



THE ROLE OF SUPPLY CHAIN DISRUPTION MANAGEMENT IN INDIAN SEA PORTS (A CASE STUDY OF ANDHRA PRADESH)

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ABSTRACT:

The recent rise in a number of calamities and terrorist acts has brought much attention to the vulnerabilities of supply chains. Having passed through many hands that span continents and entities, the reliability and timeliness of freight delivery become increasingly difficult to be assessed. Particularly, at seaports which is an indispensable node in global supply chains and where complex sea and land interfaces come into play, the role of ports in maritime supply chain disruptions needs to be explored. The changing functions of ports and the current supply chain trends denote implications that when identified, will allow better development of mitigation strategies for ports. Despite the importance of this issue, most literature focuses on generic disruptions in the supply chain and those that addresses port-related disruptions do not provide a holistic view of risk management in ports. This research thus aims to fill the literature gap by describing guidelines for port management to operationalise by way of a management model constructed through a comprehensive review of previous research and real life cases and in-depth interviews with management from a port and a port user based in Singapore. The aim is to build a more resilient and sustainable port in the light of challenging evolution of supply chain trends in the dynamic maritime climate. The management model encompasses three fundamental levels of the port, with strategic responses tailored for the institutional, management and operational levels. Implications to the operations and management of ports in the supply chain context are drawn and future research opportunities are discussed accordingly.

KEYWORDS: supply chain disruption, management model, risk management, port management.

1. INTRODUCTION

In global supply chains, seaports are critical nodes where value adding and logistics-related activities take place. However, as processes and operations in the ports increase in their complexities and range, the integration of ports into supply chain management creates a higher level of uncertainties for downstream planning, product movement as well as information exchange. For that reason, deficiencies in the ports are capable of developing into augmented unsought effects down supply chains. To make matters worse, supply chain trends and practices increase the likelihood of a disruption occurring and exacerbate the effects of disruptions (Handfield et al., 2007, Kleindorfer and Saad, 2005). The potentiality of ports to administer seamless services, operations and transfer of cargo is obviously very much aspired by port users.

The increasing assimilation and amalgamation of ports into supply chains (Pettit and Beresford, 2009) has amplified the potential of ports in supply chain disruptions. In 2011, the Great East Japan

earthquake crippled Japanese north-eastern ports and has damaged port facilities, warehouses and factories in the port areas (Takahashi et al., 2011, Jolly, 2011). One of the supply chain entities affected is Sony which, in particular, subsequently reported a 10% decrease of sales on a year-on-year comparison partly due to the detrimental effects of the earthquake (Sony Global, 2011). On the same note, the West Coast port strike disrupted supply chain activities belonging to almost half of the 1,500 respondents surveyed to assess the impact of the strike (Institute for Supply Management, 2002). While it is undeniable that not all disruptive events in the ports are capable of upsetting the rest of a supply chain as the existing supply chain network may be adequately competent to attenuate the disruptive impact propagated from the ports, the intention of preventing such a situation reduces frustration for parties whose cargo are lodged in the delays or in complete port closures, and also avoids chaos in the anticipation of thwarting of plans.

Since the introduction of containerization, the focus of research within the maritime industry revolved around improving internal operational efficiencies which does not reflect the actuality of port's integration with its peripherals. However, a handful of research studying the relationship and coordination of ports with its community (Notteboom, 2008, Van Der Horst and De Langen, 2008) is starting to appear. At the same time, elaborate research on general supply chain disruption strategies emerged only in recent years, while study on port disruption strategies concentrate on disruption causes discretely. These collectively epitomize the paucity of a port-wide holistic approach towards the management of port-related supply chain disruption (PSCD).

Hence, this paper seeks to address PSCD threats by way of a management model for minimizing port-related supply chain disruption potential of ports (PSCDM). The paper is presented as follows. The following section reviews literature examining port-related disruption management. The third section presents the methodology while the fourth discusses analysis and findings. The paper then concludes by suggesting implications of the PSCDM and indicating future research directions.

2. MANAGING PORT-RELATED DISRUPTIONS IN THE LITERATURE

Challenges in Ports

The evolutionary developments in port functions through three generations usually refer to changes in types of cargo received, port activities and members as well as degree of involvement of the port community (UNESCAP, 2002). The post containerization era witnessed marked progress in value-addedness and increasing integration into supply chains (Pettit and Beresford, 2009). With the growing importance of port hinterland, coordination and cooperation with other transport nodes create anticipated means of creating synergies (Notteboom, 2008). However, some dyadic players in a port supply chain have operational relationships but not contractual relationships and the degree of integration of the chain will be reduced due to the lack of contractual relationships between dyadic parties (Robinson, 2007). Besides, the lack of contractual relationship can also cause variabilities and uncertainties in the port supply chain system. As there already exist conflicts in the intermodal channels (Taylor and Jackson, 2000), the above problems reiterate the need for adopting holistic cooperation within the port and with its peripherals.

The more commonly discussed operational port risks are port accidents (Pinto and Talley, 2006, Darbra and Casal, 2004), port-equipment failures (Mennis et al., 2008, Gurning, 2011), mishandling of dangerous goods (Ellis, 2011), port congestion (Paul and Maloni, 2010), inadequacy of labour skills (Fabiano et al., 2010), hinterland inaccessibility (Gurning and Cahoon, 2009a), breach of security (Pinto and Talley, 2006, World Port Source) and labour strikes (Blackhurst et al., 2005, Berle et al., 2011). On the other hand, human factors such as a lack of work experience and inadaptability to new skills and technologies contribute to port risks too (Fabiano et al., 2010). Similarly, factors constituting differences among individuals increases the challenges of communication (Horck, 2008). As such, conflicts in personnel and communication are risks of the port as well (Berle et al., 2011). It is difficult to study these risks separately as they can be interconnected, hence, the root cause of any port disruptions should be mitigated instead.

Mechanisms Addressing Port Disruptions

Practitioners and researchers in the port industry share an ardent aspiration of achieving seamless cargo flow to drive profitability and carve a competitive advantage. This trend is displayed through a profuse research in addressing port connectivity (Robinson, 2002, De Langen and Chouly, 2004, Notteboom, 2008), port efficiency (Estache et al., 2002, Tongzon, 2002, Mennis et al., 2008), port costs (Lirn et al., 2004), integration initiatives (Notteboom and Winkelmanns, 2001, Bichou and Gray, 2004, Song and Panayides, 2008) and the provision of value-added services (UNESCAP, 2002, Carbone and De Martino, 2003). Unfortunately, there have been scant research on port agility (Paixao and Marlow, 2003, Lun et al., 2010) and port's adaptability to market uncertainties (Marlow and Paixão, 2003), which would offer valuable insights in creating guidelines for increasing a port's resilience.

Research related to port disruptions are scattered with regards to the type of risks addressed and the implementation of the proposed measures. There are specific tools such as the multi-level alarm system for collisions within port waters suggested by Chin and Debnath (2009), vessel restoration model by rerouting vessels developed by Guerrero et al. (2008) for the event of US port closures and optimization models applied by Paul and Maloni (2010) to compare different scenarios and severities of disruptions that caused a redirection of vessels to other ports in a network. Other instances include markov chain used by Gurning and Cahoon (2009b) to evaluate wheat supply chain risks and disruption analysis network (DA_NET) applied by Wu et al. (2007) to show propagation of attributes while measuring the impact on the supply chain system. However, these predictive instruments do not provide protection from the port risks.

In addition, there are initiatives which ports can adopt to combat port disruptions. Participating in security initiatives such as the Customs-Trade Partnership Against Terrorism (C-PAT) prevents cargo from being subjected to additional scrutiny. In particular, the United States has been active in its initiatives to counter port security incidents. These range from establishing the US Department of Homeland Security (DHS), utilising radiation detectors in ports, implementing the US Maritime Transportation Security Act (MTSA) and the ISPS Code to revised port security plans which include having extra defense layers in preventing threats (Pinto and Talley, 2006). Other instances of initiatives designed to increase maritime security are CSI and the 24-hour rule (Bichou, 2011). There are also concepts conceived to move part of port functions inland to relieve port congestion. These involve using integrated centres for Transshipment, Storage, Collection and Distribution (TSCD) of freight (Konings, 1996), satellite terminals (Slack, 1999), port-centric logistics (Beresford et al., 2011) and inland ports (Rahimi et al., 2008, Notteboom, 2008). Nonetheless, there are yet to be suggestions explicating means of combining or executing these approaches through specific actions.

In general, contemporary research addressing port disruptions do not provide a full spectrum of remedies targeting aggregated port risks. Hence, the privation of holism in the advent of PSCD management demonstrates the need to address the following research questions:

- a. What are the mechanisms which the port should initiate to minimize port-related supply chain disruptions?
- b. How should a holistic approach towards PSCD management be operationalised by the participants involved in port transport chains?

3. METHODOLOGY

Development of the Conceptual Framework

The previous literary work provides theoretical perspectives on tools and initiatives which can be synthesized and further operationalized into management guidelines for reducing the potential of SCD of a port. Based on previous work, the increased presence of ports felt by supply chains generates larger impact of new deficiencies brought by the interface, drawing attention to the supply chain disruption potential of ports. Increasing the resilience of ports will directly minimize the supply chain disruption potential of ports. As ports are increasingly integrated into supply chains, the exigency for resilient ports is induced. Additionally, the variability in supply chain trends and market uncertainties

propel the drive for resilience in the port and at the same time affect the performance of its resilience. The relationship between these factors is displayed in Figure 1.

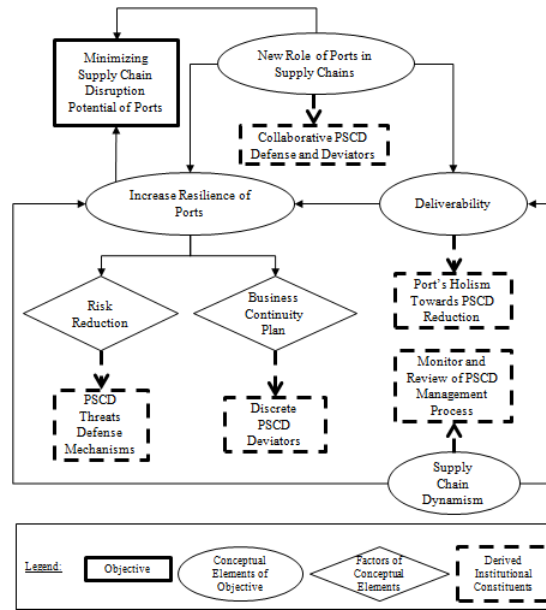


Figure 1: The Conceptual Framework
Source: Authors

Derivation of PSCDM from the Conceptual Framework

In the management of disruptions, the objective is to increase resilience which refers to risk reduction and existence of business continuity measures (Christopher and Peck, 2004). In strengthening the resilience of ports, the first step is thus the implementation of protective measures against PSCD threats which are capable of resulting in possible supply chain disruptions. This is represented by ‘PSCD Threats Defense Mechanisms’ dotted box in Figure1. However, should disruptions inevitably occur, either due to ineffectiveness of existing preventive measures or amplifying effects of exogenous variability, a list of interception measures has to be executed in order to expedite the port’s recovery capabilities or deviate the intended consequential paths of the threats. Due to the increasing integration of ports into supply chains, collaborations with multiple parties in the port community to contain or prevent PSCD are as necessary as the action plans executed by ports alone. This explains the two dotted boxes namely, ‘Discrete PSCD Deviators’ and ‘Collaborative PSCD Defense and Deviators’. Nonetheless, the efficaciousness of the above measures requires the proposition from the management level and then acceptance and implementation at the operational level. Therefore, to ensure the deliverability of the action plans, the port’s holism approach is imperative. However, even with a sound disruption-proof layer of protective and mitigative mechanisms coupled with staunch support pledged across the port, the catapultic movement towards resilience can only be swiftly accomplished when the proposed measures remain relevant in the dynamism of the market. This is the reason why regular monitoring and reviewing of the management policies is important. In this manner, the PSCDM is arranged into five institutional constituents, as presented in Figure 1, consisting of *PSCD Threats Defense Mechanisms*, *Discrete PSCD Deviators*, *Collaborative PSCD Defense and Deviators*, *Port’s Holism Towards PSCD Reduction* and *Monitor and Review of PSCD Management Process*. Section 4 describes the management model in more details.

To operationalize the above defined directives, the PSCDM is presented in three tiers: Institutional Bearings, Management Policies and Operational Actions, as shown in Figure 2. The highest echelon is the decision-making at the board and top management of the port and these strategic directions dictate management policies at the second tier, which accordingly requires the collaborative effort at port- wide level to attain the intended institutional directives. The epistemological essence of the management model is that awareness is created amongst top and middle-level management in policy making, while the lower-level management will be more acquainted with potential PSCD threats in their supervision of front-line employees in port operations.

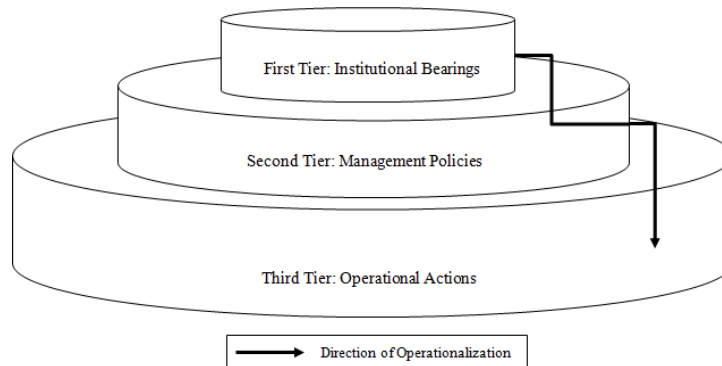


Figure 2: The Three Tiers of PSCDM

Source: Authors

The development of the operationalised actions involves the application of three theoretical approaches namely, Risk Management (RM), Business Continuity Management (BCM) and Quality Management (QM) at the Institutional Bearings. The three theoretical approaches are the fundamental driving factors that facilitates disruption management at the port. Risks should be reduced or eliminated through RM process. Alternatives and recovery plans have to be in place for emergencies and unavoidable risks and this is achievable through the BCM process. Finally, akin to Kleindorfer and Saad (2005) who applied total quality management (TQM) principles in their implementation of risk mitigating tasks, QM ensures that the port is able to maintain its delivery of services.

The PSCD consequences targeted by the PSCDM are shown in Figure 3. The list of PSCD consequences is developed through deduction from literature and logical inferences. According to literature, there has been no standard way of categorising the reported consequences and the consequences are typically grouped in the manner most relevant to the study. As this study is concerned with the propagating effects of PSCD threats, the PSCD consequences are divided into three levels, the port level, port community/maritime transportation level and the supply chain level. As shown in Figure 3, there are six PSCD consequences at the port level, eight at port community or maritime transportation level and nine at the supply chain level. Each level follows the principles of the four stages of disruptions with increasing severity – delay, deviation, stoppage and loss of service platform summarised by Gurning et al. (2011), wherever possible. In this manner, the classification of PSCD consequences in different levels expresses its range of disruptive effects. For instance, delays in operations at the port level would include delays in cargo loading and discharging and vessel berthing. This is different from the delay in cargo handling and management at the port community level as the latter refers to cargo transfer at inland corridor which takes place outside the port vicinity. Similarly, delay in cargo delivery at the supply chain level would mean that the downstream supply chain entities or end customers receive delayed shipments. In addition, the implied outcome of the PSCD consequences identified in this paper are loss of reputation, loss of profitability and loss of reliability of the port and/or supply chain entities.

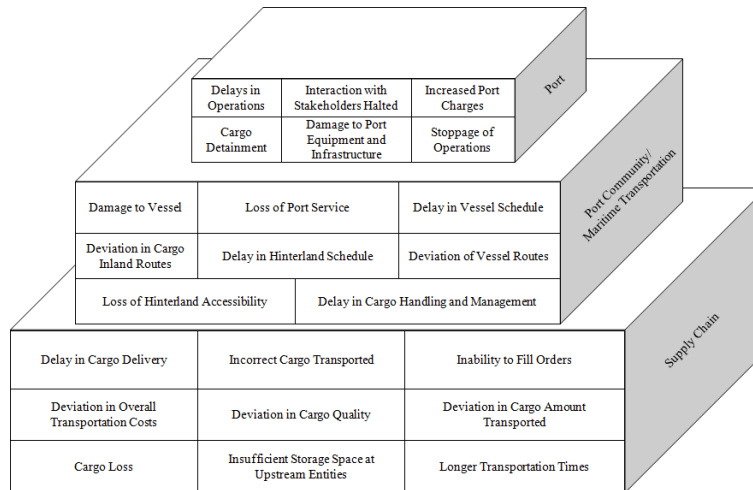


Figure 3: PSCD Consequences

Source: Authors

Data Collection Technique and Administration of the Research Instrument

As this is the first stage of a more comprehensive research to be conducted at a later stage, in-depth face-to-face interviews were selected as the main method of data collection. For this research, the sample involved the management from a tanker company and a multi-purpose port based in Singapore. The interviewees were selected based on their designation, experience and the involvement in port operations of the organization they represent. The interviews were conducted at the interviewees’ office and audio-recorded when the respondents permit. The main objective of the interviews was to obtain comprehensive insights through highlighting the research questions and the scope of the initial PSCDM in questionnaires designed separately for the port users and port operators. In particular, the initial first two tiers of the PSCDM were shown and explained to the interviewees. Changes were then made to the PSCDM to adapt the first two tiers to the interview responses and current practices at their organizations. After which, the operational actions at the third tier were developed. In summary, the final PSCDM has five institutional bearings at the first tier, 19 groups of management policies at the second and 75 operational actions at the third tier.

4. ANALYSIS AND FINDINGS

Components of PSCDM

Following the results of the interviews, the revised PSCDM is established. Figure 4 provides an overview of all the components of each institutional constituent. Descriptions of the actions of the management policies are presented in the following subsections.

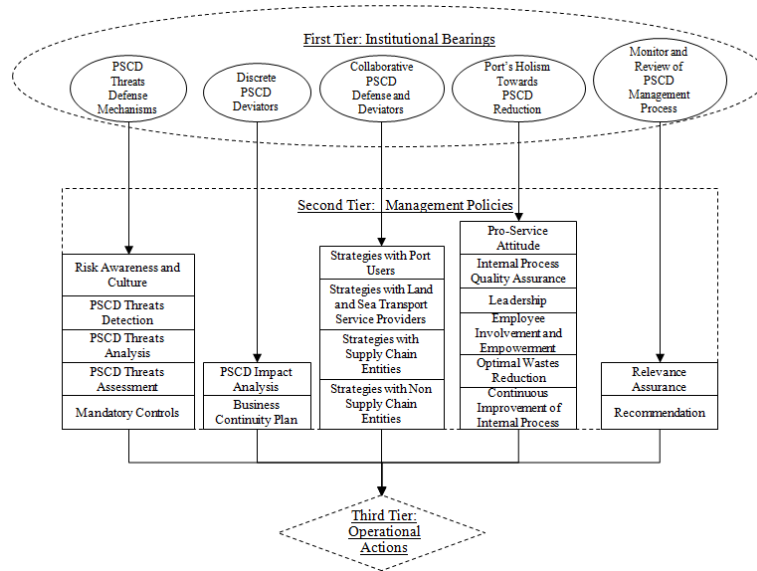


Figure 4: Components of the PSCDM
Source: Authors

PSCD Threats Defense Mechanisms

The interviewees were consonant in their views that ports contribute to supply chain disruptions and this affirms the applicability of the iterative risk management procedures in designing protective mechanisms for PSCD threats as these steps help identify PSCD threats through risk awareness and culture, provide an understanding of the PSCD threats by analyzing and assessing of the threats, and finally allow the port to administer preventive measures to reduce the likelihood or PSCD threats occurrences and to reduce the impact of undesirable consequences.

Risk Awareness and Culture

The effective management of PSCD threats is generated from intrinsic risk attitude which should be part of the port’s culture (Joint Standards Australia/Standards New Zealand Committee OB-007, 2004b). To cultivate risk awareness and culture in the port, discussions about repercussions of changes in relevant regulatories, trade policies and business and political environments should be included during safety and risk assessment meetings and these safety meetings minutes should be circulated among management. During these meetings, tools such as SWOT analysis can be used for scanning of internal port environment and PESTLE analysis can be used for external port environment. The port can also send circulars or monthly publications documenting accidents or near- misses in own and other ports to port management. Checklists should be drawn up for port staff to adhere to, for instances, checklists regarding acceptable Personal Protection Equipment (PPE) requirements and permitted and prohibited activities within yard areas. Staff training on PSCD threats identification and risk management, attendance to risk awareness programs and risk induction sessions for new employees will also raise awareness on potential PSCD threats that may lead to supply chain disruptions. Cognitive perception of PSCD threats will influence one’s behaviour and responsiveness towards a potential PSCD threat and thus risk awareness has to be cultivated to facilitate the management of PSCD threats.

PSCD Threats Detection

Identifying the PSCD threats defines the scope of focus in managing them. This process will depend on the types of cargo handled in the port and the extent of development of the port. In general,

PSCD threats can be identified by organizing safety and risk assessment meetings which stakeholders can attend to exchange perceptions and objectives so that external threats can be discovered; developing and re-visiting risk criteria for different functions of the port, stating clearly the acceptance level of each risk; establishing the acceptance level of each risk for different functions of the port; engaging in strict and frequent audits in all aspects of port operations; keeping record of incidents and near misses in own port which resulted in disruptions and use these as case of analysis when conducting risk induction sessions; launching programmed attacks on IT system to reveal loopholes after every upgrade; monitoring risk level at ports using PSCD indicators, which reflect performance and risks level of contracting parties and hinterland transport operators. After which, a list of PSCD threats will be compiled and subject to further analysis and assessment so that they can be classified for treatment.

PSCD Threats Analysis

An analysis of the PSCD threats provides an understanding of the threats in terms of their sources and consequences. The analysis can be carried out by performing 'What If' analysis on the identified threats and expressing the possible consequences, which are the effects of PSCD threats on port infrastructure, port operations and port communication systems, in monetary terms wherever possible. Moreover, the probability of the occurrences of PSCD threats has to be estimated based on past records, research, experiences and interviews with experts. These two steps will enable the mapping of risk matrix which is required for threat assessment process.

PSCD Threats Assessment

The assessment of PSCD threats aims to prioritize solutions for the threats based on the analysis results of the threats (Joint Standards Australia/Standards New Zealand Committee OB-007, 2004b). Therefore, the existing level of risk is to be compared with port's risk criteria and the threat magnitude is prioritized according to the threat's probability (P) and consequences (C) in the following manner: Low P-Low C, Low P-High C, High P-Low C and High P-High C. One interviewee mentioned a practical tool used his organization and it was the Enterprise Risk Management template in which objectives of threats assessment can be achieved. The above actions will reveal which PSCD threats require remedies and the appropriate preventive measures.

Mandatory Controls

Preventive measures will be designed for different categories of PSCD threats to manage them. For PSCD threats falling under High P-High C, the port should adopt risk avoidance measures. These can be restructuring port operations to eliminate High P-High C activities, allowing authorized personnel to enforce stop-work order once any High P-High C activities start to appear in the port, screening the background of potential staff, enforcing and adhering to mandatory security rules and regulations and inspecting port workers for full PPE, alcohol or drug consumption. On the other hand, for PSCD threats belonging to the Low P-High C category, the port should adopt risk transfer or risk sharing measures which include purchasing insurances and negotiating for acceptable dispute and risk management clauses in contracts to preserve the value of each agreement.

For all other PSCD threats, risk minimization measures should be adopted instead. One interviewee emphasized the role that technology plays in port safety and indicated that technology can be reflected from equipment like gantry cranes, stowage system and cargo distribution. As such, the minimization measures may be in the form of encrypting data transmitted through port servers; equipping warehouses with well-maintained protective mechanisms such as installing fire doors, firewalls and sprinklers; implementing port facility access controls such as implementing biometric identification and verification of staff and truckers, RFID readers, RFID tags for port staff entrance to yard areas; equipping port areas with physical security mechanisms such as installing CCTVs and alarms, have layered security levels, station armed guards who can stop rowdy behaviour or other forms of violation in the port areas; adhering to port infrastructure's Maintenance and Repair Scheme;

purchasing data leakage and loss technologies or software; screening integrated information system and internal servers for threats periodically. Additionally, the interviewees mentioned examples which are deemed as practical tools by them and these are investing in critical port infrastructure such as constructing sufficient suitable berths to accommodate vessels, improving port traffic control using Vessel Traffic Separation Scheme and developing better stowage systems. These tools can be explained by the fact that the interviewees were concerned with the availability of the port's main navigational channels and the berth scheduling of vessels, both of which require prudent selection of infrastructure investment.

Finally, for residual risks of all risks treatment and methods, the port should adopt risk retention measures. Possible approaches by doing so are investing in interchangeable parts or equipments or ensure that there are substitutes for key equipments and engaging in self insurance by setting up reserved funds which cover loss and compensation in times of crisis. The abovementioned measures seek to reduce risks in the port. However, business continuity plans should also be designed to expedite recovery process of the port, should unavoidable risks take place.

Discrete PSCD Deviators

Preventive measures alone are insufficient in reducing the potential of ports in supply chain disruptions. The development of continuity plans is imperative as affirmed by the interviewees. This will ensure a more comprehensive protection from PSCD threats.

PSCD Impact Analysis

An analysis of the PSCD impact will reveal the critical business functions, critical resource requirements and disruption scenarios (Joint Standards Australia/Standards New Zealand Committee OB-007, 2004a) which are preceding steps to business continuity plan. First, the port can map out value stream of port and perform workflow analysis to identify key operations and processes at the port. According to one interviewee, the key processes at container terminals are berthing, quay, yard and gate operations, while that at multi-purpose terminals are likely to further include general cargo operations, bulk cargo operations, warehousing operations and billing. For each key functions and processes, the port has to determine the minimum acceptable level of resources required. Based on historical records, interviews and surveys, the port then determines the length and severity of financial and operational impact resulted from each key functions and processes. The possible outcomes of PSCD disruptions are to be simulated and prioritized in monetary terms.

Business Continuity Plan

Quick decision making is expected during emergencies, hence a documented business continuity actions will be valuable. These actions shall intercept and deviate the paths of PSCD disruptions towards a less disruptive route. Based on results of risk matrix and business impact analysis, the port should establish specific emergency response plans for each department as well as for the port as a whole, documenting procedures to follow, resources to be mobilized, budget to be adhered to and the responsibility of each person involved. For instance, an interviewee indicated that there are resources planned to substitute the duties of key talents in his organization's disaster recovery plans. The response plans have to be executed in the form of drills to ensure concatenation between procedures and coherence between departments. The port can respond to all types of risks in the risk matrix by establishing early warning system or trigger points for the response plans to be activated. For instance, establish trigger points on Master Port Plans so that extra berths or other infrastructure can be developed early enough to accommodate throughput growth and support port's growth strategies. Once trigger points are hit, the port should mobilize previously appointed individual from response team for quick decision making and overlooking the response plans execution.

Throughout the execution of response plans, the port is required to maintain close contact with internal resources for troubleshooting. An interviewee stressed the importance of assigning authority to personnel for decision making and the organization's ability to extend resources to assist the

situation. To do so, it is suggested that the port collate contact information of staff for communication of disruptions after business hours and keep a detailed record of procedure manuals. Responding to minimizable and retainable risks in the risk matrix, the port can activate redundant resources. For instance, substitute equipments, interchangeable parts, real time replicated servers and cross-trained staff should be utilized during disruptions. In order to respond to transferrable risks in the risk matrix, the port can enter into short term contracts with external truckers for peak periods or holidays, during which port's internal manpower tend to run low. This action has been suggested in response to a real-life PSCD brought up by an interviewee.

Collaborative PSCD Defense and Deviators

The increased embeddedness of ports in supply chains has increased the variety of port functions and value-added services. This change in the relationship between ports and their community requires higher communication and collaboration with external parties in order to bring about positive outcomes derived from the changing role of ports.

Strategies with Port Users

Port users are those who will feel immediate impact of PSCD threats. Even with proper contingency actions in place, for these actions to be enacted coherently, the port should organise joint practices or risk management exercises with port users by involving port users' participation in drills in which emergencies such as network system breakdown will require manual document process or submission by agents and shipping lines.

Strategies with Land and Sea Transport Service Providers

Ports, land and sea transport service providers are enmeshed in their operations. Collaborative actions with these parties should work towards increasing schedule and flexible throughput allocation certainty and the extent of assistance in times of crisis. As such, the port can form cartels among several inland ports, hinterland transport operators and port operators to prevent sudden unanticipated changes to demand at any one party and to create synergies in resources allocation. To increase the port's agility, the port can have agreements with multiple hinterland transport operators to use non-contracted throughput with one when the other defaults, develop alternative inland paths together with transport operators, and enter into bilateral contracts with regional ports on leasing of warehousing space, performance of value-added services, berthing space and connections to hinterland to ensure the delivery of contractual duties by the disrupted port as much as possible. The port is thus expected to establish a mechanism to maintain close contact with regional ports, inland ports and land transport operators for these collaborative response plans to be executed in time. The well-being of these service providers will in turn affect the port directly. One way to ensure this is for the port to enter into financial schemes with major hinterland transport operators which may be in the form of lower interest rate loans to major partners to prevent a default of service. Its purpose is to prevent financial woes which can affect the service providers' ability to transport cargo within and out of the port premise. In addition, the integral element of each operation boils down to the employees executing the job; industrial actions will definitely incite a series of operations stoppage and inventory buildup. One possible solution is for the port to enter into collective agreements with its hinterland transport service providers, especially the truckers and stevedores, on issues such as working conditions, working hours and mechanisms to resolve disputes so that industrial actions can be prevented.

Strategies with Supply Chain Entities

As networks of supply chain entities are enmeshed at the port premise, their operations are vulnerable to PSCD. However, damage can be reduced when a high level of responsiveness is displayed by these supply chain entities in terms of quick decision making and effective business continuity management. This will require real time communication with the port especially in the event of a PSCD. Thus, the port needs to establish a mechanism to maintain close contact with cargo owners and

emergency response teams from stevedoring companies and shipping lines in order to ensure the expedited movement of urgent cargo out of the port and also to ascertain the tolerance for delays of the remaining cargo.

Strategies with Non Supply Chain Entities

Influential non supply chain entities which can provide insights to potential PSCD threats are the government or port authorities. Thus, the port can collaborate with relevant government agencies to gain access to intelligence information, such that it has access to information on possible terrorist attacks or contraband. On the other hand, the port can also collaborate with R&D companies to pursue process innovations. Such collaborations should seek to invent smart communication tools and technologies as these will reduce communication costs with port community and also improve port operations and processes with newer and better technologies.

The port then has to ensure that all proposed measures receive support and commitment from organization-wide for the measures to be effectively executed. Hence, a holistic approach towards PSCD management is necessary.

Port's Holism Towards PSCD Reduction

Be it combating the likelihood of a PSCD threat occurrence or working towards increasing the recovery capability of the port, correspondence between different functions and commitment from across the port are requisites in fulfilling the objectives of the PSCD management. Based on the interview responses, profitability and costs are prominent considerations besides the potential of the role in supply chain disruptions. Thus, while ensuring the protective mechanisms and deviators are effectively implemented, the deliverables from the port must be equally, if not more, attainable as every business is profit-seeking.

Pro-service Attitude

As steering towards resilience and agility is a separate strategic direction from the conventional focus on performance-oriented management, this should not mean a change of course away from profitability, which is a product of customer-retention resulting from good organizational performance. As one interviewee has pointed out, ports are selling service ultimately, hence costs of port service should always be considered. This can be done by establishing the frontier by finding out the threshold of port users for costs and tolerance level for disruptions based on past lessons, complaints and feedback gathered from port users and keep port charges within the threshold. Connectivity is another main deliverability of port service. This can be achieved by establishing the port's own 'single point' electronic system, where port users and the foreland can conveniently share data important to them such as time of ship arrivals, berthing schedules, cargo location, cargo quality, real time updated time of cargo arrival and when cargo is ready for pick up.

Internal Process Quality Assurance

The quality of port service delivered is also intrinsically defined by that of internal processes. Quality assurance of internal process can be achieved through implementing operational-level agreements between departments to ensure timeliness in the execution of internal processes and to reduce conflicts. Another approach is through updating revised data and forecasts on shared system visible to all functions in the port, so that any changes can be communicated across departments and revised plans can be prepared by respective departments as soon as possible. The information to be shared should include changes in stowage plans, changes in yard space availability, changes in warehousing space and activities on berth allocation system. Higher connectivity and an integrated level of communication would mean the advancement towards better technologies. Hence skills, knowledge and technology proficiency upgrading of port staff should also be considered.

Leadership

Support of PSCD management policies needs to be explicitly reflected through leadership style as commitment is bidirectional (Coetzee, 2005). Methods for the port to do so include entering into a harmonious corporativism involving parties from the government, labour and employers which schemes addresses workers' welfare as well as port business concerns, involving elected representatives of staff from each function in disaster recovery planning and crisis management instead of finger-pointing, inviting front-line staff to voice their grievances at periodic redress meetings, appointing trained personnel in handling media queries and communication with next-of- kin when crisis occurs, allowing elected representatives from different functions to attend safety and functional meetings with management and communicating changes in policies or processes through small group meetings. These actions will help break down the management barrier.

Employee Involvement and Empowerment

Organization-wide commitment forms the requisite of effective implementation of an organization's objectives (Coetzee, 2005). Commitment can be developed through making the employees feel valued and respected. This can be done by encouraging constructive feedback by giving out rewards regularly for feedback on useful and practical process improvements, providing a portal for staff comments regarding process improvement on condition of anonymity, enforce compulsory participation in emergency and evacuation drills, holding discussions between tripartite parties and present findings before laying down rules, delegating authority to front-line individuals for quick actions to be undertaken to contain any undesirable impact as far as possible at the operational level and approaching staff from different functions and levels for opinions, through interviews, surveys and feedback sessions, before deciding on new policies or any major revamp.

Optimal Wastes Reduction

The absence of buffers exposes the port to greater vulnerabilities. Thus, wastes should be reduced optimally and this can be achieved through making Activity Based Costing compulsory for each expense group of disruption plans and encouraging the conservation of resources wherever possible by preventing previous expenditures affect subsequent budget approvals.

Continuous Improvement of Internal Process

A constant effort engaged by the port in improving port operations and processes shall increase the port's efficiency and effectiveness. The port can regularly conduct and re-evaluate workflow analysis to improve process efficiency and reduce costs, conduct cross-industry benchmarking about supply chain disruption potential and gather feedback from port users on areas to improve in and where port has excelled in through forums, surveys, or informal events. Alternatively, the port can learn from own or other's experiences by adopting and sharing post-disruption lessons learnt within port and shipping industry through exchanging information on forums and with members of associations.

Monitor and Review of PSCD Management Process

The maritime industry is dynamic and the market is constantly filled with changing business trends. Existing plans and policies need to be monitored to identify new challenges, and reviewed for new improvements.

Relevance Assurance

To ensure relevance to the dynamic market setting, even when equilibrium has been restored, the port needs to collect feedback periodically from port users to understand their changing needs and to ensure that the actual level of service is in line with the expected outcomes. Moreover, the port needs to review and revise risk management policies and plans or and replace servers as and when risk landscape changes.

Recommendation

The PSCD management and recovery process should be evaluated to identify lessons learnt such that future PSCD can be managed more effectively. An interviewee suggested that to do so, the port can carry out post-drills evaluation to ensure alignment of drill results with port's objectives and conduct post mortem analysis on PSCD disruption management after disruptive events to identify areas for improvement accordingly.

5. IMPLICATIONS OF THE PSCDM

The results of this research provide a comprehensive academic groundwork for defining the facilitative actions and activities which individuals at the three tiers of the port can partake of. This allows a more extensive analysis in the supply chain disruption management discipline as ports are capable of playing an effective role in containing or contributing to supply chain risks due to the increasing importance of ports in supply chain environments. Hence, this aspect of research warrants attention to avoid underestimation or overestimation of supply chain risks in other supply chain disruption management studies.

As resilience of a port constitutes its competitive advantage, this management model also assists port management in retaining its clients by ensuring the functionality of port operations and increasing the port's adaptability to disruptions such that cargo can be passed on successfully to subsequent supply chain entities within the stipulated time. Furthermore, with a holistic approach adopted by the port in managing PSCD, a proximate relationship is fostered with its community and this manifestation would likely generate greater synergies in cooperation of other aspects.

6. CONCLUSION AND FUTURE RESEARCH POSSIBILITIES

Due to the absence of formalised procedures for minimizing the port-related supply chain disruption risks, this paper has proposed and preliminarily validated a holistic management model addressing actions at the institutional, management and operational levels to fill the gap. Characteristics of resilience, supply chain market and current role of ports are studied in the synthesis of the PSCDM. The execution of the management model is a participative practice which incorporates inter-disciplinary knowledge and experiences. Besides the application of risk management and business continuity management, the PSCDM achieves its objectives through integrative administration of interorganizational relationship development and operational excellence principles. However, the liner market differs greatly from that of bulk and addressing them separately could provide more specific actions catered to a particular market. On the same note, the development degree of ports varies and thus the PSCDM will likely cause discrepancies of resulted outcomes when applied to different ports. A future research opportunity could be to quantitatively validate the actions through surveys. Moreover, the right actions alone are insufficient in containing disruptions. The right action at the right time would be necessary, hence trigger points or indicators in relation to PSCD threats have to be created in order to notify ports the point of time to execute these actions. Additionally, the actions to increase recovery capabilities of the port following a PSCD should also be defined to create an even more comprehensive coverage from the disruption.

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