Experimental Study on Disaster Risk Assessment and Area Business Continuity Planning in Industry Agglomerated Areas

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ABSTRACT:

Recent large scale disasters reminded us of the risks of business interruption and further impacts on national, regional and the global economies through their supply chain. Business Continuity Plan (BCP) or the management (BCM) system, of some private enterprises, helped them endure in these catastrophic events to some extent. However, due to disruption of essential resources such as energy, water, transportation and communications, it finally was not possible to support business continuity only by individual BCP/BCM.

In order to minimize economic impacts or losses in case of large scale disaster that disrupts fundamental infrastructure in certain impacted areas, it is important to carry out risk assessment in proper scale and scenario based contingency planning of area damage mitigation. Furthermore, integrated resource management and strategic recovery at a scale of a whole industrial area are critical as a foundation for each enterprise's BCP/BCM action in concert with the public sector's actions.

The Japan International Cooperation Agency (JICA) undertook a study on disaster risk assessment and formulation of "Area BCP", as a new concept of disaster risk management in industrial agglomerated areas based on the lessons learnt from recent disasters. The Area BCP describes a framework and direction of coordinated damage mitigation measures and recovery actions of stakeholders including individual enterprises, industrial area managers, local authorities and administrator of the infrastructures in order for business continuation of the industrial cluster as a whole.

The study introduced the concept of Area BCP/BCM and attested its formulation in the three pilot areas, in Indonesia, the Philippines and Vietnam. For each area, multi-hazard risk assessment and scenario based business impact analysis have been conducted. Formulation of the Area BCP is under process through a series of discussions among relevant organizations including government, infrastructure operators, industrial complex managers and private enterprises.

Key Words: *disaster risk assessment, Business Continuity Plan, Area BCP, risk management*

1. INTRODUCTION

The Great East Japan Earthquake and Tsunami in 2011 put an incredible strain on the national economy and also had global impacts through the supply chains of industry: as an example, the supply of Japanese-made vehicle parts to automobile assembly plants around the world was severely disrupted[1)].

The 2011 Flood of Chao Phraya River in Thailand again reminded us of the risks of business termination and further impacts on national, regional and global economy through their supply chains[2)].

Considering the recent increasing economic damages by disasters and recognizing the importance of private sector as actor and partner of disaster management, the Global Platform for Disaster Risk Reduction under the support of the United Nations summarized the Fourth Session[3)] in 2013 that promotes economic resilience and fosters new opportunities for public private partnerships as part of an overall improved risk governance. Furthermore, it also highlighted agendas including private sector's

progressively aligning risk reduction efforts and developing business practices.

The most significant contribution by the private sector for disaster risk reduction are denoted by the Business Continuity Plan/Planning (BCP) or Business Continuity Management System (BCMS) of each enterprise that can reduce damages and help quick restoration from business interruption. The BCP or BCMS is standardized as ISO22301[4)] and disseminated in many business enterprises around the world.

However, for comparatively small business enterprises, the BCP or BCMS has not been formulated nor implemented yet in most of the local enterprises. This tendency is obvious particularly in developing countries where many industry agglomerated areas are located in vulnerable conditions against natural disasters.

Moreover, the business enterprises have limited capacity to mitigate damages and maintain operation by their own efforts even if BCPs are prepared, as was the case during recent large scale disasters.

In order to minimize economic impacts or losses in case particularly of large scale disasters that disrupt fundamental infrastructure in certain areas, it is important to carry out risk assessment at a proper scale and to make scenario based contingency plans for area damage mitigation. In addition, it is vital to have integrated resource management and strategic recovery plans which could support each enterprise's BCM actions in coordination with the public sector's activities.

Some studies suggested that further research on regional level management of business continuity is required. Warren[5)] explained that a significant number of public sector authorities are not preparing integrated disaster management plans nor BCPs. It is noted that further need for research exists into the impact on assets, the role of the public sector manager of certain area in assessing the risks, the strategy to prepare the coordination framework and to mitigate the effects of natural disasters and severe catastrophic events.

With this background, JICA, in collaboration with the ASEAN Coordination Centre for Humanitarian Assistance on Disaster Management (AHA Centre), has launched a study project entitled "Natural Disaster Risk Assessment and Area Business Continuity Plan Formulation for Industrial Agglomerated Areas in the ASEAN Region" since February 2013[6)].

The study aims to collect and analyze information on natural disaster risks, industrial agglomerated areas, infrastructure, lifelines and supply chains in the ten ASEAN Member States. It also aims at preparing a database of the above information so that it can be shared in the region.

The study introduced the concept of Area BCP and verified its formulation in the three pilot areas of Bekasi – Karawang industry area in Indonesia, Cavite - Laguna - Metro Manila in the Philippines and Hai Phong area in Vietnam. Selection criterias of the areas are highly agglomeration in recent years by various industries as well as exposure to increasing risk of disasters, such as earthquakes, floods, tsunamis, typhoons/cyclones.

The study identified dominant disaster types and possible scenarios of disaster impacts on the area business continuity through multi-hazard risk assessment and business impact analysis in the pilot areas. Based on the scenarios, the participants to the project are now formulating the Area BCP by having a series of discussions.

2. CONCEPT OF AREA BCP/BCM

As defined in the previous paper[6)] of this study, the Area BCP is a framework and direction of disaster risk management by stakeholders in order for business continuation of the industrial agglomerated area as a whole. These stakeholders include individual enterprises, industrial area managers, local authorities and administrators of the infrastructures. Geographical scope of the Area BCP depends on local condition or the size of stakeholder's coordination so that an industrial park, an industrial agglomerated area or even a nation can be its scope.

The Area BCP should be coordinated with each party's BCP in a way that it complementally provides essential information needed for estimating damages or for sharing resources both by public and private parties. Each BCP could refer the Area BCP to find constraints in the area for, considering the Recovery Time Objective (RTO) of the business resources and planning the recovery measures.

The study team then introduces the definition of Area Business Continuity Management (Area BCM) as a cyclic process of sharing risk information and impact estimation, determining the strategy of risk management, developing the Area BCP, implementing and monitoring the planned actions to continuously improve the Area BCM system, in coordination among stakeholders, in order to improve the capability of effective business continuity of the area (**Fig.1**).

The scale of the Area BCM system must be dynamic so that it can expand or reduce in response to the actual disaster impact and the operational situation when updated.

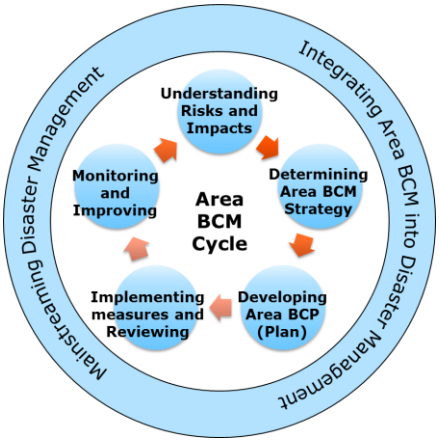

Fig.1 Area BCM cycle

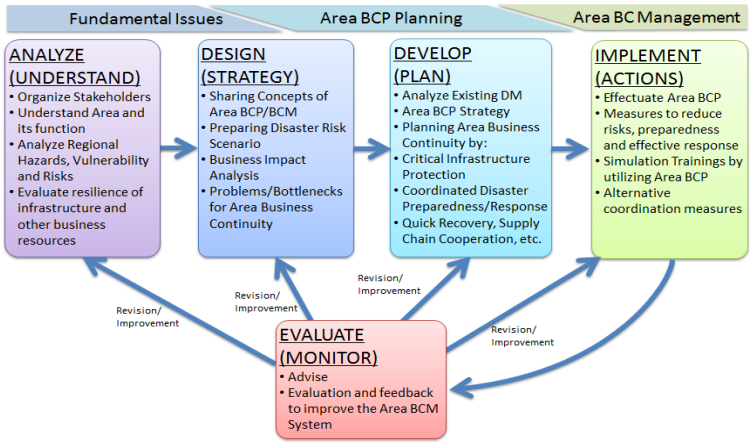

Fig.2 Steps to formulate Area BCP and implement Area BCM

Table 1 Internal and External Resources

	Human	Substance	Finance	Information
Internal Resources	Managers, Workers, Employees,	Buildings and facilities, Equipment, Parts and row materials, fuels,	Money, Account system, Assets,	Computer systems, Operation data, Archives,
External Resources	Public officers and workers	Energy (Electricity, Gas), Water (Supply, Sanitary and sewerage), Transportation (Road & Rail, Port & Airport, etc.)	Banking, Transaction system,	Internet, Tel and Fax, Communication,

The study team also defined the external goods and services which are independent of the business management but are essential for business continuity as External Resources (**Table 1**). Some External Resources often become common bottlenecks for the business continuity in certain area when affected by disaster. While the BCP is designed to prevent the company's "Core Business" from being suspended in emergency circumstances, the Area BCP/BCM is to secure the "Critical External Resources", which are essential in supporting the business operation in and around the industrial agglomerated area.

3. METHODOLOGY

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(1) Process of Area BCP/BCM

The formulation of the Area BCP in the three pilot areas was conducted by JICA study team who facilitate the discussion of the stakeholders to take steps as **Fig. 2** which is designed by the team referring to the standard procedure of the ISO22301. Among others, the followings are the core steps of the Area BCP formulation.

a) Hazard, Vulnerability and Risk Analysis

It starts from identification of the predominant hazard in the industrial agglomerated area using probabilistic analysis of multiple hazards. Simulation of the hazards in the area includes severe probabilities of occurrence. We applied 100 to 200 years return period probability in this study for the severe cases of all types of hazard.

b) Evaluation of Infrastructure and Business Resources

In order to prepare for the risk scenario in the target area, we evaluated the disaster resilience of infrastructure and business resources as well as the current situations of supply chains. Then we assessed the vulnerability and resilience of the elements related to the business continuity of the area.

c) Risk Scenario and Business Impact Analysis

The result of above evaluation and assessment superposed the risk of business interruption, and the broad impacts. Created risk scenario was the basic condition to discuss the risk management plans and measures by stakeholders at the next step.

d) Formulation of the Area BCP

This process consists of analyzing existing measures and private sector's BCPs for natural disasters, establishment of strategy for Area BCP/BCM, formulation of plan of cooperation, infrastructure development for more resilience, disaster response and monitoring the Area BCM activities to feedback.

(2) Probabilistic analysis of multiple hazards

We aim to develop a standard method of formulating Area BCP and establishing Area BCM that can be applied in many industry agglomerated areas particularly in developing countries where technical disadvantages can be found. To facilitate this purpose, the elements of the method of hazard analysis should not be unnecessarily sophisticated or highly technical. Condition of lacking basic data for analysis and financial capacity should also be considered.

Based on the above condition, the elements, i.e. tools and softwares, of probabilistic hazard analysis applied in this study were selected from widely used,

easily handled and generally applicable ones as;

a) Earthquake

For Probabilistic Earthquake Hazard Analysis, acquainted software of EZ-FRISK[7] and GSHAP[8] were applied to make the earthquake source model. For amplification by surface ground, the NEHRP[9] ground classification and amplification factor, proposed geophysical value by researchers, data used in previous JICA studies and existing geological maps were used.

b) Tsunami

For Numerical Simulation of Tsunami Propagation and Run-up, model of TSUNAMI-N1, N2, N3[10] was applied with the bathymetry data of 1350, 450, 150 and 50m grid size from GEBCO 08[11] Grid data (30"), precise topography and survey data of depth near the coast provided from research institutes and printed bathymetry maps when available.

For tsunami source model of Manila Trench [M:8.0～9.3], previous studies by Vu and Nguyen(2008)[12], Okal et al.(2011)[13], Nguyen(2011)[14] were referred. On Sunda Trench [M:9.0], study by Okal et al. (2011)[13] was referred.

For the probability evaluation, relation between the earthquake magnitude and probability of occurrence around the tsunami source area was estimated based on the earthquake catalogue.

c) Flood

For flood analysis in the area of Indonesia, runoff model by IFAS[15] and inundation model by iRIC[16] were created. In the area of The Philippines, MIKE-11 and MIKE-FLOOD[17] were applied to the runoff and inundation model respectively. In the area of Vietnam, the inland flooding was modeled by MIKE-21[17].

The topographic data collected are; ASTER GDEM[18] (30m resolution), cross section survey of river channel by handy GPS measurement, existing bench marks and elevation of embankment, road, highway.

Meteorological, Hydrological data such as rainfall, river water level, river discharge, tidal level, location of observatory, flood records were collected from governmental agencies and existing flood control plans.

Probability evaluation was calculated from rainfall record.

d) Storm Surge

Storm surge simulation was conducted by using Princeton Ocean Model (Long Wave Model[19]) with input of the Astronomical Sea Level from the public prediction models.

To make Typhoon Model as input, we set the central atmospheric pressure with the worst course based on the collected records. The radius was set based on the relation between central pressure and radius. The Typhoon model is 2D wind and air pressure model (Myer's formula[20]).

Collected data includes bathymetry from GEBCO 08, Elevation from ASTER GDEM and observed tide level.

Evaluation of probability of estimated typhoon central pressure at the site is estimated based on the collected data.

4. IDENTIFIED RISKS AND IMPACTS

Result of the probabilistic analysis of regional hazard shows the predominant natural hazards in the pilot areas; flood in Bekasi and Karawang area of Indonesia; earthquake in Cavite, Laguna and Metro Manila area of The Philippines; and flood inundation and storm surge by typhoon in Hai Phong area of Vietnam (**Fig.3**).

In this paper, as an example among the multiple hazard simulation outputs, we illustrate a simulation result of the earthquake in Cavite, Laguna and Metro Manila, which is supposed under the probability of once in 200 years, identifying the area at risk of Modified Mercalli Intensity scale (MMI) is 8~9

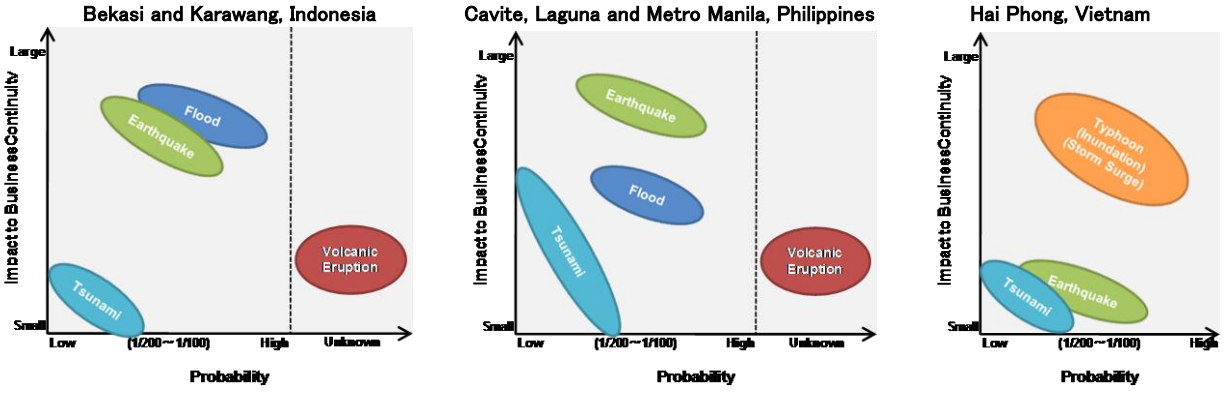

Fig.3 Dominant natural hazards and probabilities in the pilot areas

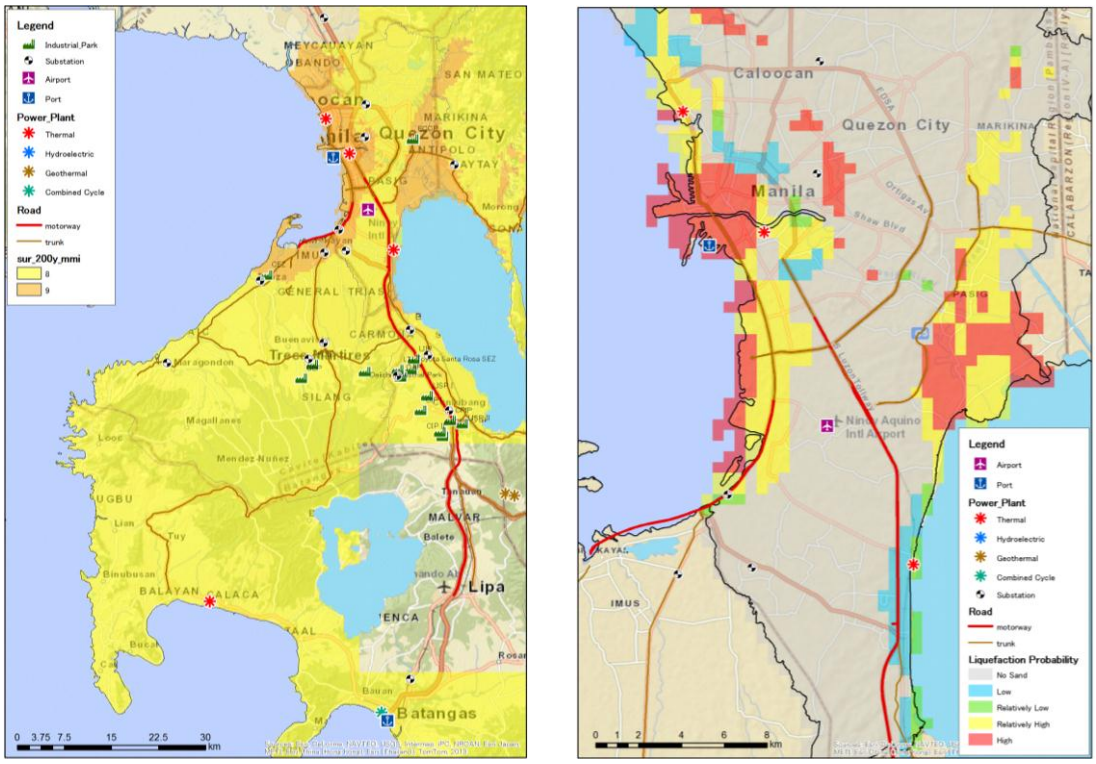

Fig.4 Simulated Earthquake Intensity (left) and Liquefaction Potential (right). Cavite, Laguna and Metro Manila, Philippines

(**Fig.4**). The figure also indicates the high potential area of liquefaction along the Manila Bay.

Based on the projected hazard and vulnerability analysis, the Business Impacts were prospected as following scenarios;

(1) Buildings in industrial park

- 10% of the buildings suffer Moderate damage. Repair is necessary.
- Some of ceiling panels and illuminator fall down and part racks may topple.
- Non anchored machine may move.
- Transformer may topple.

(2) Electric power and Lifelines

- Electric Substation stops the operation for one week. The capacity recovers to 50% in one month after and takes 3 months for full recover.
- Wired phone and mobile phone become congested because of the shortage of electric power.
- Wells and Water Tanks stop the operation for several days. The capacity recovers to 50% in one week and take one month for full recover.

(3) Transportation infrastructure

- Expressway between Manila and Cavite is closed for 2 weeks because of the liquefaction. After temporal restoration work, limited traffic will become possible.
- Traffic capacity of the Expressway between Manila and Laguna is limited in some sections. It takes one week to 50% recover and takes 2 weeks for full recover.
- Most piers of Manila Port are unable to use for several months because of the liquefaction. Several piers will become usable after temporal restoration work.
- In Container terminal, gantry cranes are severely damaged. It will take half year to recover 50% of the capacity of cargo handling.

(4) Workers of Industrial Parks

- Some of employee will be absent because 10% of their houses are heavily damaged and 20% suffering moderate structure damage.
- The traffic condition becomes worse and come late for factory.

5. AREA BCP/BCM FORMULATION

The study project has conducted the first workshops (Nov. to Dec. 2013) to share the information about 1) Hazards affecting the industrial agglomerated area, 2) Critical business resources under disaster situation and 3) Limitations of BCP at individual level. The second workshops (Feb. to Mar. 2014) addressed the agenda of 1) Impact of disaster on business operations in the industrial agglomerated area and 2) Weakness of the area for BCM. In the third workshops (May 2014), participants will discuss about 1) Direction of Approaches as the Industrial Agglomerated Area and 2) Necessary plan of Area BCM and actions to be taken by both parties of private and public sectors.

The participants both from the private enterprises and governments to the Area BCP project seek to enhance their disaster management capacity through the coordinated discussion based on the above scenario in accordance to the designed Area BCM process. They can acquire the basic knowledge on disaster as well as disaster management strategies through the workshops. Further, some participants try to establish their own BCPs in realizing the importance to prepare BCP for BCM.

The applied Area BCM formulation system gives opportunities to select the single or mixed measures of the followings;

1) Strengthening existing capacity
2) Preparing alternative measures and
3) Making temporary back-up

The method of practice on these measures varies from;

1) Cooperation and share with other stakeholders
2) Making new investment and
3) Transferring the risk

Selection of these measures and applied method allow each Business Continuity Managers to consider how to secure the availability of business resources and to cooperate with other partners by sharing the information among working group and client of each enterprises through enhanced communication. Also, these considerations promote expanded coordination with other industrial agglomerated areas and other strategically critical areas. These opportunities enhance the strategic operation in normal business to avoid any business risks and eventually contribute to disaster prevention as well as sustainable growth of all concerned parties.

6. LESSONS AND CONCLUSIONS

Application of the Area BCP/BCM enhances the coordinated disaster management capacity within the target area. Continuous revision and improvement through the Area BCM process (Fig.1) strengthen the resiliencies by reducing the vulnerability of the business community.

Creating an atmosphere to prepare plans for each stage of Disaster Management Cycle (DMC, prevention and mitigation; preparedness and response; restoration and rehabilitation) is another benefit of Area BCP/BCM, whereas private company tends to prepare only the plans for response due to their financial constraints and lack of experiences. Participants will motivate various activities, including preparing grand design, strengthening infrastructures, standardized operation, sharing resources, predetermining roles, arrangement for cost sharing, linking business plan to local disaster management, continuous training and preparation for rapid establishment of disaster management system in emergency. Enhanced continuity of the business in the area as a result could foster the local economy and employment, which may have huge impact to the nation.

Since reproduction of local jobs is indispensable after business termination, and defense of socioeconomic function is important in human life, it is important for both public and private parties to heighten the capability as an area corresponding to disasters. The Area BCP/BCM could be the vital engine for it.

The process of Area BCP/BCM also promotes all the members to aware the connectivity of other members and makes the private sector to prepare the well balanced standardized plans for all the stages in DMC.

Major challenge to promote establishing the Area BCP/BCM is the coordination among stakeholders. Area BCP/BCM requires as much participation as possible from all the parties concerned, however, it is taught to get their involvement from the beginning without any incentives. The project we mentioned was initiated by JICA and the project team worked as a facilitator to promote Area BCP/BCM. In general, however, somebody has to take a lead and ask all the parties concerned to join the discussion on unknown new conceptual system. We need to carefully study and analyze each culture and existing customs of target area to start applying Area BCP/BCM and try to create accustomed Area BCP/BCM to the local traits.

Another challenge is the difference between the geological scale of the Area BCM and the area affected by actual disaster, which we cannot predetermine. As already mentioned, the geographical scope of the Area BCP depends on local situation or the size of stakeholder's coordination, they can start and formulate Area BCP with specific target scale on specific disaster scenario. Initial Area BCP will be revised and improved through Area BCM to enhance the resiliency of the target area. Once visible output is made, some others may have an interest to join the group and forcing to expand the target area, and vice versa.

We are filing the processes of risk assessment and the Area BCP/BCM formulation adopted in the study for preparing guidelines which can be applied to the other areas in the ASEAN region.

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