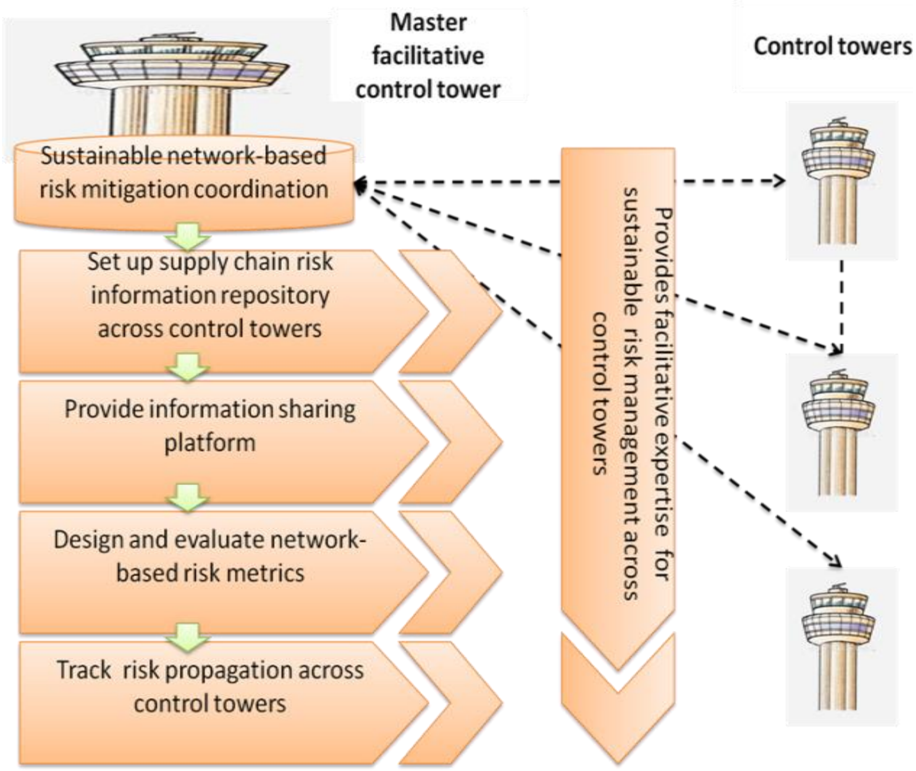
TLI – Asia Pacific White Papers Series

CHALLENGES IN MANAGING THE UNEXPECTED

Volume 15-Apr-RISK



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*The work is supported by a research grant from Science and Engineering Research Council (SERC), A*STAR (Title of Supported Project: Master Facilitative Control Tower for Risk Management of Complex Supply Chains and Ref Number: 1121790043 and 112420404).*

COLLABORATING ORGANIZATIONS:

CHALLENGES IN MANAGING THE UNEXPECTED

PRESENTED AT

A*STAR URBAN SYSTEMS INITIATIVE CONFERENCE

IN LOGISTICS & SUPPLY CHAIN MANAGEMENT

23rd April 2015

SINGAPORE

1. INTRODUCTION

Supply chain risk management has stayed at the top of the corporate agenda, given the propensity for an ever-increasing number of disasters and disruptions to business in the past decade. It is imperative that a company should understand its disruption profile prior to or at least upon a risk event, the available disruption reduction levers for mitigation, and the efficient and effective ways supply chain risk management can contribute to cost avoidance. Compounding the situation is that supply chains intersect other supply chains, sharing resources and members (nodes), in complex patterns.

This white paper documents the progress of research in Phase 1 of a multi-institution study of supply chain risks, their identification and propagation, and the subsequent visualization and monitoring. The intent is to solicit active industry discussion leading to a deeper collaborative engagement in the understanding and resolution of the challenges in building robust and resilient networked supply chains. Generally, after the occurrence of a risk event, the disruption profile of the risk-prone company can undergo two stages: decay and recovery (red line) (Figure 1).

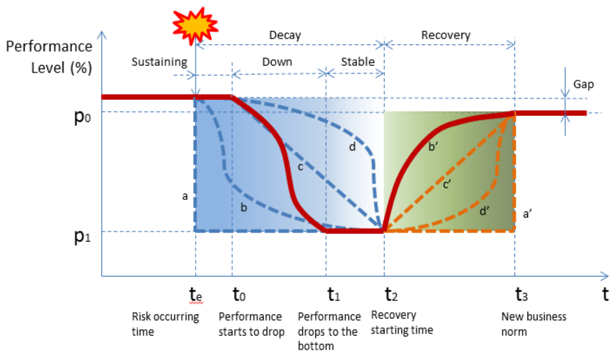

Figure 1. Disruption profile - generic decay and recovery curve

The decay stage shows a company's robustness limit upon the onset of a risk event while the recovery stage shows its resiliency in performance reaching towards its original level. Figure 2 illustrates the disruption profile of a higher robust and resilient company. On the contrary, Figure 3 reveals that a company is fragile in facing a disaster but more resilient in recovering from the disruption.

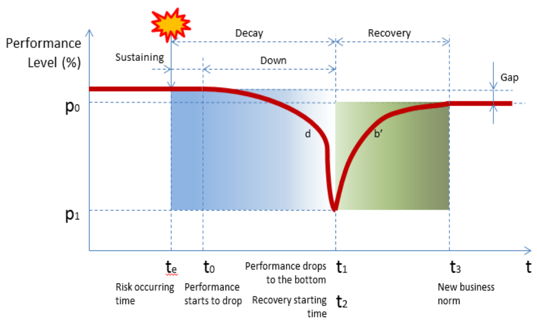

Figure 2. Disruption profile of high robustness and low resiliency

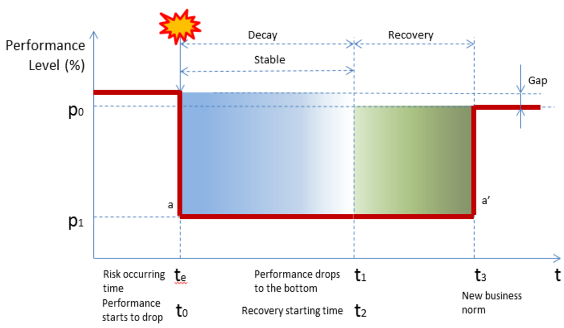

Figure 3. Disruption profile of low robustness and high resiliency

Robustness is defined as the ability of the supply chain (or its entity) to withstand a disruption without adapting its initial stable configuration and **Resiliency** is the property that enables a supply chain to resume its original shape or position after being disrupted. In previous white papers, we presented a series of levers that could be unilaterally or multi-laterally applied according to the generic decay and recovery pattern evident or anticipated.

Essentially, there are four disruption reduction levers (Figure 4):
(1) act to either delay the disruption impact, or
(2) act to reduce the disruption duration, or
(3) speed up the recovery, and
(4) contain as far as possible the disruption severity.

One or more of these levers is necessarily engaged for a strategic response.

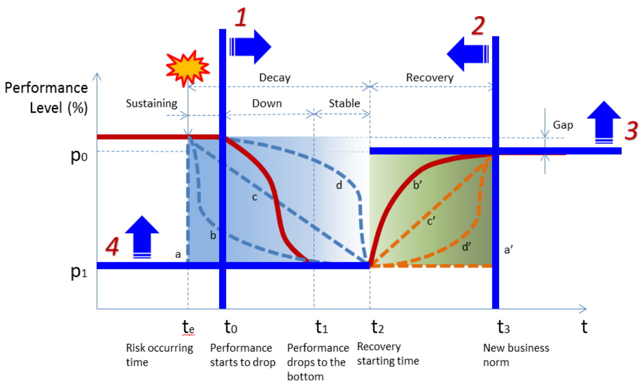

Figure 4. Four possible disruption reduction levers

Though an understanding of the disruption profile is key, just as important is a methodological response. In order to manage supply chain risks, a company should thus be able to systematically identify potential risks/disruptions embedded in its supply chain, assess their impacts, build in mid- or long-term preparedness or mitigation strategies, and monitor risks.

Figure 5. Four phases in supply chain risk management

2. SUPPLY CHAIN RISK FRAMEWORK

2.1 Risk Category (Zhou et al., 2013a)

The risk framework is categorized by three levels according to the different scopes of risk impacts - supply chain, industry, and macro levels.

- The risks at a supply chain level refer to the risks occurring in the supply chain of a focal company. The mitigation requires the reactions of the risk-hit entity only or interactions of entities from the same supply chain.
- The risks at an industry level refer to the risks occurring in the common resources shared by supply chains of different focal companies in the same industry. Two important risks are identified: competitive risk and cluster substitution risk.
- The risks at the macro level refer to the risks which can impact across the supply chains of different industries and they can also propagate from one location to another.

One important benefit of the framework is to help identifying risks, of which there is generally little awareness and requires the interactions among entities from a supply chain, different supply chains or industries.

2.2 Disruption Profile (Allan et al., 2013; de Souza and Zhou, 2014)

When a company meets a risk event, typically, the disruption profile of the risk-prone company can undergo two stages: decay and recovery. The decay stage shows a company's robustness limit upon the onset of a risk event while the recovery stage shows its resiliency in performance reaching towards its original level.

We presented a series of levers that could be unilaterally or multi-laterally applied according to the generic decay and recovery pattern evident or anticipated. There can be typically four types of decay/recovery patterns: abrupt, slow, normal, and fast (Allan et al., 2013). Essentially, there are four disruption reduction levers (de Souza and Zhou, 2014): (i) act to either delay the disruption impact, or (ii) act to reduce the disruption duration, or (iii) speed up the recovery, and (iv) contain as far as possible the disruption severity. One or more of these levers is necessarily engaged for a strategic response.

3. RISK IDENTIFICATION

3.1 Risk Exposure Index

The risk exposure index which helps a firm to understand its risk exposure level within the supply chain and that contributed by its partners so that it can choose (i) the best partners before any risk actually occurs and (ii) alternative partners post-disruption, without compromising or necessarily increasing the network's risk exposure index (Lee et al. 2015). The approach is based on the data analysis and can be available to SMEs (Small and Medium Enterprises) as little information is required for the production processes.

With the assessment of risk exposure of its supply chain, a firm can now more confidently determine both, its operational levers and the interaction levels of activities with its partners so that the potential risk exposure would be managed in advance, pre- and post-disruption.

4. RISK ASSESSMENT

4. 1 Risk Propagation Assessment (Zhou et al., 2013b)

The risk assessment starts with a supply chain mapping process to define the scope and pinpoint the location of the focal company. The supply chain risk framework is adopted to guide the process of identifying potential risks and a simulation model is used to provide quantitative assessment of impacts caused by a risk event on the supply chain members (customers, retailers, distribution centers, manufacturers, and suppliers).

4.2 Risk Measurement via Value-At-Risk (Zhang et al., 2012)

A new quantitative method for SCR (supply chain risk) measurement by Value at Risk (VaR) (Zhang et al., 2012) was developed based on disruption recovery models. It uses time equivalent derived from the recovery modes as a main measure to calculate the VaR for disruptions. The VaR supply chain risk quantification approach is implemented in the SCRM prototype.

4.3 Risk Assessment via Matrix Approach (Li et al., 2013)

Li et al. (2013) reviewed risk assessment approaches focusing on the advantages, limitations and applications of the Risk Matrix Approach (RMA), and then proposed an extended risk matrix approach (ERMA) for the purpose of overcoming the limitations of traditional RMA and improving the applicability to RMA to SCRM. New dimensions of risk metrics - detectability and recoverability are incorporated to capture SCR complexities. A case study was conducted with IBM case to demonstrate how to use user data and rank SCRs by ERMA.

4.4 Time-based risk propagation analysis (Tan et al., 2013)

A risk propagation analysis approach is developed to meet the challenge of analyzing the propagation of risk in supply chains, especially how to quantity the propagation of the risks in a supply chain network. A time-based IIM model is developed which can be used to quantify the impact of the risk along the supply chain – it means to provide the visibility of risk propagation. It can be used to calculate the propagation index of supply chain nodes.

5. RISK MITIGATION

5.1 A Novel Inventory Policy (Ghosh et al., 2014a)

Inappropriate inventory policies, which do not take into account these risks and modify their parameters, may incur a huge cost in backorders or inventory levels at the onset of a disruption. An efficient and effective inventory ordering policy should consider these factors efficiently and effectively while determining policy parameters. Ghosh et al. (2014) developed a novel inventory policy which adjusts its parameters according to the variation in demand, lead time or other cost parameters, is postulated. The policy – a 'time-adjusted' (r, Q) policy determines the r (reorder point) and Q (order quantity) values at the start of each defined time period based on the new demand forecast for order placement, rather than using the same r and Q values.

5.2 Demand Uncertainty (Qu et al., 2014)

The demand uncertainty poses a significant challenge because it makes inventory hard to control and manage. In the multiple tiers supply chain, the demand uncertainty can even cause more serious results and leads to Bullwhip effect. Through the proposed bi-level multi-criteria game model (Qu et al. 2015), retailers can make their orders by considering the competition from other retailers, the uncertain demand and the price given by manufacturers. While manufacturers can make their decisions about the price and supply by considering both the competition with other manufacturers, and the orders.

5.3 Emergency Sourcing Strategy (Ghosh et al., 2014b)

Manufacturers may face some penalties because of the failure to supply the products to customers in time. One way to mitigate the problem is to order some emergency replenishment from alternate suppliers or from the same supplier but from a different location, albeit at a higher price. Ghosh et al. (2014b) developed a stochastic model that provides the necessary conditions under which the manufacturer should place an emergency order to minimize the total cost for the risk events with low probability but high impact.

5.4 Mitigation Policy Examination Platform

A risk mitigation module is developed as part of our prototype. Mitigation policies are included in the focal company for reducing the loss caused by disruptions. For example, to mitigate supply disruption, policies are included for switching to alternative vendor or including additional vendors during disruptive events. It is important to have a holistic approach that systematically allocate optimal safety stock level for every node in supply chains and, at the same time, coordinate the production plans of manufacturers and replenishment policies of distribution centres/retailers. The mitigation policy is implemented in the system and can be selected (or set) to handle a disruption which is also need to be set in the simulation.

6. RISK MONITORING

6.1 Risk Visualization (Goh et al. 2013)

Supply chain visualization tools for risk tracking and analyzing are important for companies as the cost of being unprepared and the lack of visibility for potential and ongoing disruptions could be immense. Through the supply chain visualization platform (RiskVis), the supply chain networks and their key entities can be mapped and visualized based on their physical locations. The system enables the timely capture of data from the other modules addressing the respective challenges including risk identification and mitigation and network-based analysis, modeling and simulation.

- Capture Real-time supply chain risk management related feeds
- Display supply chain network topology
- Capture Real-time natural disasters for warning
- Provide real-time alerts according to relationships and proximity
- Trigger agent-based simulation for assisting pro-active mitigation strategies

7. MASTER FACILITATIVE CONTROL TOWER

Is a Master Facilitative Control Tower (MFCT) for supply chain risk management feasible?

There is, we believe a consensus to manage supply chain disruption risks in an optimal way considering the sustainability of supply chains for long-term development with the synergy of environmental protection and disaster recovery. Therefore a neutral coordination mechanism, the MFCT, is important to provide facilitative functions for assisting the understanding of risk propagation and coordination of network-based risk management in a sustainable way across networks.

The developed MFCT framework, integrating data modelling, analytics and simulation on top of the visualization platform, is able to provide win-win solutions for the coordination of control towers for facilitating the efforts of sustainable supply chain risk management. The facilitative functions of the MFCT are as follows:

- Provide insights for assisting response to supply chain disruptions.
- Provide insights on cascading risk propagation across integrated supply chain networks.
- Provide a complete picture in respect to connectedness in supply chains
- Provide inbound and outbound warnings about risk propagation
- Provide identification of key linkages in the networks

Information from individual control towers are categorized and protected with different levels of authorized access. With coordination and information sharing across control towers, risks can be evaluated proactively with risk mitigation compliance considering the temporal, spatial, and topological impact of integrated supply chain networks in supply chain evolution and during disruptions.

MFCT plays a neutral role in the business environment. It only takes the aggregated information, i.e., the estimated overall bi-directional transaction percentages, from each individual supply chain network. From the view of the MFCT, the possible impact of Node A to the entire integrated network can be measured, although this is beyond the scope of one particular control tower.

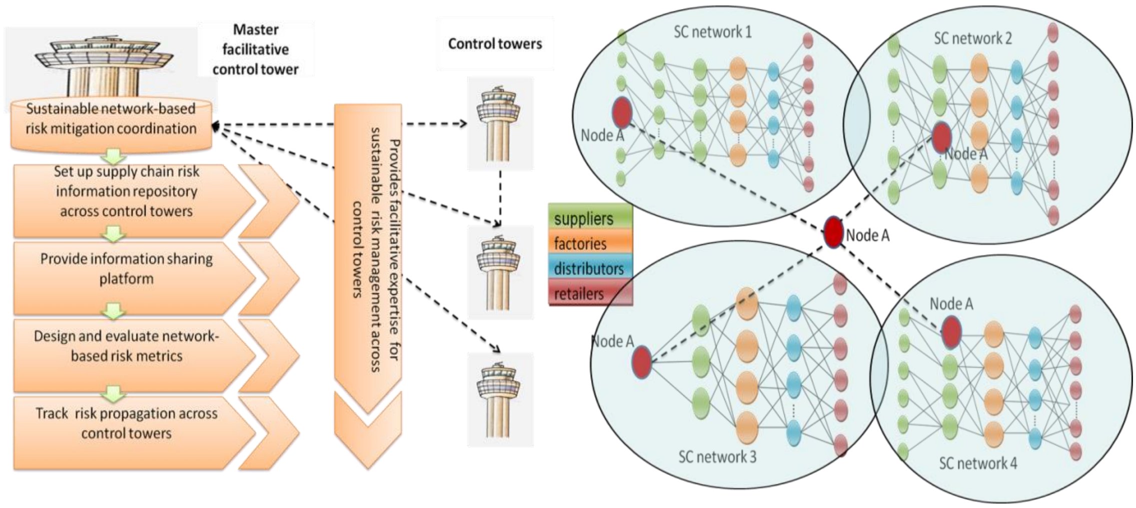

Figure 7. The MFCT framework

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