Advanced Science and Technology Letters
Vol.140 (GST 2016), pp.220-226
http://dx.doi.org/10.14257/astl.2016.140.43

Evaluation Indicators for Service Performance of Road Tunnels

Kyonghoon Kim[1], Taeil Park[2]

[1,2] Construction Policy Research Division
Korean Institute of Civil Engineering and Building Technology, Ilsan, Korea
{greatekkh@kict.re.kr, taeilpark@kict.re.kr}

Abstract. After the enforcement of 'Special Act on the Safety Control of Public Structures' in 1997, the first and second class public structure has been properly managed and subsequently leading to the overall conditions of B grade in road tunnel. This "B" grade meant that the infrastructures were structurally sound and stable. Although the infrastructures meet the safety requirements, they could not adequately correspond to the users' expectation from the serviceability and performance aspects. Thus, the objective of this study was to develop the service performance indicators and analyze the importance of each factor. To accomplish the project, this study performed a web survey to various field of specialists and provided the results of importance analysis. The result showed that high level of importance was relevant to disaster facility and low level of importance was relevant to functionality of mechanical and electrical equipment.

Keywords: infrastructure, evaluation, service performance, AHP Analysis

1 Introduction

Since 2009, 1,287 tunnels had been constructed in Korea and the number increased by 7.3% every year [1] (Fig.1). For safe and efficient facility maintenance and management of the increasing number of road tunnels, an evaluation indicator of road tunnels and methods that are objective and systematic must be developed.

However, most evaluation processes mainly focused on structural deficiencies. Other important aspects of infrastructure were often neglected regardless of their importance, such as, performance, public demand, capacity, etc., [2]. Thus, this study developed the indicators from the two different viewpoints of aspects; one was service level indicator regarding the level of satisfaction and convenience from the user's perspective and the other performance level indicator regarding the capacity and management of the infrastructures.

To achieve the goal, we selected the service performance items adequate for the Korean environment based on literature reviews, consultations and expert opinion. Then, this study performed a web survey in order to check the adequacy of the indicators. Finally, the importance of the each evaluation criteria was analyzed using

ISSN: 2287-1233 ASTL

AHP analysis. Overall, the study would provide a concrete foundation for evaluation of the infrastructure from the service performance perspective.

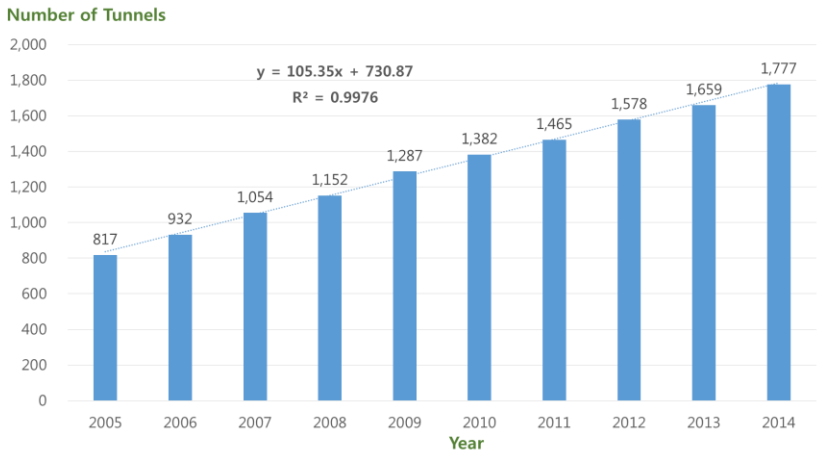

Fig. 1. Tunnel Construction in Korea

2 Review of Literature

The Korean Facility Security Corporation [3] provides evaluation indicators and methods for each evaluation item. However, the evaluation is divided largely into the condition, safety, and comprehensive evaluation categories. The evaluation mainly focuses on the items including crevice, water leakage, damage, etc., excluding the items focusing on user or functional perspective.

The study conducted by An [4] defines road facilities as the basic and indispensable facility which forms the foundation of economic activities of the country. An [4] developed the Asset Valuation Method and process for road facilities and the process has been applied to actual road facilities for analysis.

Jeong[5] claims that the studies which apply asset value of road facilities focus mostly on road pavement, intersections, and bridge facilities and he states that the research focusing on road tunnels or underground roadways is almost non-existing. Jeong developed the evaluation items for service performance of tunnel facilities and analyzed their importance. Mobility, accessibility, management efficiency, convenience, comfort level, information, environment, and regional activation were selected as evaluation items. However, Jeong failed to provide evaluation indicators that could be applied to actual road tunnel facilities.

This study developed evaluation indicators that could be applied to actual tunnel facilities and aimed to develop a method to evaluate these indicators. Since it was necessary to perform the evaluation based on objective evidence and methods, instead of including multiple evaluation indicators, we chose to select detailed evaluation indicators based on core evaluation items and analyzed the importance of each evaluation indicator.

3 Selection of Evaluation Indicators

This study selected evaluation indicators based on the user's satisfaction level and the functions of the tunnel facility.

Table 1. Detailed evaluation indicators.

Performance Category	Feature	Classification of Detailed Indicators
Serviceability	Convenience	Paving Condition
		Brightness
	Disaster	Disaster Facility
		Emergency Exit
Performance	Maintenance and Management	Functionality of Mechanical/Electrical Equipment
	Demand and Capacity	Traffic Demand

1) The road tunnel is a part of the road facility and its basic function is to provide convenient pass to its users. For the convenient pass, the surface smoothness and brightness of the pavement is important. In this regard, the Performance Evaluation Indicator for the pavement condition of Express Highway Corporation and KS Standard was used to evaluate surface smoothness and brightness of the road, respectively.

2) Tunnels were evaluated on whether they could provide a convenient evacuation in case of emergency tunnel evacuation caused by a disaster. The 'Damage Prevention Facility Installation and Management Guideline' of the Ministry of Land, Infrastructure and Transportation provided the standard for damage prevention facility installation for the various lengths of tunnels. The evaluation indicator was selected since it was important to secure emergency evacuation route in case of fire or natural disasters.

3) Indicators regarding maintenance and management were evaluated based on whether the facility provided the proper environments required for maintaining the functions of the tunnel facility. These factors considered installation conditions for mechanical/electrical equipment, such as power, supervisory control, ventilation, lighting, etc., according to facility design manual. The factors also evaluated the exterior conditions and performance of the equipment.

4) Indicator for the Demand and Capacity evaluated whether the tunnel facility provide a sufficient capacity to its users. It was evaluated based on the proportion between the actual and projected traffic volume.

4 Analysis of Evaluation Indicators

To collect opinions from specialists of various fields, a web survey was conducted through e-mails in addition to the survey linked to the webpages of tunnel facility societies. Contents of the survey included the adequacy of different evaluation indicators of road tunnels. The collected replies to the survey were analyzed for its importance based on Survey Planning, Distribution of Questionnaire, Data Processing, and Statistical processes described in the figure below (Fig. 2).

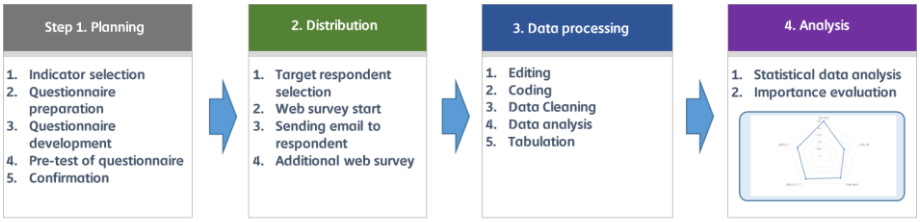

Fig. 2. Survey procedure.

1) Survey Respondents

The percentages of respondents affiliated with public research institutes, private enterprises, and schools were 40%, 40%, and 16%, respectively (Fig. 3). The distribution of industry, academic and, research institutes were considered to be fairly adequate.

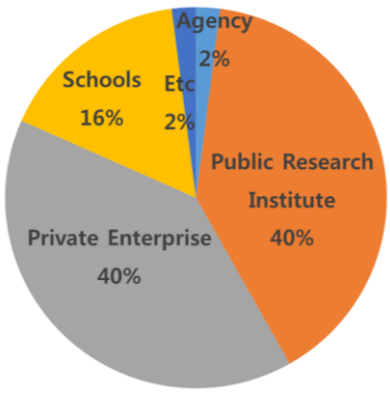

Fig. 3. Respondents' affiliated organizations.

2) Adequacy Analysis

Whether or not each evaluation indicator was adequate was evaluated using a five-point scale, the results showed that the paving condition was the most adequate and all evaluation indicators were above three points or adequate (Fig.4).

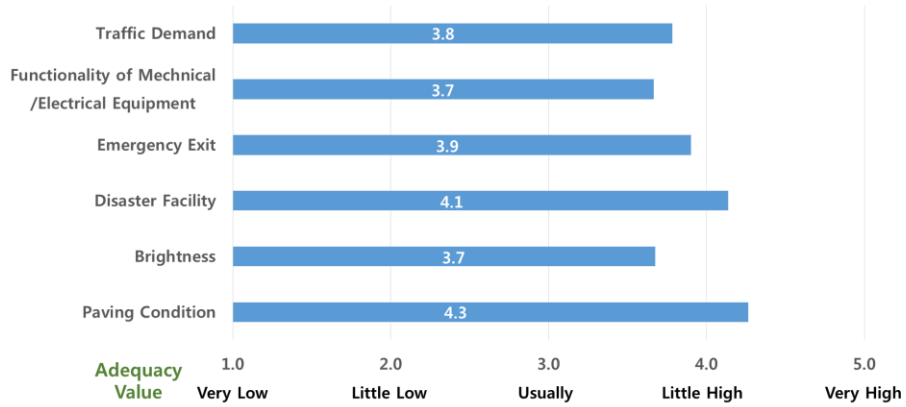

Fig. 4. Adequacy analysis.

3) Importance Analysis

The consistency index was analyzed to verify how logical and consistent the respondents made their evaluation before analyzing the importance. The consistency index value was found to be 0.00053. A lower consistency index value represented a higher logical consistency. If the value was below 0.1, responses could be considered as logically consistent. Therefore, results of this study could be considered as reasonable.

Results of importance analysis were as follows: importance for disaster facility was found to be 0.187 which was the highest; and importance value for brightness was the lowest at 0.139 (Fig.5).

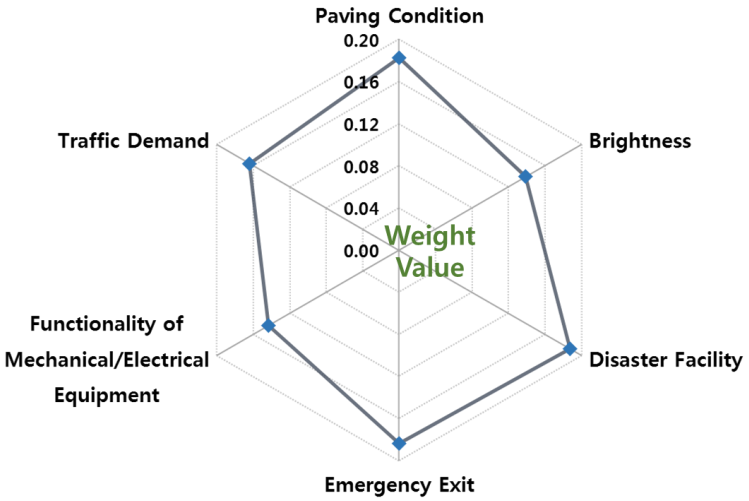

Fig. 5. Importance analysis.

5 Conclusion

For last years, governmental policies for the infrastructure were established, mainly focusing on structural deficiencies without considering performance and public demand. In this regard, the main contribution of the study was to provide evaluation criteria regarding serviceability and performance of the tunnel. The indicators were selected from the aspect of the user's perspective and infrastructure's own capacity. The web survey method was conducted to check the adequacy of the indicators and further evaluate the importance of each factor. The result of the adequacy analysis showed that all evaluation indicators were proven to be adequate. The importance analysis showed that the level of highest to lowest importance came in this order: Disaster Facility, Emergency Exit, Paving Condition, Traffic Demand, Functionality of Mechanical/Electrical Equipment, and Brightness. Future study is required to develop a detailed standard and manual, subsequently leading to evaluate the service performance of infrastructure in a systemic and rational manner.

Acknowledgement. This work was supported by grants (16SCIP-C078607-03) from the Korean Agency for Infrastructure Technology Advancement

References

1. Ministry of Land, Infrastructure and Transport: Road Service Manual (2015)
2. Kim, K.H., Park, W.Y., Park, T.I.: A Framework for the Evaluation of Infrastructures' Serviceability, International Journal of Social, Behavioral, Educational, Economic and Management Engineering, vol.9, no.6, pp.1937-1940(2015)

3. Korea Facility Security Corporation, Detailed Safety Inspection and Precision Safety Diagnosis Instructions [Tunnel] (2011)
4. An, J.M., Park, J.B., Lee, D.Y., Lee, M.J.: A Study on Asset Valuation Method for Road Facilities Maintenance, KJCEM, Vol.13, No.4, pp.141-151(2012)
5. Jeong, S.Y., Nah, H.S. Choi, W.S.: Assessment Items for the Level of Service for Tunnel Facilities from an Asset Management Perspective, JOURNAL OF THE KOREA CONTENTS ASSOCIATION, Vol.12, No.1, pp.68-79(2012)