Development and Verification of Training Method to Heighten Ability to Act Flexibly in Irregular Situations

There were no casualties to passengers in the Great East Japan Earthquake and ensuing tsunami thanks to individual JR East employees foreseeing risks in the various situations they faced, making decisions flexibly, and guiding evacuation. At the same time, personnel today have fewer experiences in serious accidents and dangerous situations not limited to just disasters such as earthquakes, so we are concerned about their ability to respond in irregular situations.

We thus developed a training method to enhance ability to foresee specific risks and decide what to do. In this, scenarios are used where details on irregular situations are not provided, and participants hold group discussions after imagining what they should do. As a result, we gained training effects by this method such as “training details being memorable for participants” and “participants recalling irregular situations after training.”

Keywords: Resilience, Education/training, Disaster prevention, Map exercise, Irregular situation, Sensitivity to risk

1 Introduction

Passengers were given guidance to evacuate from JR East stations and trains in the March 2011 Great East Japan Earthquake. We later interviewed personnel of 48 workplaces who were involved in guiding passengers to evacuate so as to identify reasons casualties to passengers were avoided. This was done so that we could use those experiences to further heighten safety in irregular situations such as disasters. As a result, we believe points in avoiding casualties were that individual personnel acted flexibly in addition to adhering to rules and manuals.

In this research, we studied a training method to heighten ability to make decisions and act flexibly in accidents and disasters by having personnel imagine beforehand in training how they would act in such situations. We assessed the training method in fiscal 2011 at workplaces, and after confirming that it is effective to a certain extent, we made preparations for company-wide introduction of the training. In fiscal 2012, we improved on issues that came up in later implementation stages and further verified items such as how effects of the training method have taken hold.

2 Abilities Needed to Respond Appropriately in Irregular Situations

2.1 Scenarios in Irregular Situations and Necessary Training

Results of analyzing details of the aforementioned interviews showed two types of response scenarios after the earthquake occurred. Those were “scenarios where things that should be done and procedures for those have been predetermined” and “scenarios where response and priority differs according to the situation.”

The former includes stopping the train in an emergency and guiding passengers to exit using ladders when trains stop between stations. On the other hand, the latter includes situations where the evacuation location differs from that of the manual and making decisions on what to do on one’s own due to inability to receive appropriate instructions and information from dispatchers and related departments, as was seen in the 2011 earthquake.

In current training for the former at JR East, training where procedures are learned by doing has taken hold. This includes training using actual cars and training using simulators. Expertise of personnel has improved thanks to that training.

On the other hand, there are few established methods as training for the latter as was demonstrated by the interviews. This showed that we need to improve ability to respond in such scenarios. We thus worked in this research to develop a training method to increase competency to foresee risks that could manifest in accidents and disasters not limited to earthquakes and to flexibly deal with those with a view of such current lack of training as being a problem.

2.2 Organization of Abilities Needed in Irregular Situations

Here we will organize the abilities required as the aforementioned competency to foresee risks and to make decisions and act flexibly in accidents and disasters according to the situation. James Reason* says that flexibility needed in irregular situations is the idea of foreseeing unpleasant surprises and flexibility to quickly adapt to the situation. Whether or not one can take appropriate action in an emergency is determined by ability to foresee diverse risks.

Regarding ability to respond in irregular situations, he says that only people and organizations that make substantial preparations in advance of the occurrence of a crisis will be able to deal with it. In light of such knowledge and the content of the interviews, Fig. 1 extracts “skills needed in irregular situations” through “competencies required to act flexibly.” This figure shows competencies required as the aforementioned “ability to foresee risks and to judge and act flexibly in accidents and disasters according to the situation,” and it is composed of “professional knowledge and skill,” “imagination,” “sensitivity to risk,” “decision-making ability,” and “ability to act.” Of those, “professional knowledge and skill” is necessary in “scenarios
where things that should be done and procedures for those have been predetermined," and a training method has already been established at JR East. “Ability to act” is general competence in “skills needed in irregular situations,” so we set the objective of this research as improving “imagination,” “sensitivity to risk,” and “decision-making ability.”

In this research, our objective was to create a training method where “case example sheets” like that in Fig. 2 are used for group discussion. This way, participants imagine possible risks and variations of action patterns according to the situation before the situation actually occurs.

The following covers characteristics of this training according to Fig. 2.

### 3.1 Overview of Training Method

#### 3.1.1. Survey of Existing Training Methods

In studying training methods to improve “competency in identifying the situation and flexibly judging and acting based on that,” we surveyed training methods being performed by other companies. Crew resource management (CRM) is being done by airlines and map exercises by the Self Defense Force and disaster prevention agencies, and the individual methods are characterized by being methods for providing participants with opportunities to think. We believed that in map exercises in particular, a method to assume disasters and the like and simulate actions could be applied to this training method in improving imagination and sensitivity to risk in irregular situations as they are a form where many people participate.

#### 3.1.2 Configuration of Method to Develop

In this research, our objective was to create a training method for railways taking into account the aforementioned examples. Personnel trained need to be made to think of response according to various possible situations in specific disasters and irregular situations, so we studied a configuration as desk training.

Specifically, we studied a training method where “case example sheets” like that in Fig. 2 are used for group discussion. This way, participants imagine possible risks and variations of action patterns according to the situation before the situation actually occurs.

### 3.1.3 Modifications of Scenarios that Lead to Improved Ability to Respond in Irregular Situations

For the “case examples” tried at workplaces, abstract scenarios immediately after an irregular situation occurs were provided where details of the situation are not known, as is shown in the case example sheet in Fig. 2. We expect that participants will be able to improve their imagination by mentally simulating eventual situations. We also made modifications such as intentionally providing scenarios where there is no set conclusion so as to improve sensitivity to risk and to use those simulating urgent situations for making the training improve decision-making ability.

#### 3.1.4 Methods of Expressing Intent that Heightens Quick Decision-making Ability

Methods for participants to express their intent are asking open questions on what should be done such as “What would you do?” and giving a choice of two answers such as with the “Yes/No cards” in the disaster prevention game “Crossroad” to prompt a decision. The open question type has a benefit in that it heightens ability to imagine the action choices themselves. On the other hand, the yes/no type can create opportunities for personnel not used to group discussions to speak up by narrowing down the choices and providing opportunities for making extreme decisions. This training was being attempted for the first time at JR East, so we tried the latter method, which enables participants to experience the urgency of an irregular situation and dilemmas in making decisions.

### 3.1.5 Methods of Providing a Feel of Diversity in Irregular Situations

The objectives of group discussions were to make participants imagine dangerous situations so as to improve imagination and sensitivity to risk as well as to make them aware through questioning by the moderator that actually taking actions is unexpectedly difficult. Specifically, (1) questions for all participants, (2) questions for those who answered “yes,” and (3) questions for those who answered “no.” We provided on the case example sheet with “cues to develop discussion” shown in Fig. 2 so the moderator could present questions at the best timing. (1) is used by both open question type and yes/no type, and (2) and (3) are used with yes/no type. By broadening discussions and providing better images through questions by the moderator as needed in situations that participants tend to overlook, we believe we can expect an improvement in ability to make decisions according to the situation.

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**Fig. 1 Skills Needed in Irregular Situations**

<table>
<thead>
<tr>
<th>Interview Issues</th>
<th>Competencies required to act flexibly</th>
<th>Urgency</th>
<th>Skills needed in irregular situations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training on exiting trains using evacuation ladders shortened time needed to use.</td>
<td>Professional knowledge and skill</td>
<td>Imagination</td>
<td>Sensitivity to risk</td>
</tr>
<tr>
<td>Did not know location of evacuation center, so listened to advice of local passenger.</td>
<td>Ability to think of many variations of how to respond</td>
<td>Sensitivity to risk</td>
<td>Ability to imagine</td>
</tr>
<tr>
<td>Uncertain of what to do when contact could not be made due to reliance on dispatcher instructions.</td>
<td>Ability to imagine what happens even with the information available</td>
<td>Ability to imagine risky events (risk prediction)</td>
<td>Decision-making ability</td>
</tr>
<tr>
<td>Associated intensity of the earthquake with a reunions to prepare to evacuate.</td>
<td>Ability to imagine risky events (risk prediction)</td>
<td>Decision-making ability</td>
<td>Ability to make decisions flexibly</td>
</tr>
<tr>
<td>Dispatcher instructed to stay subdued, but crew judged the situation to be dangerous and asked dispatcher for evacuation instructions.</td>
<td>Ability to judge priorities of actions to take according to the situation</td>
<td>Ability to make decisions flexibly</td>
<td>Tolerance to dilemmas in decision-making in urgent situations</td>
</tr>
<tr>
<td>Priority was put on trying to contact dispatcher, so duties such as evacuation of passengers were delayed.</td>
<td>Ability to calmly decide on the best actions to take</td>
<td>Ability to make decisions flexibly</td>
<td>Tolerance to dilemmas in decision-making in urgent situations</td>
</tr>
<tr>
<td>Exit at a location other than prescribed as to reduce exit time.</td>
<td>Tolerance to dilemmas in decision-making in urgent situations</td>
<td>Ability to make decisions flexibly</td>
<td>(\text{Fig. 1} ) Skills Needed in Irregular Situations</td>
</tr>
</tbody>
</table>
4. Trials of the Training Method and Verification of Results

4.1 Trials

The trials in fiscal 2011 were conducted at six workplaces for crews and personnel involved in station operations and facilities. Participants were about six ordinary employees involved in safety-related activities per location, and the moderator was somebody in an instruction position or in charge of safety. The risks assumed differed by the type of work the participants were involved in, so we prepared scenarios for each job category and tried about three case examples in each trial for the individual job categories. About 20 to 30 minutes were required for each case example.

In the trials, we explained the purview of the training method to moderators and the like in advance, and the moderator conducted the actual procedures. The Safety Research Laboratory conducted duties such as observing operations and progress of discussions. That way, we were able to extract problems and points in need of improvement and to verify the effects.

4.2 Observation of Group Discussions

We observed the relationship between improvement of “competency to foresee risks and to judge and act flexibly in accidents and disasters according to the situation” and the aforementioned abilities required in irregular situations, and we surveyed the effects of this method. This was done while providing an example of an actual group discussion.

4.2.1 Imagination

In the training, we hypothesized that imagination in regard to irregular situations would improve in group discussions on abstract scenarios.

In the example of trials for train crews, they handled the case example of “Smoke breaks out in the cabin while in a tunnel and the train stops due to a signal. Passengers try to open a door to evacuate. Do you stop them?” By intentionally giving an abstract scenario without details such as number of cars, tunnel length, and number of passengers, the variations of evacuation guidance actions that should be taken differing was discussed (have passengers take actions on their own upon giving evacuation instructions, put priority on initial fire extinguishing, attempt to move the train out of the tunnel, etc.). Subsequent developments differing depending on the relationship of train length and location of fire, track being single or double track, and other factors as information sources to correctly identify the situation were discussed.

Also, one participant proposed backing up the train if the tunnel entrance to the rear of the train is closer, a risk avoidance method not thought of by most other participants. We believe that gaining insight from what others say through discussions by large groups in ordinary times and broadening the scope of methods of overcoming issues will lead to increased imagination when encountering irregular situations.

4.2.2 Sensitivity to Risk

One way of heightening sensitivity to risk is by providing scenarios without a set outcome given and having the moderator pose questions.

For example, when the moderator posed questions on points to be cautious of when having passengers evacuate on their own was selected in the aforementioned example, other participants discussed points such as how to reduce time needed for evacuation when crowded, the possibility of the tunnel being dark, and the risk of a train coming from the opposite direction. Such presentation of scenarios without set outcomes, in-depth discussion under the guidance of the moderator, and group discussion, was found to be useful as an opportunity to imagine risks accompanying such methods of overcoming issues.

The Safety Research Laboratory prepared the scenarios this time. But preparing and discussing scenarios fitting individual workplaces is expected to further improve sensitivity to risk in in day-to-day work.

4.2.3 Decision-making Ability

To increase decision-making ability, we used training on decision-making in urgent situations such as serious accidents as well as presentation of situations difficult for participants to imagine and more severe scenarios by the moderator.

In the example of discussing the most appropriate way to overcome issues for the aforementioned case example, operation methods for procedures to pass the stop signal ahead were proposed as a way to attempt to escape the tunnel, and various actions such as guiding to evacuate from that spot and priority of initial fire extinguishing were discussed. But by the moderator providing various specific situations and restrictive conditions, we found that there would be risk no matter what method was adopted. Therefore, the “optimal method” would differ depending on conditions such as the relation of tunnel length and stop position, number of passengers, and the extent of the smoke.

In other words, making personnel understand that identifying the situation faced and quickly selecting the method to overcome this situation is key to making appropriate decisions in irregular
situations. By using training methods such as this that can simulate serious accidents and disasters, case examples that cannot be completely covered by manuals and the like and opportunities for extreme decision-making not seen in day-to-day operations could be provided. We believe that the importance of broadening choices of actions in decision-making and imagining risks could be sensed through this training method as well as “safety” always being the key to decision-making.

Continuing with such training to make decisions on one’s own may at the same time also contribute to imagining risks accompanying individual actions and improving speed of deciding what actions should be taken.

4.2.4 Summary of Group Discussions
As noted in 4.2.1 to 4.2.3, details of scenarios and response of training participants differed to some extent according the work that the participants were involved in. However, even in workplaces other than the aforementioned example of that for train crews, results of verification of group discussions were about the same. From this, we believe that we can increase group discussions using this training method the number of options for overcoming situations, contributing to improvement of ability to imagine various risks, sensitivity to risk, decision-making ability, and ability to act.

4.2.5 Interview of Participants
Participants in this training suggested that training by this method improves “competency in identifying the situation and flexibly judging and acting based on that.” This is demonstrated by their impressions such as that, “By thinking, even in normal situations, of case examples anticipating irregular situations, decision-making and taking action in irregular situations becomes faster and options for making decisions expand.” (improved decision-making ability and ability to act) and “Without such an opportunity, I would not be able to imagine irregular situations. I got a feeling for how appropriate decision-making differs according to the situation.” (improved imagination and decision-making ability).

Opinions from personnel in instruction positions showed that, compared to ordinary group discussions, participants’ awareness of being concerned parties improved. This was demonstrated by responses such as “Even personnel who seldom express their opinions actively participated in discussions.”

The results of this verification thus suggested the possibility of improving imagination, sensitivity to risk, and decision-making ability through training by this method. We were thus able to propose a specific method of heightening ability of personnel to think on their own and respond flexibly in disasters and serious accidents.

5 Modification of the Training Method
Some issues in the details of the trials of the previous chapter came to light, however. For that reason, modifications were made in a few places in fiscal 2012. The following introduces the modifications made.

5.1 Abstract Scenarios
The following opinions were given regarding the details of the scenarios:
(1) There was no sum-up after the training, so some questions were left unanswered.
(2) I didn’t know if the actions I assumed were correct, so was uncertain about what actions to take in actual situations.
(3) The scenarios were vague, so discussions were not specific.

Training at JR East is mainly to perform work for specific incidents where there is a clear answer based on manuals. This was the first attempt at training using abstract scenarios, so uncertainty was seen amongst participants. That uncertainty was caused by participants not having experienced such training before and the objective of the training—to increase the variation of conditions from abstract situations—was not sufficiently articulated to participants. Therefore, we decided to sufficiently explain to participants at the start of training that there is no one correct answer and that answers differ depending on the situation. That way, we hope to increase their understanding of the training.

5.2 Uncertainty about Changing Opinion
In this training, participants first listen to a scenario provided, imagine an irregular situation, and express what actions they intend to take. Next, they hold group discussions, but some participants continue to assert in those discussions the intention that they originally expressed.

The purpose of this training, however, is to raise ability to flexibly make decisions according various conditions in irregular situations. In other words, it is important to understand that actions must change according to the situation.

Two incidents of crews acting flexibly according to the situation stand out in the March 11, 2011 Great East Japan Earthquake. In the first, a crew had passengers get off the train and head to an evacuation center specified in the manual, but upon the suggestion of local residents, they evacuated the passengers to a location on higher ground instead. The ensuing tsunami ended up flooding the evacuation center specified in the manual, but that flooding was avoided by changing to a location on higher ground.

In another incident, the crew was instructed by a dispatcher to evacuate from the stopped train. However, passengers who lived in the area pointed out that the place where the train was stopped was the highest point in the area, advising that it would be best to stay put. The crew thus decided they should stay where they were, saving all the passengers from the tsunami.

In this way, it is clear that initial decisions can change according to the situation. So, we explained to participants that it is important to change the initially expressed intention if something new is realized through the group discussions during training.

Specifically, we noted in the training manual that it is OK to change one’s intention during discussions. We also decided to ask the moderator to tell participants that their first intention could be changed during the discussions.
5.3 Modifying Facilitation
The method of conducting this training is as introduced in chapter 3. Specifically, participants listen to a scenario provided and first decide what actions they intend to take. Then, in group discussions, they listen to the opinions of others.

We observed many instances of training being conducted, and we saw that there were differences between groups in terms of the liveliness of discussions. Some groups actively exchanged opinions, while a few did not see many opinions given, resulting in opinion exchange stalling. One possible reason is that, as noted in 5.1, participants felt uncertainty as the training was completely different from that traditionally used at JR East. Another reason may be differences in the facilitation ability of moderators.

The moderator for group discussions in this training is not stipulated in advance, and he or she is nominated by consultations within the group. Therefore, someone who is not used to proceedings of group discussions may become the moderator. We thus thought that a method of leading discussion was needed for the moderator, and we made the following two modifications.

(1) “Cues to develop discussion” are noted at the bottom of case example scenarios as shown in Fig. 3, but we prepared a Q&A list that can be referred to when one is appointed moderator.

(2) We added to the training manual items to support moderators. Modifications were made so active exchange of opinions could be promoted within the group by showing specific cautions (role of moderator, stance of the moderator, points for the moderator to heed) that the moderator can refer to in order to further discussions.

6.1 Method of Assessing Post-training Level of Memories
Taking Hold and Awareness of Effectiveness of Training
A questionnaire survey was conducted two months after the training to verify to what extent training had taken hold. This was done by confirming for 31 participants how well situations imagined in training had taken hold and the effectiveness of training.

The questionnaire noted the scenario of Fig. 3 used two months prior. Participants read to themselves the details of the training and wrote down the following, from which the effects of the training were verified.

(1) By having participants write down the details of training two months prior as they remembered it, we measured to what extent situations imagined in training had taken hold.

(2) To confirm the effectiveness of training, we first asked participants if they envisaged and thought about some irregular situations after training and if they came to think about evacuation of passengers in irregular situations from different perspectives (self motivation).

(3) As another index of effectiveness, we asked if they wanted to utilize this training for employees of group companies who usually work with them (repercussion).

6.2 Results of Assessment Two Months After Training
The following are the results of the assessment covered in the previous section.

(1) Making situations imagined in training take hold
When having participants of the previous round of training write down responses on questionnaire sheets, we found that 28 out of 31 remembered the details of training two months prior.

From that, we believed that the decision-making options imagined in training remained in their memories, and we found that those took hold as memories.

(2) Self motivation of trainees to undergo training
In the questionnaire survey of participants, 24 out of 31 responded that they came to think about what to do in irregular situations that rarely occur. Also, 23 out of 31 responded that they came to envisage and consider various cases of guiding passengers in irregular situations.

From these results, we can say that participants came to imagine irregular situations and think on their own after training.

(3) Repercussion of training to others
Out of the 31 participants asked, 30 responded that they would like to introduce the training to group companies and partner companies other than their own worksite and have them undergo training for irregular situations. From this, we confirmed a certain amount of repercussion.

In light of the above, we confirmed to a certain extent the effectiveness of training for flexible decision-making in disasters and other irregular situations.
Conclusion

JR East developed a training method in fiscal 2011 for heightening ability to foresee risks and to make decisions and act flexibly in accidents and disasters according to the situation in irregular situations. As shown in chapter 4, we conducted trials in 2011 and confirmed through observation and interviews that the training method developed is useful in heightening imagination, sensitivity to risk, and decision-making ability, all skills needed in irregular situations. Meanwhile, we made modifications to details of the training method in fiscal 2012 based on the aforementioned observations and interviews. By verifying effects of training from the standpoints of it taking hold, self motivation of participants, and repercussions of the training, we confirmed its effectiveness.

Manuals for promoting introduction of the training have been prepared covering items including (1) background to introduction, (2) overview of training, (3) specific methods of implementing training, and (4) how to create one’s own scenarios. Scenarios for case examples fitting individual types of work have also been prepared and introduced to personnel by in-company magazines and the like. And they have been utilized in various in-company safety lectures and education as well as training by individual workplaces.

Training manuals, scenarios, and the like have been released for company personnel on one of the company's information portal sites, the safety portal on the company's intranet. That way, an environment has been put in place to make training easy to implement by various workplaces by downloading manuals and scenarios from company computers.

In the future, we plan to provide support so individual workplaces can create scenarios on their own in accordance with their individual characteristics and conduct training. That will be done while continuing to research training methods.

Reference:
3) Toshiko Kikkawa, Katsuya Yamori, Atsuyo, Jyunkichi Sugiura, *Crossroad... and more* (Nakanishiya Shuppan, July 2009)