The Railway Station as Shopping Destination

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Abstract

Well-exploited business potential at a station can add considerable financial support to the capital or running expenses of a railway system. Furthermore, stations offering multiple functions can improve convenience for railway network users and enhance the overall impression of station use, thereby attracting more users. In this study, the current state of retail premises operated as adjuncts to the Japanese railway network is investigated as a mature model. Our research estimates the scale of the potential business opportunity, quantifies the effect of retail facilities on users' impressions of stations, clarifies the shopping behavior of railway users, and offers some fundamental insight into the management and operation of these adjunct functions.

Keywords promotion of public transit use, railway station, shopping behavior

Introduction

To overcome the problems of rapid urban expansion and increasing urbanization rates, there is an urgent need to improve the mass transit systems in metropolises in many developing countries. Convenient railway networks could cope with increasing travel demand, mitigate the problems of growing road use, and lead to an energy-saving urban structure. The major difficulty faced by governments in such countries is budget constraint. Another problem is whether mass transit systems would be attractive enough to citizens to prevent them from buying (and heavily using) cars. This paper proposes that stations should offer multiple functions to users. If the

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potential business opportunity of a station is well exploited, the resulting profit can be used to support the capital or running costs of the railway system. Furthermore, stations offering multiple functions improve the convenience of railway use and enhance the overall impression of stations, and thereby attract more users.

In this study, the current state of the mature retail facilities operated as adjuncts to the Japanese railway network is investigated. The research aims to estimate the scale of the potential business opportunity, quantify the effect of retail facilities on users' impressions of stations, clarify the shopping behavior of railway users, and offer some fundamental insight into the management and operation of these adjunct functions.

Multi-function stations in the Japanese mass transit system

In Japan, mass transit stations generally offer multiple functions to users. Services provided in stations include stores, restaurants, ATMs, and others. Terminal stations are often major commercial centers. For example, in Nagoya, the Nagoya station of Japan Railways is a twin-tower building of 55 stories, housing a large department store, a hotel, and many offices. The Sakae bus terminal has been designed like a large park that includes an open-air theatre, many stores, and restaurants. These adjunct facilities enhance the convenience of the mass transit network and improve feelings towards it, thereby attracting more users. Meanwhile, a station (or bus terminal) with more users offers a better business environment for the stores. In this way, a mass transit system and adjunct facilities have a positive effect on each other. Throughout Japan, it is clear that retail premises collect around railway stations, and these businesses together achieve better business performance. This pattern is more obvious in metropolitan areas where the mass transit system is well developed. Japan has three particularly large major metropolitan areas: Tokyo, Osaka, and Nagoya. Of these, Tokyo has the most advanced mass transit system. Hence the highest service level of mass transit system induces the highest ratio of trips by mass transit to trips by other means as shown in Figure 1. Meanwhile, Nagoya has a well-developed road

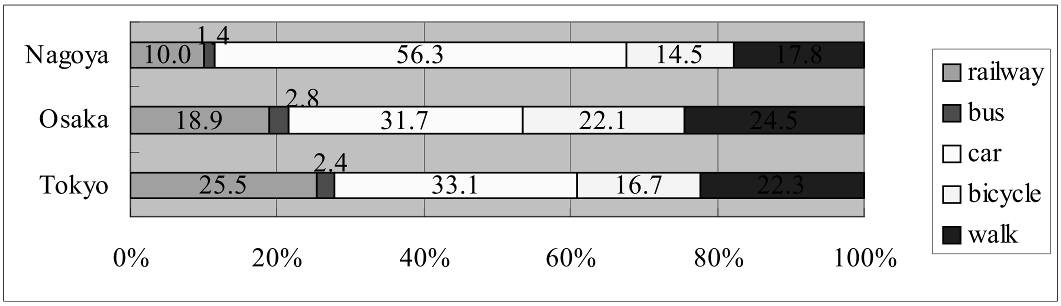

Figure 1. Modal Splits in
Three Major Metropolitan Areas in Japan

network and this induces the highest ratio of car use among the three cities.

To verify the fact that retail premises tend to congregate in areas surrounding stations and elucidate the differences caused by varying mass transit service levels, Tokyo and Nagoya are adopted for investigation in this study as two typical cities with different mass transit usage patterns.

Using GIS software, the railway networks of Tokyo and Nagoya were extracted and the stations plotted on a map. Then areas within a radius of 500 m and 1 km of each station were defined. Taking information from commercial statistics available on a 500 m mesh, two indicators (the number of shops and the sales volume) were calculated at three levels: the mean for the whole area, the mean for the 500 m station buffer, and the mean for the 1 km buffer. Figure 2 shows the result.

In both Tokyo and Nagoya, it is obvious that areas closer to stations have many more retail premises and larger volume of sales than the average for the area. Focusing

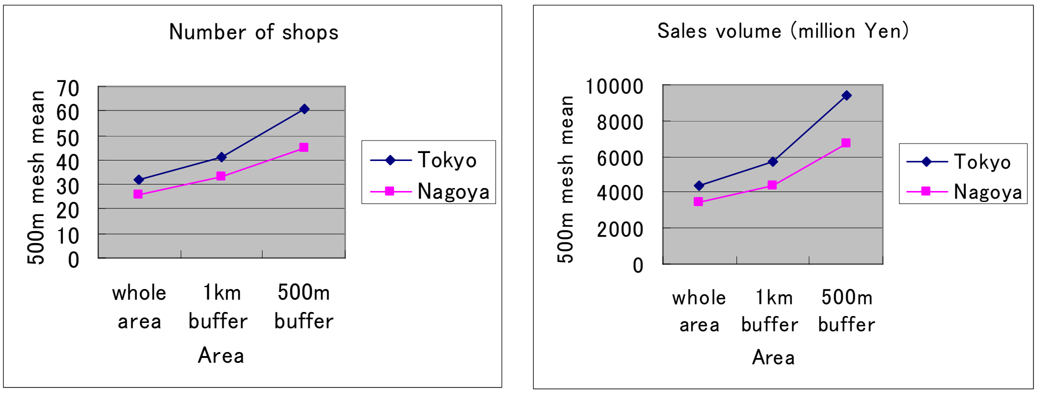

Figure 2. Commercial Concentration in Tokyo and Nagoya

on the difference between the two indicators, the volume of sales in the 500 m buffer is 2.14 and 1.91 times the volume for the whole area in Tokyo and Nagoya, respectively, though the number of shops in the 500 m buffer is 1.97 and 1.73 times the number for the whole area. This implies that mean sales per shop in 500 m buffer is higher than that for the whole area; in other words, shops closer to stations exhibit better business performance. This is the incentive for locating a shop closer to a station.

Finally, we compare the two cities. The fact that all indicators in Tokyo are higher than those in Nagoya implies that the above propensity will be stronger in cities that have a more advanced mass transit system. This indicates one important fact of urban planning: it is difficult to change an already-formed life-style influenced by city structure. If an advanced road network offers great convenience to car users, it becomes difficult for a mass transit system to attract a sufficient number of users. Accordingly, railway managers would be compelled to cut services in order to maintain profitability, and the reduced convenience will drive more users away. The falling number of potential customers leads to a deteriorating business environment for shops surrounding the stations. Moreover, the resulting lack of retail premises reduces the preference for the mass transit system and the positive impression held by users. Unfortunately, it can be said that Nagoya is today in this type of downward spiral. To avoid falling into this trap, developing countries need to develop mass transit as early as possible. Getting an advanced railway network in place ahead of mass motorization will lead to concentrations of retail premises that are easily supported and make good use of land. The resulting high level of mass transit use leads to a more sustainable and environmentally friendly transport system and urban structure. We advocate Tokyo as a model of success in transport system structure that should be the aim of metropolitan areas in developing countries. The analysis that follows considers the adjunct facilities present at railway stations in Tokyo.

The scale of the business opportunity in stations

The mean sales per shop depend strongly on the level of economic activity in a particular country, so Japanese sales volume data is not meaningful to developing countries. However, the ratio of shopping activities taking place inside stations is a figure that is transferable to other countries without significant modification, and may be used as a guide for calculating the potential business opportunity there.

In order to investigate the travel and shopping activities of people living in the Tokyo metropolitan area, a questionnaire survey in the form of a travel log was carried out. The questionnaire included a one-week travel log, in which shopping activities on each trip were recorded, as well as sections for recording feelings towards and frequency of use of 23 of Tokyo's large railway terminals. The dataset was supplied by East Japan Marketing & Communications, Inc., a major railway-business marketing company in the JR (Japan Railways) group. The questionnaire was implemented in 2001 and involved 3047 mail-in responses from residents of the Tokyo metropolitan area.

Table 2. Share of Visiting Adjunct Stores to Total Shopping Times

	weekdays	weekend days	total
visiting adjunct stores	2561	571	3132
total shopping times	9146	3819	12965
share	28.0%	15.0%	24.2%

Table 3. Share of Visiting Adjunct Stores in Week Days for Commuters

	Railway mode commuters	Others	total
visiting adjunct stores	2044	517	2561
total shopping times	5310	3836	9146
share	38.5%	13.5%	28.0%

Tables 2 and 3 show the relative frequency of use of adjunct stores with respect to total shopping activity as calculated from the travel logs. From Table 2, it is clear that use of adjunct retail premises as a ratio of total shopping activity is higher on weekdays. Taking the weekday data and analyzing it by commute mode, Table 3 shows that use of adjunct retail premises by railway mode commuters is close to 40 percent, a quite exciting figure.

A question related to the longer-term frequency of use of adjunct shops and services was also included in the questionnaire. Table 4 shows how often the respondents used stations kiosks, the most common adjunct business. As in the previous table, responses by railway commuters are collated separately and shown in the right-hand columns of the table.

Table 4. Visiting Frequency to Station Kiosks

	all respondents		railway mode commuters	
Visiting Frequency	percentage	cumulative percentage	percentage	cumulative percentage
every day	4.0	4.0	8.2	8.2
once or more a week	13.4	17.5	24.4	32.5
once or more a month	19.5	37.0	24.0	56.5
with visiting experience	57.8	94.8	40.8	97.4
no visiting experience	5.2	100	2.6	100
sum	100		100	

The constraints of the data used in this study mean that only retail premises located actually within stations could be counted; if shops located in the vicinity of the stations were included, the ratio would be much higher. However, the above tables indicate the potential market that may be available to railway operators if commercial functions are introduced into the stations they run. Clearly, the earnings from these adjuncts can help mitigate the burden of building or running the railway system.

Tables 2 through 4 also show that these adjunct facilities affect the lifestyles of users dramatically. The frequency of using adjunct retail premises varies significantly by mode of commute. For railway commuters, the ratio of over thirty percent demonstrates how much part of daily life such adjuncts have become. Though the initial reason for using these adjuncts is convenience during the commute, their use leads to the habit of using the railway for shopping trips and as such it may change the preferred means of access to certain locations. It means that rail is more likely to be selected as the mode of travel for shopping trips, even if the actual destination is not on the commute route. In short, besides the effect that commute mode has on shopping behavior, there is a desirable reaction as regards travel mode choice when going shopping. This reaction acts to accelerate the concentration of businesses around stations, support mass transit companies, and mitigate the bad influences of motorization while inducing an energy-saving urban structure.

Enhancement of overall impression through adjunct retail premises

Besides the direct effect of these adjunct retail premises, which is to increase the convenience of mass transit and help the railway generate income, the adjuncts often enhance the overall impression that people have of stations and thus indirectly attract more visitors. That is, these adjuncts can help in changing the perception of stations as mere transport facilities to places of communication or leisure. To understand how retail premises enhance the impression that users have of stations and quantify the effect, the structural equation model (SEM) approach is introduced. SEM is an extremely flexible modeling technique for handling multiple endogenous and exogenous variables, as well as latent variables.

First, factor analysis is carried out to extract responder's overall impressions of the stations. The impression indicators are configured on the basis of the attitudinal data. In the survey, the image that people have of 23 terminals in the Tokyo metropolitan area was determined through concrete binomial-choice questions from different aspects, including the indicators used in our model. The number of positive responses a station received is taken to be the score for that station. Since Tokyo Station is a unique one, with a major part of its area used for Shinkansen bullet train platforms, we excluded it from consideration.

This factor analysis was used to extract the impressions held of stations from two major points of view: one based on attributes of interest when a station is considered a transport facility, and the other based on attributes of interest when a station is considered a place of communication or leisure. We term the former the "objective overall impression" while the latter is treated as the "subjective impression". These two types of impression are introduced into our model as latent variables. The positive effect of the number of shops on subjective impression is hypothesized, as is the number of railway lines on the objective impression. Figure 3 shows the structure of our hypothetical relationship between retail premises and impression.

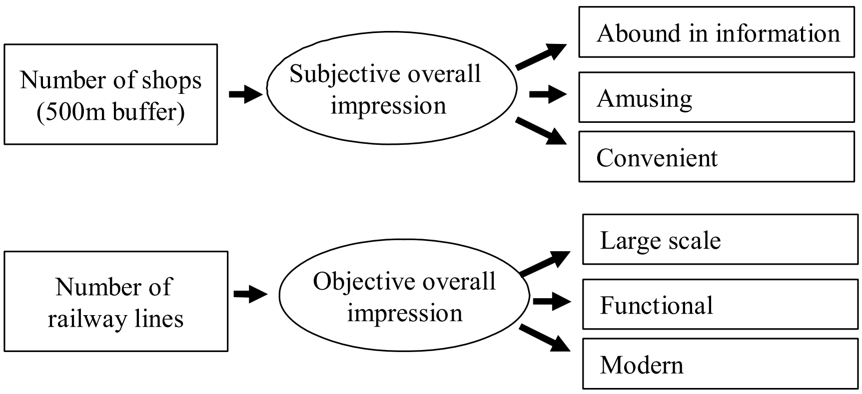

Figure 3. Structure of Our Hypothetical Model

The measurement equations are given as

$$Y = \Lambda\eta + \varepsilon$$

Where, Y is the vector of observed indicators, η is the vector of unobserved latent variables, Λ is a coefficient matrix, and ε is a vector of measurement disturbances.

Similarly, the structural equations are given as

$$\eta = \mathrm{B}\eta + \Gamma\xi + \zeta$$

where ξ is the vector of exogenous variables including the number of retail premises and the number of railway lines, B is a coefficient matrix of latent variables, Γ is a 2 by 6 coefficient matrix, and ζ is the vector of disturbances.

The software package LISREL (Jöreskog & Sörbom, 1996) is used here to make estimates of the model. Due to the small sample size (22 stations), it is difficult to obtain sufficient goodness of fit statistics, such as RMSEA or GFI. Here, it is important in the future to carry out analysis based on a larger sample size. The estimates are presented in Tables 5 and 6. All the indicators have statistically significant coefficient estimates and the expected sign.

Table 5. Estimation Results of the Measurement Model

Variable	Coef.	t-stat.
Indicators to subjective overall impression		
Abound in information	1^*	--
Amusing	0.988	22.9
Convenient	0.783	7.82
Indicators to objective overall impression		
Large scale	1^*	--
Functional	1.04	6.53
Modern	0.944	7.27

*: Coefficient is standardized as 1 for identification.

Table 6. Estimation Results of the Effects of Exogenous Variables on Latent Variables

	subjective overall impression		objective overall impression	
Variable	Coef.	t-stat.	Coef.	t-stat.
Number of shops (500m buffer)	0.803	4.16	--	
Number of railway lines	--		0.479	2.63

The results support the hypothesis developed in this study. They imply that the two hypothesized latent impressions do indeed exist, and that retail premises enhance the subjective impression. The squared multiple correlations for the structural equations are 0.68 and 0.33 for subjective overall impression and objective overall impression, respectively, indicating that the subjective overall impression is in large part explained by the number of shops but that objective overall impression is affected by other factors not included in this analysis in addition to the number of railway lines. This demonstrated enhancement effect will assist in the development of new functions at stations, besides retail premises. A model extended to include the relationship between latent variables was also estimated, but the added relationship was found to be insignificant.

Shopping behavior and the art of management

To reveal the characteristics of railway users with respect to choice of shopping destination, conventional MNL (multinomial logit) models are applied to each category of purchased items. Though these purchased items were divided into 12 categories in the original data, we recategorized them into six so as to obtain a large enough sample size for each category. These six categories were 1) juices, 2) alcoholic beverages, 3) cigarettes, 4) packed lunches and snacks, 5) newspapers and magazines, and 6) clothes, souvenirs, and groceries.

The definitions of alternatives in the destination choice models need to be made according to the purpose of the particular study. Here, railway stations are adopted as alternatives, allowing us to examine the effect of adjunct retail premises at railway stations on destination choice. Railway stations are also suitable for examining the effects of ride characteristics, such as commute time and transfer times, on shopping behavior. There are a tremendous number of stations in the Tokyo metropolitan area, and the set of choices used by each commuter is unknown to us. A technique of sampling alternatives is used to estimate the unknown parameters in the multinomial logit model (MNL) in order to avoid listing the service levels of the numerous stations included in the choice set. The alternatives are divided into four categories: the station closest to home, transfer stations on the commute route, the station closest to the office, and stations outside the commute route. Of these, stations outside the commute route include the large number of stations perceived by the decision maker. Further, there may be a number of transfer stations depending on the commute route. On the other hand, there is only one station closest to home and one closest to the office.

Sampling consists of randomly selecting one station from the "outside the commute route" category, and one of the transfer stations if there are multiple transfers. This sampling procedure yields four alternatives for use in parameter estimation, or three in a case where no transfer is made during the commute. The maximum likelihood estimation of MNL models with this sampling of alternatives is proven to yield consistent estimates of the unknown parameters (McFadden, 1978).

The sample used to estimate the logit model comprises 684 train commuters, for whom all pertinent explanatory variables are available. Finally, six conventional MNL models of destination choice with four alternatives are estimated for the six categories of items used in this study.

Table 7 shows the results for the first category, juices. The results for other categories are suppressed because of limited space. A summary of the examination is given below.

Looking at common properties, the service level (number of stores, etc.) has an undoubted effect on use of stations among the commute route. On the other hand, it does not significantly affect the use of other stations outside the commute route. This implies that no one will make a trip specially to buy a bottle of juice or other daily item. Travel time, besides access time to stations, transfer time, and residual travel time, is somewhat significant for the different station types in these models. However, in part these time variables only come into effect on specific days, such as weekdays, or for specific users, such as males having drinking habit.

The probability of purchase at the beginning or end of the railway ride varies quite significantly among item categories. For example, newspapers and magazines have a higher possibility of being purchased before the ride, whereas packed lunches tend to be purchased at the end of the ride.

Table 7. Estimation Results for Juice

Variable	Coef.	t-stat.
Office station constant	-0.319	-1.20
Transfer station constant	1.41	5.32
Other station constant	0.229	1.08
Number of commodity stores (/1000) (specific to home station, transfer station and office station)	2.83	2.65
Remaining move time to the final purpose station (hour) (specific to transfer station and other station)	2.07	4.76
Return home purpose trip dummy (specific to home station)	2.57	9.58
Work purpose trip dummy (specific to office station)	1.58	6.24
Dummy for category-6 items purchased (specific to other station)	1.64	3.72
Dummy for category-5 items purchased (specific to office station)	1.68	3.28
Dummy for category-4 items purchased (specific to home station)	2.35	5.79
Sample size	544	
L(0)	-636.5	
L(b)	-410.2	

Interactions between items are introduced into the models from three interests: compatibility between items, habits of shopping location, and induced purchase. For example, tobacco and beer are compatible, while a long trip to purchase cloth may induce the purchase of other items, such as dairy products. In fact, based with our estimations, with the exception of juices, all items revealed an increment in purchase probability at stations outside the commute route when Category 6 items (clothes, souvenirs, and groceries) are purchased there.

From a micro viewpoint, this understanding of shopping behavior will prove very useful in the management and operation of adjunct premises. The respective estimates obtained with models for the six item categories should help managers of adjunct retail premises improve stock logistics. By adding this information to data on the station user base, such as the proportion of commuters and the proportion of male users, shop managers will be able to choose stock items and volumes to suit the needs of users more closely. For example, two dummy variables, going to work and returning home, showed opposite effects on different items. This implies that good stocks of juice in the morning and snacks in the afternoon are preferred for retail premises near office areas. Similarly, access time, one of the explanatory variables in the model for the cloth category, is only significant for stations outside the commute route on weekdays. This may lead to the idea of a discount for consumers without commuter passes on weekdays, when they tend to buy cloth at nearby shops.

Further to these results, since dummy variables were set for item interactions in constructing our model, the interactions between the six item categories have been clarified. The understanding of the interactions shown in Figure 4 will be useful in the arranging of sales floors and choosing stock.

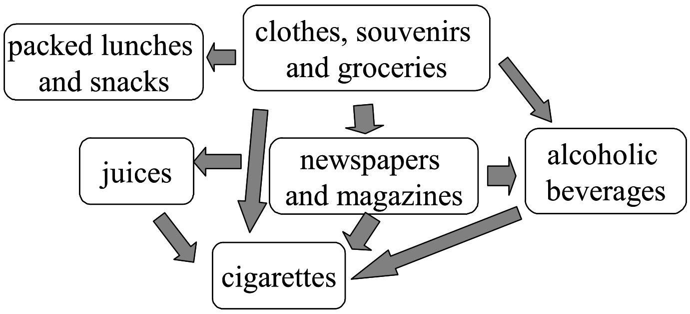

Figure 4. The interactions between item categories

Conclusions

This paper advocates the encouragement of complex functionality in the stations of mass transit systems. The feasibility and desirability of such encouragement has been demonstrated by determining the potential market in and around stations, and clarifying the effect of improved facilities on the overall impression users have of stations. Then, through analysis of destination selection behavior among railway mode commuters, we provided some fundamental insights into the management and operation of such adjunct retail premises. The advice derived from this analysis should prove useful for developing countries as they construct their own mass transit systems, enabling them to manage their systems with more intelligence.

Acknowledgement

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