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THE CYCLES OF MARITIME DISRUPTIONS IN THE AUSTRALIAN – INDONESIAN WHEAT SUPPLY CHAIN

Saut Gurning[1], Stephen Cahoon[2]
[1] Australian Maritime College, Launceston-Tasmania, AUSTRALIA, E-mail: s.gurning@amc.edu.au
[2] Australian Maritime College, Launceston-Tasmania, AUSTRALIA, E-mail: s.cahoon@amc.edu.au

Summary: *Maritime operations have the potential capability to generate wide-scale disruptive effects to all tiers in the supply-chain. Therefore, the cycle analysis of maritime disruptions may provide a number of key values to recognize the characteristics of every stage of maritime disruptions in the phase of discovery and recovery. This paper explains the generic cycles of stages in four different maritime disruptive events including congestion due to handling equipment breakdown, severe weather, earthquake, and the shortage of dry bulk ships all in the context of empirical results from a 2010 study of the Australian-Indonesia wheat supply chain. By exploring and understanding the critical components of disruption cycles, this paper argues that decision makers will be better equipped to plan for the effects of supply chain disruptions. In addition, the paper recommends effective multi-mitigation strategies for further consideration when managing maritime disruptions.*

Keywords: *Cycles of maritime disruptions, wheat supply chain*

1. INTRODUCTION

Supply chain operators are facing a variety of uncertainties on their particular leg of the supply chain due to various internal and external factors disrupting the shipment of goods from the source to the planned destinations. For example, Gaonkar and Viswandham [1], Robert *et al.* [2], and Rodrigues *et al.* [3] argue that global outsourcing strategies implemented by dominating international supply chain operators create uncontrollable deviations from their original plans when disruptions occur in one or more of the many stages of the chain flow. These disruptions also occur in the maritime related processes, which are part of the transportation cluster services in the downstream operations of the supply chain. Maritime disruptions present substantial risks in the transport of cargo in shipping-related activities caused for example by the shortage of ship fleets on a particular route or shortage of cargo at a certain period of time; or natural hazard conditions at sea such as severe wave height; or a supply/demand imbalance of containers [4-6].

Ideally, maritime disruptions could be minimised if effective disruption management systems are in place and senior managers have an understanding of how to prepare and plan for the probability of a maritime disruption. Therefore to make a strategic response to maritime disruptions requires an appreciation of the complete cycle process of maritime disruptions to enable a decrease in disruption consequences and their propagation effect due to the cycle of disruptions being a consequence of instigating factors over time. This paper explores the cycle process of maritime disruptions using the Australian-Indonesian wheat supply chain as a comprehensive view of a potential disruption configuration. By exploring and understanding the cycles of maritime disruptions, supply chain entities may be better prepared to manage the causes and effects presented by maritime disruptions and hence recognise the benefits of developing disruption management strategies.

2. DISRUPTION CYCLES

Studies on disruption cycles suggest that investigations on crisis lifecycles have provided a foundation for researchers on how to discover risk related events [7-14] (see Table 1). Due to this reason, the dominant perspectives of the risk lifecycles research tends to focus on crisis or disaster related events. The issue then is that the lifecycles analysis framework focuses primarily on crisis behaviours and correlating them with responses collected in a short period of time and then concentrating on the internal factors of an organisation where the uncertainty event occurs.

Table 1: Categorisation of crisis and disruption lifecycle

Orientation	Event based cycle	Response based cycle	Short cycle
Crisis	*Fink (1986):* * Prodormal * Acute * Chronic * Resolution *Shrivastava (1993):* * Cause * Consequence * Caution * Coping	*Barton (1993); Mitroff (1994)* * Detection * Probing / prevention * Containment * Recovery * Learning	*Roberts (1994);* * Pre-event * Emergency/intermediate phase * Long-term phase *Lauge et al.(2009)* * Pre crisis * Crisis * Post crisis
Disruption	*Tomlin (2006; 2009)* * Normal * Reaction * Failure * Recovery *British Standard (2009)* * Event occurs * Damage assessment * Plan activated * Disaster assessment * Critical processes resumed		Blackhurst (2004); Handfield *et al.* (2008) * Discovery * Recovery

As shown in Table 1, Fink [9] appears to be the first study exploring the behaviours of a risk-related event called a crisis with four major stages namely prodormal, acute, chronic, and crisis resolution. The investigation of Fink's research, which was mainly derived from medical cases, was elaborated on by Gottschalk [15], Parlar and Perry [16], Pearson and Clair [13], and Coombs [17] in various general public applications including transport operations. Under the investigation of Fink's [9] four stages, an unexpected negative event was observed by the study that mainly focused on the cognitive assessment of the causes of the disruptive event along various causal possibilities, which in turn impacts on only one crisis resolution. Three crisis study reports [7, 11, 14] demonstrate that internal inadequate controllable responses resulted in worse risk reactions than external uncontrollable influences. Using natural disasters, Mitroff [11] reveals that the external uncontrollable triggers (severe weather and earthquake) resulted in less resistance, greater support, and higher cautions and response than the internal controllable cause (such as a poor maintenance system). By providing five risk stages namely detection, probing/prevention, containment/damage containment, recovery, and learning, Barton [7] and Mitroff [11] found that the more internal and manageable a risk being handled, the more responsible an entity was considered to be. Therefore, unlike the research by Fink [9], the scope of the risk lifecycles as noted by Mitroff [11] is more related to risk-related responses rather than the cycle behaviour of the crises. Similar to the natural disaster focused research, a less complex crisis cycle is proposed by Roberts [18], and Lauge *et al.* [10] who define risk-related events mainly into three stages such as pre-crisis, crisis (emergency and intermediate phase), and post crisis.

Using industrial accidents (significant and non-significant), Williams and Treadaway [19] and Shrivastava [8] found that the internal controllable catastrophe (with a high consequence such as infrastructure failure or fire due to outdated equipment) led to higher caution and responsibility of an organisation. With the four stages of cause, consequence, caution, and coping, Shrivastava [8], Manion and Evan [20], Sriramachari [21] and Chang *et al*. [22] define the crisis cycles with proposed mitigation initiatives related to industrial situations. However, the industrial network beyond certain crisis cycles was not considered significantly in their research. The importance of the disruption risk lifecycle in supply chain studies has been initiated by Blackhurst *et al.*[23], Paul and Denis [12], Tomlin [24, 25], Pinto and Wayne [26], Handfield *et al.* [27], Kuster [28], and Lauge *et al*. [10]. Unlike the research on crisis, the cycle investigations on disruption in the supply chain mainly suggest less complex stages because they focus on risk management strategies rather than identifying the disruption behaviours. The study of Blakhurst *et al.* [23] and Handfield *et al.* [27] for example, suggest two stages to the cycle of disruptive events namely discovery and recovery, whereas Tomlin [24, 25] propose four stages starting from normal condition to failures, reaction, and then the recovery prior to once again returning to the normal condition again. The mechanism of the disruption cycle mentioned above could be as a result of observations of the disruption's structure focusing mainly on the combination of disruption response phase with strategies taken in a short period of time and relating it to past events. Similar to this, the British Standard (2009) also identifies disruption as having five stages namely the event occurs, damage assessment, disaster assessment, disaster declared plan activated, and critical process resumed. Previous studies as highlighted above do not take into consideration the interval periods and the tendencies of disruptive events investigated. Therefore, it can be argued that effective disruption management may be prepared in advance of the actual realisation of the disruption. An early detection of the pre-disruption period can assist entities in the supply chain to significantly handle disruptions. In addition, in the post-disruption phase, senior managers may consider the mechanism of disruptions to recognise why it occurred and how to prevent it from happening again. An efficient post-disruption strategy can reduce the disturbances which can create other disruptions or pre-disruptions from one entity to other entities along a supply chain. In regard to these arguments therefore, it is consequently necessary to define and understand the concept of disruption cycle for all maritime disruptive events in this paper's study.

2. EMPIRICAL DATA COLLECTION ON MARITIME DISRUPTION

To complement the above literature review, key stakeholders in various parts of the wheat industries in Australia and Indonesia were invited to participate in a telephone survey during 2009-2010, which examined senior managers' views on future maritime disruptions and the impact on wheat transport demands. Through this approach, a sample of potential respondents from the general population in both the upstream and downstream clusters of the Australian-Indonesian wheat supply chain was derived. Of all the methods employed in qualitative surveys, a telephone survey is the preferred choice to maximise response rates as well as to maintain control over the quality of the data as it produces a relatively high response rate compared to other qualitative approaches, especially compared to face-to-face interviews [29-32].

Further, as the study had a limited budget, the telephone survey was one method which incurred efficient costs for gaining data [30, 31, 33, 34]. A telephone survey also allows for data to be collected in a complete and accurate format with an acceptable level of total error at the time of the interview [35-37]. The benefits of using this technique include richness of data and deeper insight into the phenomena of maritime disruptions on the wheat supply chain. However in order to avoid the time consuming process of collecting data from the entire population of the Australian-Indonesian wheat supply chain, smaller numbers of senior managers were chosen through a sample frame. To cover the research purpose outlined above, wheat supply chain entities transporting wheat commodities from Australia to Indonesia were interviewed. Accordingly, a mixed mode of quantitative and qualitative survey was selected to collect data focusing on previous maritime disruptive events and their consequences on the wheat supply chain.

By using a multi-cluster sampling method, four parameters were used to classify the sample, similar to the approach used for selecting the population. Firstly, it was decided the trade orientation has to deal only with the wheat market between Australia and Indonesia. Secondly, as it was intended to include the whole wheat trade population of the maritime industry in the results, the selected sample population needed to represent the views of wheat supply chain entities in every sector from Australia to Indonesia. In terms of transportation and maritime operations, the process of agricultural shipment through maritime operations should be clearly indicated as the dominant mode of transport with a handling capacity of wheat of more than 100,000 tonnes annually. In relation to this, both dry-bulk and containerised wheat shipments were included as the other selected population. The third factor is the quantity of shipments, which has to indicate a large volume. This may be referred to as consecutive voyages of wheat cargo from Australia to Indonesia. The fourth is the position level of the respondents, which was expected to be from the senior management level such as CEO (Chief Executive Officer), COO (Chief Operating Officer), or Risk Manager (RM) rank. These four selecting factors of potential sample respondents were determined primarily to fulfill the generalisability concept across the wheat supply chain population and to ensure responses were from participants most likely to have an overview of the full supply chain and disruption factors. The interview questions of this study are mainly designed to assess the responses or reactions of wheat supply chain entities when dealing with decision making processes in the three main stages of disruption periods namely pre-disruption, during the disruption and post-disruption. A total of 34 interviews were recorded that ranged in length from five minutes to 90 minutes with an average length of 34 minutes per interview. One recording was unintelligible due to background noise and was subsequently difficult to transcribe, while another interview was recorded in two parts (i.e. two separate files) as some additional time was offered by this respondent to continue the previous interview that had not finished due to their limited time. This resulted in the recording and transcription of 33 completed interviews.

3. THE SURVEY RESULTS

The survey obtained details of four major disruptive events as experienced by the respondents during the period of 2007-2009 namely congestion due to equipment breakdowns, port stoppages due to the influence of severe weather, disruption due to earthquake and disruption due to a shortage of dry bulk ships. However, all respondents in the survey contributed uniformly in providing information regarding the period of discovery and the recovery phase of the various disruptive events that they experienced in their wheat supply chain. The period duration of days and hours are used to measure the stage of discovery and the recovery interval of the different disruptive events.

3.1. General disruption process

Figure 1 below shows the general cycle of maritime disruptions as a finding of the maritime disruption survey. Fifty-three per cent of respondents suggested that they tend to discover various maritime disruptive events from somewhere along the supply chain seven days after the events have occurred. These events are usually discovered through shared information given to them by their business partners and agents. In addition, 52 per cent of respondents stated that on average the maritime disruptive events added seven additional days to their lead times or service times. In terms of the time needed to return to their normal operational level (recovery), 18 per cent of respondents mentioned that they required about fourteen days after the disruption was discovered as an initial recovery phase to return to their limited operations.

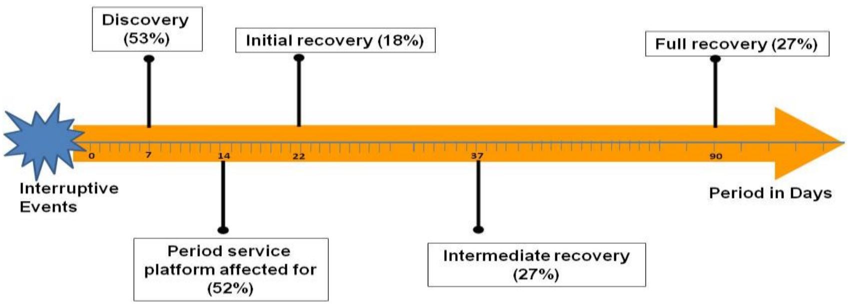

Figure 1: The general cycle of maritime disruptive events

3.2. Congestion due to equipment breakdown

Figure 2 details general cases of port congestion due to equipment breakdown that occurred in the operational area of respondents in Indonesia. The data was obtained through historical reports of the congestion cases via the telephone survey. Analysis of the data identified that the disruption, a breakdown of unloading or loading equipment was initially indicated from a delay of ports' operations on the first day after the handling equipment partially failed. This further led to a deviation phase of the ports' services (on the fifth day after the disruption happened) as unloading operations could not fulfil the operational contracts between stevedoring companies and shipping agents. By the 19th day, the capacity of the equipment was down to 70 per cent and consequently the main handling services of the ports were unavailable by the 22nd day.

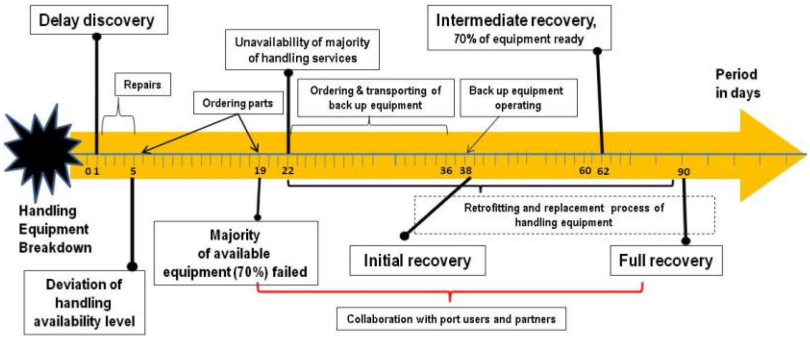

Figure 2: The cases of port congestion due to handling equipment breakdown

The port general managers ordered back-up equipment immediately; but it still took 15-16 days to get the back-up equipment on-site, set up and working. A majority of respondents stated that the ports needed 38 days to initially recover to 50 per cent of normal operations, 72 days to achieve 70 per cent of normal port operations (intermediate recovery) and about 90 days to fully recover to normal operational level as they had to complete a retrofitting and replacement program of their broken unloading equipment.

3.3. Port stoppages due to weather factors

Figure 3 indicates the disruption cycle of port stoppages due to severe weather factors as explained by respondents particularly in Indonesia. Different from the other cases, this cycle was explained in an hourly-based period instead of day by day. The cycle began with the operational delay discovered one to six hours after the severe weather occurred in the port of the respondents. Six hours after the start of the delay, the port managers found there was a significant deviation of port services as according to navigational warnings received by the port authorities from the *Badan Meteorologi Klimatologi dan Geofisika* (BMKG) of Indonesia, ships and facilities at the port, including trucks, had to be shifted in order to avoid fatal injuries at the port. Further, at the 24th hour, the majority of respondents in Indonesia stated that the port authorities closed their ports and consequently stopped operations of the ports along with those with changes in the weather by the 36th hour, the ports were initially opened and recovered 30 per cent of their services; by the 48th hour the ports had recovered by 60 per cent and finally they had fully recovered by the 60th hour.

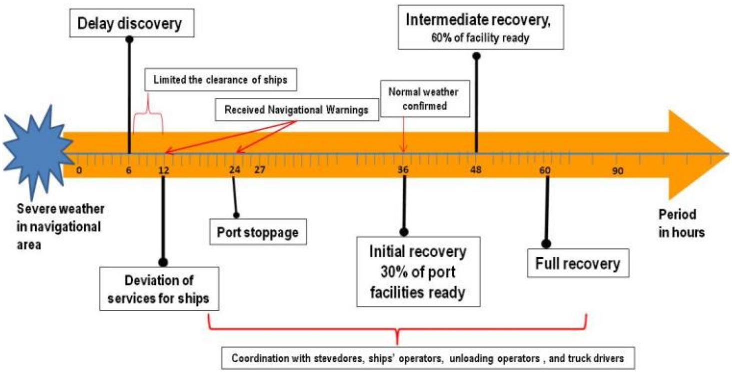

Figure 3: The cases of port stoppages due to severe weather [38]

3.4. Disruption due to earthquake

Figure 4 denotes the cycle of cases of disruptions due to earthquakes as explained by particular respondents in Indonesia. One day after the earthquake destroyed a particular port, port senior manager respondents indicated that 50 per cent to 60 per cent of the port facilities were damaged and dry bulk ships that were going to call at the ports had to reroute to other ports. On the 7th day, the port could not provide its main services as 70 per cent of their facilities were unavailable. After finding back-up supports, providing temporary facilities and new operational procedures, the port managed to recover with 30 per cent of the port facility ready for operation on the 50th to 62nd day. It took a further month until the 90th day for the port facility to be fully restored.

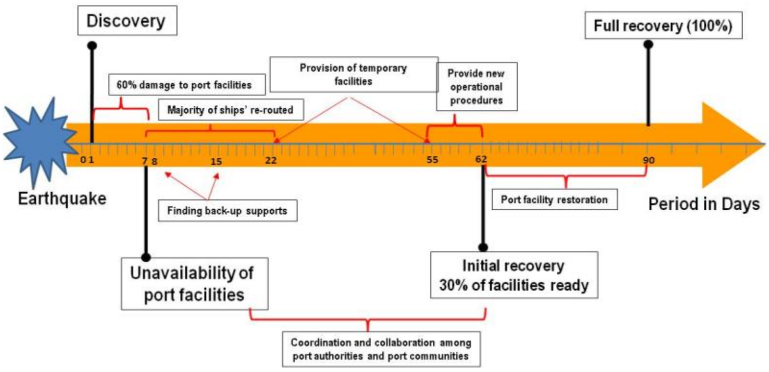

Figure 4: The cases of port disruptions due to earthquake

3.5. Disruption due to shortage of dry bulk fleet

The cycle analysis of a disruption case due to dry bulk fleet shortage as informed by respondents in both Australia and Indonesia in the period 2007-2008 is shown in Figure 5. The figure indicates that the cycle started from the discovery of the shortage in the dry bulk fleet by supply chain partners on the 7th day after the disruptive events occurred. This event was driven by a rise in international bulk freight rates. Consequently, seven days later, significant delays in shipping operations were identified and experienced by shippers. In response, the respondents promptly decided to top up the wheat cargoes at the loading port while waiting for available ships to transport the cargoes to unloading ports assigned by buyers.

This response was followed with other immediate actions such as rerouting the cargoes to other nearby ports including revising shipping contracts with 3P/L (third party logistics) or 4P/L (fourth party logistics) partners. By implementing these actions, the respondents found that the initial recovery stage was achieved 50 days after the disruption occurred. Next, the intermediate recovery was attained 75 days after undertaking significant measures to change the transport mode from bulk to containerised shipment. Further, on the 80th day the full recovery stage was achieved after changing the unloading ports to those previously assigned by buyers. The next sub-section will discuss how more insight into respondents' views on responses and preparedness was gained as their previous mitigation strategies including various significant factors were required in the preparation of the mitigation strategies. The findings from the telephone interview may provide a general indication that existing mitigation responses applied by respondents were not efficient in terms of time required to manage maritime disruptions. This is due to taking seven days to discover the disruptive events and up to 90 days on average being needed to recover from the disruptions. Some new effective strategies are needed to shorten the cycle of maritime disruption which has occurred previously.

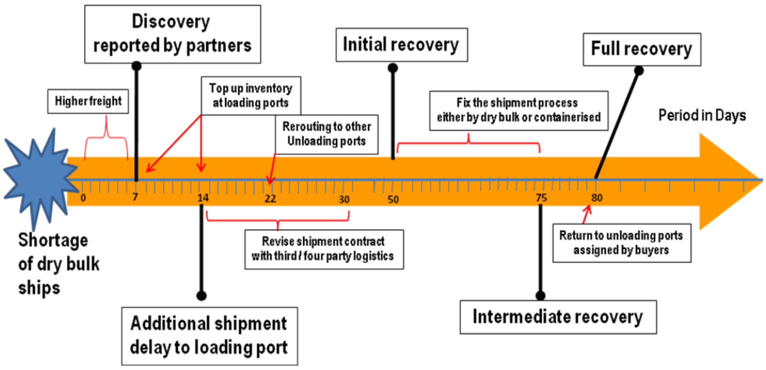

Figure 5: Cases of port disruptions due to the shortage of dry bulk ships

4. RECOMMENDATION

The survey of senior managers explored the issue of mitigating actions predominantly within the context of individuals or entities along the wheat supply chain using a maritime leg in their operations. By interviewing senior managers along the wheat supply chain, various problems and resolutions were realised as empirical mitigation responses in three stages namely pre-disruption, disruption and post-disruption for uncertainty and interruptions particularly in the maritime leg. In the pre-disruption stage, the existing mitigation strategy at this stage (as appears in Figure 6), identified that the dominant reactions of maritime users in the wheat supply chain were to apply contingency planning which principally consists of supply flexibility and insurance management (generally for marine cargo insurance). This is achieved through transferring risk or risk-sharing decision methods such as insurance plans and outsourcing strategies. Other entities along the chain may also apply reserved maritime routes, provide strategic stock (through agency service) and back-up systems and optimum ordering policies in their contingency plans for responding to worst case scenarios of maritime disruptions. Those mitigations were taken especially when they have problems with the shortage of dry bulk ship in the market and port congestion problems particularly in some Australian grain terminals.

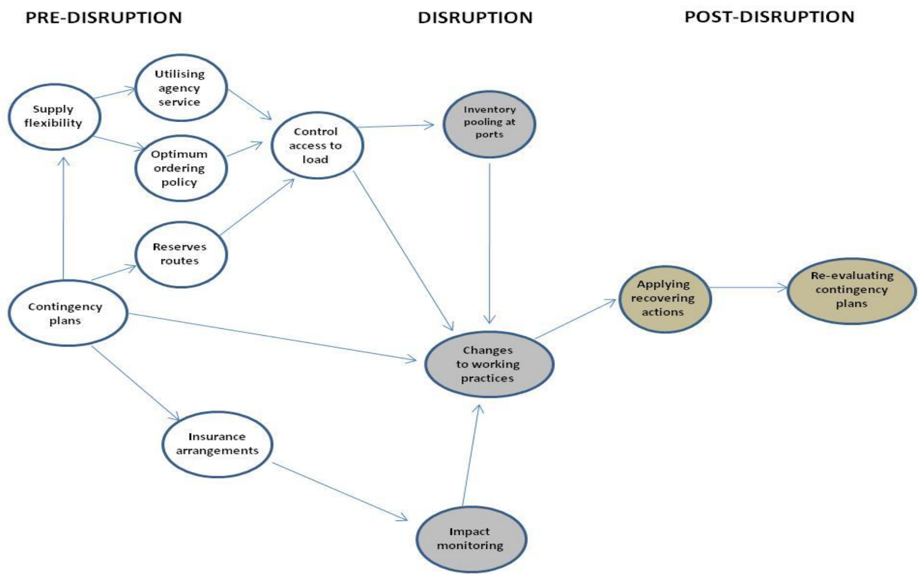

Figure 6: Existing multi-mitigation strategies of wheat supply chain from entities [39]

5. CONCLUSION

The discussion of maritime disruption cycles experienced by respondents above may further explain whether the previous mitigations are effective or not. The findings through the telephone interview may provide a general indication that existing mitigation responses applied by respondents were not efficient in terms of time required to manage maritime disruptions. This is due to taking seven days to discover the disruptive events and the 90 days needed to recover from the disruptions on average. Some new effective strategies are needed to shorten the cycle of maritime disruption which has occurred previously.

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