Development of a Support Tool to Learn Lessons from Incidents Experienced by Others

In order to achieve safer operation by preventing railway accidents, it is important to learn lessons from accidents happening at our company, including incidents experienced by other workers at different offices. However, it is not easy to learn from incidents happening at different offices because each case usually appears to be different at the surface level and extraction of the underlying factors is needed for lessons to be fully learned. We, therefore, developed a support tool to identify underlying factors and facilitate learning from incidents that occurred at different offices.

Keywords: Human error, Human factor, Accident analysis, Cognitive psychology

1 Introduction

In order to prevent occurrence or reoccurrence of human errors, it is important to learn lessons from accidents and incidents experienced by other workplaces, thinking of one's own workplace or one's self in same situation as others. JR East has developed lessons out of accidents and incidents experienced inside and outside the company by placing signs about them at workplaces and using them for case studies. However, incidents experienced by others cannot be easily applied to one's own workplace in the same manner as others if the equipment and tasks concerned differ from one's own. Furthermore, if one does not understand the factors that induce those accidents or incidents, countermeasures formulated by other workplaces can be superficial or not convincing, so they might not be carried out.

We thus developed a “support tool to learn lessons from incidents experienced by others” (hereinafter, “the tool”). Based on the information of such incidents, personnel can use the tool to identify the type of error and the factors that induce that error, apply those to examples at their own workplace or in their own duties using those factors as the key, and finally come up with their own countermeasures. An outline of the tool is as follows.

2 Issues in Using Lessons from Incidents Experienced by Others and Direction for Improvements

2.1 Issues in Using Lessons

Our survey on use of lessons at individual workplaces summarized major issues as the following three points.

Issue 1
With just signs and announcements alone, people cannot obtain an in-depth understanding of the incident, and they soon put it off as being irrelevant to them.

Issue 2
Even if people try to apply lessons to their own workplaces, countermeasures would be superficial and not sufficiently effective without understanding of essential factors that induced errors in that incident.

Issue 3
Effective methods of discussion based on lessons have not been established, making it difficult to facilitate in-depth discussion.

2.2 Direction of Improvements to Allow Effective Utilization of Lessons

To solve those three issues, we thought out the following improvement mechanisms.

Improvement mechanism 1
Mechanism where people can identify the essential factors of the error and formulate countermeasures, focusing on characteristics of each of four types of errors taking into account the mechanism by which errors occur (improvement for Issue 2)

Improvement mechanism 2
Mechanism where lessons are applied without fail to incidents requiring attention at one's own workplace, leading to countermeasures (improvement for Issue 1)

Improvement mechanism 3
Mechanism where individuals think for themselves first and then discuss and share views in groups (improvement for Issue 3)

We thus decided to create a support tool to learn lessons from incidents experienced by others that enables the improvement mechanisms 1 to 3, above, to be put in place.

3 Analysis Process of the Tool

As a way to bring about the above-mentioned improvement mechanisms 1 to 3, we came up with a process in which incidents experienced by others can be applied to accidents or incidents at one's own workplace and countermeasures to those formulated (Fig. 1). The process is exemplified by people identifying the type of the error in accidents or incidents and the factors that induced those based on the analysis flow record of the tool and applying those to accidents or incidents at their own workplaces that can occur in the same mechanism with the same factors. Hints for this are gained from the work or location in their own workplaces. The following explains the analysis process of Fig. 1 in the order of the flow.

3.1 Categorizing Types of Errors

Errors with results apparently similar to each other can occur in different mechanisms. For example, in the case of an error where one discovers that his/her wallet was left at home, such an error can occur when the person forgot to put the wallet in the bag as a
result of being asked to do something at the very moment when putting the wallet in the bag. That is an error where the person forgets what to do in the course of an action. On the other hand, if the person leaves his/her wallet as a result of mistakenly thinking the wallet was already in the bag, that is an error where the thought itself is wrong. In the former case, the person forgets what to do; therefore, it would be effective to put up a sign saying something like “Do you have your wallet?” on at the front door to remember. However, in the latter case, such a sign would not be effective because the person believes the wallet is in the bag. In this way, a countermeasure cannot be effective without it fitting the mechanism by which errors occur. For that reason, we considered categorizing types of errors to analyze errors extracted from incidents experienced by others in accordance with the flow of the mechanism of occurrence.

Types of human errors can be categorized in many ways. Our tool employs a method of categorization advocated by Dr. James T. Reason from a viewpoint of cognitive psychology. Reason’s categorization of human errors into slips, lapses, and mistakes. That method was employed because, criteria of the categorization is based on the difference in the mechanism by which errors occur, taking into account human information processing process, level of habituation of behavior, and the like. Categorization of errors is thus expected to assist more appropriate identification of factors that induce the error.

Analyzing 132 errors extracted from major accidents and incidents of JR East in fiscal 2009 to 2011, we found that four error types including the above-mentioned three error types plus violations account for approx. 90% of the total. Thus, to be easy to understand for analysis beginners, we renamed those types of errors “Intentional action”, “Forgetfulness”, “Judgment error”, and “Unconscious reflexive error” as shown in Table 1, and we used those in the tool.

We also made a Yes/No flow chart (Fig. 2) that allows users to be led to the proper error type using characteristics of individual errors. That way, users could properly categorize into those four error types the errors picked out from incidents experienced by others. By repeatedly using this flow, users can learn the characteristics of those four important error types.

### 3.2 Typical Inducing Factors of Individual Error Types

Each of error type has its own typical factors that induce that error. Forgetfulness, for example, can include case where one was spoken to when performing a task and skipped a procedure when returning to the task. In this case, an “interruption”, such as being spoken to, is a typical factor that induces forgetfulness.

To identify such typical inducing factors, we picked out 213 inducing factors from reference documents about human errors in field such as railways, aviation, electrical power, and medicine. We further narrowed those down into 28 inducing factors related to railways. Taking into account the analysis results of major accidents and incidents of JR East in the past three years, we finally narrowed down inducing factors to the six important factors shown on the right side of Fig. 2. By narrowing down to just important inducing factors, we made the tool easy to use for even beginners in the field of analysis to identify inducing factors. That was also done to allow learning of details about inducing factors.

### 3.3 Support in Application of Incidents Experienced by Others

Sometimes people cannot apply experiences at other workplaces to their own due to differences in areas such as equipment and work details. An example is an incident where a car was stalled in a level crossing at a slowdown section for construction work and the level crossing obstruction alarm was activated. The train driver subsequently returned the alarm to normal status according to instructions from the dispatcher but forgot the
slowdown command and restarted operation at normal speed. In this case, people at a workplace without level crossings might not be able to apply the case as the incident relevant to them. Using the Yes/No flow chart in Fig. 2 to identify the error type as forgetfulness and the inducing factor as interruption would make it easy for users to think of various examples by searching for duties and locations at their own workplace similar to those at which incidents experienced by others occurred. Doing so would make it easy to apply such an incident experienced by others using as the key for that the inducing factors such as a case where the driver forgets a slowdown command and restarts operation at normal speed after stopping due to rolling stock failure, injury accident, detection of abnormal sound, and the like.

3.4 Support in Formulation of Countermeasures

In formulating countermeasures, it is important that they be based on the mechanism by which errors occur. Consider the aforementioned case where the driver forgets the command in the slowdown section due to interruption such as rolling stock failure. When the driver restarts operation after taking measures to deal with rolling stock failure and the like, it will be difficult for him to remember the slowdown command without some sort of reminder. Considering the mechanism by which errors occur, a way to remember the omission in the job process will be needed after interruption in this case. Thus, when a job is suspended, a way to deepen memories or make external records will be important. In this case, one example of countermeasures is putting a memo on the cab showing the slowdown command.

In this way, taking into account the process by which an error occurs due to interruption as the inducing factor, we can say one of the focus points of countermeasures is devising a work method that reminds personnel what to do even if they forget it. Similarly, we considered the focus points corresponding to typical inducing factors of individual error types and chose ten focus points to enter in the tool (Fig. 3). By narrowing down the focus points of countermeasures, we can formulate countermeasures based on the mechanism by which errors occur for individual workplaces while learning the concepts of countermeasures corresponding to the inducing factors.

### 4 Structure of the Tool

#### 4.1 Structure of the Tool as a Whole

The actual tool is the size of two A3 paper sheets arranged side by side. Table 2 (1) to (4) are shown on the front side, and (5) is on the back surface. For the structure of (5), we carried out interviews at field offices on items such as usability and made repeated improvements (Fig. 4). This was based on the relation shown in Fig. 3.

#### 4.2 Structure of the Worksheet

The main part of the tool is the analysis flow chart. The results of work such as actual analysis and application to one’s own workplace are entered in a separate worksheet shown in Table 2 (6) and put into practice. The work procedure of the worksheet is composed of nine items. For the aforementioned improvement

---

**Table 2 Structure of Tool as a Whole**

<table>
<thead>
<tr>
<th>Structure (1)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall explanation</td>
<td>Background and purpose for developing the tool</td>
</tr>
<tr>
<td>Mechanism analysis</td>
<td>Explanation of reason for analysis through examples</td>
</tr>
<tr>
<td>Workflow</td>
<td>Explanation of how to use referring to worksheet (6) using examples</td>
</tr>
<tr>
<td>Countermeasure analysis</td>
<td>Explanation of details of inducing factors using day-to-day error examples</td>
</tr>
<tr>
<td>Countermeasure list</td>
<td>Reference for entry of results of analysis steps in worksheet (6)</td>
</tr>
</tbody>
</table>

---

**Fig. 3 Relations between Error Types, Inducing Factors, and Focus Points for Countermeasures**

**Fig. 4 Analysis Flowchart (Table 2 (5))**
mechanism 3 (mechanism where individuals think themselves first and then discuss in groups and share views), each individual extracts errors (procedure 1) to choose the focus point of the countermeasure (procedure 6). Then, with someone such as an instructor at the workplace as the facilitator, the people work in one or more groups collecting and narrowing down the results of individual work (procedure 7), applying the lesson to their own workplace (procedure 8), and formulating countermeasures (procedure 9). What is most important in applying the lesson is to summarize in group(s) the inducing factors (procedure 7) identified by individuals (procedure 4) and then apply them in the group(s) to their own workplace with those inducing factors as the key.

4.3 Example of Analysis
Fig. 5 is an example of analysis where a driver used the worksheet for information on incidents experienced by others.

[Information on incident experienced by others]
A car was stalled in a level crossing in the slowdown section for construction work and the level crossing obstruction alarm was activated. The train driver returned the alarm to normal status according to the instructions of a dispatcher but forgot the slowdown command and restarted operation at the normal speed, exceeding the limit speed.

5.2 Trial Results
The results of analysis of replies to the questionnaire for the following evaluation items revealed that users could effectively identify inducing factors of incidents experienced by others, apply the error type and the inducing factor to their own workplaces, and formulate countermeasures (Fig. 6).

Comments from users shown in Table 3 proved that they could more easily understand the mechanism by which errors occur when using the tool. However, in cases where users chose two or more error types in their individual work, it was sometimes difficult to summarize in the group work, resulting in difficulty in application to their own workplaces and formulating countermeasures. For such cases, support to the facilitator in the group work and other tips will be needed.

5.1 Trial Users and Method
The trial tool users were 675 employees of 39 workplaces including stations, crew offices, and maintenance depots. For the trial method, we carried out a questionnaire survey before and after the trials and interviews after trials to verify effectiveness in preventing errors as well as usability. The incidents experienced by others were different for individual workplaces.

5. Verification of Effectiveness

6. Conclusion
We concluded that using at field offices the support tool to learn lessons from incidents experienced by others could allow personnel to understand the mechanism by which errors occur and formulate countermeasures at their workplaces. In work to come, we will devise a support method for facilitators in group work and develop a system to collect and share analysis results from individual workplaces. In this way, we will make further improvement to promote use of the tool.

Reference: