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Research paper

Expectations and satisfaction towards railway companies by residents in Japan

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ABSTRACT

Railway companies in Japan, which have successfully managed their business using TOD approach, now face a decrease in the general population under a motorised society. They are trying to cooperate with residents along their operating lines by expanding their activities, but it is unclear what residents expect of railway companies and to what extent residents are satisfied with these companies. This paper uses questionnaire survey data to explore this issue quantitatively. Expectations and satisfaction are examined using both aggregate and disaggregate analysis. In disaggregate analysis, expectations and satisfaction are jointly modelled in bivariate ordered probit models to investigate the interrelationships between them. The results are as follows. Residents have high expectations in various issues, and those in metropolitan areas tend to be satisfied with the transportation-related services provided by railway companies. However, there is quite a large amount of dissatisfaction with railway company activities in fields other than transportation. Expectations and satisfaction depend on the respondents' attributes, including residential geographical conditions, and these vary even among stations within the same company, but expectations and satisfaction have little relationship to whether or not residents frequently travel by train.

1. Introduction

Japanese railways are primarily run by private companies. They have successfully managed their business using a transit-oriented development (TOD) approach since the early 20th century. Railway companies in Japan operate not only in transportation, but also in a wide range of related businesses, including real estate development, retail store operations, and entertainment park owners. Although their business models face new challenges due to population decline and the progress of motorization in the 21st century, railway companies have expanded into new business fields, such as nursery centres, and have tried to cooperate with communities along their railway lines to enhance their brand values.

While railway companies have tackled these problems, few studies have examined how residents along railway lines evaluate how railway companies increase the attractiveness of their towns. Few surveys ask residents to express their level of expectations and satisfaction with the railway companies that operate near their community. This paper utilises online survey data from across Japan that was collected as a part of the activities of a research committee named “Railway Business and Community along its Lines” at the Urban Transportation Research Institute, Kansai Region Association of Railway Operators (UTI). This data was quantitatively analysed and evaluated to assess the current situation of railway company activities.

The paper is organised as follows. Focusing on local railways, Section 2 overviews the railway businesses in Japan and their challenges in recent years. Section 3 reviews existing literature on the research motivation behind this paper. Section 4 outlines the online survey used by this paper. Quantitative analyses are presented in Sections 5–8, in which Section 5 compares the influences of several organisations, including railway companies, on the attractiveness of communities. The expectations of residents and their satisfaction with railway companies are examined using aggregate analysis in Sections 6 and 7 and using disaggregate analysis in Section 8. Section 9 is the conclusion.

2. Railways in urban areas in Japan

Japan has a huge railway network covering both interurban

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corridors and local areas. More than 27,600 km of railway lines are operated by a total of 213 railway companies, which include six JR passenger companies, the so-called "16 majors," and other small railway companies. JR passenger companies were privatized from the former Japan National Railway in 1987 and divided horizontally (not vertically) into JR East, JR Central, JR West, JR Hokkaido, JR Shikoku, and JR Kyushu.

Most of the "16 majors," private railway companies operating mainly in greater metropolitan areas, were founded in the early 20th century. After opening their initial railway lines, they expanded their businesses and made profits through the TOD approach. A typical example is Hankyu Railway in Osaka. Ichizo Kobayashi (1873–1957), a founder of the current Hankyu Railway corporation, laid the railway's first line in the northern skirts of Osaka, where few people lived at that time. He started a land and housing subdivision sales business and developed residential areas along the railway line. Since he accepted long-term monthly-instalment payment methods, the middle-class, which grew during the industrial revolution, moved from the inner-city of Osaka to the newly developed areas. He also attracted schools to the suburbs, which the railway line had begun to serve. This solved one-way unbalanced passenger transportation during peak hours and made railway operations more efficient. "Based on these spillover effects, Japan's electric railway companies increased involvement in the real estate sector, leading to accelerated urbanization in the following years" (Kikkawa, 2023). Furthermore, he expanded a variety of services for residents, such as department stores and amusement parks, that generated additional passengers during off-peak hours and holidays (Kashima, 2018; Oikawa, 2017). Those ideas and practices successfully contributed to the railway business.

The TOD approach was introduced not only in the three large cities of Tokyo, Osaka, and Nagoya, but also in regional hub cities. Most of the railway companies in those areas run not only transportation services, but also real estate and other businesses. The former national railway, JNR, did not use the TOD, but the privatized JR companies have all expanded their businesses, which typically include shopping centres, hotels, and real estate. It is often the case that JR hub stations have shopping centres attached, which are run by their affiliate companies. During the 20th century, private railway companies, including the JR companies, successfully operated their business and made excellent profits against the background of population growth and rapid urbanization.

However, the working-age population in Japan has trended downward since 1997, while the number of aged people has drastically increased. According to the national census, 28.6% of the population was aged 65 and over in 2020, which is higher than the percentage in 2000 by 11.2% points (Statistics Bureau of Japan, 2021). Real estate developments no longer expand as they did before. In fact, most of the amusement parks run by railway companies have closed down. As motorization increased, conventional high streets around railway stations declined except in the Tokyo and Osaka areas, resulting in the closure of department stores run by railway companies. The position of railways in the daily lives of the Japanese people is obviously changing.

Under these circumstances, railway companies have explored new business fields, such as nursery centres, and also have held various events, such as picnics, festivals for children, and guided tours. Special "beer trains" on ordinary commuter lines are popular nowadays. They seemingly try to collaborate and cooperate with communities along their railway lines to enhance their brand values.

Nevertheless, there is no evidence that their strategies are successful. Regarding the conventional TOD approach, the outcome was quantitatively proved by data, such as population, land price, and shop sales. On the other hand, it is difficult to quantify the relationships between the railway companies and the communities along their lines. Brand values are partly reflected in land prices, but the qualitative aspects of the relationships are more important. Therefore, this paper tries to analyse these qualitative issues using a quantitative approach.

3. Literature reviews

As for the satisfaction of public transport passengers, previous studies have taken two main approaches. The first approach examines the factors (e.g., service attributes, socio-demographic, geographic characteristics, and psychological attributes of passengers) that influence passenger satisfaction or loyalty (e.g., Abenoza et al., 2017; Allen et al., 2019; Grisé & El-Geneidy, 2018; Lai & Chen, 2011). These studies were based on findings and methods from marketing studies. The second approach investigates the relationship between satisfaction with daily travel contexts (i.e., travel satisfaction) and subjective well-being (SWB) (e.g., Delbosc, 2012; Ettema et al., 2010). This travel satisfaction is considered a life domain-specific satisfaction that is included in cognitive SWB, e.g., job satisfaction, health satisfaction, and satisfaction with social relationships (De Vos & Witlox, 2017; Ettema et al., 2010; Friman et al., 2013). Customer satisfaction (CS) is also regarded as a domain-specific satisfaction limited to the cumulative purchasing experience for specific products/services from the perspective of SWB (Ettema et al., 2010). In particular, "satisfaction with travel scale (STS)," a well-known method for measuring travel satisfaction, was developed by Ettema et al. (2011) using measurement methods from SWB research. Based on STS, over the past decade, factors influencing travel satisfaction, such as travel-related attitudes, residential built environment, socio-demographic, and household characteristics, have been intensively studied (e.g., De Vos et al., 2021; De Vos & Witlox, 2017; Gao et al., 2018; Mouratidis et al., 2019; Ye & Titheridge, 2017).

Customer satisfaction (CS) has long been an important research topic in marketing studies. This is because CS ultimately leads to customer loyalty, i.e., re-purchase behaviour, and consequently, company performance (e.g., Anderson et al., 1994). Various antecedents of CS have been explored, including perceived quality and customer value (e.g., Cronin et al., 2000; Fornell et al., 1996; Oliver, 2010). One of these antecedents is customer expectation, and CS has traditionally been derived from "expectation-disconfirmation" theory (e.g., Oliver, 1980; Oliver, 2010). According to this theory, CS is determined by the degree of confirmation or disconfirmation between the level of expectation before purchasing a product/service and the level of the actual performance of a product/service perceived after purchasing. In other words, customers feel satisfied when the perceived performance exceeds their expectation level (positive disconfirmation) and dissatisfied when it falls below their expectation level (negative disconfirmation). Thus, since satisfaction is influenced by a customer's prior expectations, it is important to concurrently grasp both expectations and satisfaction.

Only a few studies have incorporated individual expectations to examine the key factors that increase potential rail users and their loyalty to rail services (Brown et al., 2019; Fu et al., 2018). Brown et al. (2019) categorised residents into four groups, (no expect, no ride), (no expect, ride), (expect, no ride), and (expect, ride), based on residents' expectations before the construction of new light rail and actual ridership after the introduction of its service. They found that these groups have different perceptions of its social benefits, such as economic opportunities, community benefits, and housing improvements associated with light rail development. Fu et al. (2018) applied the expectation-disconfirmation theory to the satisfaction-loyalty link to further understand customer loyalty in the public transit service context. They confirmed that the inclusion of the expectation and confirmation concepts does improve the explanatory power of the satisfaction-loyalty link in the context of public transit use. These studies show that it is essential to understand residents' expectations as well as satisfaction to identify the determinants of public transport use.

However, to the best of our knowledge, few studies have examined the differences between the expectations of residents (including both rail users and non-users who live near railway lines) for rail companies and the roles actually played by these rail companies. Moreover, few studies have examined the degree of satisfaction based on the level of the residents' expectations, although many studies have examined the determinants of satisfaction with public transit service and the determinants of travel satisfaction in daily travel from the perspective of SWB. This study aims to clarify the role that residents expect railway companies to play in the future and how to improve the attractiveness of the areas along railway lines by quantitatively analysing data from an online survey given to residents.

4. Outline of the survey research

Unlike conventional passenger satisfaction surveys, which limit respondents to passengers and ask about attitudes related to transportation services (e.g., frequency, speed, and comfort), the survey used in the present study has the following characteristics.

1. Respondents are residents along railway lines and include both railway users and non-users.
2. Contributions by the railway companies to the residents' daily lives are compared to those by other organisational bodies (e.g., local governments and neighbourhood councils).
3. Considering the expectation-disconfirmation theory described in Section 3, the respondents were asked to report both their level of expectations and satisfaction. As for the roles played by the railway companies, the study examined not only railway service, but also other social functions.

The first point was addressed by distributing a link to the questionnaire through a variety of channels, for example, the webpage of the UTI, e-newsletters published by railway operators who are members of the UTI, and personal communication from the committee members, including the authors. Packs of tissue with small leaflets were also distributed to advertise the questionnaire. As for the second point, the questionnaire listed eight organisations (railway companies, local governments, and so on) and asks respondents to evaluate each organisation's influence on the attractiveness of their communities ("great influence," "slight influence," and "no influence"). The details will be explained in Section 5. Regarding the third point, the questionnaire listed 13 items that railway companies might contribute to their neighbouring communities, and asked respondents to express their expectations and satisfaction with each item. In order to minimise the burden on the respondents, they were asked to choose one of five answer pairs (expect, be satisfied), (expect, not be satisfied), (expect a little, be satisfied), (expect a little, not be satisfied), and (not expect at all, satisfaction is not asked). The details, including a description of the 13 questionnaire items, will be explained in Section 6. Note that some of the items in this questionnaire are based on items from "Nishinomiya City Community Development Evaluation Questionnaire 2008" (Nishinomiya City, 2008).

The survey was conducted between October 2018 and January 2019. A total of 958 responses were collected from around Japan. However, respondents residing in the six prefectures in the Kansai region accounted for 84% of the total number of responses, with Osaka Prefecture alone accounting for 45%. Because the survey was not based on random sampling, the respondents were recruited from a variety of channels to minimise sample selection bias, and priority was given to collecting as much data as possible.

Looking at the demographics of the respondents, around half of the respondents were in their 40s and 50s. Elderly people in their 60s and over accounted for only 12%, which might be due to the survey method of using the internet. Considering that people aged 65 and over comprised 28.6% of the total population in 2020, our sample is biased towards younger generations. It is also notable that 77% of respondents were male and singles accounted for only 19%, which differs from Japan's population structure. However, it is unclear how these biases affect the results. Company employees accounted for 44% of the respondents, and 63% of them uses the train as a means of commuting to work or school. More than half (57%) used trains five or more days a week, and 94% of the respondents took trains at least once a month. Regarding the number of automobiles owned by households, 33% of respondents had no car, which is almost the same percentage reported for respondents in Osaka prefecture (31%), and relatively higher than the national average of 15% for households of two or more people (Osaka Prefectural Government, 2023). According to person trip data (Keihanshin Metropolitan Area Transportation Planning Council, 2012; Ministry of Land, Infrastructure, Transport and Tourism, undated), railways accounted for 24% of commuting traffic in Osaka Prefecture in 2010 and for 17% in Japan as a whole in 2015. From the standpoint of modal split, the sample in the present study has more railway users than the average. These characteristics of the respondents could result in higher expectations of railways, but the relationship between the respondents' frequency of train use and their expectations is unclear. This issue also should be examined.

5. Influences on the attractiveness of communities

This section describes the results of the survey about influences on the perceived attractiveness of communities. In general, railways are an important means of transportation for cities. Railway companies in Japan have greatly contributed to the development of cities through their TOD strategies. However, as described earlier, the situation seems to be changing. Because no data existed to determine the extent of the influence that railway companies have on the attractiveness of communities' lives, this study compared the extent of their influences with seven other organisations.

In our survey the respondents are requested to choose one of three answers—"great influence," "slight influence," or "no influence"—for each organisation. Railway companies are considered to have a great influence on the attractiveness of their communities, since 71% and 8% chose "great influence" and "no influence", respectively. For ease of comparison, the diffusion index (DI) of "influence" is calculated by subtracting the percentage of "no influence" from the percentage of "great influence." Results are presented in Fig. 1. The DI of influence is the largest in railway companies (DI: 53% points) followed by large retailers (DI: 24% points).

The DI of influence varies across respondents' socio-economics.

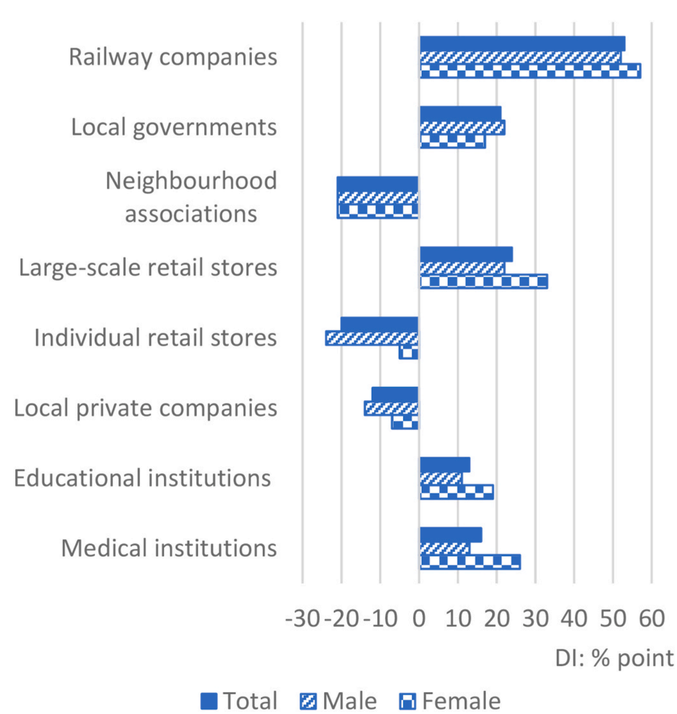

Fig. 1. Influence on the attractiveness of communities by gender.

Females have higher DIs for many organisations: the DI for railway companies is 57% points for females and 52% points for males. The level of urbanisation also affects the DI. Fig. 2 presents the results for Osaka City, the Osaka City suburbs (Osaka Prefecture except for Osaka City), and regional areas. Taking advantage of the large sample size, the study focused on Osaka Prefecture to compare city centre and suburbs. The sample for the regional areas was obtained from the data of prefectures outside the three metropolitan areas of Tokyo, Nagoya, Osaka and their surroundings. Except for the residents of Osaka Prefecture, the residents in these three metropolitan areas are excluded from this analysis. The DI for railway companies is particularly high in Osaka City (48% points) and in the Osaka City suburbs (58% points) compared to the regional areas (42% points). Nevertheless, even in regional areas, railway companies achieved the highest DI, followed by local governments (36% points). The DIs for neighbourhood associations and individual retail stores are negative in all regions.

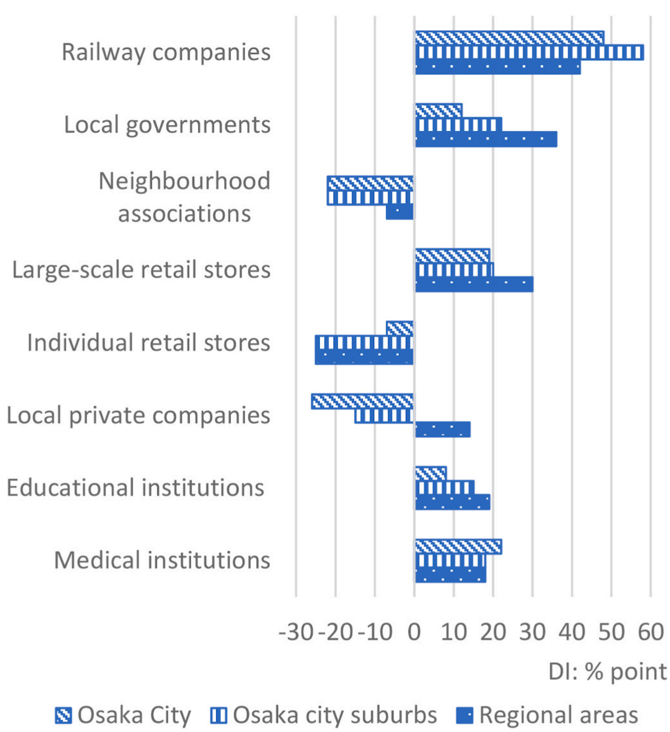

Fig. 2. Influence on the attractiveness of communities by region.

6. Expectations and satisfaction towards railway companies

This section analyses respondent expectations and satisfaction towards railway companies on an aggregate basis. The respondents were asked to choose one of five answers: E2S1 (expect, be satisfied), E2S0 (expect, be unsatisfied), E1S1 (expect a little, be satisfied), E1S0 (expect a little, be unsatisfied), or E0 (not expect at all). For ease of comparison, this section defines the two DIs (Expectation DI and Satisfaction DI) as follows.

$$\text{Expectation DI} = (\#(\text{E2S1}) + \#(\text{E2S0}) - \#(\text{E0})) / \#(\text{Total})$$

$$\text{Satisfaction DI} = (\#(\text{E2S1}) - \#(\text{E2S0})) / (\#(\text{E2S1}) + \#(\text{E2S0}))$$

where # (.) represents the number of respondents choosing the alternative in parentheses.

Fig. 3 presents the results of the 13 questionnaire items. Regarding Expectation DI, "c. providing an environment where people can casually go out (casual outings)" and "a. convenience for daily shopping (daily shopping)" received high scores of 63% points and 54% points, respectively, followed by "e. creating lively shopping areas and spaces in front of the station (lively environment near station)" and "i. initiatives to create a good townscape (good townscape)" at around 40–50% points, while "g. planning events to promote health (health-promoting events)" and "h. fostering trust between local residents (trust between residents)" are slightly negative, which means "expect" and "not expect" are almost balanced. Regarding Satisfaction DI, higher Satisfaction DI scores are not always related to higher Expectation scores. The Satisfaction DI for a (daily shopping) and c (casual outings) are also high (around 30% points), corresponding to the Expectation DI being larger than 50% points, while the Satisfaction DI for e (lively environment near station) and i (good townscape) are −9% points and −6% points, respectively, with the corresponding Expectation DI being larger than 40% points.

Quite a few differences in Expectation DIs and Satisfaction DIs are found between genders in Figs. 4 and 5. Females have higher Expectation DIs than males in all items, by more than 10% points in many items, including 18% points higher than males for "l. initiatives to protect the safety and security of the community (safety/security)." Gender differences in Satisfaction DIs are not clear-cut, but it is notable that the DI for "b. providing childcare environment and facilities (childcare)" is negative in contrast to males, and the DIs for "d. providing places to meet and socialise with friends and acquaintances (socialising place)" and "m. support for the participation of diverse local residents in social activities (social activities of diverse residents)" are lower than those for males by 10% points or more.

By region, Fig. 6 shows that Expectation DIs are generally lower in regional areas, especially for a (daily shopping), which is 27% points lower than the overall average. This is not surprising considering the recent decline of cities in regional areas. However, the Expectation DI of 27% points is composed of 14.5% "not expect" and 41.3% "expect." Expectations for rail companies are not necessarily low even in regional areas. It is also interesting that m (social activities of diverse residents) is relatively higher in regional areas than in Osaka at 17% points, and 7% points higher than the overall average. The lack of public spaces in car-oriented regional areas could make people, especially non-drivers, expect railways and train stations to serve as sociable spaces to meet each other.

As for Satisfaction DI by region shown in Fig. 7, people in regional areas are considerably dissatisfied with b (childcare), e (lively environment near station), "f. organising events that make people want to go out (events encouraging outings)," "j. providing opportunities and places for lifelong learning (lifelong learning)," "k. providing opportunities to become familiar with culture and arts (culture/arts)," and m (social activities of diverse residents), in which DI scores are below −25% points. Especially, Satisfaction DI for e (lively environment near station) is further negative with −35% points in regional areas, although the Expectation DI is 33% points. This is possibly due to declining high streets around train stations in regional cities. It indicates that railway companies, which had expanded their businesses by TOD strategy in the previous century and have struggled with severe business conditions due to motorization and decrease in population in recent years, cannot adequately respond to the residents along their lines, who still expect more than transportation services.

Fig. 8 presents Expectation DI and Satisfaction DI by age. Looking at the entire average of DIs for all the 13 items, while the relationship between age and Expectation DI is not clear-cut, Satisfaction DIs are higher in their teens and 20s, and lower in their 30s, 50s and over. In particular, a striking difference among age groups is found in the case of e (lively environment near station) as shown in Fig. 9. Satisfaction DIs are 60% points in their 10s and −60% points in their 70s and over, respectively. There may be a gap between the generations in their emotional attachments to the liveliness of high streets around train stations.

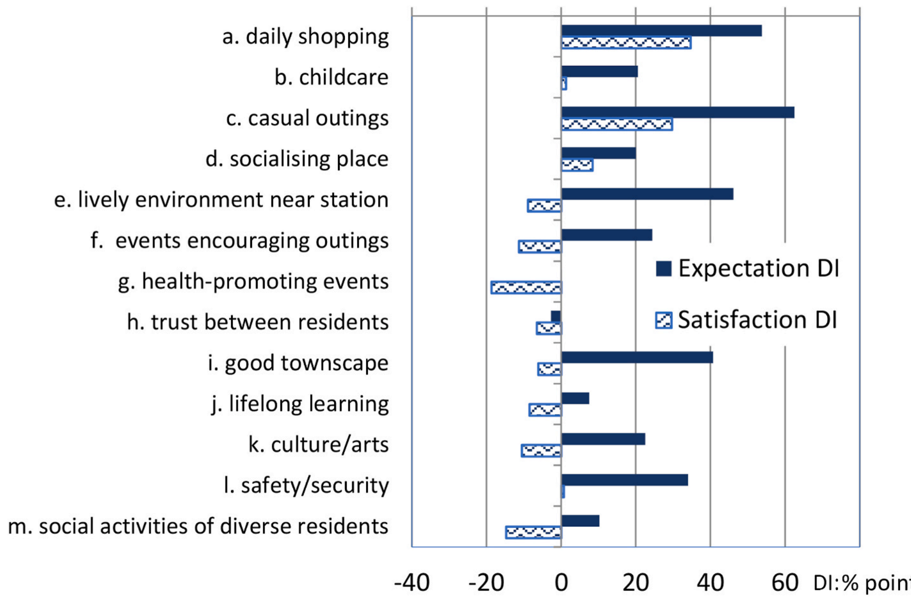

Fig. 3. Expectation DIs and satisfaction DIs.

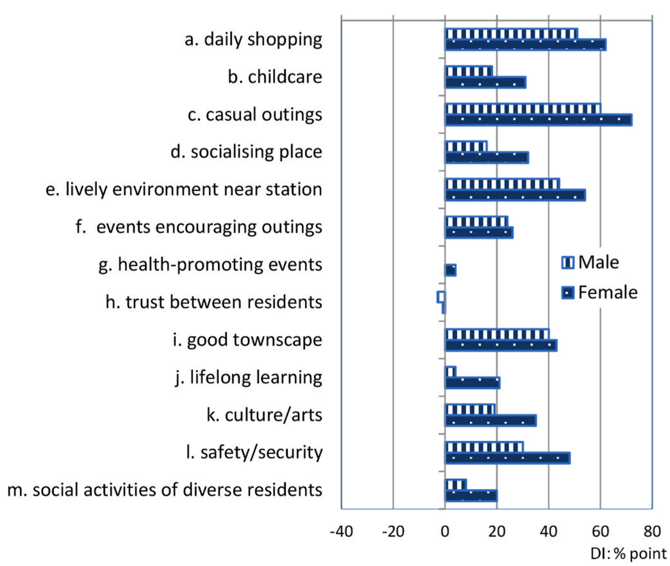

Fig. 4. Expectation DIs by gender.

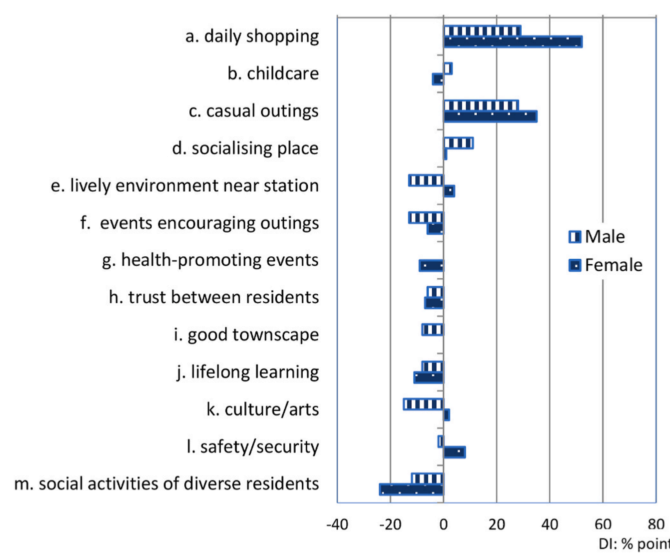

Fig. 5. Satisfaction DIs by gender.

7. Expectations and satisfaction by type of stations

This section focuses on station types. Stations differ in many aspects, including the number of passengers and the environment and geographical characteristics around the stations. Respondents whose nearest stations are on the Hankyu Railway lines were chosen. The choice of Hankyu Railway is due to the large number of observations in our dataset. What is more, Hankyu Railway is a successful private railway company in Japan that has adopted the TOD style business model, and it is worth analysing how residents currently perceive this railway company.

The train stations of Hankyu Railway are classified into four types: main stations in large city centres that are ranked in the top five in terms of boardings (Type 1), stations surrounded by commercial facilities with many boardings (Type 2), small stations located in the “inner-city” area (Type 3), and small stations in residential areas on branch lines (Type 4). It should be noted that the sample size for each type is not large: 12 for Type 1, 44 for Type 2, 19 for Type 3, and 41 for Type 4. Since train stations of Type 1 are not located in residential areas, this study focused on Types 2, 3, and 4 as they were more appropriate for analysing the relationships between the railway company and the community along the line.

The DIs for influence on the attractiveness of communities as defined in Section 5 are calculated for each station type, and residents around Type 2 (DI: 78% points) and 3 (DI: 77% points) stations tend to feel the influences of railway stronger than residents around Type 4 (DI: 59% points) stations. The results for Type 2 stations are quite reasonable because they are hub centres under the TOD strategy. The results for Type 3 stations, however, are a bit surprising. Inner-city areas often have some urban problems, and railways or railway stations in the areas (Type 3) could have a potential to revive the areas even though users of railway stations are not so large.

Looking at Expectation DIs for the thirteen items in Fig. 10, residents around Type 2 stations tend to have higher expectations of railways than for other types, especially for a (daily shopping), c (casual outings), and e (lively environment near station), whose DIs are more than 70%

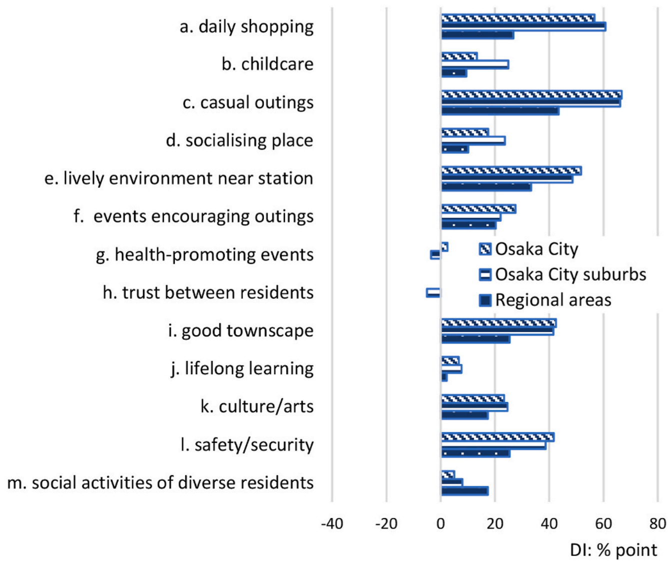

Fig. 6. Expectation DIs by region.

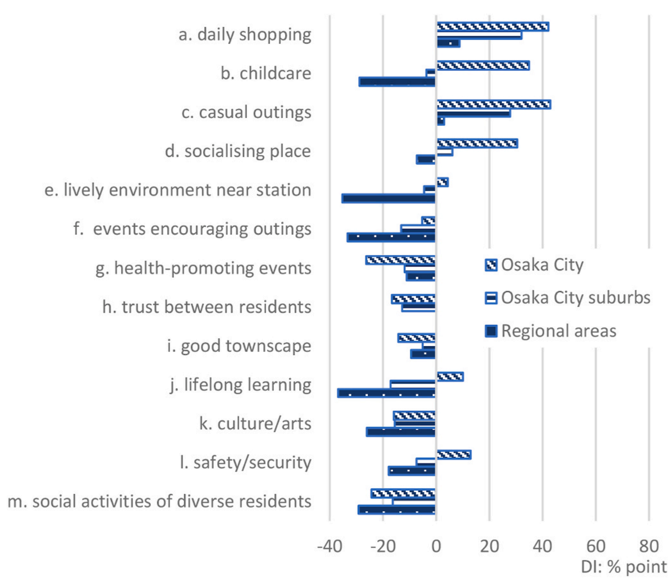

Fig. 7. Satisfaction DIs by region.

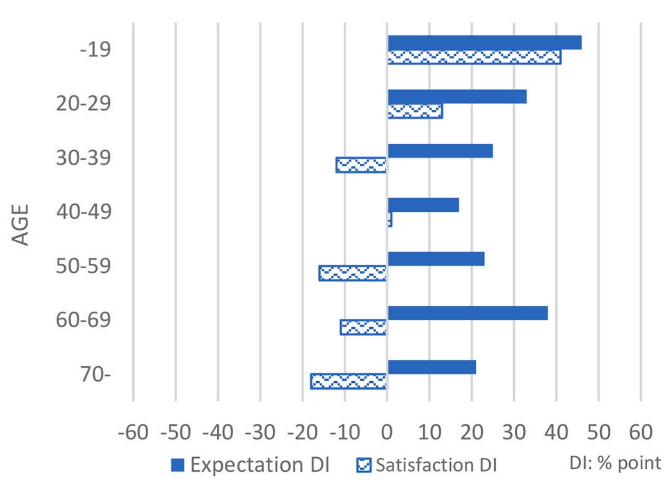

Fig. 8. Expectation and satisfaction by age (Average of DIs for 13 items).

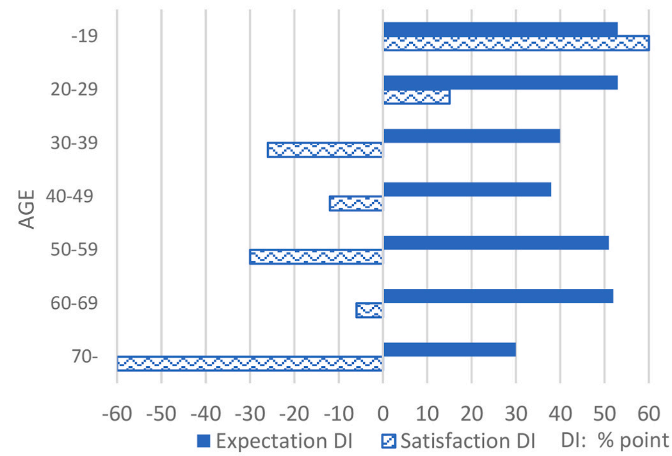

Fig. 9. Expectation and satisfaction by age (DIs for "e. lively environment near st.").

points. These results are consistent with the influences on the attractiveness of communities, as mentioned above. Most of the Expectation DIs for Type 3 stations are relatively lower than for the other types, but it should be noted that the DIs for eleven of the thirteen items are positive even in the case of Type 3 stations.

The Satisfaction DIs for the thirteen items are presented in Fig. 11. While the Satisfaction DIs for a (daily shopping) and c (casual outings) are high for all types of stations and are in line with high Expectation DIs, those for e (lively environment near station) in Types 3 and 4 are negative despite their high Expectation DIs in corresponding items. In particular, dissatisfaction far outweighs satisfaction in the case of Type 3 stations, with a Satisfaction DI of −46% points. Also, more residents around Type 3 stations feel dissatisfied with h (trust between residents).

Regarding the case of Type 4 stations, although some of the Satisfaction DIs are negative, the average of all thirteen Satisfaction DIs is the highest among those for all station types. In recent years, small stations on branch lines have actively planned various events, such as hikes and town tours, to attract local people. These efforts might bear fruit to some degree.

In short, within a single railway company, expectations and satisfaction differ by the type of station. Considering that residents around small stations also expect the railway company to play diverse roles, it is quite important to meet their expectations in line with geographical conditions.

8. Disaggregate analysis between expectations and satisfaction

The aggregate analyses in Sections 6 and 7 revealed the general relationships between expectations and satisfaction. This section further investigates the relationships by applying disaggregate analysis that utilises the bivariate ordered probit model, which facilitates examining two types of interrelationships.

8.1. Bivariate ordered probit model

For each individual i, let y_{1i} represent the observed level of expectation ($y_{1i} = 2$: Expect/1: Expect a little/0: Not expect at all), and let y_{2i} represent the observed level of satisfaction ($y_{2i} = 1$: Be satisfied/0: Be unsatisfied). As shown in Section 4, realisable combinations of (y_{1i}, y_{2i}) are $(2,1)$, $(2,0)$, $(1,1)$, $(1,0)$, and $(0,\varphi)$.

Propensity functions for individual i with respect to expectation (y^*_{1i}) and satisfaction (y^*_{2i}) are written as:

$$y^*_{1i} = \boldsymbol{\beta}'_1 \mathbf{x}_{1i} + \varepsilon_{1i} y_{1i} = j \text{ if } \mu_{1,j} < y^*_{1i} < \mu_{1,j+1} \quad (1a)$$

Fig. 10. Expectation DIs by station type (Hankyu).

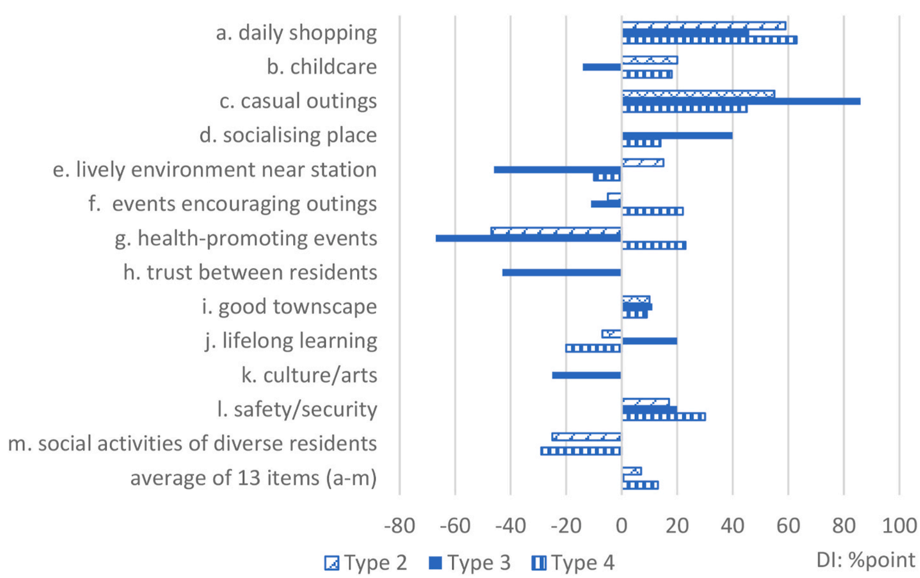

Fig. 11. Satisfaction DIs by station type (Hankyu).

$$y_{2i}^{*} = \boldsymbol{\beta}_2^{'}\mathbf{x}_{2i} + \gamma D_{y_{1i}=1} + \varepsilon_{2i} y_{2i} = k \text{ if } \mu_{2,k} < y_{2i}^{*} < \mu_{2,k+1} \quad (1b)$$

where $\mathbf{x}_{1i}$ and $\mathbf{x}_{2i}$ are vectors of exogenous variables, and $\boldsymbol{\beta}_1$ and $\boldsymbol{\beta}_2$ are corresponding vectors of parameters; $D_{y_{1i}=1}$ is a dummy variable (1 if $y_{1i} = 1/0$ otherwise), and γ is a corresponding parameter; $\boldsymbol{\mu}_1$ and $\boldsymbol{\mu}_2$ are threshold parameters; and random error terms ε_{1i} and ε_{2i} are assumed to be distributed identically and independently across respondents in accordance with the standard bivariate normal distribution, in which means are zeros, variances are ones, and correlation is ρ.

The model is designed to analyse the following interrelationships between expectation and satisfaction. (1) Level of expectation directly affects the level of satisfaction, which is suggested by the expectation-disconfirmation theory. (2) Unobservable components in two latent variables are correlated. Regarding (1), the relationship could be either positive or negative. If both residents and railway companies have similar understandings in the roles that railway companies should play, then the roles that the residents expect of railway companies are also recognized by the companies and played by them, resulting in positive γ. However, according to expectation-disconfirmation theory, the level of satisfaction can be defined by the actual level of service provided minus the expected level of service. Therefore, even when the same level of service is provided, those having lower expectations are more likely to be satisfied with the service, resulting in negative γ. Regarding (2), since the expectations and satisfaction are related, factors other than explanatory variables may or may not be positively or negatively related.

Care must be taken to identify the models (Maddala, 1983). $\mathbf{x}_{1i}$ must include at least one variable not included in $\mathbf{x}_{2i}$. The variable must be related to y_{1i}^* but is independent of y_{2i}^*. The variable chosen here is *Intention* (1: Yes to 'I chose the current place of residence because public transportation (e.g. rail and bus) is convenient'; 0: otherwise). The questionnaire listed 19 reasons for choosing the place of residence, including *Intention*, and asked respondents to choose as many items as were applicable. It is reasonable to assume that those having the above *Intention* expect the railway companies to play some role (not exactly known with respect to any items of a–m). *Intention* may be related to satisfaction, as well. However, except for special occasions, when people choose a place of residence, especially in unfamiliar areas, it is more natural for people to expect the service rather than be satisfied with it.

The probability that individual i replied (y_{1i}, y_{2i}), $P_{i,y_{1i},y_{2i}}$, is expressed as:

$$P_{i,2,1} = \Phi_2\left(-\left(\mu_{1,2} - \boldsymbol{\beta}_1'\mathbf{x}_{1i}\right), -\left(\mu_{2,1} - \boldsymbol{\beta}_2'\mathbf{x}_{2i}\right), \rho\right)$$

$$P_{i,2,0} = \Phi_2\left(-\left(\mu_{1,2} - \boldsymbol{\beta}_1'\mathbf{x}_{1i}\right), \mu_{2,1} - \boldsymbol{\beta}_2'\mathbf{x}_{2i}, -\rho\right)$$

$$P_{i,1,1} = \Phi_2\left(-\left(\mu_{1,1} - \boldsymbol{\beta}_1'\mathbf{x}_{1i}\right), -\left(\mu_{2,1} - \boldsymbol{\beta}_2'\mathbf{x}_{2i}\right), \rho\right) - P_{i,2,1}$$

$$P_{i,1,0} = \Phi_2\left(-\left(\mu_{1,1} - \boldsymbol{\beta}_1'\mathbf{x}_{1i}\right), \mu_{2,1} - \boldsymbol{\beta}_2'\mathbf{x}_{2i}, -\rho\right) - P_{i,2,0}$$

$$P_{i,0,\varphi} = \Phi_1\left(\mu_{1,1} - \boldsymbol{\beta}_1'\mathbf{x}_{1i}\right)$$

where, $\Phi_1(\cdot)$ and $\Phi_2(\cdot,\cdot,\rho)$ are the cumulative distribution function of the standard univariate normal and standard bivariate normal distributions, respectively.

The parameters are obtained by maximizing the log-likelihood function:

$$L = \sum_i \sum_{(y_{1i},y_{2i})} \delta_{i,y_{1i},y_{2i}} \, ln\left(P_{i,y_{1i},y_{2i}}\right)$$

where, $\delta_{i,y_{1i},y_{2i}} = 1$ if the i replies (y_{1i}, y_{2i}) and 0 otherwise.

The parameters to be estimated are $\boldsymbol{\beta}_1$, $\boldsymbol{\beta}_2$, γ, ρ, $\mu_{1,2}$, $\mu_{1,1}$, and $\mu_{2,1}$. Note that $\mu_{1,0} = \mu_{2,0} = -\infty$ and $\mu_{1,3} = \mu_{2,2} = \infty$.

8.2. Results

Table 1 presents the variables that are included in the models. The bivariate ordered probit (BOP) and univariate ordered probit (UOP) models are estimated for all 13 items (*a–m*), and estimates are presented in Appendix Table A1. The likelihood ratio test is performed between the BOP and UOP models. The tests find that the BOP models outperformed the corresponding UOP models in a (daily shopping), c (casual outings), h (trust between residents), and i (good townscape), while the UOP models are superior in the other nine items.

Fig. 12 is a graphical presentation of estimates extracted from Table A1. For items in which the UOP models are superior, only UOP models are presented, while for items in which BOP models are superior, both BOP and UOP models are presented for the purpose of comparison. Parameters estimated with $p < .05$ level are shaded in black with "+" notation for positive estimates and shaded in grey and "-" notation for negative estimates. Variables not included are crossed out.

The BOP and UOP estimates are compared for a (daily shopping), c (casual outings), h (trust between residents), and i (good townscape). Correlations in error terms are estimated negatively. The parameters of *Expectation* differ significantly between the BOP and UOP models. They are more positive in BOP models than in UOP models. They are insignificant in UOP, and positive and $p < .05$ in BOP for a (daily shopping) and c (casual outings), negative and $p < .05$ in UOP and positive and $p < .05$ in BOP for h (trust between residents), and negative and $p < .05$ in UOP and insignificant in BOP for i (good townscape). Ignoring the correlation in the error terms results in biased estimates for *Expectation*. This is in line with the simulation study by Filippini et al. (2018).

The parameters for *Expectation* are significantly negative in eleven of the thirteen UOP models. This generally supports the expectation-disconfirmation theory. However, it should be noted that respondents with higher expectations are more satisfied with the service in three BOP models, two of which closely relate to the roles of transportation (items a and c). If the interpretation in Section 8.1 is correct, then the positive parameter suggests that the companies are meeting the transportation expectations of the residents. This might be an indication of desirable relationships between the companies and residents.

The BOP models outperformed the UOP models for four items—a (daily shopping), c (casual outings), h (trust between residents), and i (good townscape)—while UOP models outperformed the BOP models for the remaining nine items. The four BOP and the nine UOP models are interpreted. Parameters of *Intention* are estimated positively and significantly in all four BOP models, as well as in four UOP models. Those having chosen a place of residence due to public transportation convenience (positive Intention) expect more of the railway companies, not only as a means of transportation, but also in other roles, such as b (childcare), f (events encouraging outings), g (health-promoting events),

Table 1
Definition of variables.

Variables	Definition
Intention	1 if one of reasons of choosing resident is easy access to public transport (e.g. railways and buses); 0 otherwise
Expectation	1 if expect; 0 expect a little or no
Workers	1 if worker; 0 otherwise
Students	1 if student; 0 otherwise
Males	1 if male; 0 otherwise
Younger	1 if 30 years old or younger; 0 otherwise
Middle aged	1 if 31 years old or older *and* 60 years old or younger; 0 otherwise
Frequent users	1 if railway use is 5+ days/week; 0 otherwise
House owners	1 if owning house; 0 otherwise
Car owners	1 if owning 1+ cars; 0 otherwise
Single dwellers	1 if living alone; 0 otherwise
Urban residents	1 if living in city centres of Tokyo, Yokohama, Nagoya, Kyoto, Osaka, and Kobe; 0 otherwise
Rural residents	1 if living in prefectures outside three metropolitan areas, Tokyo, Nagoya, Osaka and their surroundings; 0 otherwise

and l (safety/security).

Furthermore, some interesting results were obtained. *Males* have significantly negative expectations in nine items, while there were no significant parameters in satisfaction except for m (social activities of diverse residents). This supports the results in Section 6 that show that females have higher Expectation DIs than males. *Rural residents* are less likely to have higher expectations, and that younger residents are likely to be satisfied. These results are also consistent with the results in Section 6. It is also notable that *Workers* are less likely to be satisfied with some of the roles, including transportation. In addition, *Frequent users* have no significant effect on expectations. In satisfaction, there are three items of thirteen, with which *frequent users* are more satisfied. The levels of expectations and satisfaction towards railway companies of non-users are similar to those of users in many items.

9. Concluding remarks

This study conducted a web-based questionnaire survey for residents along railway lines and quantitatively investigated the recent business strategies of railway companies in Japan. First, the degree of influence of the railway companies on the attractiveness of the resident's communities is compared with that of other organisations. Second, expectations and satisfaction are analysed based on the responses to thirteen questionnaire items. As a disaggregated analysis, the study used bivariate ordered probit models as well as univariate ordered models to eliminate possible biases.

As for the influences, residents perceived railway companies to have a greater impact on the attractiveness of their communities than other organisations, such as educational institutions. This perception is stronger in metropolitan areas, where railway networks are densely developed, but regional areas have the same tendency.

In terms of expectations and satisfaction with railway companies, while expectations and satisfaction are high for daily shopping and casual outings as a means of transportation, many respondents were dissatisfied with the railway companies' contributions to creating lively shopping areas and spaces in front of the station and initiating a good townscape, despite high expectations for these items. According to the probit models, while the two BOP models show that the railway companies are meeting the expectations of residents, the UOP models, which show negative relationships between expectations and satisfaction in nine of the questionnaire items, might explain the expectation-disconfirmation theory to a certain extent. This indicates that railway companies have failed to satisfy residents along the line in terms of various issues. By region, the expectations of railway companies are generally greater in metropolitan areas. This is also shown by the negative rural estimates in the probit models. However, it should be noted that even in rural areas, "expect" far exceeded "not expect" in many items. In particular, expectations in supporting social activities of diverse residents are higher than the average. This indicates that people in a rural area having a car-oriented society expect railways stations to be interchange hubs, where all of the inhabitants, including vulnerable groups, have access.

The probit models also demonstrate four significant relationships between the attributes of the respondents and expectations/satisfaction in the questionnaire items. First, those who chose the current place of residence due to convenient public transportation are likely to have strong expectations of railway companies, not only as transportation means, but also as actors that contribute to communities across a broad range of aspects. Second, workers tend to be dissatisfied with the performance of the railway companies. This is probably because they are fed up with congested commuter trains. Third, females generally have higher expectations than males, although no item satisfy females significantly. This indicates that railway companies should make more effort to meet their expectations. Fourth, whether or not residents are

	a. daily shopping				b. childcare		c. casual outings				d. socialising place		e. lively environment near station		f. events encouraging outings	
	BOP		UOP		UOP		BOP		UOP		UOP		UOP		UOP	
	Exp	Sat	Exp	Sat	Exp	Sat	Exp	Sat	Exp	Sat	Exp	Sat	Exp	Sat	Exp	Sat
Intention	+		+		+		+		+						+	
Expectation		+				-		+				-		-		-
Workers		-		-						-		-				-
Students					+						+		+			
Males	-		-	-	-		-		-		-		-			
Younger								+			-	+				+
Middle aged					-		-		-		-	+				+
Frequent users				+		+		+		+						
House owners																
Car owners					+						+					
Single dwellers												+				
Urban residents						+								+		
Rural residents	-		-	-	-		-		-							-
Correlation	-						-									
n	958		958		958		958		958		958		958		958	
Final LL†	-1333.47		-1336.83		-1473.75		-1270.65		-1275.81		-1489.57		-1443.29		-1497.39	
LR test‡	6.72						10.31									

	g. health-promoting events		h. trust between residents				i. good townscape				j. lifelong learning		k. culture/arts		l. safety/security		m. social activities of diverse residents	
	UOP		BOP		UOP		BOP		UOP		UOP		UOP		UOP		UOP	
	Exp	Sat	Exp	Sat	Exp	Sat	Exp	Sat	Exp	Sat	Exp	Sat	Exp	Sat	Exp	Sat	Exp	Sat
Intention	+		+		+		+		+						+			
Expectation		-		+		-				-		-		-		-		-
Workers								-								-		-
Students			+		+						+	-	+		+		+	
Males											-		-		-		-	+
Younger								+		+		+		+				
Middle aged								+										
Frequent users																+		
House owners														+				
Car owners	+	-									+							
Single dwellers									+									
Urban residents																		
Rural residents							-		-	-								
Correlation			-				-											
n	958		958		958		958		958		958		958		958		958	
Final LL†	-1471.26		-1449.76		-1452.66		-1437.32		-1439.27		-1474.86		-1485.92		-1452.96		-1478.67	
LR test‡			5.79				3.90											

Note: Exp and Sat are the propensity function for Expectation and Satisfaction, respectively. The parameters are estimated with statistical significance in cells marked with black and "+" notation (positive and $p<.05$) and grey and "-" notation (negative and $p<.05$). Variables not included are crossed out.

†: Final log-likelihood.

‡: Likelihood ratio test against zero correlation. Critical chi-squared value is 3.84 at a 5% level of significance.

Fig. 12. Extracted estimates for BOP and UOP models.

frequent train users is not necessarily a significant factor in having expectations. In other words, residents along railway lines could evaluate option values and/or non-user values regarding railways.

Expectations and satisfaction towards railway companies depend on the environment and geographical conditions and vary even among stations within the same company. As a whole, railway companies in metropolitan areas, which have historically expanded their businesses using the TOD strategy, still successfully meet expectations as a convenient means of transportation. However, in spite of expectations, there is significant dissatisfaction with their actual activities in fields other than transportation. There are gaps between expectations and satisfaction, especially in regional areas and between genders.

In recent years, railway companies in Japan have been trying to widen their business fields. However, our analysis shows that their activities are not satisfying the expectations of the residents along the lines. Therefore, the railway companies should become involved in fields other than transportation and use their assets in cooperation with communities and municipalities. For example, railway stations and the spaces under viaducts may be utilised for nursery care facilities, adult schools, libraries, and community museums. These facilities could be "third places" in communities. Some of these facilities are related to welfare policy of municipalities, but if private railway companies and municipalities work together to make these areas more attractive and enhance the brand value of the areas, then more people will choose to reside along the railway lines, thereby contributing to the long-term profits of the railway companies. Such an effective use of railway stations and other facilities could be applicable to transit-oriented development (TOD) in other countries. While TOD strategies have been based on population growth and continuous urbanisation, revising them to widen their scope to improve the quality of life and the communities along their lines will benefit both companies and communities.

Credit author statement

Kiyohito Utsunomiya: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition; **Nobuhiro Sanko**: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization, Funding acquisition; **Chikako Keumi**: Conceptualization, Methodology, Writing – original draft, Writing – review & editing

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix

Table A1
BOP and UOP estimates.

	a. daily shopping		b. childcare		c. casual outings		d. socialising place		e. lively environment near station		f. events encouraging outings	
	BOP	UOP	BOP	UOP	BOP	UOP	BOP	UOP	BOP	UOP	BOP	UOP
Expectation												
Intention	0.309**	0.231**	0.164**	0.186**	0.450**	0.378**	0.096	0.031	0.181**	0.133	0.188**	0.177**
Workers	0.016	-0.015	0.208	0.213	0.131	0.105	0.203	0.202	0.258**	0.238*	0.003	-0.011
Students	-0.007	-0.025	0.452**	0.458**	0.319	0.309	0.491**	0.485**	0.424**	0.423**	0.287	0.274
Males	-0.224**	-0.236**	-0.274**	-0.271**	-0.315**	-0.317**	-0.299**	-0.287**	-0.207**	-0.219**	-0.027	-0.022
Younger	0.219	0.197	-0.262	-0.271	-0.293	-0.306	-0.483**	-0.472**	-0.083	-0.075	0.039	0.045
Middle aged	-0.088	-0.074	-0.317**	-0.309**	-0.443**	-0.449**	-0.559**	-0.555**	-0.119	-0.112	-0.030	-0.019
Frequent users	0.149	0.179*	0.017	0.009	-0.050	-0.037	-0.045	-0.052	0.044	0.053	-0.031	-0.023
House owners	-0.057	-0.066	-0.087	-0.083	-0.089	-0.086	-0.086	-0.071	-0.069	-0.062	-0.118	-0.120
Car owners	0.043	0.047	0.284**	0.297**	0.086	0.083	0.231**	0.222**	0.017	0.019	0.185**	0.177*
Single dwellers	0.050	0.075	-0.127	-0.117	0.140	0.157	0.132	0.136	0.015	0.020	0.032	0.035
Urban residents	-0.017	-0.005	-0.059	-0.043	0.001	-0.010	0.147	0.163	0.030	0.031	0.076	0.080
Rural residents	-0.454**	-0.476**	-0.218*	-0.232**	-0.352**	-0.406**	-0.174	-0.193	-0.180	-0.201*	-0.064	-0.059
mu_1,1 (threshold)	-1.470**	-1.518**	-0.972**	-0.942**	-2.109**	-2.168**	-1.226**	-1.242**	-1.307**	-1.337**	-0.786**	-0.790**
mu_1,2 (threshold)	-0.305	-0.360*	0.135	0.165	-0.748**	-0.820**	-0.073	-0.091	-0.079	-0.111	0.338*	0.333*
Satisfaction												
Expectation	0.974**	-0.017	0.688**	-0.507**	0.923**	-0.087	0.887**	-0.303**	0.816**	-0.200**	0.475	-0.550**
Workers	-0.337**	-0.434**	-0.258*	-0.207	-0.278*	-0.303**	-0.347**	-0.343**	-0.172	-0.065	-0.293*	-0.404**
Students	-0.053	-0.120	-0.197	0.061	-0.294	-0.246	-0.569**	-0.407*	-0.198	0.008	-0.284	-0.220
Males	-0.108	-0.244**	0.240**	0.106	0.023	-0.107	0.263**	0.108	0.047	-0.082	0.006	-0.007
Younger	0.041	0.132	0.414**	0.336	0.432**	0.336	0.674**	0.556**	0.305	0.313	0.416*	0.566**
Middle aged	-0.024	-0.073	0.271*	0.093	0.140	-0.040	0.590**	0.327**	0.020	-0.058	0.349**	0.442**
Frequent users	0.109	0.248**	0.145	0.257**	0.271**	0.327**	0.130	0.157	0.053	0.111	0.078	0.100
House owners	-0.133	-0.196*	0.027	-0.053	-0.018	-0.070	0.091	0.074	-0.073	-0.134	0.097	0.033
Car owners	-0.048	-0.050	-0.196*	-0.013	0.038	0.066	-0.078	0.110	-0.060	-0.075	-0.192*	-0.135
Single dwellers	-0.165	-0.153	0.260**	0.284*	-0.020	0.048	0.102	0.313**	0.066	0.108	0.094	0.151
Urban residents	0.100	0.126	0.230*	0.316**	0.121	0.148	0.026	0.206*	0.218*	0.299**	-0.017	0.046
Rural residents	0.024	-0.293**	0.129	-0.068	0.129	-0.085	0.036	-0.169	-0.048	-0.219	-0.239	-0.382**
mu_2,1 (threshold)	-0.215	-1.043**	0.232	-0.229	0.426	-0.530**	0.529**	0.011	0.385	-0.161	0.001	-0.308
Correlation												
Correlation	-0.696		-0.837		-0.665		-0.873		-0.723		-0.723	
n	958	958	958	958	958	958	958	958	958	958	958	958
Final LL†	-1333.47	-1336.83	-1472.25	-1473.75	-1270.65	-1275.81	-1488.55	-1489.57	-1442.04	-1443.29	-1495.87	-1497.39
LR test‡	6.72		3.00		10.31		2.04		2.50		3.03	

	g. health-promoting events		h. trust between residents		i. good townscape		j. lifelong learning		k. culture/arts		l. safety/security		m. social activities of diverse residents	
	BOP	UOP	BOP	UOP	BOP	UOP	BOP	UOP	BOP	UOP	BOP	UOP	BOP	UOP
Expectation														
Intention	0.171**	0.172**	0.171**	0.172**	0.370**	0.366**	0.115	0.101	0.155**	0.153*	0.203**	0.174**	0.090	0.062
Workers	-0.003	-0.012	-0.091	-0.091	0.163	0.167	0.020	0.022	0.054	0.050	0.015	0.017	0.108	0.099
Students	0.315*	0.304*	0.396**	0.400**	0.348*	0.355*	0.557**	0.557**	0.388**	0.384**	0.385**	0.385**	0.522**	0.517**
Males	-0.069	-0.070	-0.042	-0.041	-0.091	-0.098	-0.264**	-0.263**	-0.263**	-0.264**	-0.298**	-0.300**	-0.187**	-0.188**
Younger	-0.198	-0.189	-0.252	-0.246	-0.121	-0.121	-0.174	-0.170	-0.180	-0.176	-0.112	-0.104	-0.147	-0.139
Middle aged	-0.184	-0.176	-0.202	-0.203	-0.261*	-0.261*	-0.180	-0.178	-0.194	-0.191	-0.232*	-0.230*	-0.161	-0.157
Frequent users	-0.034	-0.032	-0.019	-0.021	0.022	0.024	-0.004	-0.008	-0.047	-0.045	0.014	0.005	-0.057	-0.063
House owners	-0.129	-0.128	0.033	0.029	0.179*	0.178*	-0.010	-0.008	-0.084	-0.081	-0.059	-0.050	-0.079	-0.082
Car owners	0.264**	0.260**	0.175*	0.169*	0.025	0.029	0.263**	0.263**	0.164*	0.162*	0.094	0.090	0.177*	0.178*
Single dwellers	0.082	0.079	0.015	0.011	0.221*	0.236**	0.088	0.093	0.109	0.111	0.132	0.146	0.174*	0.188*
Urban residents	0.085	0.083	0.053	0.046	-0.011	-0.006	0.002	0.002	0.034	0.034	0.081	0.089	0.019	0.010
Rural residents	-0.008	-0.002	0.060	0.071	-0.246**	-0.241**	-0.117	-0.124	-0.094	-0.095	-0.101	-0.117	0.102	0.090
mu_1,1 (threshold)	-0.591**	-0.593**	-0.538**	-0.543**	-1.090**	-1.085**	-0.753**	-0.756**	-1.128**	-1.128**	-1.349**	-1.359**	-0.753**	-0.773**
mu_1,2 (threshold)	0.599**	0.597**	0.630**	0.622**	0.214	0.219	0.445**	0.441**	0.105	0.105	-0.100	-0.113	0.442**	0.419**
Satisfaction														
Expectation	0.167	-0.531**	0.753**	-0.556**	0.277	-0.561**	0.130	-0.515**	-0.380	-0.623**	0.323	-0.550**	0.685	-0.639**
Workers	-0.282	-0.340*	-0.060	-0.258	-0.304**	-0.286*	-0.288	-0.312*	-0.317*	-0.316*	-0.447**	-0.527**	-0.267	-0.346**
Students	-0.221	-0.134	-0.342*	-0.142	-0.188	-0.110	-0.713**	-0.573**	-0.377	-0.336	-0.284	-0.184	-0.373*	-0.053
Males	0.092	0.074	0.025	-0.002	0.073	0.044	0.159	0.062	-0.073	-0.111	0.134	0.006	0.279**	0.238**
Younger	0.414*	0.371	0.310*	0.182	0.627**	0.635**	0.535**	0.517**	0.483**	0.461**	0.337	0.329	0.312	0.349
Middle aged	0.293*	0.242	0.239*	0.130	0.376**	0.299*	0.109	0.037	0.128	0.101	0.168	0.067	0.267*	0.249
Frequent users	0.116	0.129	0.038	0.064	-0.044	-0.017	0.062	0.069	0.085	0.082	0.194*	0.239**	0.085	0.080
House owners	0.272**	0.243*	0.114	0.239*	-0.087	-0.028	0.134	0.144	0.302**	0.293**	0.040	0.019	0.161	0.173
Car owners	-0.330**	-0.255**	-0.169*	-0.101	0.006	0.003	-0.210	-0.124	-0.128	-0.108	-0.114	-0.099	-0.258**	-0.229*
Single dwellers	-0.087	-0.057	0.088	0.187	0.014	0.127	0.065	0.115	0.221	0.239*	-0.243*	-0.205	-0.142	-0.009
Urban residents	-0.083	-0.050	-0.025	0.037	-0.088	-0.091	0.205	0.231*	0.174	0.182	0.154	0.229*	0.126	0.232*
Rural residents	-0.084	-0.108	-0.153	-0.218	-0.145	-0.310**	-0.205	-0.289*	-0.132	-0.151	0.035	-0.038	-0.122	-0.101
mu_2,1 (threshold)	-0.141	-0.218	-0.141	-0.394*	0.023	-0.360*	-0.276	-0.415*	-0.308	-0.408*	-0.175	-0.713**	0.057	-0.220
Correlation														
Correlation	-0.529		-0.918		-0.566		-0.481		-0.184		-0.597		-0.890	
n	958	958	958	958	958	958	958	958	958	958	958	958	958	958
Final LL†	-1470.82	-1471.26	-1449.76	-1452.66	-1437.32	-1439.27	-1474.72	-1474.86	-1485.87	-1485.92	-1452.18	-1452.96	-1478.49	-1478.67
LR test‡	0.87		5.79		3.90		0.27		0.10		1.56		0.36	

†: Final log-likelihood.

‡: Likelihood ratio test against zero correlation. Critical chi-squared value is 3.84 at a 5% level of significance.

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