Proceedings of the Sixth International Conference on
Railway Technology: Research, Development and Maintenance
Edited by: J. Pombo
Civil-Comp Conferences, Volume 7, Paper 27.1
Civil-Comp Press, Edinburgh, United Kingdom, 2024
ISSN: 2753-3239, doi: 10.4203/ccc.7.27.1

The Contribution of Town Functions and Services to Station Congestion Levelling

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Abstract

Stations close to large event venues can become overcrowded and dangerous due to the concentration of users after the event. We considered that encouraging users to change their behaviour voluntarily and staggering the hours of use of stations individually would lead to station congestion levelling and the avoidance of dangerous conditions. In this study, the users who came to the events were first typified by cluster analysis and then personas were clarified. In addition, focusing on the behaviour and insights of each person, a human-centred design process was used to derive and evaluate service proposals that are appropriate for each persona and can encourage behaviour change.

Keywords: user surveys, congestion levelling, behaviour change, factor analysis, cluster analysis, human-centred design, crowd control

1 Introduction

In rail operations, the occurrence of heavy congestion at stations and on trains not only reduces user satisfaction, but also creates dangerous conditions that can lead to accidents such as crowd avalanches and users falling off platforms. Congestion is the norm at major stations in Tokyo. Stations close to venues where concerts or sports matches with audiences in the tens of thousands are held in particular become very crowded after the event. This is because large numbers of users crowd into stations in a short space of time to go home. One possible way to keep the number of people staying at the station to an appropriate size is to restrict entry at the turnstiles.

However, the risk of crowd avalanche remains, as users stay in the streets and squares around the stations. However, this is not a desirable method, as users stay on the roads and squares around the station, which may pose risks such as crowd avalanches, and frustration at not being able to enter the station may cause other problems. On the other hand, we considered that an approach that encourages users themselves to undertake a variety of spontaneous activities after the event, rather than going directly home, would result in a dispersal of the timing of their arrival at the station, and would rather level congestion while improving satisfaction levels.

Therefore, the following initiatives were implemented in this study with the aim of reducing station congestion caused by users returning home en masse after the event.

(1) Understanding the background of users coming to events and analysing psychological factors

We conducted user surveys to understand the behavioural characteristics of users coming to events and to identify psychological factors that could drive behaviour change. We also carried out a cluster analysis of users to clarify the persona image of each cluster and to understand the cluster occurrence rate.

(2) Design of service ideas

We derived a service idea that works on persona behaviour factors and decentralises congestion. In addition, we created a customer journey for our service idea.

(3) User evaluation

We used interviews to brush up on the service idea and customer journey, and questionnaires to conduct a quantitative assessment of acceptability.

In the Methods section of the next chapter, specific details of the initiatives and results are described for (1) and (2) above. In addition, the results of the interview survey and brush-up points of the service idea and customer journey in (3) are described in Chapter 3, Results. Finally, the user's behaviour change potential is described in Conclusions and Contributions.

2 Methods

2.1 Understanding the background of users coming to events and analysing psychological factors

We have implemented the following initiatives using the Human-Centred Design methodology to create service ideas and customer journeys that achieve behavioural change for users.

(i) Research on previous studies and previous cases
(ii) Quantitative research using web questionnaires
(iii) Identification of factors that influence users to change their behaviour and analysis of personas image.

Each of these is described in more detail below.

2.1.1 Research on previous studies and previous cases

Prior research and earlier cases in Japan include the congestion visualisation application service in references [1], which is designed to relieve the stress of not being able to check congestion within leisure facilities without going to the site. The second was a case study in references [2], such as a PoC to encourage the use of commercial facilities around large-scale event venues to promote consumption within the region by event visitors. However, there is no example of a human-centred design to construct a tour promotion measure with the aim of shifting the timing of arrivals around a railway station. In addition, although an analysis was conducted in references [3] that the reduction of fatigue due to the placement of appropriate rest areas contributes to the promotion of circulation in the design of commercial facilities, there are no examples of service designs that consider the psychological characteristics of different user typologies and the timing of their arrival at the station.

Based on this, the study first hypothesised psychological factors influencing behavioural change in promoting city circulation and avoiding congestion among rail users who attended the event. The hypothesised psychological factors are listed below in Table 1.

Category	Description of the psychological factors hypothesis
Perspectives on information gathering	Degree to which they think they are good at reaching the right information
	Degree to which they think they have information on which they can make decisions.
	Degree to which the timing of the presentation of information is perceived as appropriate.
Perspectives on fatigue	Degree of susceptibility to physical and mental fatigue.
	Degree to which outgoing behaviour is affected by fatigue .
Perspectives on tolerance to congestion	Degree to which congestion information is used to transform behaviour on a regular basis.
	Degree to they feel that the timing of the presentation of congestion information is appropriate.
	Degree to which congestion avoidance is reasonably integrated into planning.
Perspectives on planning	Degree to which rest periods, rest areas, etc. are built into the plan in anticipation of exhaustion.
	Degree of planning with concern for the impact of fatigue on their own plans for the following day and beyond.
	Degree of ability to act as planned on the day
	Degree of flexibility on the day to find places to go.
Perspectives on hobbies and preferences	Degree to which they engage in circular activities to enjoy their favourite content.
Perspectives on the eventfulness of outings	Degree to which they would like to preserve memories related to the event.

Table 1: List of psychological factors hypothesised

2.1.2 Quantitative research using web questionnaires

Based on the hypothesis of psychological factors, we conducted a web-based survey to 'quantitatively understand the proportion of users by behaviour before and after event participation', 'identify important psychological factors' and 'derive a target persona image'.

Users returning home en masse from an event, which is the focus of this study, have diverse attributes and environments, including their place of residence and whether or not they have a reason to hurry home. In some cases, depending on the circumstances of the urgency to return home, it may be difficult to encourage behaviour change. Therefore, We targeted users with the exception of 'users who have circumstances that require them to be home by a specific time' and conducted a questionnaire survey. The questionnaire was conducted between 9 and 19 June 2023, which may have affected the responses as it was immediately after the end of the pandemic.

7,000 samples were collected in the screening and 1,000 in the main survey. The screening distribution conditions were 20s-50s with equal gender-age allocation. Users who attended the event were also typed according to the time required from their place of residence to the event venue and whether they undertook any circular activities on their way home from the event. We also identified value differences for three types of passengers: users who live close by and engage in circular activities, users who live further away and engage in circular activities, and passengers who do not engage in circular activities. First, the main results on what actions are taken before and after participation in the event are presented.

- The number of users who attended events in the past year was 2,550 out of a screened sample of 7,000.
- Of these 2,550 users, nearly 40% of the users said that they did a circular activity before the event and went home immediately after the event, around 25% said that they did not do a circular activity before the event but after the event, around 14% said that they did a circular action before and after the event, and the rest said that they did not do a circular activity. Many of the users who said they would make a circular activity were also those who said the time required from their home to the event venue was 90 minutes or less by train.
- Many users ate and drank in cafés and restaurants, walked around and went sightseeing in the area, and engaged in shopping activities. On the other hand, there were fewer users of entertainment such as movies and karaoke, beauty and massage service, and work.

2.1.3 Identification of factors that influence users to change their behaviour and analysis of persona image

We conducted a factor analysis of the responses to questions in the questionnaire about psychological factors affecting circular activity behaviour and congestion avoidance and identified 12 psychological factors that are important in promoting behaviour change. We interpreted the implications of each factor by considering the

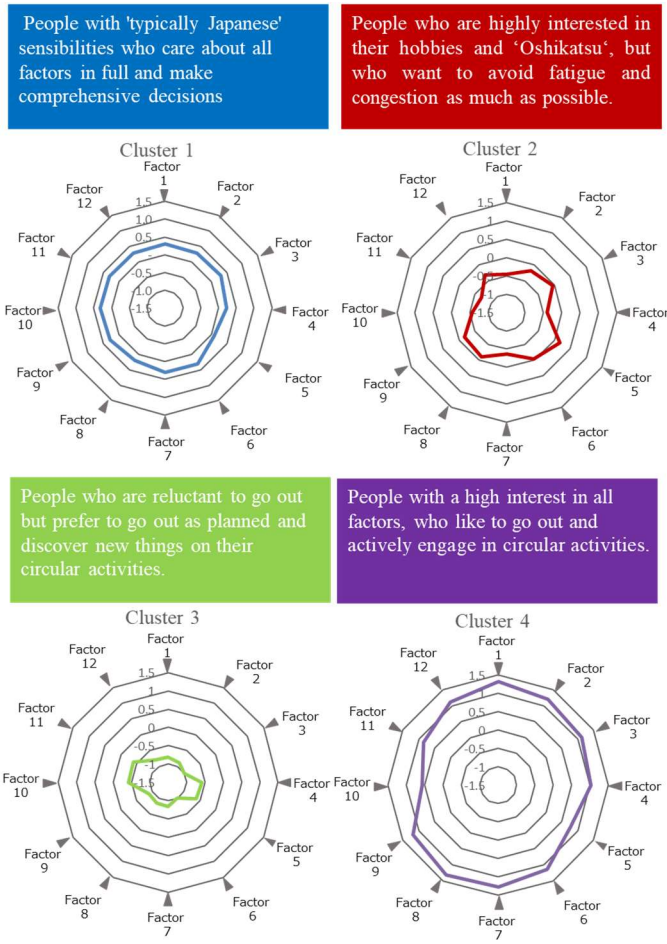
commonality of the content of several questions that are strongly related to each factor and gave each factor the following name. Note that each factor does not represent an objective measure of competence, but rather the user's own subjective response. In addition, 'oshikatsu' in factor 6 represents various forms of support for one's favourite idols, actors and characters, and is a popular activity in Japan. For example, consuming idol, actor or character content is part of 'Oshikatsu'.

Order of factors	Name of psychological factor.
Factor 1	Good information-gathering skills
Factor 2	Importance of memory making
Factor 3	Positive attitude towards circular activities when time is available
Factor 4	Level of confidence in physical fitness
Factor 5	Positivity to congestion-avoidance behaviour
Factor 6	Positive attitude to hobbies and ‘Oshikatsu’
Factor 7	Positivity towards measures to avoid fatigue
Factor 8	Resourcefulness on the day
Factor 9	Importance of time spent with companion
Factor 10	Prefer new discoveries during circular activity
Factor 11	Good planning skills
Factor 12	Not worrying about spending money

Table 2: 12 factors extracted from factor analysis.

We then performed a cluster analysis using the k-means method, classifying the users who responded to the questionnaire into four clusters based on their responses to the factors. Based on the trends in the mean factor scores for each of the four clusters classified, we interpreted the typical personality profile in each cluster as follows.

- Cluster 1: People with 'typically Japanese' sensibilities who care about all factors in full and make comprehensive decisions.
- Cluster 2: People who are highly interested in their hobbies and 'Oshikatsu', and who do things such as circular activities with a companion, but who want to avoid fatigue and congestion as much as possible.
- Cluster 3: People who are reluctant to go out, but prefer to go out as planned and discover new things on their circular activities.
- Cluster 4: People with a high interest in all factors, who like to go out and actively engage in circular activities.



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Factor 11	Good planning skills
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Figure 1: 12 Interpretation of the typical personality profile of each cluster

Confirming the differences between the clusters, cluster 4 has higher scores on all factors, showing that they enjoy going out and actively engage in circular activities. Cluster 3, on the other hand, appears reluctant, with small scores for all factors. Among the 12 factors, Cluster 2 has a higher score to ' Positive attitude towards circular activities when time is available', ' Positivity to congestion-avoidance behaviour', 'Positive attitude to hobbies and 'Oshikatsu'' and 'resourcefulness on the day'. Cluster 1 has an average score for each factor compared to the other clusters and appears to enjoy going out while making rational decisions.

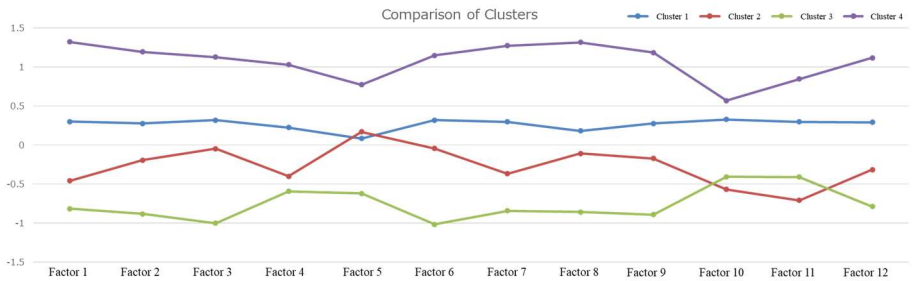

Figure 2: Comparison of clusters

The ratio of the number of people classified in each cluster is shown in Figure 3. It was found that Cluster 1 was particularly prevalent at 40%, followed by Cluster 3, Cluster 2 and Cluster 4.

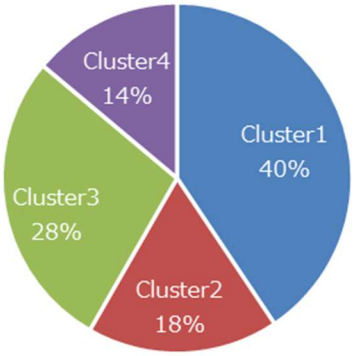

Figure 3: Percentage of people in each cluster

We defined the four clusters we were able to extract as user personas and used them to create hypotheses for service ideas and draft customer journeys.

2.2 Design of service ideas

We conducted a workshop-style ideation to generate service ideas using the results of our previous research. We designed multiple service ideas to drive behaviour change for each persona, which were then incorporated into the customer journey and brought together as a single suite of services. Of the four personas, cluster 4 is considered to voluntarily perform circular activities and congestion avoidance behaviour, so service ideas were generated for clusters 1, 2 and 3 in this study.

In the interview survey conducted after the service idea and customer journey design, users who fit each persona were asked to rate how they felt about this customer journey (do they want this service, are they likely to be satisfied, are they dissatisfied, etc.). The service ideas and customer journeys for each of clusters 1, 2 and 3 are outlined below.

- Service ideas to promote behaviour change in Cluster 1 ('Service idea A')

Overview:
This service is an application that selects an event you want to visit and suggests a chain of related recommended spots and other information and a circular activities plan. Cluster 1 has a typical Japanese mindset and makes comprehensive decisions, paying attention to various factors. They also have interests that lead to circular activities. However, they may not be able to choose and act if they have too many options.

We therefore create this service idea, which provides users with congestion information and then suggests the best circular activities to suit their preferences. The app was structured in such a way that users' circular activities with the app are

consequently actions that avoid congestion. There is also a function that records and learns from users' outing logs and evaluations of app suggestions to optimise suggestions for the next time onwards. In addition, the service allows users to discover their own interests when they come to a city, they have visited more than once, for example by visualising the differences from their previous visit experience.

Functions included in this service:
1. A function to suggest places to visit in the vicinity.
2. Ability for the app to learn about your purchasing and circular activities preferences.
3. A function to records where you have stopped.
4. A function that suggests ways to avoid congestion.
5. A function that suggests shopping and other services that suit your tastes after you have gone out.

- Service ideas to promote behaviour change in Cluster 2('Service idea B')

Overview:
This service is designed to turn the entire city into linked content in accordance with the timing of idol and artist gigs and other events. For example, special menus at restaurants, drop-in spots and other relevant content can be experienced throughout the city. Cluster 2 has a higher score on the factor of Positivity to congestion-avoidance behaviour and on the factor of Positive attitude to hobbies and 'Oshikatsu'.

We therefore created a service idea in which multiple contents are prepared throughout the city to meet the preferences of each user, and each user is free to select these contents and perform a variety of circular activities after the live show, resulting in a dispersed arrival timing at the station for each user. The service idea also incorporates a function that makes users feel as if new spots are appearing one after another by gradually releasing and distributing information on related spots.

Functions included in this service:
1. Event-related spots to be located throughout the city.
2. A function where information on event-related spots is gradually unlocked and new spots appear one after another.
3. A function to naturally avoid congestion while touring around event-related spots.

- Service ideas to promote behaviour change in Cluster 3('Service idea C')

Overview:
This service is an application that includes a digital album function, a function that allows users to book, pay for and use events, and a function that allows users to book, pay for and use facilities around the venue. Cluster 3 is considered to be a personality profile that is reluctant to go out and dislikes the hassle but prefers to discover new things during a circular activity.

For this reason, we have structured this service idea to minimise the hassle, so that a single app can be used to book, pay for and use various facilities and create memories. In addition, tickets are issued via QR codes, and related activities around the venue, restaurant reservations and take-out payments are also configured to be completed

within the same app. It also includes functions to stimulate 'oshikatsu', such as the distribution of coupons that can be used at facilities around the venue and participation in a digital stamp rally. The service also has a function to suggest circular activities, and automatically generates albums using photos taken with the in-app camera to help create memories.

Functions included in this service:

1. A function to book event tickets, restaurants, and nearby facilities with a single app
2. A function that allows you to select a spot you want to visit in the app and the app will automatically suggest a route around that spot.
3. Digital album function for easy shooting and image registration.
4. A function to suggest spot tours taking into account the characteristics of the destination and the event.
5. A common ticket function that allows event tickets, tickets for nearby facilities and coupons to be used.

3 Results

3.1 user evaluation

We have implemented the following initiatives to improve each of the service ideas we created.

(i) Conducting and analysing user interviews.
(ii) Brush up on service ideas.

First, we interviewed 30 users about the customer journey we had created, analysing their willingness to use the service idea and areas for improvement. We then brushed up our service idea based on the improvements we had identified from our analysis of the interviews.

3.1.1 Conducting and analysing user interviews

We interviewed 30 users who fit the personas targeted in this study to ascertain their willingness to use each service idea. At the beginning of the interview, we explained the service idea and customer journey we had created to the users. The users were then asked to indicate whether they felt the service was worthwhile, whether they would use it and whether they were dissatisfied with it, based on their own experiences and sensitivities.

The results showed that there was a high willingness to use the service ideas A and B, with more than 70% of the respondents responding positively to service ideas A and B, such as 'I will use it' and 'I will use it somewhat'. In addition, the results also showed that nearly 70% of respondents were willing to use service idea C.

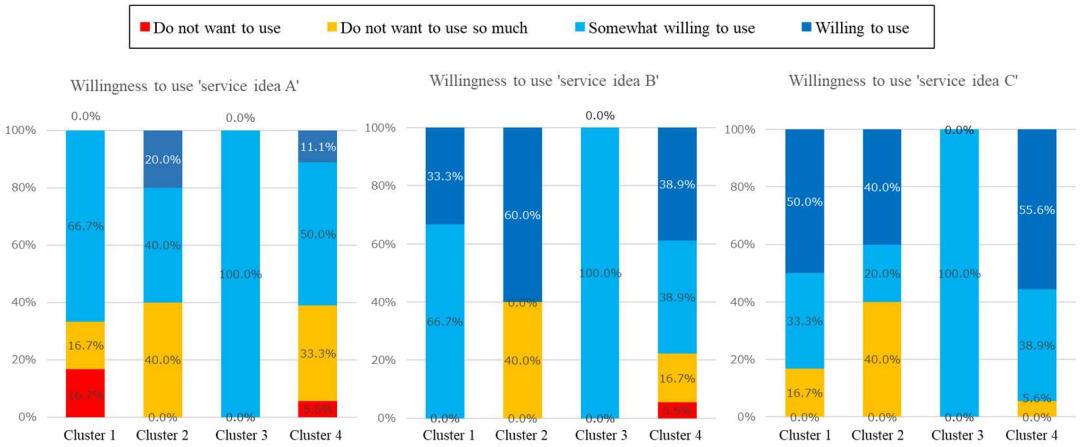

Figure 4: Willingness to use each service by cluster

Next, the following information was obtained on the main areas of dissatisfaction and improvement for each service.

- Service idea A;
  Users said they did not like the idea of having so many notifications on their smartphones.
- Service idea B:
  Users said that the gradual release of content information was difficult to schedules.
- Service idea C:
  A user said, "The application contains too many functions, so it is difficult to grasp the overall picture of the functions. It would be good if the functions could be switched on and off depending on the user".

3.1.2 Brush up on service ideas

We brushed up the service idea and customer journey based on the improvements identified from the analysis of the interviews. As there was a high level of willingness to use all service ideas, the structure and concept of each function was not changed, but improvements were reflected in the detailed functional requirements and touch points in the customer journey. Below are the areas of improvement for each service idea.

- Service idea A
  We modified the content of service idea A to provide various suggestions when users voluntarily use the app for information. The customer journey then reflected the idea of refraining from offering suggestions via notifications to smartphones.

- Service idea B:
  We changed the customer journey for service idea B from a design where information on city content is released gradually to a customer journey where information provision is completed by the previous day.
- Service idea C:
  We changed the customer journey for service idea C to allow users to select the functions they want to use from a menu, which they can turn on and off themselves.

4 Conclusions and Contributions

We conducted a quantitative survey of each of the brushed-up service ideas via a web-based questionnaire to ascertain willingness to use each service for each of its functions. The reason for carrying out this survey is that it enables an understanding of the priorities of each function.

This survey was conducted with users who fit the four personas and 1,000 people responded. Table 3 below shows the results of the analysis of users' willingness to use each service idea for each function.

	Function	willingness to use Percentage of respondents who 'would like to use' or 'would like to use somewhat'
service idea A	**A function to suggest places to visit in the vicinity**	**77.00%**
	Ability for the app to learn about your purchasing and circular activities preferences	**61.00%**
	A function to records where you have stopped	**65.80%**
	A function that suggests ways to avoid congestion.	**76.00%**
	A function that suggests shopping and other services that suit your tastes after you have gone out.	**42.50%**
service idea B	**Event-related spots to be located throughout the city**	**70.20%**
	A function where information on event-related spots is gradually unlocked and new spots appear one after another.	**55.10%**
	A function to naturally avoid congestion while touring around event-related spots.	**74.10%**
service idea C	**A function to book event tickets, restaurants, and nearby facilities with a single app**	**72.90%**
	A function that allows you to select a spot you want to visit in the app and the app will automatically suggest a route around that spot.	**67.20%**
	Digital album function for easy shooting and image registration.	**49.90%**
	A function to suggest spot tours taking into account the characteristics of the destination and the event.	**67.90%**
	A common ticket function that allows event tickets, tickets for nearby facilities and coupons to be used.	**80.70%**

Table 3: Users' willingness to use each function of each service idea

The results of the analysis show that, in particular, "A common ticket function that allows event tickets, tickets for nearby facilities and coupons to be used", "A function to book event tickets, restaurants, and nearby facilities with a single app", "A function to naturally avoid congestion while touring around event-related spots." and others, with more than 70% of users indicating a willingness to use them. These are functions that can encourage users to undertake circular activities. This study has shown that the development and implementation of these service ideas has the potential to

encourage changes in the return home behaviour of different types of users and contribute to the dispersion of station congestion during events.

In this study, we were able to derive service ideas that take into account the psychological characteristics of each user type through a human-centred design approach. As the survey period was during the recovery period of Corona, it is possible that users' willingness to engage in circular activities during events has now changed even more positively. In the future, we intend to use the findings of this study to further concretise and brush up our service ideas and implement PoC etc. We will then develop the service as we test the effectiveness of this service idea in dispersing congestion.

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