A Consideration of Safety Measures Taking into Account Social Values

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When we look at railway safety over a 20 year span, it can be seen as having steadily improved by continuous safety measures. At the same time, society increasingly asks for peace of mind. That demand would suggest that railway safety measures are facing a turning point. In this article, we will delve into the issues and future direction of railway safety measures while showing previous studies on the need to take into account social values to improve both safety and peace of mind and on how to apply such consideration in safety measures.

Keywords: Safety, Peace of mind, Trust, Decision making, Risk, Management

1 Introduction

JR East has continued to promote safety improvement measures since its establishment in 1987. As shown in Fig. 1, those measures resulted in the reduction of the number of railway operational accidents as defined by the Railway Accident Reporting Rules to approx. a third of previous levels, demonstrating steady improvement of safety.

On the other hand, society increasingly asks to be provided with peace of mind in addition to safety. Such a demand suggests that peace of mind needs to be taken into account in safety measures. But there are no previous studies focusing on specific types and kinds of safety measures that give railway users peace of mind. This article thus speculates, based on the previous related studies, how railway safety measures should progress to improve user safety and peace of mind.

First of all, we need to define safety and peace of mind. Based on the reference materials1, this article defines safety as “the actual status where there is little risk of users suffering damage” and peace of mind as “a psychological state where railway users feel safe.”

2 Implementation of Safety Measures and Issues Identified

2.1 Implementation of Safety Measures

JR East is aiming for extreme safety levels and to give our customers peace of mind based on assured safety, as is declared in the Basic Management Policies of “JR East 2020 Vision—Challenge—”. Safety measures therefore need to be advanced in a manner where both safety and peace of mind for railway customers can be improved effectively.

To improve safety, lowering the risk that safety engineering deals with—risk that specialists objectively estimate (hereinafter, “engineering risk”)—should be considered. Engineering risk can be represented as a combination of the scale of damage in an accident and frequency at which accidents occur. There is, however, no previously proven research that has firmly established a specific framework to improve peace of mind. Future research will be conducted based on related previous research, and here we decided to consider safety measures based on a certain amount of assumption.

We have defined peace of mind as a psychological state where railway users feel safe, but what then are factors of concern that can inhibit such a state? Here, we roughly classify those concerns into two parts. One is the scale of the risk itself that causes the concern, which is equivalent to engineering risk, and the other is whether or not the railway operator takes appropriate measures to prevent accidents. Such appropriateness takes into account the level of responsibility of the operator, and we will call the responsibility level “operator’s responsibility”. The operator’s responsibility includes causes of the hazard (operator error, equipment failure, natural disaster, etc.), handling of repeated accidents and handling of accidents that might cause serious damage. Defining the combination of engineering risk and operator’s responsibility as social risk, we decided to start from the premise that peace of mind of customers can be improved by reducing social risk.

Engineering risk and social risk defined here can be expressed in a formula as shown in Fig. 2. Estimating with this formula the scale of damage and the frequency of occurrence of an accident along with the operator’s responsibility will allow us to identify the scale of engineering risk and social risk for the individual hazards to be evaluated. This method allows us to make multifaceted examination of a safety program as it can express the effects of safety measures as two risks.
2.2 Issues Identified

In ordinary safety management, we calculate engineering risk by individually expected hazard and carry out countermeasures starting from those that are the most cost effective. For railways, however, this method does not always work. For instance, compare the following two cases.

| Case (1) | Collision of trains due to a problem with the operation system |
| Case (2) | Derailment and overturn of a running train due to a landslide caused by torrential rain |

We do not make an exclusionary choice between those two in actual safety measures, but let us consider which should be given priority for explanatory purposes. In both of the accidents, a large number of injuries or fatalities could be expected. If the scale of engineering risk in both cases is equal and the cost effectiveness is equal too, for which accident should response be given priority? To this question, many people would probably answer Case (1). It is easy to understand when comparing the risks from the perspective of engineering and social risk.

We compared the two cases on the assumption that engineering risk of those is equal. From a social perspective where the operator's responsibility is added to the engineering risk, however, the scale is different. If a difference is visible in the priority of safety measures for the two cases, the reason could be that the stakeholders see the risk as social risk instead of engineering risk. Accordingly, we can predict social risk if we can appropriately measure the scale of the operator's responsibility that would bring about a difference between engineering risk and social risk. How the scale of the operator's responsibility should be estimated for individual accidents is the issue identified of this article.

Obviously, the operator's responsibility is not defined from the operator's own perspective. It is to be determined on the social view that is created by cultural background, historic development and changes of social situation (hereinafter, "social values"). If we can identify the social values and estimate the operator's responsibility based on that, we could obtain a new indicator, social risk, and it will help in promoting effective safety measures.

The next chapter will introduce some informative social trends and previous research.

3 Social Trends and Previous Research

3.1 JIS Q 31000:2010 (ISO 31000:2009)

Studying and reviewing safety measures is a part of risk management efforts. As risk management is seen as being of more importance recently, a Japanese standard of risk management, JIS Q 31000\(^1\) was formulated in September 2010. This is developed based on the ISO 31000 international standard of risk management issued in November 2009, without altering technical contents and structure. The standard does not target any specific field but intends to be a universal standard that will provide guidelines to apply risk management to diverse organizations and businesses. ISO/IEC Guide 51:1999 is a widely known basic safety standard, and ISO 31000 is consistent with that.

The risk management process in ISO 31000 is expressed as shown in Fig. 3. Risk assessment is a part of risk management, and this is shown as the shaded area of the figure. Risk identification is identifying risks to be investigated. Risk analysis separately estimates occurrence frequency and damage scale of an accident and predicting the extent of risk by multiplying the frequency and scale. And risk evaluation is a process of determining whether the evaluated risk is within or out of the acceptable range. What we should pay attention to here is that the importance of communication and discussion with stakeholders is stressed in each process, so each process is connected with an arrow to communication and discussion. The concept of stakeholders here in terms of railway safety measures is departments involved at the operator along with the users. The figure shows the importance of considering values of stakeholders in the individual processes.

\[ \text{Social risk} = \text{Engineering risk} \times \text{Operator's responsibility} \]

![Fig. 2 Definition of Engineering Risk and Social Risk](image)

![Fig. 3 Risk Management Process Provided in ISO 31000](image)

3.2 Research on Trust in Social Psychology

When considering social values, previous research in the field of social psychology is informative. In this field, the importance of trust in different social relations has been debated. An operator’s loss of social trust will lead to cost increases in its business activities.
and eventually to obstacles to its business activity. Here we cover two models regarding trust (Fig. 4) and consider the relationship to safety measures. The reference documents state that people with lower level of interest in the relevant issue tend to depend on a traditional trust model and people with a higher level of interest tend to depend on a Salient Value Similarity (SVS) model.

Generally, railways are regarded a safe mode of transport. In normal situations with no accidents occurring, the public has a hard time being conscious of the safety of railways, consequently showing a low level of interest to safety. We can therefore consider people's trust of the railway operators according to a traditional trust model. In this model, obtaining social recognition that the operator is competent and intends to diligently utilize that competence in its safety measures is important for gaining trust. In this context, it is necessary to understand that in such normal situations, efforts to contrive and implement safety measures will draw little attention and will not necessarily lead to high social appreciation.

On the other hand, once a serious accident occurs, news reports and concern over being involved in similar accidents increase people's consciousness to safety, drawing higher interest. So, social awareness may shift in the direction of dependence on the SVS model. The SVS model suggests that society relies on the railway operator when it recognizes that the railway operator shares major values with society. Society thus comes to appreciate the competence and diligence of the operator. This means safety measures the operator gives priority to and whether the priority is the same as that demanded by society become important. It is therefore important to make daily efforts to identify the social value of safety measures society demands and to incorporate that view in safety measures.

3.3 Research Outside Japan
The Railway Safety and Standards Board (RSSB) of the UK is one of the research institutes conducting various railway-related studies. Here I will discuss one of their studies on social values.

The RSSB has modeled a hierarchical structure of social concerns about railway accidents in a research report (Fig. 5). In this model, they have defined hazards to be evaluated as short stories and received responses to 21 questions at the end of the hierarchy (in an 11-level rating system from 0 to 10). Based on those responses, they have made quantitative evaluation of societal concerns.

The fact that efforts to evaluate social values (concerns) in railways have been underway in other countries too is the same as the premise and direction of this article of estimating the operator's responsibility based on identification of social values. It also supports the premise of this article. The study case cannot be, however, applied to Japanese railways as is, because the application method of the study contents is different and the output of the social psychology and risk perception varies greatly according to factors such as cultural background. Still, this RSSB study probably includes many informative views since it is based on detailed reviews of research in the field of social psychology and risk perception mainly in Western countries.
recent sudden intense rainfall occurs is difficult to predict, and specific technical countermeasures cannot be envisaged. Thus, it tends to be regarded as being difficult to control. As a result, the operator’s responsibility is relatively heavier in case (1) than in case (2). This can explain the reason why more people suggest that countermeasures to case (1) should be given priority.

Making use of the above concept, it would be possible to estimate the operator’s responsibility by doing a questionnaire survey on how people recognize the locus of cause and controllability of a hazard. What is important here is that recognition of controllability can change. For example, people who think that control through expensive technology is difficult might think that such technology should be used once the cost is lowered. It is therefore useful to conduct periodical surveys on how society recognizes controllability of accidents.

The second theme of our research is whether or not Japanese society requires railways to be zero-risk. Some tendencies that may be informative are shown as follows from the results of a questionnaire survey conducted in fiscal 2010, although detailed analysis of those tendencies has not yet been completed.

In the survey, we asked about the level of demands regarding use of railways to JR East users as well as users of railways in wide areas of the Kanto, Kinki and Tohoku regions. The demands given in the results included various items such as stability, service, and peace of mind on top of safety. As a result, when the users were asked simply if action “is desirable”, demands for preventive measures against “train collision” and “train derailment” came out on top. Conversely, demands regarding those placed relatively lower when they were asked if “improvement is needed”. The results can be interpreted that users attach great importance to safety but do not necessarily need more safety than currently provided. Our presumption is that people place relatively more importance on demands other than safety, such as stability and service, when they acknowledge that safety has reached a certain expected level.

The concept of tolerable risk—accepting risk less than a certain level in relation to the gained benefits—is seen as the norm in Western countries, but that seems difficult to accept in Japan. It is thus not discussed much. But, if the tendencies regarding people’s demands can change when safety reaches a sufficient level, we can think that there might be grounds for accepting the concept of tolerable risk. While the survey was just one conducted in a normal situation, it could be a theme for future studies that include the relationship between people’s risk recognition and tolerable risk in case of an accident.

**Future Direction**

This article has introduced previous research and explained the importance of taking into account social values in railway safety measures. In order to achieve safety and peace of mind declared in the “JR East 2020 Vision”, the method by which social values are achieved in safety measures becomes important.

Reviews of previous research, however, revealed no research that suggested specific methods of applying social values for risk management, although some research did show the importance of considering social values and attempted to model those. And, in the field of social psychology, there are few arguments on peace of mind, while many argued mainly on the issue of trust. In light of those circumstances, we believe it is important to examine those individual themes within the scope of Japanese railways, and we have started some of that examination. In that research, we will continue studying how JR East should comprehend the structure of safety, peace of mind and trust. The structure should suggest social values to be considered and allow us to estimate the operator’s responsibility. The ultimate goal will be utilizing the operator’s responsibility in preparation of an indicator for safety measures (Fig. 6) to make full use for effective safety measures.

### Conclusion

When making decisions on safety measures, social values were likely taken into account. The point here is how reasonably those values should be considered and how they should be combined with other decision factors. We thus will proceed with research to bring about “extreme safety” and “peace of mind for passengers”, no matter how difficult it may be.

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**Reference:**

4) RSSB, "TS47: Modeling Societal Concerns," http://www.rsb.co.uk/