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Supplementary Remarks on Lessons Learned from the Great East Japan Earthquake

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Abstract:

This paper takes a broad look at non-nuclear socio-technical systems that demonstrated highly resilient behavior during and after the Great East Japan Earthquake and tsunami. The lessons described in the accompanying papers are re-examined in conjunction with the responses exhibited by various organizations. After a preliminary review of cases from various sectors, a more detailed review was conducted on the activities of three organizations: Tohoku Electric Power Company, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and the Ishinomaki Red Cross Hospital. Through this review, which was carried out based on the guidelines provided from Resilience Engineering, it became evident that valuable lessons are effectively derived from good practices emergently conducted during and after the earthquake and tsunami.

Keywords: Critical Infrastructure Resilience, Resilience Engineering, Good Practice, Lesson Learning

1. INTRODUCTION

Innumerable problems and failures have been pointed out in the responses of various socio-technical systems concerning the Great East Japan Earthquake. Many countermeasures have been proposed based on the simple principle of preventing recurrence by removing the causes of problems or protecting the systems against the causes of failure. This “find-and-fix” approach is effective to a certain degree in improving the safety of the given socio-technical systems and in deriving lessons that are applicable to other socio-technical systems. However, reliance on this approach alone is not enough. It would be better to adopt a broader perspective so that we can learn as much as possible from a major disaster like the Great East Japan Earthquake.

The importance of paying attention to good practices when trying to derive lessons has been emphasized in the two preceding reports from this workshop. The present paper supplements the reports by examining the possibility of deriving lessons from non-nuclear socio-technical systems that demonstrated high performance in resisting the Great East Japan Earthquake. Typical examples of such systems are found in various sectors such as railway, shipping, electric power, gas, oil, telecommunication, medical and local government administration. Good practices demonstrated by such examples have been included in published documents on a sector-by-sector basis. However, cross-sectoral studies of good practices have not been performed. Accordingly, this paper provides an overview of examples from different sectors and reports on our attempts to derive lessons from examples from the electric power sector, the transportation sector (focusing on the function of MLIT) and the medical sector, which played important roles in providing relief to the victims after the earthquake. The purpose of this report is to examine the generality or applicability of observations made in the two preceding reports through these attempts to derive lessons.

2. METHOD

The two preceding reports indicated the usefulness of following the guidelines proposed by Resilience Engineering as part of the methodology when trying to derive valuable lessons from good practices. The present study adopted the same approach, i.e., the four core capabilities suggested by Resilience Engineering (Hollnagel, 2009), their supplementary requirements and a supporting factor model for responding successfully proposed in our previous studies (Yoshizawa et al., 2015). Based on these models, the case study was performed.

The abovementioned four well-known core capabilities (sometimes called four cornerstones) emphasized by Resilience Engineering are as follows (Hollnagel, 2009):

- Responding, i.e., knowing what to do;
- Monitoring, i.e., knowing what to look for;
- Anticipating, i.e., knowing what to expect;
- Learning, i.e., knowing what has happened.

In addition to the above, Yoshizawa et al. (2015) emphasized the importance of explicitly describing the following four supplementary requirements:

- Preparation and allocation of appropriate resources;
- Proactive rather than reactive actions;
- Learning from success and good practices;
- Capability of noticing.

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The importance of these supplementary requirements has been mentioned by researchers of Resilience Engineering (Hollnagel, 2009; Lay, 2011). However, those who attempt to apply in practice their introductory knowledge about Resilience Engineering tend to focus on the four core capabilities, failing to pay enough attention to the supplementary requirements. Therefore, these four supplementary requirements should be explicitly described.

Needless to say, readiness for effective resilient behavior should be ensured by the technical and non-technical skills, attitude, and physical and mental health of field staff, while successfully maintaining the quality of the working environment (Komatsubara, 2011; Yoshizawa et al., 2015). Studying examples and reviewing scenarios with attention to these capabilities and requirements makes it possible to effectively derive lessons from good practices.

Specifically, this study followed the procedure below:

Step 1: Identify examples of high performance and core activities in these examples.

Step 2: Identify supporting factors enabling such activities in consideration of the four core capabilities emphasized by Resilience Engineering, the supplementary requirements and the Yoshizawa model.

Step 3: Formulate lessons by compiling or organizing identified factors.

3. CASES

3.1 Good Practices

Since this study aims to derive lessons from the good practices of responding to the Great East Japan Earthquake, it focused on examples pertaining to critical infrastructure that plays an important role in surviving and recovering from a major disaster. Based on the results of a preliminary study that covered sectors such as electric power, gas, oil, food, medical and telecommunication, the following examples were identified from three different sectors as typical examples of socio-technical systems or their grouping that demonstrated highly resilient performance.

In the service area of Tohoku Electric Power Company, the earthquake caused the interruption of power supply to 4.86 million households. As a result of the shutdown of a number of thermal and nuclear power plants along the Pacific coast, the company lost 6 GW of its 16 GW of generation capacity. Nevertheless, the company resumed the supply of power to about 80% of the abovementioned 4.86 million households within three days after the earthquake. By the end of March (i.e., within three weeks after the earthquake), the company had resumed the supply of power to 96% of the households. Considering that the availability of electric power is a key factor in the recovery of other types of social infrastructure, this quick recovery of power supply greatly contributed to the recovery efforts in many other sectors.

The Tohoku Regional Development Bureau of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) led the efforts to quickly reopen access ways to the devastated coastal area. Assuming the complete loss of coastal roads, the project was implemented in three stages: Stage 1 – ensuring traffic routes on north-to-south main roads, namely, the Tohoku Expressway and National Highway Route 4; Stage 2 – opening roads and removing obstacles to establish comb-like traffic routes extending from the north-to-south main roads to the east; and Stage 3 – rebuilding coastal roads. There were innumerable challenges: roads and bridges had suffered devastating damage, it was difficult to procure heavy construction machinery and find operators, and fuel was scarce. Nevertheless, Stage 1 was completed by the end of the day on March 11. As to Stage 2, 11 of 15 routes were reopened by the end of the day on March 12 and the remaining routes by March 15. As to Stage 3, 97% of the routes were reopened within one week after the earthquake. This performance is also one of the important activities that helped improve the efficiency of disaster relief actions.

The actions taken by medical institutions are another important factor that contributed to reducing the damage from the great disaster. In the Tohoku area, many of the hospitals along the Pacific coast lost their functions due to damage from the tsunami. However, being on high ground, the Ishinomaki Red Cross Hospital was undamaged. This is a general hospital with approximately 400 beds, 100 doctors and 350 nurses, and also serves as a regional emergency rescue center. After the loss of grid power, the hospital was able to sustain minimum use of facilities by relying on emergency power generators. While the number of patients requiring emergency care is normally about 60 persons a day, more than 1,200 patients were at the hospital on the day after the earthquake. In addition, local residents arrived at the hospital looking for shelter. A highly tense situation emerged as food supplies, drinking water, medical-use water, medicine, etc., were at risk of running out. Many difficulties were faced both within the hospital and in interacting with outside parties. Despite such adversities, the hospital remained functional as a result of intense efforts and thus saved many lives. Finally, on April 11, the hospital resumed normal services to outpatients.

3.2 Contributing Factors

Tohoku Electric Power Company

A firm attitude, characterized by a strong sense of mission in maintaining the supply of electric power, was shared across all corporate divisions including the transmission and distribution (T&D) division. A group of 375 persons from the undamaged Niigata Branch Office, constituting the first team that provided proactive support, began their response activities at 15:30, shortly after the earthquake. Before departing, they ensured self-sufficiency by preparing resources such as food supplies, water and tents in addition to the equipment required for restoration work. Within 48 hours after the earthquake, the Niigata Branch Office dispatched about 700 employees, namely about 60% of its T&D division members, to Sendai and nearby localities. This entailed careful planning as demonstrated by the dispatch not only of technicians but also administrative staff members in charge of logistics. The head office procured and made use of seven