Internet Journal of Society for Social Management Systems Vol.10 Issue 1 sms15-6835
ISSN: 2432-552X
ORIGINAL ARTICLE

Inspection System for Road Infrastructure

Shinichi MAEDA*, Tetsuro KUDO**, Seigo NASU***
Chodai CO., LTD*
Oriental Consultants Co., LTD**
Kochi University of Technology***

***Abstract*:** In Japan, from concerns about the social loss that aging road infrastructure is cause, the importance of maintenance is growing even more. In order to properly practice the maintenance of road infrastructure, it is necessary to road asset management system. However, it shall correspond to mere system rather than the implementation of the practice. In this paper, the sub-system "inspection system" of road asset management system for the purpose of implementation to the local governments is presented. "Inspection System", in order to accurately grasp the state of the road infrastructure, is a system that improves the ability of the inspection engineer. First, out of the ability of the inspection engineer, confirmed the necessary elements for the accurate inspection. Each element is classified as technical factors and psychological factors. From these two factors, constructed a decision-making model involved in the inspection implementation of inspection engineer. Next, analyze by inference the psychological behavior at the time of inspection activities of inspection engineer. A combination of this analysis and decision-making model was constructed to "inspection engineer model" closer to the real situation. Finally, the "inspection system", based on the "inspection engineer model" is presented. It was defined rule and method for improving multiple processes (ex: Education program for the inspection engineer, Inspection qualification system, Inspection Manual etc...) related to inspection.

Keywords: Road asset management, Inspection system, Inspection engineer model, Logic model of mindset, Theories of reasoned action and planned behavior

1. INTRODUCTION

In Japan, from concerns about the social loss that aging road infrastructure is cause, the importance of maintenance is growing even more. In order to properly practice the maintenance of road infrastructure, it is necessary to road asset management system. However, it shall correspond to mere system rather than the implementation of the practice.

In this paper, the sub-system "inspection system" of road asset management system for the purpose of implementation to the local governments is presented.

2. Bridge Inspection System of Kochi Prefecture

2.1 The current bridge inspection system

Bridge Inspection System of Kochi Prefecture (Old inspection system), are operated by the "Kochi Prefecture Bridge Inspection Manual (March 2006)". Old inspection system, there is a portion different from the inspection system in the other local governments.

The first is that the prefecture staff is implementing the periodic inspection. This is the only example in Japan.

Received: 2015.09.15 / Accepted: 2016.01.20
Internet Journal of Society for Social Management Systems Published Date: 2016.12.20

The second, in the advisor meeting constituted by experts, it is that it has been reviewing the inspection results. Kochi Prefecture staff include a person who is not a bridge inspection expert. However, this scheme, the minimum accuracy required for maintenance can be performed ensuring

The old inspection system has been operational about eight years. As a result, the mistake of the inspection results are reduced. Thus, it can be seen that the continuous improvement of inspection accuracy is being achieved.

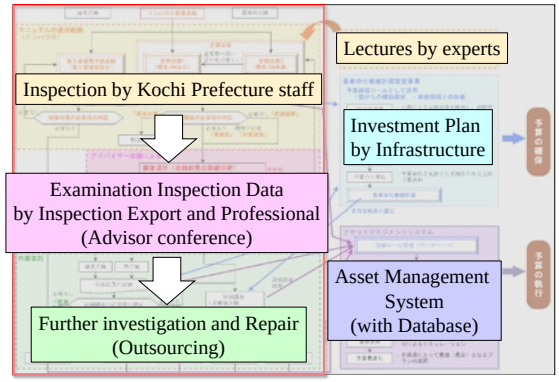

Fig1. Old Inspection system of Kochi

2.2 The New bridge inspection system

In the old inspection system, improvement of the technical capabilities of the inspection staff was confirmed. However, it was not sure whether is how improvement. For example, in the first adviser conference, it was found that there are many mistakes in two of damage type. After that, these inspection errors are added to the workshop or text, the improvement of inspection accuracy is observed. But, why were many mistakes in the two types of damage, it is not known. To analyze them, it is necessary to focus on the engineer's mindset.

New bridge inspection system of Kochi Prefecture (New inspection system) is a system that incorporates the mindset analysis model of inspection engineers. First, the inspection engineers, it measures the mindset and understanding degree for inspection. The mind, it refers to the attitude to the inspection action. Degree of understanding, it refers to the process of inspection action. The perception and evaluation of the damage includes both elements. Then, from the measurement items, we will analyze the items to be cause of the inspection mistake. In the analysis, with particular attention to the psychological factors of inspection engineers, to discover the cause of the inspection mistake. The new inspection system, the results of the analysis are set to be reflected in the development of the inspection engineers. Reflecting the results of the analysis to the education program and qualification system, we aim to achieve sustainable inspection accuracy improvement.

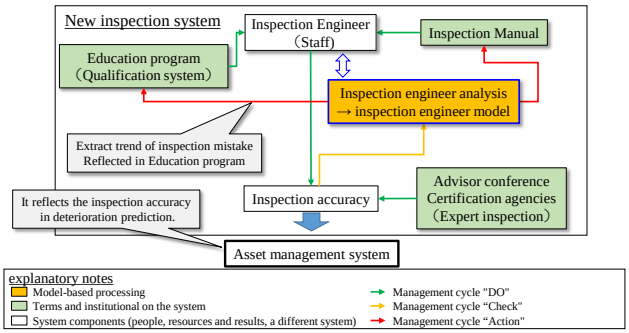

Fig2. New Inspection system of Kochi

3. Inspection engineer analysis

3.1 Structure and purpose Analysis model of the inspection engineers

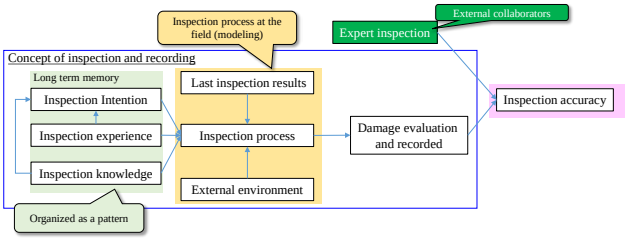

Fig3.Analysis model of the inspection engneers

Inspection action of inspection technician, it was modeled in psychology techniques. Inspection engineer's analytical model, it is intended to identify the factors that affect the accuracy of the inspection. Behavior of the inspection process, on the basis of the psychological approach to model.

3.1.1 Structure and purpose Analysis model of the

inspection engineers

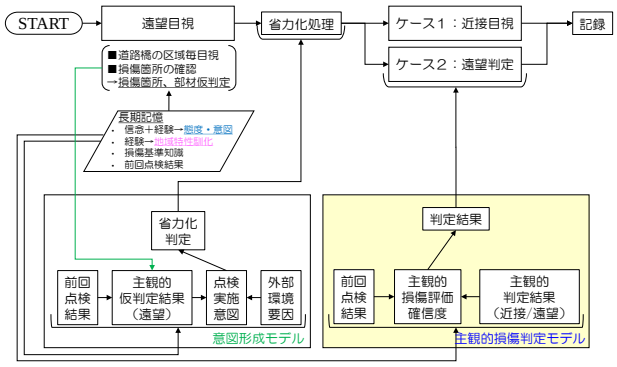

Fig4.Inspection Process

From a standard behavior of the inspection manual and inspection engineer, it was assumed the inspection process. From this inspection process, to model the step that is considered to be miss the inspection mistakes and damage.

3.1.2 Intention formation model of inspection engineer

Intention formation model, according to inspection implementation intention (Intention of carrying out the inspections), is assumed model the state of the bridge. Supposed bridges state affects the inspection actions of inspection engineer. Inspection action is divided on the exact implementation and labor saving.

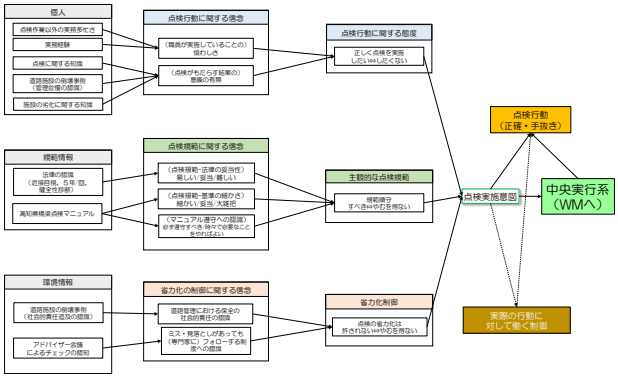

Fig5. Inspection implementation intention model by The theories of reasoned action and planned behavior

Fig5. is obtained by modeling the intention regarding inspection conducted inspection engineer. This model was a reference to the hybrid model of the theories of reasoned action and planned behavior of Aizen & Fishbein.

Judgment of labor saving by intention formation model, it considered different from the judgment of the labor-saving in the field. Intention formation model is a model that determines the inspection action based on knowledge drawn from long-term memory, short term information obtained in the field are not reflected. The actual labor saving decision is influenced by subjective awareness of information (Comparison results and of the previous inspection, the surrounding bridges environment, etc.) obtained from the survey visually. Information obtained by the overview visually be assumed similar to the subjective Damage Evaluation of the near viewing, which will be described later. However, the information obtained by the visual appearance is considered less than the near viewing. Damage is considered to be a level which can be confirmed.

To summarize, in this model, the decision on the implementation of bridges inspection is considered to be formed from the three items. The first one, is the intent of the inspection engineer. The second is the comparison result of the previous inspection result and the current inspection result. Finally, is the environment around the bridge. However, of the three items, it does not mean there are always items that most influential. The strength of the effect of each item is different by the inspection engineer. Therefore, it is necessary to interview the inspection engineer.

In this model, inspection technician determines whether or not to labor saving during inspection. The labor saving, and refers to the fact that is not performed proximate visual inspection at the time of inspection.

3.1.3 Subjective damage judgment model of inspection engineer

Subjective judgment damage model is a model that inspection technician assumes that doing proximate

visually during inspection. This model, is modeled damage recognition at the time of proximate visual inspection. This model is incorporated the concept of working memory shown in Fig6.(by A.Baddeley), were constructed. In this section, the interaction of the intention of the working memory and inspection engineer, shows a model for outputting the evaluation result of damage recognition.

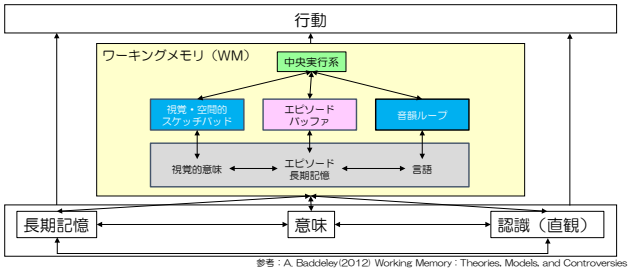

Fig6. Working memory

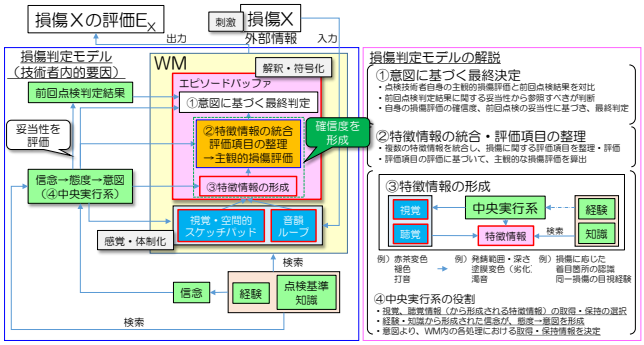

Fig7. The subjective judgment damage model by working memory

Working memory is a processing mechanism for forming the information necessary for selection of the action. First, temporarily holds the external information (short-term memory retention). Next, it refers to the necessary information from the inspection engineer its own storage (long-term memory). Finally, integrating the short-term memory and long-term memory, to form the information needed for action selection.

This integrated information is a semantic information (Episode buffer) about the damage. Damage assessment, and that it is based on inspection procedures, which the Ministry of Land, Infrastructure and Transport has been established, it can be properly evaluated. But, damage caused to the actual bridges, there are a plurality of information around. The plurality of information, there is a possibility of inhibiting damage recognition by inspection engineer.

The reason for inspection engineer mistake in the assessment of the damage is considered to be not carried out proximity visual by labor saving. On the other hand, mistake of damage evaluation of the case of implementing the proximity visual inspection, it is believed to be a misidentification of information acquisition.

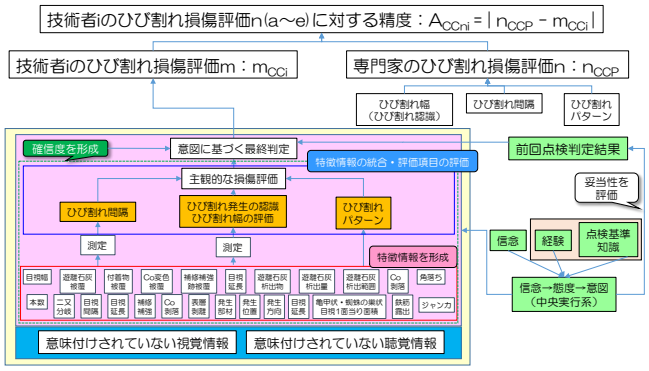

Fig8. The subjective judgment damage model of concrete cracks

Fig8. is a subjective damage evaluation model for "concrete crack" which was created based on a conceptual model of Fig7. In this study, we constructed a subjective judgment damage model for each damage type to target the five damage types (Table1) that have a significant impact on the soundness of the bridge.

Inspection engineer evaluates the damage by linking the inspection items and feature information.

Table1. Damage type by Bridge (element) type

Bridge(Element) type	Damage type
Concreate	Concreate cracks
	Slab cracks
	Deterioration of repair element

Steel	Corrosion
	Steel cracks

The connection pattern can be assumed to be divided into several. In the future, it will be confirmed by interviews.

3.2 Implementation of the interviews to the inspection engineers

In the future, based on the previous hypothesis, we will interview the inspection engineer.

Is an inspection engineer in Kochi Prefecture staff, we are planning to twice interview. At first, it carried out before inspection implementation. Then again it will interview after the inspection. From this process, it can be expected to confirm the learning effect of inspection experience. Prior to these interviews, now, we have conducted interviews of experts of inspection. The purpose of this interview is to verify the validity of the hypothesis of the present study.

After the interview, considering the answer of inspection experts, to modify the model. After the model of the modification, it is planned to carry out the interviews with the inspection engineer.

Table2. Interviews Planning

	Target
Pre Interviews	Inspection Export
First Interviews	Inspection Engineers (Kochi Prefecture staff)
Second Interviews	

4. Conclusion and Future Policy

In this paper, we have described the two things. The first is the construction of a bridge inspection system for performing the continuous improvement of inspection accuracy. The second is the inspection engineer analysis method for operating the inspection system. According to the present system, it can be expected to achieve a sustainable maintenance.

System and analysis techniques described in this paper, for the implementation of the Kochi is a preparatory stage for the current trial.

REFERENCES

Land, Infrastructure and Transportation Ministry, 2014. 道路の維持修繕に関する省令・告示の制定について(道路法施行規則の一部改正等), Land, Infrastructure and Transportation Ministry HP, URL:http://www.mlit.go.jp/report/press/road01_hh_000412.html, (last date accessed: 15 Sep 2015). (Website References)

Land, Infrastructure and Transportation Ministry, 2014. 橋梁定期点検要領 H26.6, Land, Infrastructure and Transportation Ministry HP, URL:http://www.mlit.go.jp/road/ir/ir-council/pdf/yobo3_1_6.pdf, (last date accessed: 15 Sep 2015). (Website References)

T. Kudo, 2012. Prediction Concept and Maintenance Scenario for Infrastructures Having Variation in Deterioration, (Thesis or Dissertation)

A. Baddeley, 2007. *WORKING MEMORY, THOUGHT, AND ACTION*, *FIRST EDITON*, Oxford University Press, 459 p. 2007 (Book Translation version)

I. Aizen, M. Fishbein, 2005, The Influence Attitudes on Behavior, URL:http://web.psych.utoronto.ca/psy320/Required%20readings_files/4-1.pdf,(last date accessed: 15 Sep 2015). (Website References)