

The 3rd International Conference on Earthquake Engineering and Disaster Mitigation 2016 (ICEEDM-III 2016)

Business Continuity Management System for the Risk Governance in Port Sub-sector

Kenji Ono^{a*}, Kentaro Kumagai^a, Yasuhiro Akakura^b, and Felipe Caselli^c

^a Disaster Prevention Research Institute, Uji 611-0011, Japan

^b National Institute for Land and Infrastructure Management, Nagase 239-0826, Yokosuka, Japan

^c Universidad de Valparaiso, Valparaiso, Chile

Abstract

Earthquake and tsunami has been and will be one of the major threats to the logistics services and business activities in the port and shipping sub-sector. One of the examples includes the Great East Japan Earthquake in 2011 (GEJE2011), which causes serious damages to port facilities in the eastern Japan, resulting in huge economic losses due to long continued supply chain disruptions. In this regard, the authors first review an impact of the GEJE2011 to logistics and industries in ports for identifying disruption risk and its consequences due to natural disasters. Currently being developed business continuity management (BCM) frameworks including the international and national BCM standards are also reviewed to discuss skills and expertise for properly meeting BCM requirements in the port sub-sector. Based on the discussion, the authors propose due procedures and analysis techniques for managing business continuity of the sub-sector. Intensive discussions at the pilot project site, in the ports of Japan and Chile were undertaken by the authors who have been engaged in a Japan-Chile international research collaboration project. Authors conclude that systematic analysis procedures for establishing business continuity management system in ports are vital for maintaining continuity of logistics infrastructure services and a variety of business activities in ports.

Keywords: Business continuity management system, Port sub-sector, Disaster management.

1. INTRODUCTION

Resiliency of logistics infrastructures such as ports is one of key elements for the modern industry and business, therefore, is essential for the local, regional and global economy. Developing business continuity plans (BCPs) for major port operations are strongly requested from port users in this regard. The government of Japan is currently keen on tackling to this policy agenda particularly in the aftermath of the GEJE2011. Preparing BCPs for ports is not straightforward, however, for people from the port community, which normally creates a multi-stakeholder business colony with different business interests and no single management system. Following sophisticated risk management procedures required by the international standard, ISO22301, is also another challenge.

Among the past researches in terms of disaster management at ports, Manosouri et al [1] discussed on decision making procedures of risk management at ports. Miyamoto and Arai [2] identified an importance of a gap between transportation demand and cargo handling capacity at ports for assessing port continuity, and undertook a preliminary work for preparing BCP in the port of Nagoya. Abe [3] proposed a framework for considering port continuity based on supply and

demand relationship of port logistics service. Berle et al. [4] explained failure mode of port logistics functions with a view to BCP preparation. Omer et al. [5] evaluated resiliency of port logistics by considering port and shipping network. In terms of negative impact of port shutdown to the national port system in the United State, a study undertaken by Trepte and Rice [6] should be referred. Novati et al. [7] also evaluated influence of natural and human-made disasters on port network system.

By referring the above literatures, this study discusses and proposes a methodology for systematically preparing a BCP for port logistics in line with ISO standards, which was not necessary followed by the past port BCP discussions. Particular emphasis is placed on the practice to undertake business impact analysis (BIA) for improving quality of the business continuity strategy. In this regard, the study first reviews consequences and lessons learnt from the past large scale disasters. Significance of business continuity is identified in the local, national and global context as well as an initial response to the disasters. The proposed BIA techniques and some of output obtained from case study undertaken by the authors are presented in this paper. Issues and agendas for further discussion and research are also provided.

2. RISKS OF PORT LOGISTICS AND ITS CONSEQUENCES

2.1. Impact of the Great East Japan Earthquake to Ports

In the GEJE2011, various types of port damages including failures of breakwaters and quay walls, liquefaction at the quay apron, burial on access channel and turning basin due to the tsunami debris including vehicles and containers, were observed in pacific coastal ports of the east Japan.

One of the bottleneck works for emergency port rehabilitation in the aftermath of the GEJE2011 was opening-up of port waters blocked by tsunami debris. It was unexpected time consuming works for Japanese port community to remove floating debris, and to sound sea bottom obstacles and sedimentation for securing water depth to enable to accommodate ships. There were, for example in the Sendai area of the port of Sendai-Shiogama, 531 irregular points were detected for further investigations and dredging works as shown by red dots in Fig.1. Commencement of the works was awaited until the withdrawal of tsunami alert which continued 51 hours after the earthquake occurrence. The works could start only on March 14, 2011, almost two days later.

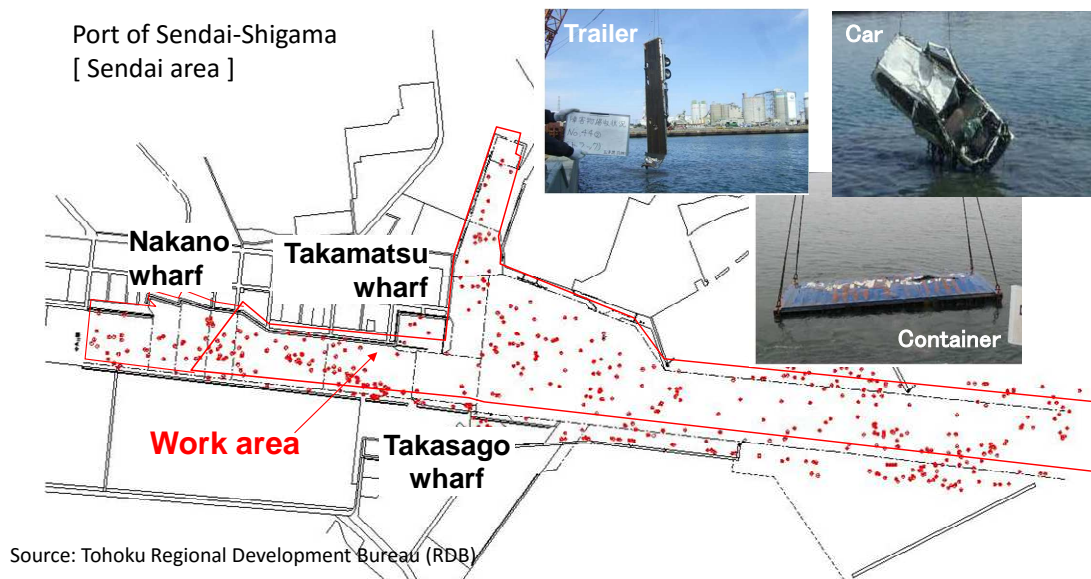


Fig.1. Clearance works of the sea bottom debris in the port of Sendai-Shiogama

Right after withdrawal of the tsunami alert in the east Japan coastal area, water cleaning-up operations were actively undertaken by Ministry of Land Infrastructure, Transport and Tourism (MLIT), and the concerned port authorities. As the results of their efforts, some quays became temporarily available for emergency ship calls in the major ports until the

end of March, 2011, while full commercial ship calls were prolonged, mainly because of the concern of ship navigation troubles due to the remaining debris on the bottom of the port water. Announcement of free ship navigation at the port of Sendai-Shiogama, for example, was in May 21, 2011, when salvage works of the sea bottom debris were finally completed.

It took, however, more time to resume the full scale terminal operations in the ports. For example, 3 months was needed in Takasago-container terminal in Sendai-Shiogama Port to re-open the berth No.1, and a half year was necessary before the container cranes became operational. In the meanwhile, the terminal could not properly respond to the cargo handling demand of the industries and businesses, therefore, the majority of Tohoku cargos were transported through Tokyo Bay area ports or ports on the Sea of Japan, resulting in much more transportation costs incurred by the consignees/consigners. It also disrupted the supply chain of various local manufacturers and enlarged the damages to Japanese economy.

Based on the above experience, MLIT launched in June, 2012 a new policy development for improving earthquakes and tsunami countermeasures for port facilities [8], which includes:

- Preparing and implementing port-BCP under the mutual cooperation of port community for enabling effective and prompt restoration of cargo transportation services in the port under the limited human/material resource availability.
- Mutual back-up frameworks of port functions to be developed and included in the port-BCPs.

2.2. Impact to the Local and National Productions

The fine materials and highly purified chemical products supplied by the basic material industries in the east Japan area are essential for operations of the processing and assembly industries in the global context, so the supply shortages of these materials caused by the GEJE2011 set off a chain reaction of production network disruptions. One of the most essential products identified was micro-processors, for which providing silicon wafers is vital. Ultra-thin copper foil is also a critical basic material because it is needed to produce flexible microprocessor substrates, and Tohoku companies have a 20% global share of these products. The limited operations of these suppliers due to the GEJE2011 suffered microprocessor production in Tohoku, which consequently affected operation of automobile, industrial machinery, and home electronics assembly lines across in the nation.

2.3. Further Propagation of the Negative Impact

One of the most important manufacturing clusters in the east Japan area is a production of parts, components, and ICs for the automobile, electronics, and optical industries. Some of the supply chain was, however, disrupted by the GEJE2011, resulting in paralyzing the entire manufacturing cluster in the area. This production shutdown was not limited to the area, but spread out across the country and even to overseas manufacturers throughout the global supply chain network. Fig. 2 illustrates Toyota's operations across the world in the three month times after the GEJE2011.

Domestic assembly lines of Toyota factories were shut down immediately after the disaster to confirm the safety of employees and their families, and to allow investigation of damages to the production lines and supply chains. By 38 days after the GEJE, domestic assembly lines had recovered to about 50% of normal operation capacity, which had reached to 70% levels in the June.

Overseas factories were not directly affected by the GEJE, but gradually suffered from poor supply of parts and components from Japan. This was observed as a dramatic fall of the production level of complete cars down to around 40% of normal levels in the 40–45 days after the GEJE. Largest negative impacts were reported from North American Toyota factories of 20% operation levels followed by the 30–50% levels in China.

Fig. 3 displays time-series productions, in Japan, of complete passenger cars, microprocessors, and automotive parts such as engine parts, drivetrains, transmissions, control parts, suspension and brake parts, car audio equipment, car navigation systems, and cooling devices for car air conditioners. These data are shown as indices taking production values of October 2010 as 100. Microprocessor sales records are also indicated in the figure as "Microprocessor (S)". Note that the microprocessor supply decreased by only 20–30% in April 2011, while automobile production dropped by about 80% in the same month.

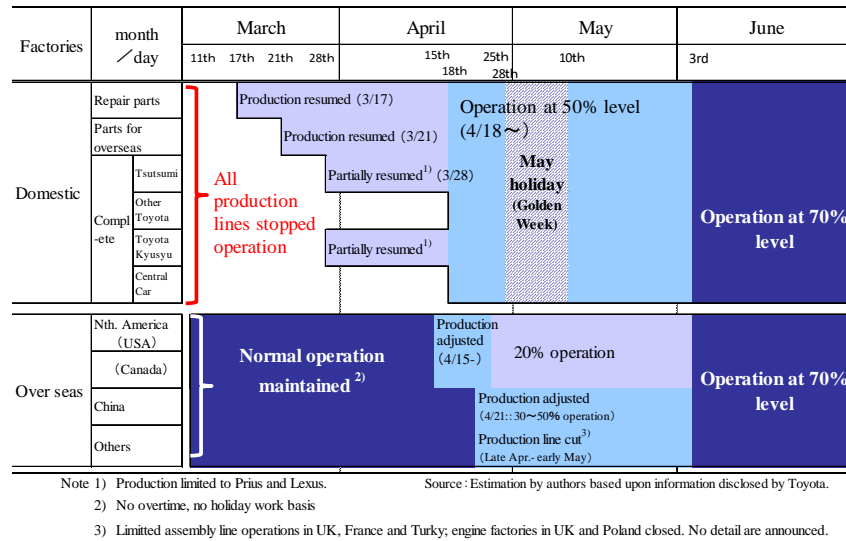
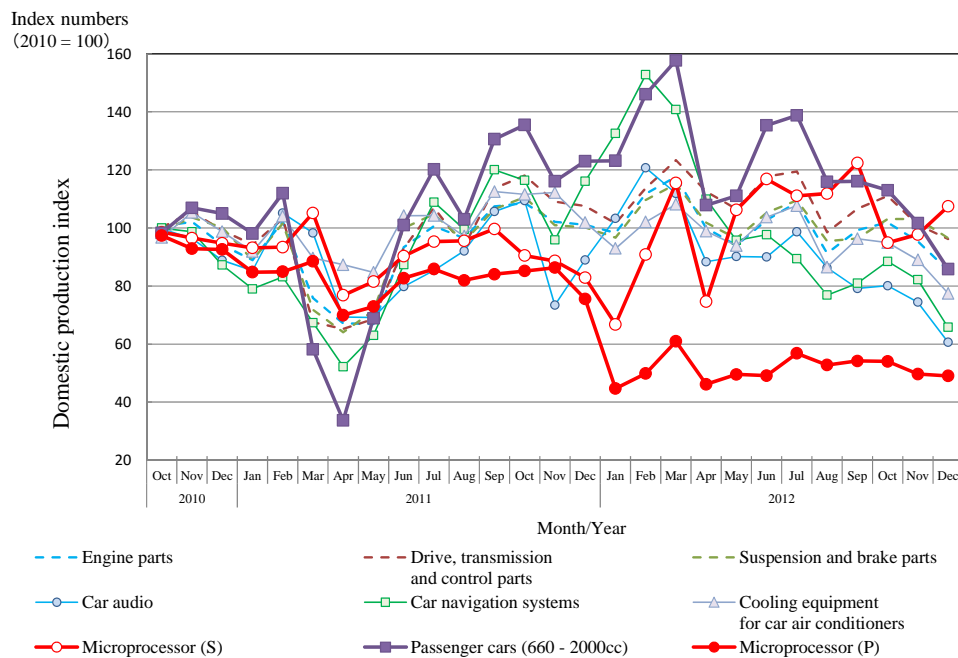


Fig. 2. Post-disaster operations at Toyota Factories



Note: Engine parts, drive, transmission, and control parts, and suspension and brake parts: Japanese yen basis. Others are quantity basis.

Data: Machinery statistics, Ministry of Economy, Trade and Industry

Fig. 3. Production of microprocessors, automotive parts, and passenger cars

The authors consider the data may indicate that the supply disruption of microprocessor in the area badly suffered a variety of automotive parts and component productions, and caused much larger negative impact on automobile assembly line operations. It is also noted domestic microprocessor production stays lower after the GEJE because of replacement by the overseas microprocessors alternatively imported soon after the GEJE occurrence.

3. BUSINESS CONTINUITY FRAMEWORKS FOR PORTS

3.1. Standards and Guidelines of BCP

Based on a lesson learnt from September 11 Attack in the United State, American National Standard Institute initiated discussions on the standardization of national security at the International Organization for Standardization (ISO), which finally issued in 2012 “ISO22301: Social security - Business continuity management systems - Requirements”. The new international standard provides a broad-based framework of the BCM to cope with a wide range of critical and emergency situations including large scale disasters, based on the experiences of 2004 Indian Ocean earthquake and tsunami and 2005 Hurricane Catrina storm surge.

In Japan, Cabinet office published a Business Continuity Guidelines (1st edition) in 2005, which was amended in 2009 by considering 2009 flu pandemic, and also in 2013 based on occurrence of the GEJE2011. In terms of business continuity at ports, MLIT issued in 2015 “Guidelines for Preparing Business Continuity Plans at Ports (Port BCP Guidelines)”. [9]

ISO22301 requests, for selecting and determining the business continuity strategy, to set prioritized timeframes for resuming business activities at a specified minimum acceptable level, taking into consideration of the time within which the impact of not resuming provision of products and services would become unacceptable. This evaluation process is defined as a BIA exercise. BIA provides information about a maximum tolerable time period of the clients against the disruption, based on which BCP decides required resumption timing of the business operations. [10]

3.2. Outline of the Port-BCP

BCP is a plan of actions, to be prepared in advance, for the purpose of securing continuous existence of the entity of making the plan, and not only to prepare the initial response such as secure of the employee or prevention of secondary disaster, but also to enable the entity to continue or restore, within the acceptable period, the most important activity of the subject. [11]

In 1995, the function of Kobe Port was completely suspended by the earthquake occurred at just beneath the port. The restoration of the Kobe Port took a long time, during which, although other ports such as Osaka Port provided alternative port cargo handling services, most of the transship container cargos of Kobe Port had shifted to Busan Port. These shifted cargos did not come back to Kobe Port even after the complete restoration of the port.

Considering the experience referred above, the purpose of preparing port-BCPs may be summarize as an anchoring of users to the port by restoring port function to the targeted service level within the certain period. In this view, i) toughening port structures such as seismic retrofitting, ii) accelerating rehabilitation works of the port facilities by preparation in advance of procurement process streamlining for damage investigation, design and civil works, and iii) ensuring substitute logistics services in alternative ports, are due considerations for preparing port-BCPs.

Fig. 4 shows the relationship between demand and handling capacity of port cargos in port-BCPs. Right after the outbreak of the disaster, handling capacity in ports may not be enough, however, toughening works and/or accelerating rehabilitating process will help the port to maintain some of port services if necessary proactive actions were taken under the port-BCP. If the cargo handling capacity is still insufficient to stop the gap between demand and supply, alternative port service provider is to be sought for maintaining continuity of the logistics.

The process to prepare port-BCP is as shown in Fig. 5. As the demand side approach, BIA is utilized to determine maximum tolerable period of downtime (MTPD) and recovery time objective / recovery level objective (RTO/RLO). As the supply side approach, risk assessment (RA) is employed to evaluate predicted recovery time / predicted recovery level (PRT/PRL). RTO/RLO and PRT/PRL shall be compared, and when RTO is shorter than the PRT with PRL meeting the requirement of RLO, risk treatment measures as shown in the above lines of i) – iii) is required, and when RTO is longer than PRT, preparatory analysis for the port-BCP are deemed to be completed.

The mission of RA in the context of port-BCP is, as such, to evaluate damages of resources for maintaining port operations, and resiliencies of those resources as PRT/PRL.

Resources to be considered in the port-BCP include variety of facilities, equipment, human resource, system and so on. Typical resources needed for port operations include quay walls and piers, access channel, breakwaters, cranes and other cargo handling equipment, and port access road. [12]

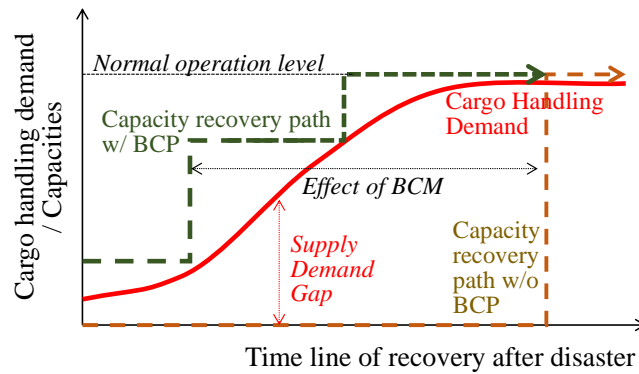


Fig. 4. Schematic view of supply and demand gap of the port logistics services

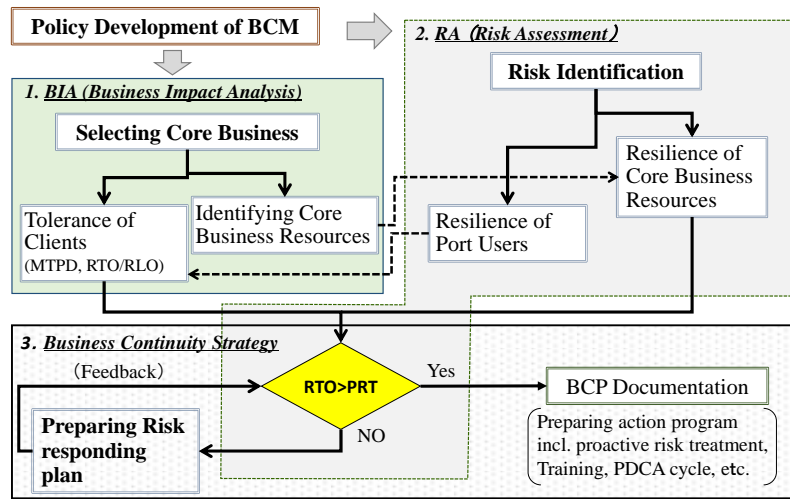


Fig. 5. Procedures for preparing port-BCPs

4. SYSTEMS APPROACH AND ANALYSIS METHODOLOGY FOR PREPARING BCP

The governments, universities and research institutions in Japan and Chile recently undertook a joint research project for developing an earthquake and tsunami resilient society under the Japan International Cooperation Agency (JICA) and Japan Science and Technology Agency (JST) sponsored international research collaboration, namely SATREPS Chile project, which includes research program to establish methodological framework for preparing BCMS for port sub-sector.

Based on the output from SATREPS Chile project, this chapter introduces some particular techniques, by focusing on BIA, to be considered when port community tackles to the BCP preparation. These techniques may be used by following a systematic procedure to diminish excessive dependency on personal capacity and judgment, and to achieve transparency and traceability for later review and update.

4.1. Business Flow Analysis for the Port Core Business

Screening major port businesses for selecting one or a few core businesses is a starting point of BIA. Once selected, the business flow structures are to be analyzed for identifying necessary operational resources of the port logistics service provision. Securing business resources under disaster affected situation are one of most essential considerations for properly securing port business continuity.

In view of the above, it is helpful for port community of building the BCMS to employ a business flow analysis based on the IDEF0 method. The business flow analysis is a technique of developing diagrams to breakdown structure and operational procedures of the core businesses.

IDEF0 method is a tool for identifying the detail structures of business operations and resources mobilization. The IDEF0 method is a function modeling methodology originally designed for identifying decisions, actions, and activities included in an organizational function or social/information system. Komatsu et al (2013) introduced “job cards” for developing business flow diagram of water treatment plant in Osaka, Japan. [13] An examples of business flow diagram and a template of job card modified by the authors for port BCP preparation are illustrated in Fig. 6 and Fig. 7.

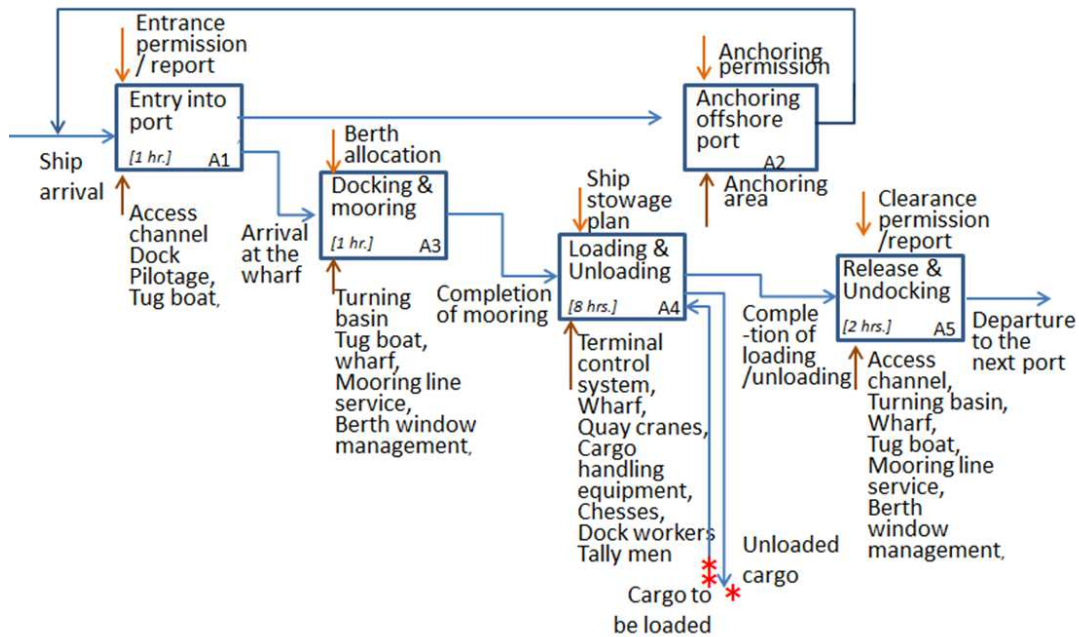


Fig. 6. An example of business flow diagram of port terminal operation

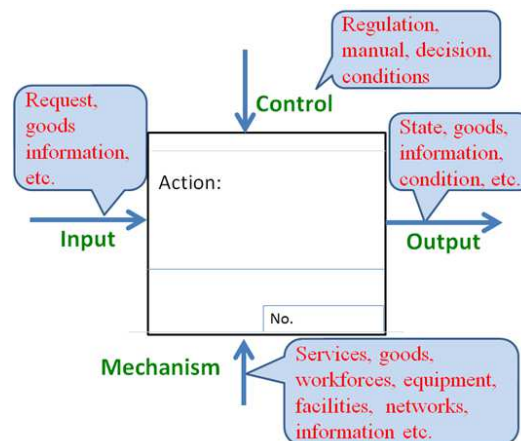


Fig. 7. Modified job card for port BCP preparation

As illustrated, a business flow diagram is defined as a kind of event chain system, where mobilizing job cards helps identify: i) necessary operational steps, and ii) required resources for respective step, for properly implementing the port core business. In this analysis, there are two inputs to be considered in each job card: ie. “mechanism” from below and “control” from the top, as shown Fig. 7. The mechanism includes resources directly used for processing the step, and the

control represents necessary information or decision making for processing it such as permission, notification, policy, guidelines, program, and any other regulations and conditions of concern.

As a result of the above mentioned business flow analysis, a complete description of the core business operations including business operation structure and steps, and the directly needed resources and controls are obtained. Based on these information, a complete set of resources needed for the core business operations are to be identified by following instructions given on a series of worksheets, which is named “a worksheet system” in this paper.

4.2. Worksheet System

Intensive discussions are needed for selecting port core businesses and identifying needed resources for them. Both processes are most important part of BIA implementation, because disasters in the context of business operations, always mean the loss or lack of resources such as facilities, equipment, materials, information, and human and financial resources. The BIA also assists in finding bottlenecks for securing resources to continue core business operations. Data processing procedures for extracting resources from the business flow diagram, removing duplication of collected resources, classifying resources into the typical resource categories and clarifying their mutual dependency relationships are due course of BIA to find bottleneck or critical resources in an effective manner. Many BIA implementation procedures including a variety of templates and worksheets has been proposed accordingly. [14] Among them, Caselli *et. al* [15] has proposed a worksheet system for BIA implementation for preparing port-BCP. The authors consider the system could provide port communities with an effective tool to select port core business, to undertake the resource analysis and evaluation, and to address the maximum tolerance of the port clients also included in the BIA exercise. [5]

Among the worksheets included in the system, Fig. 8 and Fig.9 schematically demonstrate worksheet operations for extracting and classifying resources needed from the business flow diagram, which provides information about what kind of resources are needed for implementing each step of the port's core business. The “mechanisms” indicates direct resources needed, and from the “controls” information, resources required for providing such controls are to be found.

Opera -tions	Control	Executing agency	Resources	
			Resource for control	Resource for activity
A 1	Entry in port	Customs, Harbor master, Port	CIQ officers/offices, Harbor master officer, Port MIS, SeaNACCS, Harbor master office,...	Access channel, Tug boat, Pilot, Port radio, Electric/water/fuel supplies, Telecommunication service,
A 2	Moorin g	Harbor master	Harbor master officer, Telecommunication	Anchoring area, Service vessels
A 3	Docking	Berth	Terminal operator staff,	Turning basin, Quay wall, Tug boat, Line men, Port

Fig. 8. A worksheet for identifying resources from business flow diagram

Opera -tions	Resources for control and operations				
	Outside supply	Human resource	Facilities /equipment	ITC systems	Buildings /offices
A 1	Electric/fuel/ water supplies	CIQ officers/ offices, Pilot,	Access channel, Tug	Port MIS, SeaNACCS,...	CIQ offices, Harbor building,
A 2	Water supply	Harbor master officer	Anchoring area	Telecommunicati on service	
A 3	Electric/fuel/ water supplies	Line men	Quay wall, Turning	Terminal operation system	Terminal operation station

Fig. 9. A worksheet for classifying resources into a commonly used categories

As shown in Fig. 8 and 9, worksheet system assists in processing resources on “step by step” basis for discovering critical or bottleneck resources for maintaining and quickly recovering port core business operations.

Table 1 shows, as one typical example, a complete set of the resources needed for container terminal operations for which the authors undertook BIA exercise in the port of Osaka, Japan.

Table 1. List of identified operational resources of a container terminal

Outside supply	Human resource	Facilities /equipment	ITC systems	Buildings /offices
Electric/fuel/ water supplies, Telecommuni- cation service	CIQ officers, Port authority staff, Harbor master officer, Pilot, Line men, Stevedore's staff, Dock workers, Crane operator, Yard planner, track driver, RTG operator, Gate clerk	Access channel, Anchorage, Turning basin, Quay wall, Tug boat, Apron, Service vessel, Quay crane, RTG, Trailer/Chassis, Container slot, Reefer consent, Gate, Access road, CIQ inspection equipment	Sea-NACCS, Port MIS (Management Information system), Port radio, Terminal operation system, Port security system	Harbor building, Port authority office, Harbor master office, Harbor traffic control office, Shipping agent office, Terminal operation station, Stevedore's site office, Marine house
<i>(5 items)</i>	<i>(18 items)</i>	<i>(24 items)</i>	<i>(5 items)</i>	<i>(9 items)</i>

5. ISSUES AND FURTHER DISCUSSIONS

During discussions about BCP preparation methodologies with port community in Japan and Chile, many questions were raised from the community members in terms of justification and feasibility to implement detailed analysis for port-BCP preparation. Among them, most fundamental question seemed to be a governance capacity of the communities to undertake BCP preparation and implementation at ports.

It is implicitly assumed by ISO22301 that a single management entity undertakes BCM, which involves in ports, however, a number of port related public offices and business entities including stevedoring companies and port service providers. As such there may be institutional questions of who is going to work as a BCM host organization, how to create and maintain cooperative relationship among the community, and what is a possible mechanism to properly make a consensus for developing and operating BCMS at ports.

Main players at port logistics operations may include port authority, stevedoring companies, maritime pilots and CIQ authorities, therefore strong commitment of these parties are essential to successfully operate BCMS. Taking into account this fact, the Port BCP Guidelines request to set up in the respective port “Port-BCP consultative meeting” for shearing information in order to have common business continuity target and risk awareness. Port authority, local offices from the government, and national designated port management companies are expected to participate in the Port-BCP consultative meeting as core members.

In the modern economy, various manufacturing activities deeply depend on supply chain systems which comprise a wide range of business entities, so manufacturers are always at risks of supply chain disruptions due to uncontrollable natural and human-made hazards. Supply chain disruption risks must thus be addressed with the participation of local, national, and global business societies. Among the notable recent challenges from this viewpoint includes a concept of district continuity plan (DCP), which identifies common targets of the area, and shears risk information and business continuity policies among the member entities in terms of the area-wise disaster management. It is not so easy for the entities respectively to cope with, in particular, large scale disasters, therefore, these community members are strongly requested to take necessary actions in a collaborative manner for achieving a common goal [16].

The similar concept may be an area-BCP, which is a newly included international cooperation policy development undertaken by JICA. Under the area-BCP concept, manufacturers and service providers are requested to take concerted actions for securing common business infrastructure functions such as transportation, communications, and utilities supplies [17].

Difficulty of properly operating BCP worksheet system is also among issues raised by mainly risk management practitioners. As discussed in the above section, BIA implementation based on the worksheet system is rich in transparency, which facilitates the information sharing among the port administration and business entities, and encourages participation in the BCM activities including preparing BCP of the port.

On the other hand, the step-by-step working procedures and multi-layered structure of the worksheets system causes an excessive working load of the staff being engaged in BIA exercises, therefore, sometimes results in the insufficient or uncompleted analysis. Developing a BIA worksheet system for port BCP, the authors noted that the main stream system included 14 worksheets, therefore, only transcribing data from the sheet to sheet may impose burden works on the BIA staff. Table 1 showed a list of identified operational resources of a container terminal of the port of Osaka. The resources were obtained from the workflow analysis and added up to 61. Authors consider it substantially impossible to process humanly these bulky and duplicative data. As such, introducing computer aided data processing system for preparing worksheets were considered vital for properly adopting worksheet system to BIA.

6. CONCLUSIONS

This study discussed on procedures and methodologies for preparing BCP by focusing on BIA implementation techniques. Lessons learnt from the past large scale disasters such as the GEJE2011 were reviewed and issues and agenda for further discussions were also highlighted.

The authors noted that an employment of systematic approaches including BIA for preparing BCP is vital for efficient and effective implementation of BCM at ports, for which the proposed traceable consecutive analysis tools such as business flow diagrams and worksheet systems are powerful to properly undertake BCP preparation.

In this regard, it is concluded that further system development be needed for improving performance of these BCP analysis as more humanly and user friendly working procedures.

Issues in terms of the port community governance for promptly coping with any emergency situation and securing port logistics continuity were identified as fundamental agendas in association with building BCMS at ports. On-going initiatives for area-wise continuity discussions in terms of securing energy resource supply and infrastructure services such as DCP and area-BCP may offer a new direction in further discussing on the matter.

The authors consider the above discussions may pave the way of sophisticating methodologies for port-BCP preparation, and will undertake research activities in the area for contributing to further resilient global maritime transportation network.

ACKNOWLEDGEMENTS

This study was jointly undertaken by the Disaster Prevention Research Institute, Kyoto University and Escuela de Ingeniería Civil Oceánica, Universidad de Valparaíso, Chile as a part of SATREPS Chile project sponsored by JICA and JST. Many data and information were provided by the Ministry of Land, Infrastructure, Transport and Tourism, Japan and Dirección de Obras Portuarias, Ministerio de Obras Públicas de Chile. The authors also consider that the study could not be completed without an active participation of port communities in BIA discussions, which were undertaken by port of Iquique, Chile and port of Osaka, Japan. In particular, outstanding contributions were made by Empresa Portuaria de Iquique and Dream International Container Terminal Co. Ltd of Osaka port. The authors highly appreciate these all supports and assistances extended to the study.

REFERENCES

- [1] Mansouri, M., Nilchiani, R. and Mostashari A., "A policy making framework for Resilient Port Infrastructure Systems", *Marine Policy*, Vol. 34, pp.1125-1134, 2010.
- [2] Miyamoto, T. and Arai Y., "Proposal of Measures for Continuity of Port International Distribution Service in Case of Earthquake", *Journal of Coastal Zone Studies*, Vol. 22, No.4, pp.93-104, 2010.
- [3] Abe, T., "An examination on the measures for resiliency of port logistics services after large scale earthquakes", *Proceedings of International Association of Maritime Economists Conference 2013*, Paper ID: 20.
- [4] Berle, O., Rice Jr., J. B., and Asbjorslett, B. R., "Failure modes in the maritime transportation system –a functional approach to throughput vulnerability", *Maritime policy and Management*, 38(6), 605-632, 2011.

- [5] Omer, M., Mostashari, A., Nilchiani, R., and Mansouri, M., “A framework for assessing resiliency of maritime transportation systems”, *Maritime policy and Management*, 39(7), 685-703, 2012.
- [6] Trepte, K. and Rice Jr, J. B., “An initial exploration of port capacity bottlenecks in the USA port system and the implications on resilience”, *International Journal of Shipping and Transport Logistics*, 6(3), 339-355, 2014.
- [7] Novati, M., Achurra-Gonzalez P., Foulser-Piggott, R., Bowman G., Bell, M. G. H. and Angeloudis, P., “Modelling the Effects of Port Disruptions: Assessment of Disaster Impacts Using a Cost-Based Container Flow Assignment in Liner Shipping Networks”, *Transportation Research Board 94th Annual Meeting Compendium of Papers*, 2014.
- [8] Fundamental policy for earthquakes and tsunami countermeasures in ports, Transport policy council, MLIT, 2012. (In Japanese)
- [9] Business continuity guideline, Central Disaster Management Council, Cabinet Office, Government of Japan, 2015.
- [10] ISO 22301: Societal security - Business continuity management systems - Requirements, International Organization for Standardization, 2012.
- [11] Akakura, Y., Ono, K., Ichii, K., “Earthquake and tsunami damage estimation for port-BCP, *Geotechnics for Catastrophic Flooding Events*”, pp.233-238, Taylor & Francis, 2015.
- [12] Ono, K., Takino, Y., Akakura, Y., Introducing Business Impact Analysis into Business Continuity Management for Port Logistics. *Proceedings of Infrastructure Planning Vol.48*, Committee of Infrastructure Planning and Management, JSCE. (In Japanese)
- [13] Komatsu, R., Hayashi H., Ohara, M., Samejima, R., Tamase, M., Toyoshima, K., Kimura, R., and Suzuki, S., “Developing business continuity plan for water treatment facilities based on the business impact analysis and the risk assessment of tsunami caused by the theoretically maximum Nankai Trough Earthquake— Through the case study at Osaka Municipal Waterworks Bureau—”, *Journal of Natural Disaster Science. JSNDS 32- 2*, pp.183-205, 2013. (In Japanese)
- [14] Kon, M., “Manual for practitioners on preparing business continuity plan”, Ohomu Express Co. Ltd, 2009. (In Japanese)
- [15] Caselli, F., Reyes, M., Beale, M., Akakura, Y., Ono, K.,, “Methodology and procedure of business impact analysis for improving port logistics business continuity management”, *Journal of Integrated Disaster Risk Management*, 2016.
- [16] Isouchi, C., Shiraki, W., Iwahara, H., Inomo, H., Takahashi, K., “Formulate guidelines for district continuity plan (DCP) for the event of large scale flood disaster and utilization of community disaster management plan (CDMP) ”, *Journal of Japan Society of Civil Engineers, Ser. F6 (Safety Problem)*, Vol. 70 (2014) No. 2 p. I_31-I_36
- [17] Baba, H., Adachi, I., Takabayashi, H., Nagatomo, N., Matsumoto, H., and Shimano, T., “Introductory study on Disaster Risk Assessment and Area Business Continuity Planning in industry agglomerated areas in the ASEAN”, *Journal of Integrated Disaster Management*, Vol.3 No.2, Dec. 2013, pp.184-195.