (This paper extends the study presented in [9], incorporating new surveys).

2. RESEARCH SIGNIFICANCE

The sustainability of regional cities has become a concern with the declining population. Creating places where people can interact with others while adding value is crucial. Realizing human-centered public spaces is unclear in regional cities, where car-dependent lifestyles have been established. Clarifying the actual usage of the space in front of a station is significant for establishing methods for creating human-centered public spaces.

3. OUTLINE OF STUDY SITE

Hannan City is in the southern part of Osaka Prefecture, approximately 45 km from the city center. It has a 54,276 population (according to the 2015 national census). The city encompasses several residential complexes developed in the 1970s. It is currently experiencing a rapidly aging population, a declining younger population, and a decreasing working-age population.

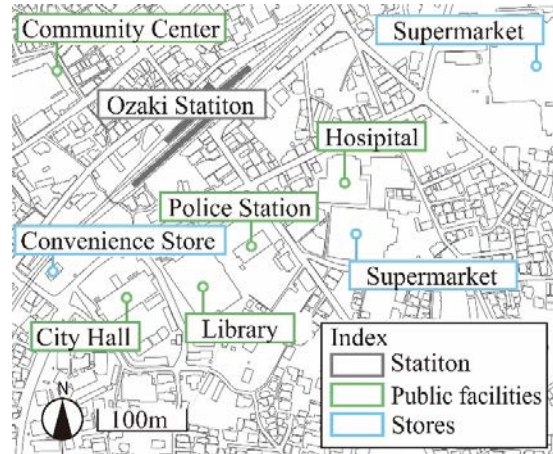


Fig. 2. Map around Ozaki Station on Nankai Railway



Fig. 3 The area before the Ozaki Station in 2022.



Fig. 4 The on-street parking before Ozaki Station in 2023.

On the southern side of the Ozaki Station are city halls, hospitals, libraries, police stations, and commercial facilities, making it one of the central stations in the city. The northern side is a residential area with fishing villages and old streets (Figs. 1–2).

The Ozaki Station is a stop for express trains on the Nankai Line; however, the plaza in front of the

station is undeveloped. This causes people and cars to mix on the road during the morning and evening high-traffic hours (Figs.3–4).

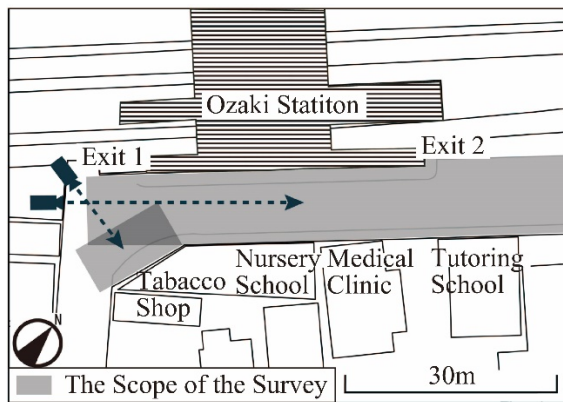


Fig. 5 Scope of the Staying Behavior Survey



Fig. 6 The cameras installed in 2019 for the survey.

Before the Ozaki Station, the roads are being renovated into one-way traffic roads to lower the on-street parking-driven congestion. The project commenced in August 2023 and is expected to complete by March 2024.

4. RESULTS

4.1 Staying Behavior Survey

Videos were recorded to understand station

Table 1 Staying Behavior Survey Method

Purpose of Survey	Understanding station users' staying behavior and attributes in the space in front of the station.	
Date of Survey / Number of People	November 9, 2019 (Sat.)	36 people
	December 11, 2019 (Wed.)	58 people
Scope of Survey	The survey focused on the space in front of the station on the south side of the Ozaki Station.	
Definition of Staying Behavior	Waiting	Waiting for someone to arrive
	Conversation	Engaging in conversation
	Rest	Standing still
	Other Activities	Activities other than the above

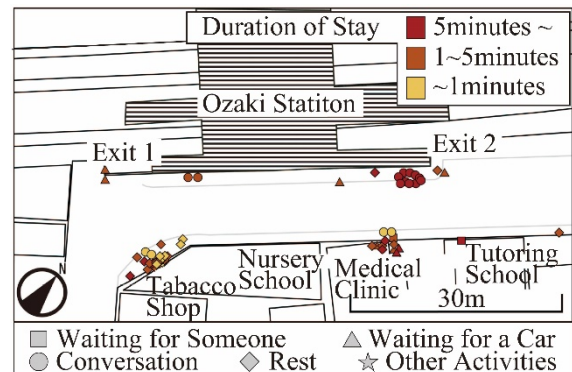


Fig. 7 Staying Behavior on a Weekday

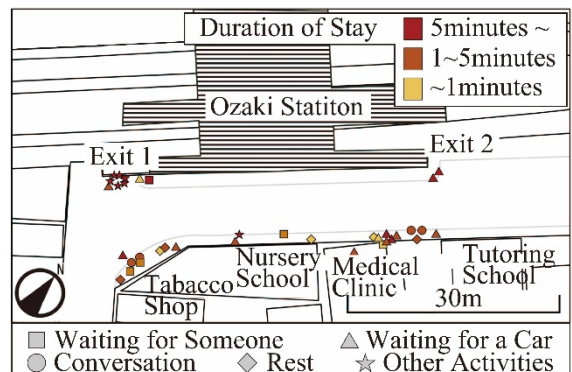


Fig. 8 Staying Behavior on a Weekend

users' staying behavior. With the cooperation of relevant parties, the videos were recorded from the rooftop of a building adjacent to the survey area.

The recording started at 09:30 to align with the

Table 2 Results of Staying Behavior Survey

Day of Week	Staying Behavior	Age Groups			Total Count (people)	Ratio (%)	Average Duration of Stay
		10s to 20s	30s to 40s	50s and over			
Weekday	Waiting for Someone	1	0	1	2	3.4	5'00"
	Waiting for a Car	6	1	1	8	13.8	3'45"
	Conversation	13	0	3	16	27.6	6'24"
	Rest	3	14	15	32	55.2	2'47"
	Total	23	15	20	58	100.0	4'3"
Weekend	Waiting for Someone	3	0	2	5	13.9	4'6"
	Waiting for a Car	5	5	4	14	38.9	5'14"
	Conversation	0	4	0	4	11.1	1'30"
	Rest	1	1	4	6	16.7	1'20"
	Other Activities	6	0	1	7	19.4	6'43"
	Total	15	10	11	36	100.0	4'19"

Table 3 Circulation Behavior Survey Method

Survey Date	Date	Time	Site	Number of People
	Dec. 12, 2018 (Wed.)	18:00–20:00	South side	13
	Dec. 19, 2018 (Wed.)	16:00–18:30	South side	90
	Jun. 16, 2019 (Wed.)	16:30–18:00	South side	53
	May 8, 2019 (Wed.)	16:30–19:00	North side	98
	May 15, 2019 (Wed.)	16:30–18:00	North side	60
	Dec. 1, 2019 (Sun.)	16:00–17:30	South side	52
	Dec. 1, 2019 (Sun.)	17:30–19:30	North side	50
	Total			416
Survey Area	Within a 300 m radius of the Ozaki Station.			
Subject of Survey	Pedestrians exiting from the Ozaki Station.			
Starting Criterion	Pedestrians who pass through the starting point after the survey start time.			
Termination Criteria	(1) Entering a building. (2) Exiting the designated survey area. (3) Pedestrians boarding bicycles, cars, etc. (4) Staying for more than 10 minutes.			

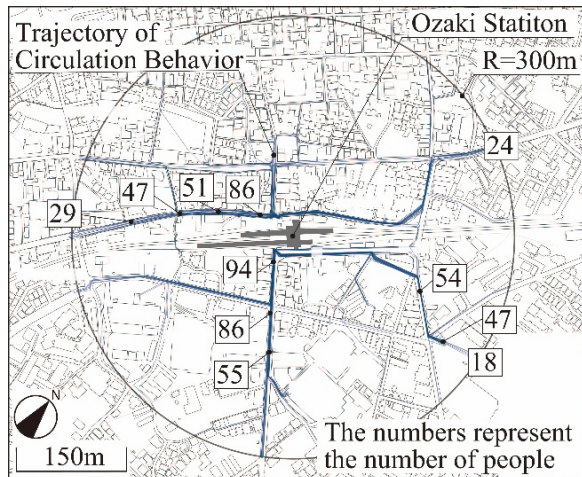


Fig. 9 Circulation Behavior Survey Results (2)

opening hours of the cooperating tenants. It ended at 17:00. A video camera was set up to capture images in two directions, as shown in Fig. 5–6.

The staying individuals were determined based on the study by Yamaguchi et al. [5], in which a transition from moving behaviors, such as walking, to standing still was observed. Table 1 defines the staying behavior. Data were obtained from a survey conducted over two days, weekdays and weekends, with 58 people on weekdays, 36 on weekends, and 94 on weekends.

The data indicated that more people stayed on weekdays. The average stay duration showed no significant difference between weekdays and weekends (approximately 4 min). The staying behaviors on weekdays were predominantly categorized as “rest” at 55.2% (with “smoking” being the most common among them, accounting for 14 people or 24.1%), and “waiting for a car” accounted for 38.9% on weekends (Table 2).

Furthermore, the areas near the tobacco shop and the clinic near the station exit were the most common locations for staying on weekdays and weekends. This is because the Ozaki Station does not have an open space in front of the station where people can stay. Moreover, these locations have fewer interactions with other pedestrians, making them more conducive to staying. This was characteristic of the “conversation” behavior by a group of men in their 30s near Exit 2 on weekdays and mobile gaming activities (categorized as “other activities”) by a group of teenage students near Exit 1 on weekends (Fig. 7–8).

There is no designated open space in front of Ozaki Station; however, it was observed that people stay in areas conducive to transient activities for a certain period.

4.2 Circulation Behavior Survey

A survey on circulation behavior was conducted to understand the behavior and characteristics of station users (Table 3). The survey was conducted within a 300 m radius, centered around the ticket gates of the Ozaki Station, considering the walking distance (300 m) defined in the location normalization plan. Furthermore, this range generally includes major facilities around Ozaki Station.

Table 4 Circulation Behavior Survey Results (1)

Activities after getting off the station	North side					South side				
	Age groups			Total (person)	Ratio (%)	Age groups			Total (person)	Ratio (%)
	10-20's	30-40's	50's and over			10-20's	30-40's	50's and over		
Enter a store	4	3	4	11	5.3	23	25	28	76	36.5
Transfer to a car	7	9	12	28	13.5	1	2	1	4	1.9
Transfer to a pick-up car	12	1	5	18	8.7	9	2	5	16	7.7
Transfer to a bicycle	20	11	10	41	19.7	24	15	17	56	26.9
Transfer to a motorcycle	1	1	1	3	1.4	4	2	0	6	2.9
Transfer to a bus	-	-	-	-	-	0	2	6	8	3.8
Transfer to a cab	0	0	2	2	1.0	-	-	-	-	-
Returning home	15	13	5	33	15.9	1	0	0	1	0.5
Out of survey area	43	16	13	72	34.6	11	20	10	41	19.7
Total	102	54	52	208	100	73	68	67	208	100

Table 5 Outline of Parking Space Survey (1)

Purpose of Survey	To clarify the parking rate in the parking lot during the peak commuting hours of 5–7 p.m. on weekdays.
Survey Date	Feb. 15, 2019 (Fri.) 17:00-19:00
	Apr. 23, 2019 (Fri.) 17:00-17:30
	May 22, 2019 (Fri.) 17:30-18:00
	May 31, 2019 (Fri.) 17:00-18:00
Survey Area	Within a 300 m radius of the Ozaki Station.

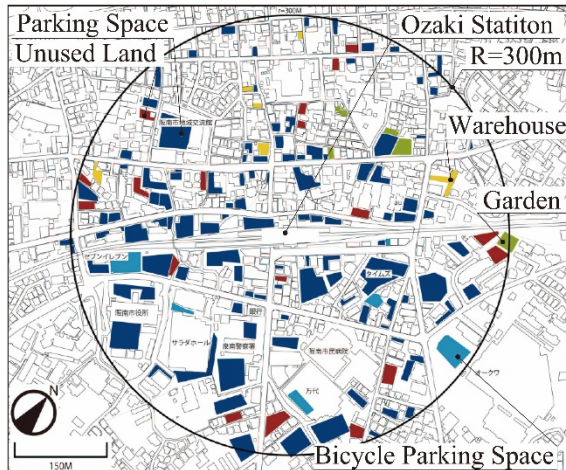


Fig. 10 Distribution of Underutilized Land in the Station Area

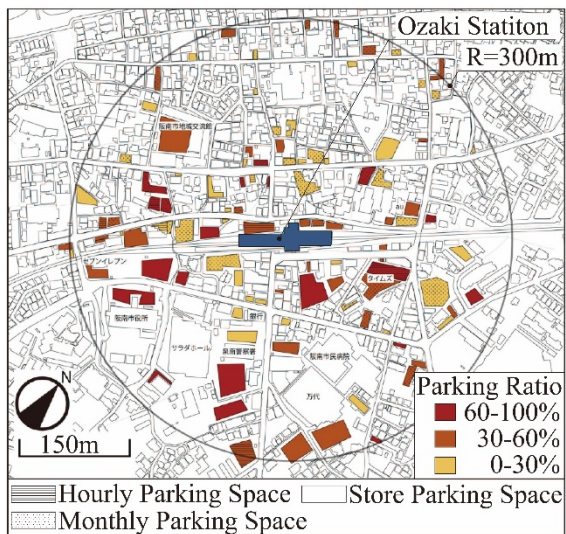


Fig. 11 Types and Parking Rates of Parking Spaces in the Station Area

Table 6 Percentage of Parking Spaces in the Station Area

	Parking Ratio			Total
	0–30%	30–60%	60–100%	
Number of Parking Spaces	48	46	22	116
Ratio (%)	41.4	39.7	19.0	100

The survey methodology involved randomly selecting pedestrians exiting the station, tracking them, and recording their attributes and behaviors.

Table 7 Outline of Parking Space Survey (2)

Purpose of Survey	To understand the use of parking spaces along the roads within a 150 m walking distance from the station.
Survey Date	Weekday: Nov. 20, 2019, 8:20-18:50
	Weekend: Nov. 3, 2019, 8:20-18:50
Survey Method	To survey the number of parked cars, the parking lots are observed by circling them around, starting at 20 minutes after each hour for the south side of the station and 50 minutes after each hour for the north side, according to the arrival of express trains.



Fig. 12 Types of Parking in the Station Area

The survey was concluded when they entered a building or left the designated survey area to meet the specified termination criteria. This process was repeated by returning to the starting point and tracking another pedestrian as the next subject.

Based on the results of the circulation behavior survey (Table 4 and Fig. 9), the "out-of-survey area" category accounted for the highest percentage (34.6%) on the northern side of the station. Except for the 5.3% who "enter a store," there was a higher occurrence of "returning home" or "transferring to a vehicle." It can be inferred that the station area served as a mere transit point for the subjects.

On the station's south side, "enter a store" accounted for 36.5%. This may be because of the presence of several commercial facilities on the southern side of the station. It can be inferred that the station area served as a transit point and commercial center.

4.3 Parking Space Usage Survey

4.3.1. Parking Space Usage Survey Within a 300 m Radius of the Station

The parking space usage survey captured the distribution of underutilized land, including parking spaces, in the Ozaki Station vicinity (Table 5).

Within a 300 m radius of the Ozaki Station, 150 locations of underutilized land existed. 116 of these were parking spaces, accounting for 77.6% of the total underutilized land (Fig. 10). Other unused land areas included bicycle parking spaces, warehouses,



Fig. 13 Typical monthly parking space in 2019.



Fig. 14 Typical hourly parking space in 2023.



Fig. 15 Typical store parking space in 2023.

and garages.

The parking rates in parking spaces in underutilized areas were assessed. The results indicated parking spaces with a 0%–30% parking rate accounted for 41.4% of the total space (Fig. 11 and Table 6).

4.3.2. Parking Space Usage Survey Within a 150 m Radius of the Station

Changes in the utilization of parking spaces within a 150 m walking distance from the station

exit were investigated to clarify the actual usage of parking facilities. This survey focused on parking spaces in the station vicinity, including 22 and 15 spaces on the north and south sides, respectively (Table 7 and Fig. 12–15).

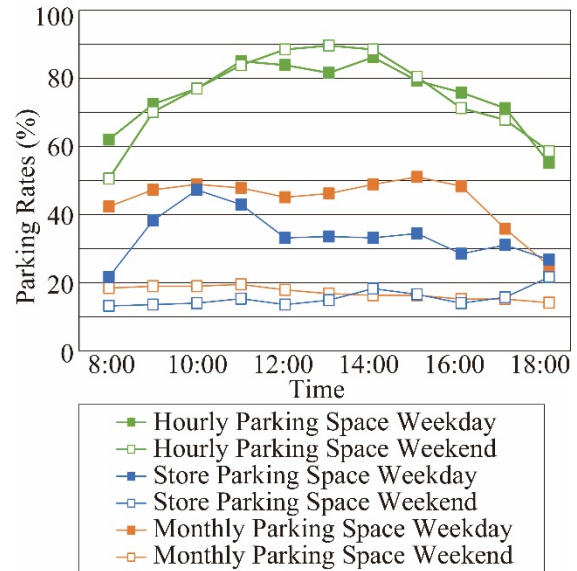


Fig. 16 Trend of Parking Rates by Parking Space Type

There were five hourly parking spaces. No significant difference was observed in the parking rates between weekdays and weekends. The average parking rate was approximately 60%–80%.

There were 10 monthly parking spaces. The parking rates were approximately 40%–50% and less than 20% on weekdays and weekends, respectively. It can be inferred that commuters use these monthly parking spaces as park-and-ride facilities.

Twenty-three parking spaces were attached to stores. Their parking rates were 30%–50% on weekdays, peaking at 10:00, and approximately 15% on weekends. The high usage on weekdays was associated with frequent visits to hospitals and banks (Fig. 16).

Across all types of parking spaces, weekend parking rates were lower than those on weekdays, averaging approximately 30%. Thus, approximately 70% of open spaces are available on weekends.

5. DISCUSSION

This study clarified the station's role in a regional city's downtown area by examining the case of the Ozaki Station in Hannan City, Osaka Prefecture. The following usage patterns were observed:

1) Staying behavior: People in the station area stayed for approximately 4 min. “Rest” accounted for 55.2% of the cases on weekdays, and “waiting

for a car” accounted for 38.9% on weekends. The subjects remained in areas with less pedestrian interference.

Yamaguchi et al. [5] reported the behavior of staying at the Center Kita and Minami Stations in the Kohoku New Town, Kanagawa Prefecture. The short duration stays (< 5 minutes) constituted 60.5 and 81.6% at the Center Kita and Center Minami Stations, respectively. The short-duration stays were predominant. Their station-front pedestrian spaces were not similar to the Ozaki Station. However, these observations can be extrapolated to the Ozaki Station.

Conversations (37.5%) and mobile phone usage (29.5%) were common behaviors at the Center Kita Station. Similarly, the conversations (58.3%) and mobile phone usage (31.9%) were common at the Center Minami Station. Resting (55.2%) and conversations (27.6%) were common during the weekdays at the Ozaki station while waiting for a car (38.9%), and other activities (19.4%) were common during the weekends. The Center Kita and Minami Stations are surrounded by commercial facilities, while the Ozaki Station is not. Therefore, resting and waiting for a car were common at the Ozaki station. The station surroundings reflected the staying behaviors.

2) Circulation behavior: 94.6% of the population passed through the station's north side during their commute. “Enter a store” accounted for 36.5% on the south side, indicating that the space was a commercial center.

Further, the circulation behavior elucidated the relationship between the station-front commercial facilities and the proximal pedestrian spaces [5]. About 66.5% of stayers at the Center Kita and 36.8% at the Center Minami Stations’ station-front pedestrian spaces moved to the commercial facilities. This number was 36.5% at the Ozaki Station’s southern side, the study area in this research. These locations exhibit different station-front spatial conditions and stayer and station-user demographics. Therefore, a direct comparison was complicated. However, the commercial facility customer movement at the Ozaki Station (southern side) was comparable to the Center Minami Station, suggesting the potential commercial importance of the Ozaki Station’s southern side.

3) Use of parking spaces: Among the underutilized areas around the station, 77.3% were parking spaces. Parking spaces with a parking rate below 30% accounted for 41.5%. The parking lots within a 150 m radius of the station exit had a utilization rate of approximately 30% on weekends.

Murakami et al. [8] reported the parking lot usage around the regional city railway stations. These stations were developed during the Yamagata Shinkansen station extension. The conditions at these stations are not comparable to the Ozaki

Station. The Shinjo Station parking occupancy during weekdays and weekends was 30.1% (301 cars/1,000 spaces during peak hours) and 46.8% (468 cars/1,000 spaces), respectively. The Sakuranbo-Higashi-Ne Station’s holiday parking occupancy was 34.3% (142 cars/600 spaces). The other four stations (the Sakuranbo-Higashi-Ne Station during weekdays and the other three stations) exhibited 20% parking occupancy during weekdays and weekends. These observations suggest that the regional city railway station parking lots exhibit lower occupancy. Toki et al. [2] reported the vibrancy-generating options in the plaza spaces. They proposed employing automobile-designated plaza spaces for regional activities through staggered time slots. The Ozaki Station parking lots bear the potential to be converted into vibrant places.

6. CONCLUSIONS

Here, the Ozaki Station in Hannan City, Osaka Prefecture, was employed as a case study to elucidate the role of regional city downtown stations in vibrancy. The staying and circulation behaviors and parking space usage suggested that such station areas bear the potential to be explored for functions other than mere transit points. The potential of these areas in facilitating shopping activities and creating opportunities for extended stays can be maximized by utilizing unused parking spaces and creating spaces for lingering, particularly on low-traffic days.

7. ACKNOWLEDGEMENTS

This research was supported by JSPS KAKENHI Grant Number JP18H01606. We want to thank the Urban Development Department of Hannan City for survey cooperation and Editage for English language editing.

8. REFERENCES

- [1] Road Bureau, Ministry of Land, Infrastructure, Transport and Tourism, “2021 ROADS IN JAPAN”, <https://www.mlit.go.jp/road/road_e/pdf/ROAD2021web.pdf>, 2021, [Accessed 2023. 6.3].
- [2] Toki A., Kaijima M., “Practical Use Model from Time Lag Use in Station Plazas—A study on design method of plaza type parking lots in local cities (2)”, *Journal of Architecture and Planning (Transactions of AIJ)*, Vol. 77, Issue 671, 2012, pp. 95–102.
- [3] Kotaki S., Takayama J., Nakayama S., Rachi M., “Research on the Factor and Subject in a Station Square of a City Center Station that Capacity is Insufficient”, *Journal of Japan Society of Civil Engineers, Ser. D3 (Infrastructure Planning and Management)*, Vol. 70, Issue 5, 2014, pp. I_723–

- I_733.
- [4] Iwamoto T., Nakamura F., Okamura T., Yabe T., "A Study on Integrated Maintenance of Urban Railway Station, Station Plaza and their Surroundings", *Infrastructure Planning Review*, Vol. 23, 2006, pp. 641–649.
 - [5] Yamaguchi K., Murota M., Akaba Y., "A Study on the Relationship of Sitting and Resting Behavior Action between Large-Scale Commercial Facilities and the Adjacent Station Square -A Case of Study on Town Center of Kohoku New Town", *Journal of Architecture and Planning (Transactions of AIJ)*, Vol. 82, Issue 737, 2017, pp. 1747–1755.
 - [6] Takahashi H., Goto H., Sakuma Y., Saito R., Ishii T., "The Relationship between the Movements of Visitor's Walking Around and the Density of Stores on Commercial Area -A Case Study on the Area Around Shimokitazawa-Station", *Journal of the City Planning Institute of Japan*, Vol. 40-3, 2005, pp. 649–654.
 - [7] Akazawa K., Kawabata R., Negami A., "A Study on Impacts Made by Chain Stores on Shop-Around Behaviors of Visitors and Inter-Store Structures in Shopping Streets — A Case of Shopping Streets at the Metropolitan Areas —", *Journal of Architecture and Planning (Transactions of AIJ)*, Vol. 85, 2020, pp. 113-120
 - [8] Murakami T., Nishiue H., "A Study on Characteristics of Parking Lot Users around Railway Station in Local City -Case Study of Parking Lots at the New Stations along Yamagata Shinkansen", *Journal of the City Planning Institute of Japan*, Vol. 36, 2001, pp. 625–630.
 - [9] Yoshikawa K., Kato S., Minami Y., Azuma S., Kanbara R., Kida T., Sakanaka H., Takahashi K., Sakuma Y., "Field Survey on Pedestrian Behavior in the Frontal Areas of Station -A Case Study on Ozaki Station in Hannan City, Osaka Prefecture", *Proceedings of The City Planning Institute of Japan, Kansai Branch*, Vol. 17, 2019, pp.77-80.
 - [10] Hannan City in Osaka Pref., Hannan City Location Normalization Plan, 2018, p. 86.

Copyright © Int. J. of GEOMATE All rights reserved, including making copies, unless permission is obtained from the copyright proprietors.
