Improving the ability to direct the rescue of passengers and oversee restoration in the event of a major railway disorder

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Abstract. To minimize disruptions caused by railway disorders, we need to create a situation in which an on-site command system functions as effectively and smoothly as possible, where the director in particular plays a central role. Accordingly, we interviewed employees who have had experience of director in such situation. As a result, we found that both non-technical skills and his psychological readiness were required of the director to ensure that his directions would be followed out.

Keywords. Non-technical skills, Group dynamics, Leadership, Resilience Engineering

1. Introduction

In August 2015, a power failure occurred in the vicinity of Yokohama station when an overhead contact line was cut. When this occurred, we rescued passengers from two trains stopped on the tracks and led them the nearest station. It took over six hours to perform recovery work and about 350,000 passengers were affected.

JR East is needed to create a situation in which the On-Site Emergency Base (hereafter ”Base”) establish the on-site command system quickly and smoothly when there is a possibility that the railway disorder will become a large scale.

Base director makes sure passengers are guided to the nearest station from a stopped train. The director also coordinates the recovery of damaged equipment, transmission of relevant information to concerned departments such as the train operation, rail facilities, publicity etc., and activities with police and fire departments. He assigns team leaders to perform the above duties under his control, and works in close cooperation with the area branch office headquarters, as well as with the transportation headquarters responsible for operation and management of the train.

The Base director in particular plays an important role in minimizing to impact of rail disruptions. We thus interviewed employees who had experience as director, in order to understand the requirements for playing this role.

2. About the Base

2.1 Establishment of the Base

We establish specific communication and recovery systems according to a manual when large-scale railway disorders. Below is an excerpt of a description of the Base as described in the manual.
Purpose of establishment] A large number of people are required to work when a large-scale railway disorder occurs. At the scene of an accident, it is necessary outside of their normal line of duty to prevent secondary accidents or injuries, through an efficient system of communication, for which the Base is established.

[Standard of establishment] Being established in the case of a disorder requiring a long period of time for recovery, making train operations difficult over a long period of time or in which there have been fatalities or injuries of passengers or employees. It may also be established in the case of an event in which there is a risk of such situation occurring.

[Instructions for establishment] The transportation headquarters will assign an appropriate person to establish the Base from among the employees dispatched to the scene of the accident.

[Appointment of director] The manager of the station in charge of the area in which a disorder was occurred (district station manager) is responsible as director. Until the district station manager arrives at the scene, the highest ranking employee among all present will be responsible, handing over a responsibility to higher-ranking employee upon their arrival on the scene.

2.2 Composition of the Base

A passenger rescue team, a recovery team and a communication team are formed under the Base director. Figure 1 shows the system at the time of a major railway disorder, including the organization of the Base.

![Figure 1 Overall system at the time of a major railway disorder](image-url)
Table 1 Overview of the director’s tasks

<table>
<thead>
<tr>
<th>Early response</th>
<th>Recovery work</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Rush immediately to the scene of the accident</td>
<td>● Regularly hold meetings at the Base</td>
</tr>
<tr>
<td>● Contact transportation headquarters</td>
<td>● Understand current status, development, and expected work completion</td>
</tr>
<tr>
<td>• Establish the Base</td>
<td>● Share workload information of each team</td>
</tr>
<tr>
<td>• Check the status of operation suspension</td>
<td>● Prioritize multiple tasks</td>
</tr>
<tr>
<td>● Confirm injuries, provide relief</td>
<td>● Adjust between teams</td>
</tr>
<tr>
<td>● Understand cause of failure and trouble</td>
<td>● Send information to the branch office headquarters</td>
</tr>
<tr>
<td>● Rescue Passengers</td>
<td>● Necessary arrangements (meals, breaks, media etc.)</td>
</tr>
<tr>
<td>● Hold the 1st meeting at the Base</td>
<td>● Respond to unforeseen circumstances</td>
</tr>
<tr>
<td>• Confirm all team leaders</td>
<td>● Check whether workers remain in the track</td>
</tr>
<tr>
<td>• Make a communication system within the Base and between the branch</td>
<td>● Report when work is over</td>
</tr>
<tr>
<td>office headquarters and the transportation headquarters</td>
<td></td>
</tr>
<tr>
<td>● Coordinate with police and fire departments</td>
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</table>

2.3 Overall picture of the director's task
There are many tasks to carry out as part of early response, but are usually the same in each case. In recovery work, tasks depend on the type of failure or trouble and how the situation develops. An overview of the Base director's tasks according to early response and recovery work phases as prescribed in the manual are presented in Table 1.

3. Issues that might interfere with the role of the Base director

On-Site Emergency Bases were established 14 times (4.7 per year on average) for railway disorders in the Tokyo metropolitan area occurring from FY 2013 to 2015 (Examples: signal device failure, fallen electric pole, cut overhead contact line, cable burnout, failed and stalled locomotive, track flooding). We analyzed confidential reports on these railway disorders and organized the problem in regards to the Bases.

3.1 Base establishment delayed, district station manager not responsible for early response
In the 14 events in which Bases were established, it took 80 minutes on average from the occurrence of disorder for the Base to be established and 134 minutes average for the district station manager to arrive. Many of these occurred late at night, early in the morning or on holidays, so delay by the district station manager was inevitable. Therefore, it is key to improve the performance of the personnel responsible for arriving on the scene first (manager of operations or branch office employee).
3.2 Causes of major railway disorders are extremely varied

The causes of major railway disorders vary, as shown at the beginning of this chapter, and there were also cases where several failures and types of trouble occurred simultaneously. Therefore, Base operations did not proceed according to the manual, and flexible responses corresponding to the situation were required.

Also, railway disorders occur day and night on any day of the week. It is pointed out that, as a result, securing human resources and materials can be difficult depending on the situation.

3.3 Problems tend to be concentrated in the early response phase

In this phase, the director is confronted with situation competing for his attention (e.g., passenger rescue and facility repair) and faces dilemma when making decisions.

3.4 Low frequency of opportunity

Since the frequency of Base establishment is once every 2 or 3 months, many stationmasters finished their tenure without any director's experience at all. Therefore, it was found difficult to perform the role of director, especially understanding the manual and the accumulating experience. It turned out that there were many employees who felt uneasy about assignment to the duty from interviews described below.

4. Document research

In addition to the above-mentioned confidential reports on 14 railway disorders, we analyzed in-house document which described the experiences of employees involved in the establishment and operation of the On-Site Emergency Bases.

"Record of recovery activities of train derailment accident on Kawasaki station premises, February 2014"

- [About the accident] A roadrailer entered a track before it was to be closed for the night and collided with a deadheaded train running on the same track. When the driver of the roadrailer received an instruction from the safety leader to move to a point in the middle, he assumed that he could move it into a section of the track that had not been closed yet. Two cars of the deadheaded train derailed and overturned, and two crew members were injured. Recovery took a whole day.

"JR East Chroniclers of Safety Seminar lecture text"

- Train collision accident on Otsuki station premises, October 1997.
  When an express train passed on the main line at high speed, a driver of some shunting cars misunderstood the shunting signal, started moving cars and hit the side of the express train. Many express train cars and shunting cars derailed, and one of the express train cars overturned. 78 passengers were injured, and recovery took about 36 hours.

- Derailment accident on Utsunomiya station premises, October 1996.
  Shunting cars derailed as a result of having forgotten to remove chocks. Many ground facilities such as switches and sleepers were broken. Recovery took about 8 hours.

Furthermore, we analyzed papers and books on which the results of research for countermeasures with headquarter responses were written, in cases of disasters.
Niigata Prefecture Earthquake (October 2004, 59 deaths, about 120,000 houses damaged)

- Emergency response efforts applying the incident command system by local government in the Hurricane Katrina (August 2005, about 1,300 deaths, 1,200,000 damaged houses).
- A book that summarizes examples of responses by the national government in the Great East Japan Earthquake of March 2011 (The largest earthquake to hit Japan in recorded history; about 25,000 dead and missing, 400,000 houses collapsed or were partially destroyed, disastrous damage occurred to the coastal area due to a huge tsunami with maximum wave heights of 10 m or more. These served as guides to the command of early response (e.g. understanding to importance of establishing an early response system within the first hour).

5. Requirements for the Base director to properly fulfill role, as obtained from interviews

We interviewed seven employees with experience as director within the past three years. A semi-structured interview method was adopted so that the order of the questions can be changed according to the answer. In addition, interviews were conducted using an interview method of 2 interviewers and 1 respondent to prevent outside influence.

   When a fire broke out in a building adjacent to Yurakucho station, employees evacuated passengers and suspended operation of affected lines including the Shinkansen. After confirming with firefighters that there was no danger of the fire spreading to railway facilities, the employees resumed operation. As a consequence, trains scheduled to run in the vicinity could not operate at all for about 6 hours. It caused 619 trains to be canceled (including cancelations by section), affecting about 270,000 passengers.

2. Failure of overhead contact line on Tokyo station premises, December 25, 2014.
   An anchor bolt of a metal fitting holding an overhead contact line broke for some reason and insulator suspended. After that, when a train passed through, all pantographs were damaged and a blackout occurred. The damaged train was connected to another train and housed in the car depots while repair of the overhead contact line was done on the spot. As a consequence, trains scheduled to run in the vicinity could not operate at all for about 6 hours. It caused 76 trains to be canceled (including cancelations by section), affecting about 67,000 passengers.

3. Fallen electric pole near Akihabara station, April 12, 2015.
   One of the two pairs of electric poles laid between the Yamanote line inner and outer lines fell, blocking these tracks and suspended operation of affected lines. Employees called crane trucks on site and carried out recovery works. As a consequence, trains scheduled to run in the vicinity could not operate at all for about 11 hours. It caused 715 trains to be canceled (including cancelations by section), affecting about 410,000 passengers.

4. Track flooding due to the breakdown of underground water drainage pump near Tokyo station, December 5, 2015.
   A groundwater discharge pump in a tunnel stopped due to accumulated mud. Because the overflowing groundwater flooded railroad tracks, employees drained with a pump provided for the emergency. In consequence, trains scheduled to run in the vicinity could not operate at all for about 13 hours. It caused 173 trains to be canceled (including cancelations by section), affecting about 77,000 passengers.

   During the exchange of feeders at night, workers accidently broke an electric pole, blocking the track. In consequence, morning trains scheduled to run in the vicinity could not operate at all for about 6 hours from the first morning train. It caused 156 trains to be canceled
5.1 Requirements to be fulfilled by a Base director

From interviews to employees with experience as Base director, we obtained a variety of data on factors that would allow them to serve as director, as well as other problematic factors. We classified these factors and problems according to the level of ability that the director should have. We further rearranged these as requirements for fulfilling the role of director. As a result, we were able to concentrate on the “physical and environmental requirements” and “human requirements” as described below.

- Preparedness within assigned area (physical and environmental requirements).
- Having knowledge of what is written in manual regarding each task and being able to act using the corresponding technical skills. In addition, having “non-technical skills” and "psychological preparation" to effectively fulfill the role of director, and utilize them in action (personal requirements).

The definition of personal skills etc. to be possessed by the director used here are as follows.
- "Knowledge": Knowledge of tasks described in the manual, such as "what you should do next is...."
- "Technical skills": Professional skills necessary for executing tasks based on the above "knowledge".
- "Non-technical skills": Skills such as cognitive and social skills that complement technical skills, and contribute to safe and efficient task performance.
- "Psychological Preparedness": A prepared attitude for overcoming psychological and contextual elements that prevent task execution. We added this item especially because we found from the interviews that there were many employees who felt uneasy about dealing with the Base director.

5.2 Physical and environmental requirements

We found out that preparing necessary items in advance led to smooth response on site. For example, "Having materials such as whiteboards and generators already loaded on an emergency vehicle needed the smooth launch of the Base". In addition to the preparation of goods, there were cases where daily collaboration with police stations and fire departments, for example, brought about a smooth response at the time of the emergency. On the other hand, there were also episodes where these deficiencies brought about a corresponding stumbling block.
Table 2: Examples of "knowledge," "technical skills," "non-technical skills" and "psychological readiness" for successfully carrying out director's tasks

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Knowledge</th>
<th>Technical skills</th>
<th>Non-technical skills</th>
<th>Psychological readiness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirm injuries and provide relief</td>
<td>Confirm injuries</td>
<td>Confirm with drivers and transportation headquarters</td>
<td>After arriving at the scene of the accident, confirm immediately the suspension of the adjacent line operations “situational awareness”</td>
<td>When there are injuries, assign recovery workers to relief work</td>
</tr>
<tr>
<td>Passenger rescue</td>
<td>Where a train is stopped between stations, have passengers a light by ladder and guide them to safety</td>
<td>Obtain staff necessary for guiding passengers to safety; decide path and destination</td>
<td>Apply “leadership” by assigning labor personnel to first assist with passenger relief; Apply “teamwork” by obtaining information from anyone familiar with local area to advise on route decision</td>
<td>Think about the stress of passengers trapped in the car, such as temperature, congestion, etc; Make quick decisions</td>
</tr>
<tr>
<td>Hold Regular meetings at the Base</td>
<td>Understand current status, progress, and expected work completion</td>
<td>Gather all team leaders; Illustrate steps of each operation to help understand overall progress and prospect of completion</td>
<td>In a case of conflict between tasks, adjust in order to minimize interference “decision making”</td>
<td>Do not be afraid to discuss the arguments from both sides and find consensus; No need to understand all the details</td>
</tr>
<tr>
<td>Send information to branch office headquarters</td>
<td>Assign full-time staffs in charge of information and have them dispense of it simply in time</td>
<td>Clear information is sent simply and in time “communication”</td>
<td>Keep in mind that there are elements that can interfere with the proper transmission of information, such as technical failure or misunderstanding on the part of the recipient</td>
<td></td>
</tr>
</tbody>
</table>

*Words in quotation marks are the main categories of non-technical skills by R. Flin.et.al.*
5.3 Personal requirements

We analyzed interviews with employees with experienced as Base director regarding each task mentioned above, and organized the requirements for successfully carrying out these tasks using the "knowledge," "technical skills," "non-technical skills" and "psychological readiness" criteria. Examples are shown in Table 2.

6. A study on methods to improve the capability of the Base director not to waste time in establishing the early response system

We organized the issues facing the Base director in effectively fulfilling his role, and the requirements to successfully carry out tasks. We are currently developing a method to improve the capability of the director to efficiently and quickly establish an early response system, since there were numerous issues in this phase in particular.

6.1 Who should be trained?
The subjects should be Chiefs and assistant managers of institutions, and employees of branch offices. When a major railway disorder occurs, some of them will be in a position responsible for prompt dispatch and establishment of a Base. About 1,500 employees are eligible for training.

6.2 How to implement the training

After the major railway disorder in Yokohama mentioned in Chapter 1, all branch offices have been conducting annual large-scale training to be able to set up a branch office headquarters and a Base. While it is impossible to educate all eligible with such large-scale training, it is also difficult to establish new training opportunities. Therefore, we have decided to consider structuring the content and volume of this education by assuming the following as an educational opportunity.

- Some target employees can acquire the requirements to fulfill the role of Base director through an annual large-scale training.
- Incorporate the requirements for Base directors into the assistant managers training held at branch offices. We can adjust the content and volume to incorporate it into the training.
- We can also create an environment in which individuals can learn to spare time from their work. We can also adjust the content and volume to a self-study made.

In view of the above, the requirements for teaching materials would be as follows.

- Subjects need to be able to picture an actual situation of the Base.
- Subjects need to be able to have a concrete image, such as the atmosphere of the Base, the roles of director and actions of other employees, just by self-study materials.
- Subjects need to be able to learn the requirements for Base director in a short time.

6.3 Composition of teaching materials

We compare the composition of teaching materials that satisfy the teaching material requirements and can also maximize educational effect provided in Table 3. We have developed an image training program for unusual situations that was expected to improve operator’s ability to manage trade-offs in a crisis and enhance the resilience of individual workers as well as groups of workers.
### Table 3 Comparison of teaching materials

<table>
<thead>
<tr>
<th>Teaching materials</th>
<th>Leaflet</th>
<th>Illustrated teaching material</th>
<th>Image training program for unusual situations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time required</td>
<td>Depends on the quantity</td>
<td>short</td>
<td>long</td>
</tr>
<tr>
<td>Advantages</td>
<td>Acquire extensive knowledge</td>
<td>Easy to picture the situation</td>
<td>Acquire imagination skill, sensitivity to risk, and decision-making ability</td>
</tr>
<tr>
<td>Disadvantages</td>
<td>Hard to understand</td>
<td>Can only be used in specific cases</td>
<td>Requires a facilitator</td>
</tr>
</tbody>
</table>

The teaching materials must give a clear idea of the Base, which most employees have never experienced. Therefore, we have decided on a number of a group of teaching materials, consisting of illustrations that subjects can utilize as a basic teaching material, a leaflet for attaining knowledge as a supplementary teaching material and image training program as an applied teaching material for unusual situations that enhance ability to act flexibly. Furthermore, we can develop them with the following functions.

1. To provide an image of the role and function imposed on the Base.
2. To understand requirements for Base director, along with the confusion and mental conflict that arises in the early response stage.
3. To improve the director’s ability to cope flexibly while making full use of “non-technical skills” and “psychological preparedness”.

These are the initiatives we are currently pursuing.

### 7. Conclusion

The main issues regarding the director and his role in a Base as established upon the occurrence of a large-scale railway disorder were obtained as follows.

- Major railway disorders rarely occur, but once they do, the director is required to demonstrate a certain level of performance.
- It is difficult to familiarize oneself with the role and behavior of director from superficial understanding obtained merely from a manual or accumulated experience, and furthermore obtained the director is required to respond flexibly according to circumstances.

From interviews with employees with experience as Base director, we obtained a variety of data on factors that could be used in serving as director, as well as factors that would hamper and prove problematic. We classified these factors and problems according to the capability that the director should have.

Based on these issues, we concentrated on the requirements for a director based on “physical and environmental requirements” and “personal requirements”. In this study, we focused on “personal requirements” and got knowledge, technical skills, non-technical skills, and psychological preparation regarding each task into shape as requirements to improve director’s performance.

We will develop teaching materials for people who are potential Base directors to assist them in their role when the circumstances arise.
References