

## A Study of LOS Evaluation Model for Inter-Regional Railway Station

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**Abstract:** Stations, as interface for passengers between urban/region and transport, are one part of railway infrastructure. It is considered quite important to strengthen the function of railway network with stations as cornerstone to maximize the function of these trunk railways.

In this study, we verified the consistency of the evaluation model for LOS of inter-regional railway station, based on the results of the questionnaire survey to close passengers' feelings. As a result, it is confirmed that the result of the previous research almost accords with the passengers' feelings by this study.

*Keywords:* Shinkansen as an Inter-Regional High Speed Railway System,  
LOS value of Shinkansen Stations, AHP (Analytic Hierarchy Process)

### 1. INTRODUCTION

JRJT is the unique governmental agency which has constructed various types of railways in Japan. One of our great missions is to construct Shinkansen high speed rails (hereinafter, Shinkansen). To date, JRJT has completed Shinkansen lines of Joetsu, Kyushu, Tohoku (northern extension), and Hokkaido.

The trunk railway lines including Shinkansen are crucial mass transit system as a part of national land backbone in Japan. Stations, as interface for passengers between urban/region and transport, are one part of railway infrastructure. It is considered quite important to strengthen the function of railway network with stations as cornerstone to maximize the function of these trunk railways. Each Shinkansen station is a transit node representing the regional identity and many of the stations contain a kind of symbolized feature in their architecture.

The government of Japan enacted the Basic Policy Law in Transportation Development in 2013. In this law it calls for mutual collaboration between transit entities even in legal affairs. One of typical examples is improvements of transfer facilities in some stations shown as below:

➤ Shin-Hakodate-Hokuto Station (Hokkaido Shinkansen);

*Transfer at a platform between Shinkansen and conventional line*

➤ Niigata Station (Joetsu Shinkansen);

*Transfer at a platform between Shinkansen and conventional express train as a part of elevation project of conventional line*

➤ Okayama Station (Sanyo Shinkansen);

*Improvement of transfer corridor between Shinkansen and conventional line*

The main mission of this study is to acquire comprehensive insights concerning to the collaboration between Shinkansen Station and local municipalities. In this paper, we focused on the targets to discuss the LOS (Level of Service) Value evaluation model for existing stations and verify the result with actual feelings of passengers by questionnaire survey.

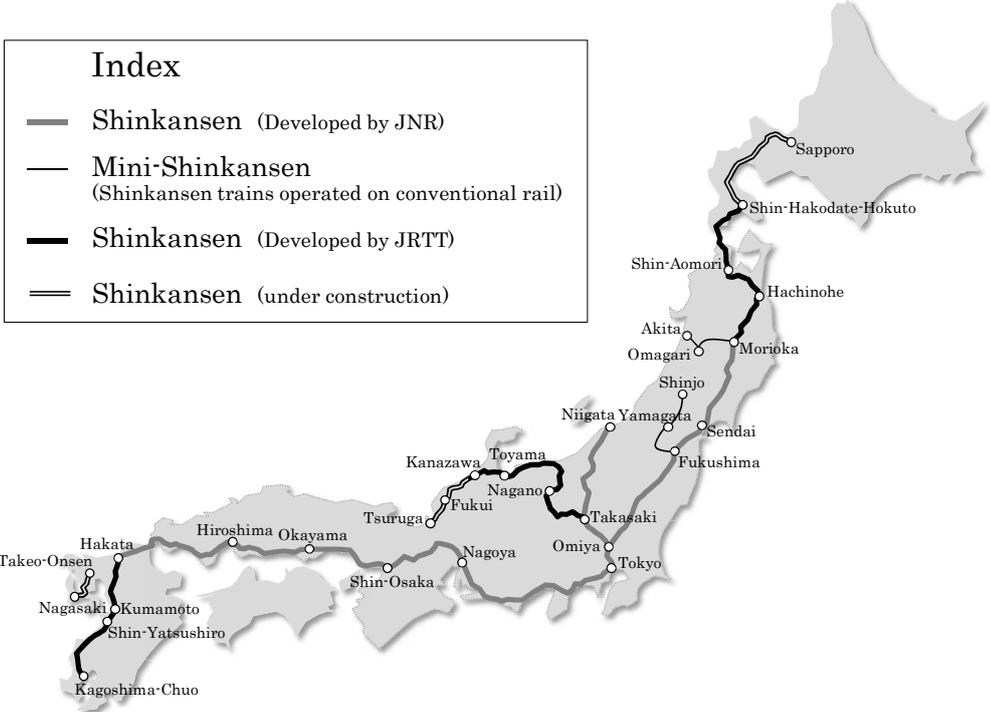


Figure 1. Current Shinkansen Network Map



Figure 2. An Example of Shinkansen Station Exterior (Kanazawa)

## 2. Review & Method

### 2.1 Review

JRJT has developed quantitative evaluation method for transfer and connection at these railway stations to improve quality of the stations. This method is utilized and feedbacked at the actual railway projects.

Concerning to the quantitative evaluation, Uchida *et al.* (2008) evaluated the transfer between Shinkansen and conventional line with AHP (Analytic Hierarchy Process).

Tochigi and Hanyuda, (2013) established a station evaluation model by extending above method by Uchida *et al.* (2008) for the transfer with feeder transit. Additionally, data of transfers were corrected by research at 89 stations.

Saitoh *et al.* (2016) revised the evaluation method by the research at newly opened Shinkansen stations after the study by Tochigi and Hanyuda, (2013).

### 2.2 Tochigi-Hanyuda's Method by AHP

Evaluation model for station users' environment by Tochigi and Hanyuda, (2013) enables quantitative evaluation of station LOS Value about the movement by Shinkansen based on the type of the purpose such as business or pleasure and traffical behavior of the passengers. This model is to evaluate LOS Value in each station based on a score out of 100 points.

LOS Value is calculated as below: Firstly, various elements concerning to the usage of station facility are described as digitalized indexes according to the on-site research at each station. Each index is relatively evaluated through the statistic process and output as five-staged score (Max: 5 min: 1). LOS Value of each station is produced by totaling above each index with multiplication with the 'weight' by AHP. The elements concerning to the usage of station facility are shown in the left side cells of Table 1 (Evaluation Indexes).

Table 1. Evaluation Indexes and Digitalized Importance based on result of Questionnaire

| Evaluation Indexes                                |  |  | Digitalized Importance *                |          |
|---|--|--|---|----------|
| Large Category                                    | Middle Category                          | Small Category   | Buisness                                | Pleasure |
| (ABC) Transfer Convenience                        | Movement for Transfer                    | (A1) Up-Down Movement  | 1.33                                    | 1.44     |
|   |  | (A2) Horizontal Movement   | 1.44                                    | 1.53     |
|   |  | (A3) Transfer Gate and Transfer Ticket                                     | 1.32                                    | 1.45     |
|   | Waiting Space for Transfer               | (B) Comfort in Waiting Space   | 0.96                                    | 1.11     |
|   | A Sense of Ease on Transfer              | (C1) Information on Transfer   | 1.52                                    | 1.58     |
|   |  | (C2) Connection for Transfer (Frequency of Access Transit)                 | 1.62                                    | 1.56     |
|   |  | (C3) Seat Availability of s Transportation Mode to be transferred          | 1.25                                    | 1.25     |
|   |  | (D1) Presense or Absence of Passege Connecting the both sides of a Station | 0.92                                    | 1.11     |
|   | (DE) Condition around Shinkansen Station | Comfort around Station   | (D2) Cultural Value of Station Building | 0.60     |
| Convenience of Commercial Facility around Station | (E1) Variety of Shops                    | 1.13   | 1.31                                    |          |
|   | (E2) Opening Hour of Shops               | 1.05   | 1.19                                    |          |
| (FG) Service Level of Access Transit              | (F) Diversity of Access Transit          | 1.52   | 1.52                                    |          |
|   | (G) Operating Hour of Access Transit     | 1.53   | 1.55                                    |          |

\* Digitalized Importance based on result of Questionnaire

To acquire the 'weight' shown above objectively, it is recommended to conduct research directly on passengers at Shinkansen station by AHP. However, it is considered difficult to conduct such a research on ordinary passengers because AHP contains plenty of questions and requires understanding about the method itself.

Then Tochigi-Hanyuda, (2013) had conducted this AHP research on some faculties and experts because these people are considered to have enough experiences and knowhows to understand this method and passengers' consciousnesses appropriately.

### **2.3 Mission in this study**

The method shown above was presented at 13th WCTR and fully utilized to the actual Shinkansen projects as suitable evaluation model for Shinkansen station by JR TT.

Eight years has passed since the introduction of the method. This study contains verification of the method by applying it to the current passengers' feelings taking into consideration of new railway lines and segments since then.

### **2.4 Method of this Study**

Questionnaire surveys are conducted targeted on the passengers at new Shinkansen Stations to measure the feelings of passengers concerning to the LOS at Shinkansen station.

Concretely, six new Shinkansen stations (Shin-Yatsushiro), Shin-Minamata on Kyushu Shinkansen, and Annaka-Haruna, Joetsu-Myoko, Kanazawa on Hokuriku Shinkansen) are selected considering the wider area and representing each different scale.

The issues to conduct Tochigi-Hanyuda's AHP research on ordinary passengers are considered as below:

- Large volume of questionnaire is bothering targeted answerers.
- Difficult method makes answerers complicated thereby the answers from them might be less trustworthy.
- It is challenging to design efficient questionnaire in minimum number of questions.

Therefore, questionnaire is designed to question the importance of the indexes in 3-tiered (0-1-2) evaluation. This is a simpler questionnaire than Tochigi-Hanyuda's AHP research and its output does not contain the 'weight'. For that reason, verification is conducted by comparison between the ranking of average importance of each index based on the answers and the weight of original evaluation model.

## **3. Analysis**

### **3.1 Outline of Questionnaire Investigation**

Questionnaires were distributed on Nov. 22nd, 2019 at Kanazawa Station and on Oct. 4th, 2019 at five other targeted stations. Weekday (Friday) was selected to get well-balanced answers from both business passengers and pleasure passengers.

As shown in Table 2, total 4,826 sets of the questionnaire were distributed at six stations and 962 sets were retrieved. Thus, ratio of retrieved sets was 19.9%.

Table 2. Overview of Questionnaire Investigation

| Shinkansen | Station         | Date            | Number of Passengers<br>(per day, 2018) | Number of Distribution | Number of Retrieval | Retrieval Ratio |
|------------|-----------------|-----------------|---|------------------------|---------------------|-----------------|
|            | Kanazawa        | Nov. 22nd, 2019 | 48,800                                  | 1,500                  | 248                 | 16.5%           |
| Hokuriku   | Nagano          | Oct. 4th, 2019  | 42,800                                  | 1,500                  | 346                 | 23.1%           |
|            | Joetsu-Myoko    |                 | 4,540                                   | 601                    | 114                 | 19.0%           |
|            | Annaka-Haruna   |                 | 600                                     | 292                    | 91                  | 31.2%           |
| Kyusyu     | Shin-Yatsushiro | Oct. 4th, 2019  | 4,200                                   | 464                    | 77                  | 16.6%           |
|            | Shin-Minamata   |                 | 1,180                                   | 469                    | 86                  | 18.3%           |
| Total      |                 |                 |   | 4,826                  | 962                 | 19.9%           |

Retrieved answers were refined for segmentation. Namely, they were sorted into business (441) and pleasure (213) to analyze as the goal of this study. Though, if an answer is considered as both business and pleasure, the answer is added to both categories.

The answerers are principally office workers in their forties to sixties (business). Answerers' occupation and output concerning to the purpose of the trip are shown in figure 3 to 5.

The result shows that business trips mainly consist of commuting workers and students. This means the railway is used not only for unusual business trip but also for daily trip.

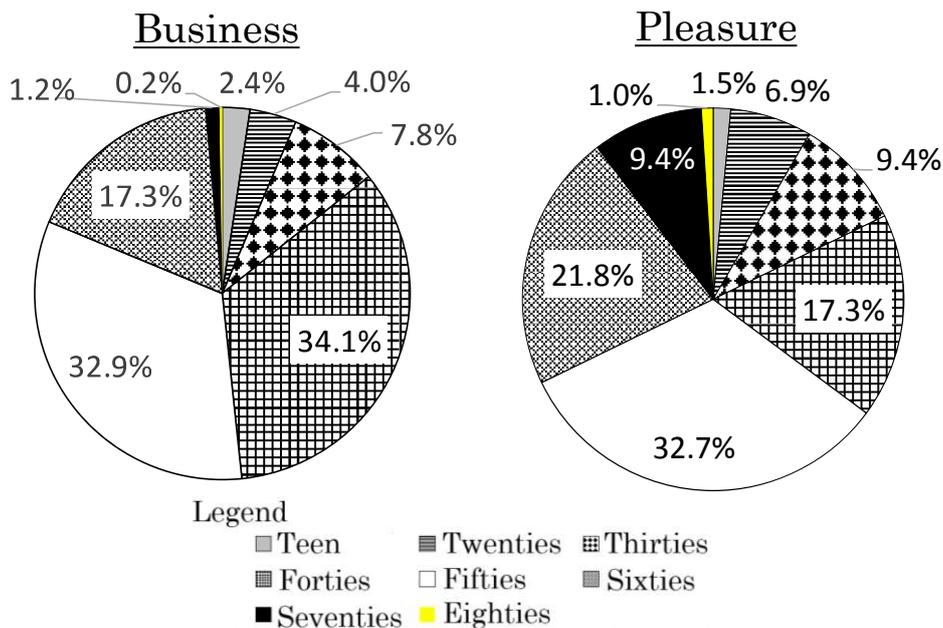


Figure 3. Age Distribution

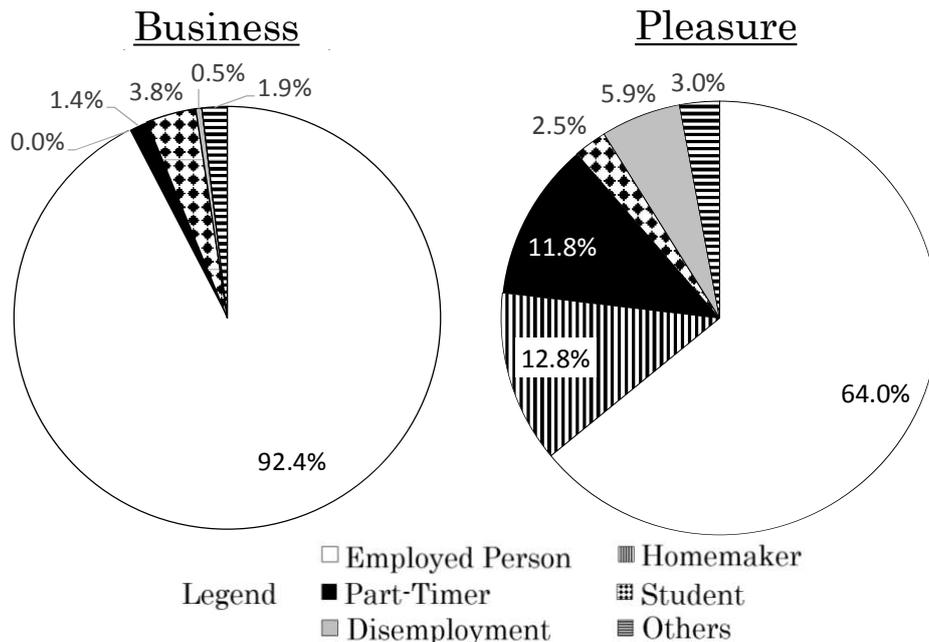


Figure 4. Occupation Distribution

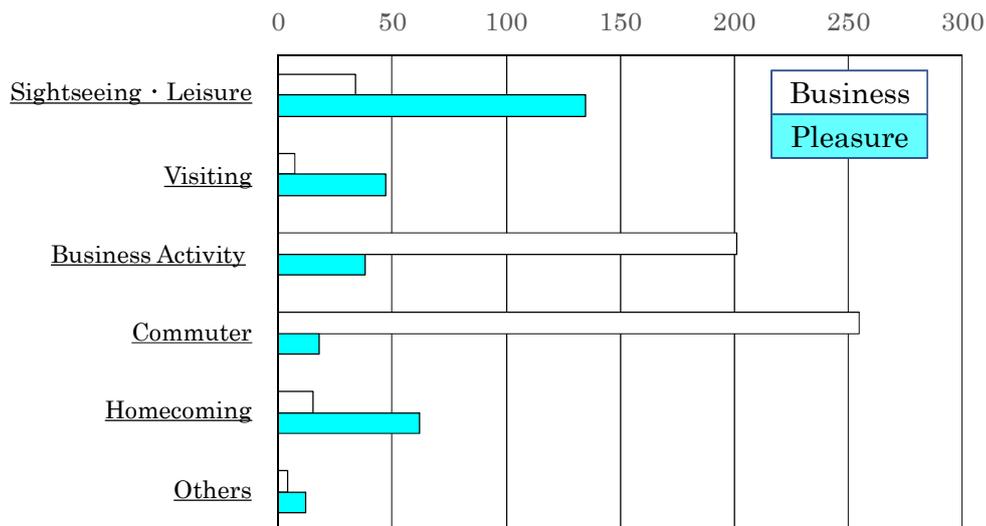


Figure 5. Purpose of Trip

### 3.2 Main Target Answer of Questionnaire Investigation

Importance of each index is digitalized based on the result of questionnaire (table 1). This clarifies most important index for passengers on station LOS.

Business trippers are most interested in the service level of feeder transit such as the number of alternatives and convenient timetable. Importance of coordination at transit node is often argued, and this research endorses this argument.

Pleasure trippers are most interested in the easier feelings at a strange place represented by discernible transfer guidance.

Both trippers are relatively interested in the convenient traffical movement such as shorter transfer distance.

### 3.3 Comparison between AHP and this Questionnaire Investigation

The result of analyses in the previous section and that of the Tochigi-Hanyuda's AHP research were compared and analyzed by the scattering diagram of each index ranked by weight.

The comparison of the ranking of each index by station access evaluation model (note: station LOS Value evaluation model targeting Shinkansen passengers who originate in the vicinity of the Shinkansen station), is shown on figure 6 for business trip and figure 7 for pleasure trip.

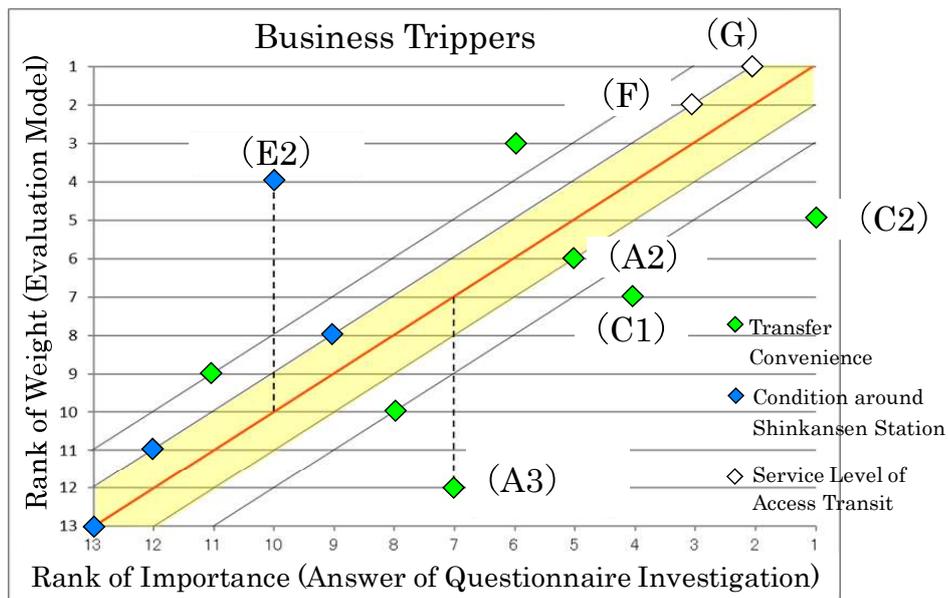


Figure 6. Rank of Importance/Weight (Business Trippers)

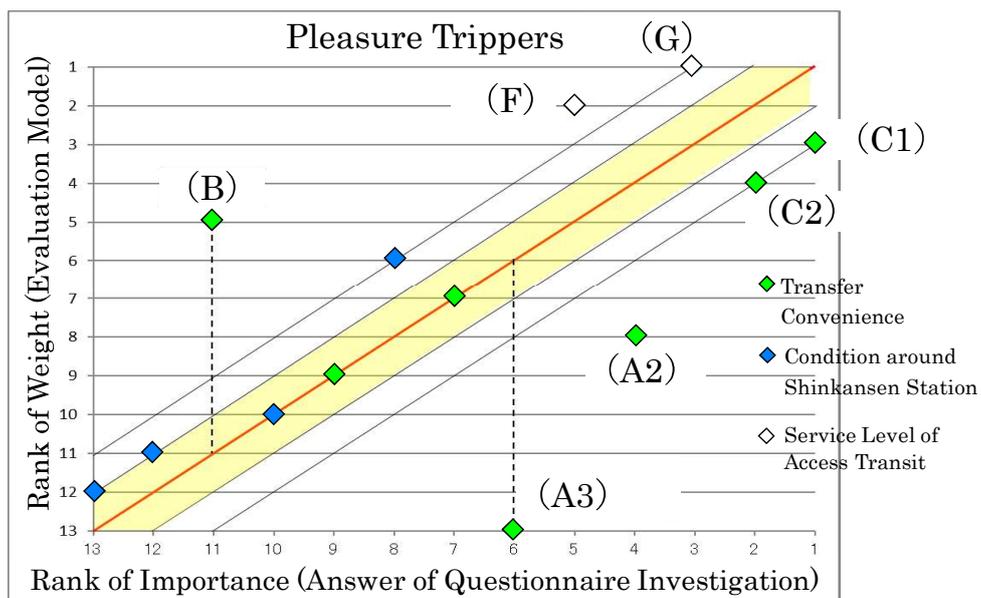


Figure 7. Rank of Importance/Weight (Pleasure Trippers)

By the comparison, it is confirmed that the result of the Tochigi-Hanyuda's AHP research almost accords with the passengers' feelings by this study.

Some indexes are deviated, though, this result gives an interesting insight.

For example, rank of 'opening hour of the shop' (E2) in business trip is higher in the AHP research but lower in the questionnaire survey. This shows that business trippers do not always depend upon the shop in the station.

For example, rank of 'comfort in waiting space' (B) in pleasure trip is higher in the AHP research but lower in the questionnaire survey. Needless to say, station furniture such as bench is necessary and important facility in stations. The answers by questionnaire survey seems to be backgrounded by the passengers' movement to aboard the Shinkansen train soon after their arriving at the station.

In both business trip and pleasure trip, ranks of transfer gate and transfer ticket are relatively high in the questionnaire survey. Though various reasons are considered for this result, it seems that some passengers avoid action of purchasing new ticket at transfer.

#### **4. Conclusion and Application**

Tochigi and Hanyuda, (2013) confirmed that the convenience improvement policy increases the evaluated value of station users' environment by the case study of the convenience improvement policy for Shinkansen station using station users' environment evaluation model and onsite survey at the station. In other words, it implies that there are some causes not to realize users' convenience improvement policy about users' most concerning contents at low-ranked station.

Base on above insights, we conducted questionnaire survey and existing material survey to clarify what kind of steps the municipality and stakeholders in the vicinity of the station took in the occasion of the opening of the Shinkansen line. These surveys mainly target the users' most concerned contents including transfer convenience and service level of feeder transit.

In questionnaire survey for municipalities, we selected among the municipalities whose station LOS Values are relatively high and some of questionnaire papers are distributed.

The contents of the questionnaire are as below:

- Impact of the policies conducted before opening:  
Urban planning and development, transit, tourism and commerce and industry, etc.
- Post-opening policies:  
Establishment of new organization or council and their efforts  
Purpose of the policy and process of the review

We hope we could introduce these policies in the next opportunity.

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