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Supply Chain Disruption Handling:
A Dynamic Extended Resource-Based (DE-RBV) View

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ABSTRACT

Harsh competition and rapid changing environment have made supply chain risk management a fashionable area of management research. But till now there is no research clearly analyzing the underlying mechanism in supply disruption handling. Drawing upon the Resourced Based View (RBV) including Dynamic Capability Theory, this paper developed Dynamic Extended Resource Based View (DE-RBV) to meet supply risk management requirement. Four different capabilities for supply risk handling are presented, i.e., Preventive Capability, Back-up Capability, Substitute Capability and Warning Capability. A conceptual model is set up which captures the relationships between supply disruption handling capabilities and supply disruption handling performance.

KEYWORDS: Supply chain disruption, Supply risk handling capability, Resource Based View, Dynamic theory

I. INTRODUCTION

On March 17th, 2000, a fire destroyed the production circumstance in Philips's plant in New Mexico, which is a common supplier for both Nokia and Ericsson. As a result, both Ericsson and Nokia suffered serious supply disruption. But Nokia recovered while Ericsson had to exit from cell-phone market. This is a typical case which is well referred by the researchers in supply chain risk management area (Sheffi Y., *The Resilient Enterprise: Overcoming Vulnerability for Competitive Advantage*, 2005). The reason that Nokia and Ericsson had totally different consequences after the same supply disruption is that the capabilities of the two companies to handle supply risks were different.

Nowadays, the business environment is becoming more and more turbulent and uncertain; organizations are not limited as boundary-conscious entities; many of them are distributed world-wide instead, both physically and virtually. This transition has increased the potential that the disruption may propagate throughout its supply chain network. Globalization, integration and outsourcing, and the continued trend to "lean" have made supply chains more complex and

increased the supply chain risks. More and more researchers and practitioners realize the existence of a new risk situation in supply (Juettner, Peck, & Christopher, 2002) (Kajuter, 2003) (Brindley, 2004). Supply chain disruptions have been the most pressing concern facing firms.

Although all companies in a supply chain have to encounter risks in a supply chain to a certain degree, and the supply chain risk may cause great damages to the companies in the supply chain, a MIT study found out most companies haven't thought about managing supply chain risks and vulnerabilities systematically (Sheffi Y., *The Resilient Enterprise: Overcoming Vulnerability for Competitive Advantage*, 2005). The main reason is that there is no generally consistent understanding about risk management and they lack of operational methods to handle the risks.

1.1 Literature Review

The existing literature about supply chain risk management mainly focused on risk identification, assessment, mitigation and recovery. Most studies have been done by presenting conceptual model via anecdotal evidence, case study, and secondary dataset.

Research on supply chain risk issues mainly covers supply chain vulnerability (Svensson, *A conceptual framework for the analysis of vulnerability in supply chains*, 2000), business continuity planning (Zsidisin, Melnyk, & Ragatz, 2005), supply chain resilience (Sheffi & Rice Jr, 2005), and supply chain risks (Chopra & Sodhi, 2004) (Hendricks, Singhal, & Zhang, 2009). (Craighead, Blackhurst, Rungtusanatham, & Handfield, 2007). Christopher (2004) presented some basic rules for creating a resilient supply chain, which includes supply chain understanding, supply base strategy, supply chain collaboration, agility, and creating a supply chain risk management culture (Christopher, *Creating resilient supply chains*, 2004). Lee presented Triple-A supply chain which has three characters i.e., agility, adaptability and alignment, for the supply chain to give the companies sustainable competitive advantage (Lee H. , 2004).

Regarding supply chain disruptions, there are mainly four research issues in current existing literature:

- a) Understanding and perspective on risks. For example, March, et al, presented managerial perspectives on risk and risk taking (March & Shapira, 1987). Paulsson (2007) researched the definitions and understanding of supply chain risk in his dissertation paper (Paulsson, 2007).
- b) Identifying the primary drivers and enablers of disruptions and the factors influencing the probability of disruptions (Kilgore, 2003) (Stauffer, 2003) (Craighead, Blackhurst, Rungtusanatham, & Handfield, 2007) (Sheffi Y. , 2005) (Tang, 2006) (Kleindorfer & Saad, 2005). Christopher and Peck (2004) categorized risk into internal to the firm, external to the firm but internal to the supply chain network, and external to the network (Christopher & Peck, *Building the Resilient Supply Chain*, 2004). Jiang, et al, tries to find the root causes of job dissatisfaction which leads to turnover, which is one of the sources of supply chain risks (Jiang, Baker, & Frazier, 2009).
- c) Examining the economic and other consequences of disruptions (Hendricks & Singhal, *An empirical analysis of the effect of supply chain disruptions on Long-run stock price performance and risk of the firm*, 2005) (Hendricks & Singhal, *The effect of supply chain*

glitches on shareholder value, 2003) (Rice.Jr & Caniato, 2003).

- d) Discussing risk management and the process of risk management including risk identification, assessment, practice, strategy, and evaluation. Supply chain strategies and structures that can reduce the possibility and damages of disruptions are also researched (Lee H. , 2004) (Kleindorfer & Saad, 2005) (Sheffi Y. , 2005) (Tomlin, 2006) (Swafford, Ghosh, & Murthy, 2006) (Tang, 2006) (Craighead, Blackhurst, Rungtusanatham, & Handfield, 2007) (Ketchen Jr. & Hult, 2007). Cohen and Kunreuther (Cohen & Kunreuther, 2007) presented a conceptual framework for risk analysis; Neiger, et al., (Neiger, Rotaru, & Churilov, 2009) presented a process engineering methodology for supply chain risk identification; Knemeyer et al developed a process for proactively planning for catastrophic risk events (Knemeyer, Zinn, & Eroglu, 2009). Chopra et al., (Chopra & Sodhi, 2004) pointed two things that managers must do when establishing a supply chain risk management strategy. One is that the whole organization should have a shared understanding of supply chain risk; the second is that general risk-mitigation approaches should be adapted to the circumstances of the company. Using interpretive structural modeling (ISM) method, Faisal et al (2006), did research on the dynamics and relationships between various enablers to mitigate risk in a supply chain. They found trust among supply chain partners, collaborative relationships among supply chain members, information sharing in the supply chain, and knowledge about risks are the enablers which play a key role to counter risks in a supply chain. (Faisal, Banwet, & Shankar, 2006). Braunscheidel et al., (Braunscheidel & Suresh, 2009) did research on the impact of cultural antecedents (market orientation and learning orientation) and three organizational practices (internal integration, external integration and external flexibility) on supply chain agility of a firm which is considered as a risk management initiative.

While extant inquiry is informative, there is no theory provides generally consistent understanding about the underlying mechanism of disruption handling. Although a lot of different strategies and methods to handle supply chain risk are proposed, how those strategies and methods work and why same strategies has different effect for different firm have not been explained.

Hendricks et al. (Hendricks, Singhal, & Zhang, 2009) empirically test whether operational slack, business diversification, geographic diversification, and vertical relatedness influence the supply chain disruption handling performance. Although Hendricks et al justified the effectiveness of strategies in handling supply chain disruptions, they didn't give the reason why the strategies can affect the level of damages of supply chain disruption. How the strategies work to affect the capabilities of handling supply chain disruption? Why certain companies with the same supply chain strategies have different supply chain disruption handling performance?

Autry and Sanders (Autry & Sanders, 2009) present a framework documenting business continuity planning capabilities. The conceptual framework integrates the technology, processes, and human resources needed to develop supply chain security management capabilities. Technology, processes, and human resources are given as specific categories of dynamic firm capabilities. The categories they proposed are common categories for a firm to do business, and of course those categories will affect risk handling performance, but what risk handling capabilities exactly is, and through what and how those aspects affect risk handling performance, are not analyzed. This weakness will hinder the researchers and practitioners to apply this framework when handling supply chain risk. They cannot explain why one firm suffers more severe supply disruption than another firm with similar capabilities that they presented.

Ponomarov (Ponomarov & Holcomb, Understanding the concept of supply chain resilience, 2009) presented a conceptual framework of the relationship between logistic capabilities and supply chain resilience. In his framework the logistic capabilities includes demand management capabilities, supply management capabilities and information management capabilities. These three capabilities lead to dynamically integrated logistic capabilities. Supply chain resilience includes three steps: event readiness, efficient response and recovery. Again, the capabilities researched here are only common functional capabilities. Ponomarov (2009) introduces “3Cs” core psychological principles of resilience, i.e., control, coherence, and connectedness (Reich, 2006), into supply chain resilience, forming components of capabilities. Although three “Cs” reflects the underlying components of supply chain risk handling capabilities to certain degree, they are too abstract and not operational for supply chain management, because supply chain is quite different with individual human being. In Resilience/ Capability matrix, Ponomarov gives the corresponding aspects and issues of the capabilities corresponding to different stages of supply chain resilience. This is a very good step to make the abstract capabilities more operational. But the issues listed are still isolated; the relationship among the issues and how these issues work to improve resilience are still not clear.

Craighead et al., (Craighead, Blackhurst, Rungtusanatham, & Handfield, 2007) analyze how supply chain design characteristics and mitigation capabilities affect the severity of supply chain disruptions. Craighead et al., present three supply chain structure characteristics including Supply chain density; Supply chain complexity; Node criticality. They also present two supply chain mitigation capabilities including recovery capability and warning capability.

1.2 Importance of This Paper

While extant inquiry is informative, there is a lack of investigations on supply disruption handling capabilities and the underlying mechanism of disruption handling process. How the practices and strategies work for handling risk has not been discovered. This paper provides additional value to this body of knowledge.

The supply risk handling capabilities presented in this paper can help a firm systematically analyze why certain kinds of supply chain practices are good to handle risk in specific situations and find out where capability gaps exist for a firm. The model presented in my paper calls into question whether it is suitable to adopt or fight popular practices such as Lean, Global Sourcing, and Single Sourcing etc., without analyzing the impact of supply risk in a holistic way.

For example, there exist quite different opinions about lean supply chain. Whether lean is good for mitigating supply chain risk or not, different researchers have different opinions because they analyze from different perspectives. The dispute about LEAN's impact on supply risk cannot be understand clearly without the understanding of supply handling capabilities presented in this paper. If we just mention lean without clearly analyzing how 'lean' relates to supply chain capabilities, managers still don't know whether they should be lean and to what level the lean should be when facing specific situations.

The capabilities that I presented can help the managers to decide on using which kind of supply chain practice (for example, Postponement, Component Design, etc) based on their impact on supply risk handling capabilities. My paper gives thorough and extensive analysis of supply disruption handling capability and how they relate to traditional RBV and dynamic capability theory.

II. MAIN CONCEPTS OF THE RESEARCH AREA

To better understand the underlying mechanism of supply chain risk management, it is necessary to make clear the definitions and understanding of the main basic concepts or constructs within this area, i.e., supply chain disruption, supply chain risk, vulnerability, flexibility and resilience. Due to the length limitation of this paper, I just discuss the concepts regarding supply chain disruption.

2.1. Supply Chain Disruption

There exist obviously different understandings about disruption in current literatures (Tang, 2006) (Crandall, 2010) (Fahlen, 1997) (Paulsson, 2007) (Svensson, A conceptual framework of vulnerability in firms' inbound and outbound logistics flows, 2002). I consider disruption as any unwished event, randomly or deliberately, small or big, which leads to deviations from plan and whose consequences are negative. Disruption is an outside event, but the level of disruption is reflected by the effect to the recipient suffered the disruption. Same event might have different impacts on different recipients. Disruption reflects the interaction of the unwished event and the recipient.

Supply chain disruptions are unanticipated events that disrupt the normal flow of materials and goods in a supply chain (Svensson, 2000; Hendricks & Singhal, 2003; Kleindorfer & Saad, 2005) (Craighead, Blackhurst, Rungtusanatham, & Handfield, 2007)

Melnyk et al gives their understanding of supply chain disruption: "the outcome of a process whereby one or more events (to be referred to as the "triggering event") taking place at one point in the supply chain adversely affect the performance of one or more components located elsewhere in the supply chain." (Melnyk, Rodrigues, & Ragatz, 2009)

Melnyk et al, gives a clear description of supply chain disruption, they discussed that supply chain disruption can be viewed as the result of a chain of events. It starts with an event that triggers the disruption, and then transmitted via the supply chain from the source of the event to the firm. As the disruption moves through the chain, the impact is influenced and shaped by the factors such as the location of the disruption in the supply chain, the inventory, buffering policies, ordering, and reactions by the various supply chain partners, the amount of visibility about the disruption, the accessibility of alternative sources of supply, and the lead times. (Melnyk, Rodrigues, & Ragatz, 2009)

In supply chain, disruption source, i.e., the triggering event can be separated into supply side, focal unit or demand side. Supplier Side Supply Chain Disruption (SS-SCD) is the focus of this paper as compared to Customer Side Supply Chain Disruptions (CS-SCD) since it is the most important component for supply chain disruptions. The analysis about the basic constructs suits all kinds of disruption analysis.

A transfer point is a location within a supply chain where a supplier firm hands over what has been ordered to a customer firm in the supply chain (Paulsson, 2007). A successful handing over includes fulfilling the four perfect order objectives: one time delivery, order completeness, order correctness and defect free (Gaudenzi, 2005). Another way is to use four utilities including form utility, possession utility, place utility and time utility to make judgment of whether the conditions of handing over has been satisfied. Handing over failure cannot be avoided. A

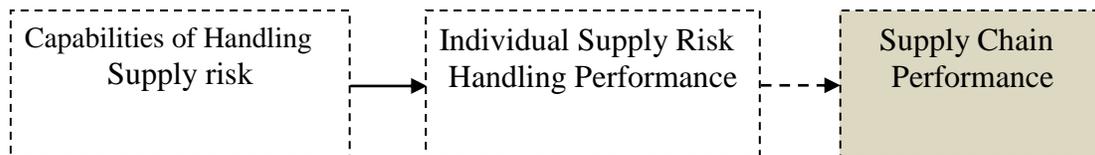
disruption in supply chain refers to any handing over failure or lack of utilities transferred which leads directly or indirectly to negative consequences for a focal firm. (Paulsson, 2007)

To facilitate estimating the likelihood, based on different relative roles that human beings and random factors play in their cause, disruptions can be divided into three categories: natural disasters, accidents, and intentional attacks (Sheffi Y. , *The Resilient Enterprise:Overcoming Vulnerability for Competitive Advantage*, 2005) . In my research, I refer disruptions to the result of any unwished event, including the failure of the supply handing over due to the fluctuation of supplier motivation or immorality, rather than just due to outside events.

III. GENERAL RESEARCH FRAMEWORK

A model is “a representation of a system that is constructed to study some aspect of that system or the system as a whole. (Cooper & Emory, 1995)” In this paper, I present an explicative model to improve our understanding of the key concepts and the underlying mechanism of supply risk handling. Based on the clarification of the main constructs of this area above, an overall theoretical model is presented which can reflect the underlying mechanism of supply disruption handling. Fig. 1 is a generalized theoretical model. The model shows the basic mechanism of supply risk management.

Figure 1. Generalized Research Framework



1) Capabilities of handling risk will impact individual supply risk handling performance. Each risk, no matter what kind of, will be handled to certain degree. The result of handling the risk is affected by the capabilities of handling the risk.

2) Individual risk handling performance will affect the supply chain performance. Accumulated risk handling performance affects the overall supply chain performance. We should pay attention to that the relationship between risk handling performance and supply chain performance is not positive linear relationship. Risk handling is a qualifying factor, which means without risk handling, the firm cannot guarantee the competitive advantage or performance of the company if there is any disruptions happened, but more risk handling performance does not necessarily lead to better firm performance. Since the handling of risk is not free, and the disruption may not happen, so sometimes the firm who invests in handling certain disruptions takes more burden of the cost compared with the company who just ignores the disruption without taking any action in the condition that the disruption does not happen in that period. The benefit of invest on risk handling will only show its positive effect when the disruption actually happens, otherwise, when the disruption does not happen, the firm's investment on handling the risk will be the lost compared with other company who took the risk and didn't take any actions. To make it more understandable, let's give further analysis about the difference between making risks handling strategy and other firm strategies.

When we make strategies, we normally make decisions based on “benefit/cost analysis”. For common firm strategies, Benefit= the actually benefit from the firm’s strategies. For risk handling strategies, Benefit= the benefit from avoiding certain disruptions. Only as the outside threat happens, can the decision maker prove the benefit of handling the risk and justify the cost of taking those actions. For example, if the firm takes action to handle earthquakes, but there is no earthquake happened in that evaluation time period, and if the evaluation criteria are just based on the financial outcome, then the decision maker cannot prove the benefit of the risk handling strategy and cannot justify the investment. The investment of handling disruptions might actually add cost on the firm and lead to disadvantage. The benefits of other kinds of strategies are consistent with the firm’s performance, while the benefit for risk-handling strategies are not so. Without the actually happening of the disruption, they are actually contradicted with each other. So we cannot say that risk-handling performance positively relates to the firm’s performance.

Due to the special character of risk handling strategy and practice, one way of solving the conflict between the two “benefits” is to adjust the evaluation criteria of firm’s performance based on how much risk it has taken. (Here, risk is from overall risk perspective when making decisions instead of individual risk). Instead of only based on financial outcome during the evaluation time period, the risk taking coefficient should be included.

Firm’s performance= Firm’s financial performance*(1-Risk-taking Coefficient)

The risk-taking coefficient will decrease if risk-handling performance increases. In this way, the firm’s performance might have positive relationship with risk-handling performance. But it is not always the truth because the cost of risk-handling strategy also counts here. Risk-handling performance might decrease risk-taking coefficient, but at the meantime, it might decrease firm’s financial performance because of the additional cost of handling the risk. If the cost is too high, it will significantly decrease firm’s financial performance, and the cost may not be compensated by the risk-taking coefficient. This sometimes happens when the firm unsuitably invests on a risk-handling strategy which does not provide much benefit to the company.

IV. THEORY DEVELOPMENT—“DE-RBV” FOR RISK MANAGEMENT STRATEGY

4.1. Resource-based theory (RBV)

Resource-based View (RBV) has considered companies as the organization with heterogeneous bundles of resources that are derived internally from tangible and intangible factors including assets, skills and capabilities (Wernerfelt, 1984) (Barney, 1991). There are six major categories of resources, i.e., financial resources, physical resources, human resources, technological resources, reputation, and organizational resources (Grant, *The Resource-Based Theory of Competitive Advantage: Implications for Strategy Formulation*, Spring 1991). The resources and capabilities that is valuable, rare, inimitable and non-substitutable (VRIN) can provide the basis for sustainable competitive advantage of the company (Barney, 1991) (Peteraf, 1993).

According to Grant (1991), a capability is “the capacity for a team of resources to perform some task or activity.” The capabilities of a firm are “what it can do as a result of teams of resources working together.” Resources are the source of a firm’s capabilities. “For most firms, the most important capabilities are likely to be those which arise from an integration of individual functional capabilities. (Grant, *The Resource-Based Theory of Competitive Advantage*:

Implications for Strategy Formulation, Spring 1991)” Prahalad and Hamel use the term “core competencies” to describe the central, strategic capabilities, which are “the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technology. (Prahalad & Hamel, May/June 1990)” (Grant, *The Resource-Based Theory of Competitive Advantage: Implications for Strategy Formulation*, Spring 1991) Capabilities can be considered as organizational routines. Capabilities cannot be obtained simply by assembling a group of resources: Capabilities includes complex patterns of coordination among people and other resources. It requires learning through repetition to improve this coordination. Organizational routines are predictable and regular patterns of activity, which consists of a sequence of individual’s coordinated actions. In essence, a capability is a routine, or a group of interacting routines. The organization itself is “a huge network of routines.” To an organization, routines are like what skills are to the individual. Individual’s skills are often carried out without conscious coordination. Organizational routines also involve tacit knowledge. Because capabilities involve interactive resources, they are less mobile than individual resources. Capabilities need to transfer the whole team of resources. Unconscious coordination and tacit knowledge make it difficult to imitate capabilities in a new company. (Grant, *The Resource-Based Theory of Competitive Advantage: Implications for Strategy Formulation*, Spring 1991)

4.2 Dynamic Capability Theory

‘Dynamic capabilities’ is defined by Teece (Teece, Pisano, & Shuen, 1997) as “the firm’s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments.” Eisenhardt etc (2000) argue that dynamic capabilities are a set of specific and identifiable processes such as strategic decision making, product development, and alliancing. (Eisenhardt & Martin, *Dynamic capabilities: what are they?*, 2000) Dynamic capabilities are “the antecedent organizational and strategic routines by which managers alter their resource base—acquire and shed resources, integrate them together, and recombine them—to generate new value-creating strategies (Grant, *Toward a knowledge-based theory of the firm*, 1996) (Pisano, 1994)” Teece uses ‘dynamic capabilities’ approach to explain how combinations of competences and resources can be developed, deployed, and protected. Based on this approach, it is important to develop management capabilities, and difficult-to-imitate combinations of organizational, functional and technological skills to effectively coordinate and redeploy internal and external competences (Teece, Pisano, & Shuen, 1997). The term ‘dynamic’ refers to the capacity to renew competences to achieve congruence with the changing business environment. Timing is critical and the circumstance is difficult to determine here. The term ‘capabilities’ in ‘dynamic capabilities’ “emphasizes the key role of strategic management in appropriately adapting, integrating, and reconfiguring internal and external organizational skills, resources, and functional competences to match the requirements of a changing environment.” (Teece, Pisano, & Shuen, 1997)

Eisenhardt etc (2000) argued that although dynamic capabilities are idiosyncratic and path dependent, they possess commonalities across firms. In moderately dynamic markets, dynamic capabilities are the traditional conception of routines, while in high-velocity markets they are simple, highly experiential, unstable and fragile processes with unpredictable outcomes (Eisenhardt & Martin, *Dynamic capabilities: what are they?*, 2000). Since the functionality of dynamic capabilities can be duplicated across firms, their value for competitive advantage lies in the resource configurations that they create, not in the capabilities themselves.

There is some debate regarding the understanding of capabilities. For example, Peng (Peng, 2009), look at capabilities the same as resources. To facilitate the understanding and analyzing

supply chain risks based on RBV (Resource-based theory) and Dynamic capability theory, it is necessary to give a clear understanding of capabilities in this area. My understanding is that the capabilities of handling supply chain risks are different with the capabilities for pursuing competitive advantages. The purpose of supply chain risk handling capabilities is to guarantee the smooth functioning of other capabilities to pursue competitive advantage. So it doesn't matter whether the capabilities can be duplicated or not.

4.3. Extended-RBV

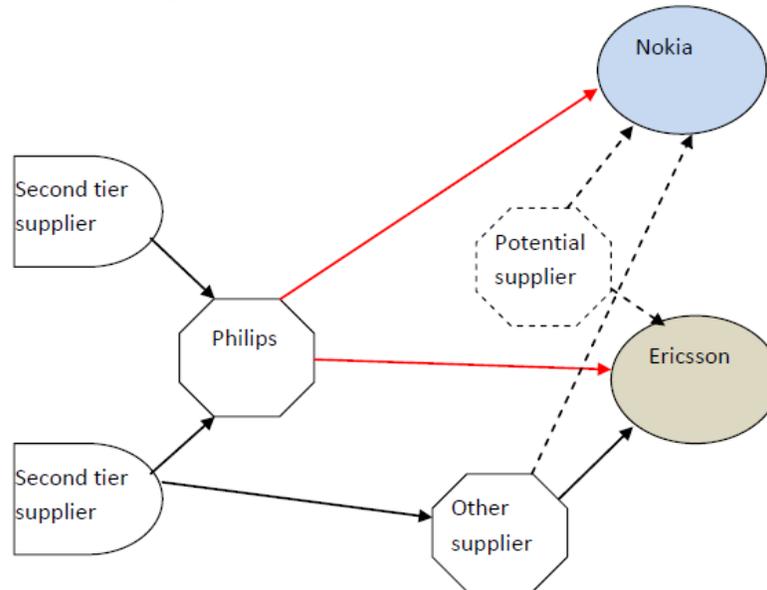
In current integrated world-wide market, almost no company can get sustained competitive advantage without relying on external resources. RBV traditionally downplays external resources as a potential source of competitive advantage on the ground that they are theoretically available to all firms (Barney, 1991). It generally overlooks the joint exploitation of resources through the firm's network relationships. Souter (Souter, 2000) pointed that except for the risks of their own company, risks in other links of their supply chain should also be paid attention to by the company. (Souter, 2000). Similarly, Christopher et al., also pointed out that company should identify potential sources of the risks "at every significant link along the supply chain. (Faisal, Banwet, & Shankar, 2006)" (Christopher, et al., 2002). Narasimhan emphasized that buying firms must invest in supplier firms in order to develop their capabilities because supplier performance might degrade and it may cause risks to the supply chain (Editorial, Narasimhan, & Talluri, 2009).

From above, we can see that in analyzing supply chain, the narrow perspective of RBV cannot adequately address many issues, especially supply chain risk management. Mathews (Mathews, 2003) gives the term 'Extended RBV' which includes both access to network and internal resources. Network resources may include relation-specific assets, inter-firm routines, complementary resource endowments and effective (network) governance (Dyer & Singh, 1998). Since the purpose of this paper is to handle supply chain disruption instead of getting competitive advantage of the company, the resources that I refer should be generalized to all kind of resources which could help the functioning of the business. Whether they possess the characters of VRIN (valuable, rare, inimitable and non-substitutable) doesn't matter for our topic. This can also avoid the argument and confusion about whether VRIN can be the source of sustained competitive advantage in RBV theory. Another reason is that sometimes it needs the cooperation of the society, government, companies in the whole industry including competitors to handle serious disruptions such as terrorism. So it is not suitable to try to make use of a disruption to get competitive advantage, although sometimes it does work this way. In a supply chain, when disruption happens, except for actual resources possessed by the company, it is also important to make full use of the potential resources available in the network of the firm to supplement the shortage of the supply.

We can draw great lessons from the Nokia/Ericsson case mentioned earlier regarding supply chain risk management. One is that compared with Ericsson, Nokia has better capability in making use of the resources (both actual and potential) in the supply chain.

When the disruption happened in Philips, Ericsson was not aware of the seriousness and kept on waiting while Nokia took immediate actions, which included the President's visiting Philips to help them to find substitute way to mitigate the shortage of production and trying their best to absorb all the remaining capacity of Philips to support Nokia. When Ericsson realized how serious the situation was, it was too late for them and there was no resource left available for them. To analyze the extended resources more deeply, I describe it with Fig.2:

Figure 2. Illustrated Supply Framework



In Fig.2, Philips is the supplier of both Ericsson and Nokia. Ericsson may have another supplier which supplies the same components as Philips does. There might be another potential supplier which currently is not supplier of Ericsson and Nokia, but when disruption happens, the potential supplier's capacity might be used.

Extended Resource perspective allows us to consider the resources in a broader way. First, it does not only consider the resources of the supplier; it also considers the resources of non-supplier whose resources can be utilized when disruption happens. When disruption happens in Philips, it is important for Ericsson to contact potential suppliers and other firms to try to absorb as much capabilities as possible. Secondly, it does not only consider the resources and capabilities in the supplier, i.e., not only consider the reliability of the supplier, it is also important to see whether the capabilities can be fully dedicated to the focal company when disruption happens. For example, if Philips were not the supplier of the same product to Nokia, most of the remaining capability of Philips might have been dedicated to Ericsson when disruption happened to Philips. If this were true, Ericsson wouldn't have suffered so much.

From above, we can see Ericsson was vulnerable to the disruption in the Philips plant not only because it relies on single supplier; but also because there is another major industry player relying on the same supplier (Sheffi Y. , *The Resilient Enterprise:Overcoming Vulnerability for Competitive Advantage*, 2005). Since I use extended RBV to analyze supply chain disruptions, it is not enough to just evaluate the resources and reliabilities of current or potential suppliers, it is also important to consider how the resources can be available or dedicated to the focused company when disruption happens. This is very important for the recovery or resilience of the focused company.

To think it even more broadly, when evaluate the reliability of first-tier supplier, it might not be enough to just consider the resources and reliability of the second-tier suppliers, it is better to consider how the second-tier suppliers' resources can be dedicated to the first-tier supplier

when disruptions happens. Same iterative analysis is with the third and fourth tiers upstream. In summary, the broader the scope of consideration, the better the focused company will be prepared for the disruptions in the supply chain. The environment of the firm can be separated into three levels, i.e., External Environment, Supply Chain Context, and Internal Environment (Brindley, 2004). Extended RBV should consider all the possible resources that the firm can utilize in the entire environment.

4.4. Dynamic Extended RBV (DE-RBV)

RBV holds a relatively static view of resources because of its traditional focus on building barriers (or isolating mechanisms) to prevent competitors from imitating, acquiring or substituting resources. It does not address issues like environment change and supply chain disruptions. Helfat and Peteraf (2003) presented 'Dynamic RBV', which is helpful to analyze supply chain disruptions (Helfat & Peteraf, 2003). From dynamic view, the circumstance of the firm change dynamically; the resources that the firm can utilize (extended resources) also change dynamically. On one hand, it is important for the firm to watch the changes in the supply chain and respond quickly; on the other hand, the firm should actively build up dynamic capabilities to deploy resources to achieve desired goals. Dynamic capabilities enable resources and capabilities to be renewed in congruence with changing environment (Teece, Pisano, & Shuen, 1997).

To meet the requirement of supply chain disruption analysis, this paper presents 'dynamic extended RBV' (DE-RBV), which combines both 'dynamic' and 'extended' perspective on RBV, to analyze the capabilities for handling supply disruptions in the general model. It can help managers to endeavor to handle disruptions in increasingly demanding environments.

4.5. DE-RBV to Risk Management Strategy Analysis: A Practical Framework

Grant presents a practical framework using Resource-based view. The framework that Grant gives is based on two premises: first, the firm's strategy is directed by internal resources and capabilities; second, the primary source of profit for the firm is from resources and capabilities. (Grant, *The Resource-Based Theory of Competitive Advantage: Implications for Strategy Formulation*, Spring 1991)

To facilitate my explanation, two different perspectives for strategy formulation and analysis are summarized:

- Strategies only from competitive advantage (CA) perspective
- Strategies integrating supply chain risk strategy

There are three different points between the two perspectives:

'Strategies only from CA perspective' neglects the abnormal disruptions which can hinder or even destroy the firm's capability to get competitive advantage. Actually handling supply chain risk should be qualifying factor for pursuing the firm's competitive advantage. Only with the capability to keep the business's continuity can the firm achieve sustained competitive advantage.

Since supply chain risk is integrated into the analysis when establishing strategy of the firm, we cannot perceive internal resources and capabilities as the basic direction for the firm’s strategy. Extended RBV should be used here.

Due to the character of dynamic change of supply chain circumstance, dynamic view should be used in the strategy analysis framework.

Based on the difference pointed above, I present my practical framework for risk management strategy analysis based on DE-RBV (see Fig. 3).

Figure 3. DE-RBV Approach to Risk Management Strategy Analysis: A practical framework

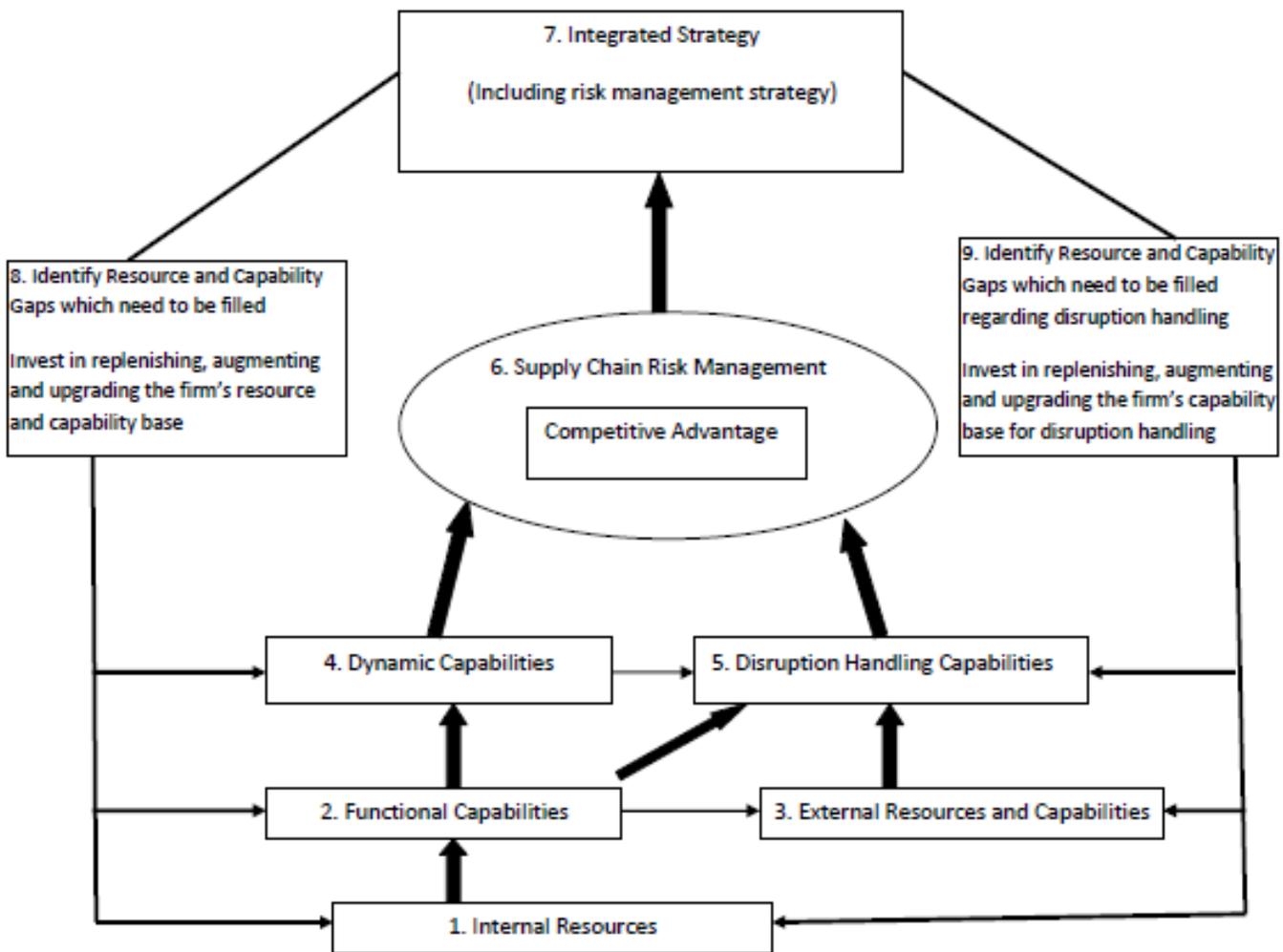


Fig.3 presented in this paper is a framework based on DE-RBV. It is adjusted from Grant’s framework based on RBV (Grant, 1991). We can see the stages when doing strategy analysis:

- 1) Identify and classify the firm’s resources. Appraise strengths and weaknesses relative to competitors. Identify opportunities for better utilization of resources.

- 2) Identify the firm's functional (operational) capabilities. Identify the resources inputs to each capability and the complexity of each capability.
- 3) Based on the firm's internal resources and capabilities, identify the external resources and capabilities that can be utilized, and the difficulty in the utilization.
- 4) Based on the firm's functional (operational) capabilities and resources, identify the dynamic capabilities (higher order capabilities) which can reorganize and resemble the composition of the firm's resources and capabilities when situation changes.
- 5) Based on the firm's dynamic capabilities and resources available, figure out the capabilities to handle supply chain disruptions, which include: Preventive Capability, Back-up Capability, Substitute Capability, and Warning Capability.
- 6) Based on the firm's dynamic capabilities and disruption handling capabilities, appraise the rent-generating potential of resources and capabilities in terms of: (a) their potential for sustainable competitive advantage, (b) the appropriability of their returns regarding supply chain disruptions handling. Supply chain risk management handling is the base and qualifying factor of the firm's competitive advantage. The investment in handling supply chain risk may not have positive relationship with performance of the company (or competitive advantage) since it is only a qualifying factor. It is not 'the more investment of handling risk, the better the return will be'.
- 7) Select a strategy which best exploits the firm's resources and capabilities relative to external opportunities and risks. Supply chain risk strategy is an important and necessary part of integral strategy of the company. Without supply chain risk strategy, it is almost impossible for the company to keep sustained competitive advantages.
- 8) Based on the strategy and the changing situation of the company, identify resource and capability gaps which need to be filled. Then invest in replenishing, augmenting and upgrading the firm's resource and capability base.
- 9) Based on supply chain risk management strategy and the changing circumstance of the company. Identify resource and capability gaps which need to be filled regarding disruption handling. Then invest in replenishing, augmenting and upgrading the firm's capability base for disruption handling.

Except for the stages described above, there are several points needed to be notified.

- This framework reflects DE-RBV. The extended resource based view is reflected by stage 3. The dynamic view is reflected by: (a) dynamic capabilities in stage 4; (b) after stage 8 and 9, there are arrows coming down, which reflects the perception of changing and reconsidering the resources and capabilities repeatedly and iteratively.

- In stage 6, the competitive advantage is located within the supply chain risk management boundary, which means supply chain risk handling is the qualifying factor and a base to keep competitive advantages. Supply risk is actually disruptions of the resources, so the relationship between supply risk and competitive advantages is as important as the relationship between resources and competitive advantages.
- Supply chain risk strategy is a necessary part of overall strategy. It can be the safeguard of the company to achieve competitive advantages. Based on RBV, business strategy should be viewed as 'a quest for Ricardian rents', which means the "returns to the resources which confer competitive advantage over and above the real costs of these resources" (Grant, *The Resource-Based Theory of Competitive Advantage: Implications for Strategy Formulation*, Spring 1991).
- Business strategy should be guaranteed by supply chain risk management strategy to make the business continue.

4.6 Hierarchies of Capabilities and 'Supply Chain Risk Management Capability'

Capabilities have different hierarchies. Functional (operational) capabilities are zero-level capabilities, which reflect to what extent the company can make use of its internal resources to keep the business functioning. Dynamic capabilities contrast with ordinary (or operational) capabilities by being concerned with change. As a set of identifiable and specific processes, dynamic capabilities can be perceived as upper order capabilities but it also includes different hierarchies. Some dynamic capabilities are of lower level, while some other dynamic capabilities are of higher level. For example, product development capability is a sort of dynamic capability. Compared with product development, strategic decision making is of higher level dynamic capability because it is based on other dynamic capabilities including product development capability and alliancing capability. Because capabilities are complex, structured and multidimensional (Winter, 2003), dynamic capabilities, as a kind of capability, are also complex. The core idea of dynamic capability is its 'change', i.e., can reorganize and change the use of lower level capabilities and resources.

Supply Chain risk management capability is a kind of capability, but it is a different categorization. It does not classify based on 'routines' or 'processes', but on what the company can do by utilizing the resources and capabilities available. It is consistent with the view that "capability is the capacity for a team of resources to perform some task or activity. (Grant, *The Resource-Based Theory of Competitive Advantage: Implications for Strategy Formulation*, Spring 1991)" My view of supply chain risk management capability synthesizes resources, the zero-order capabilities and higher-order capabilities, and get a special kind of capabilities, which particularly reflect the capabilities to handle supply chain disruptions. They are different with dynamic capabilities such as product development capability and acquisition capability. Like other dynamic capabilities, supply chain risk management capabilities are also for handling change, especially for handling disruptions that are unexpected changes to the firm. These capabilities are used to guarantee the firm's other capabilities' smooth functioning.

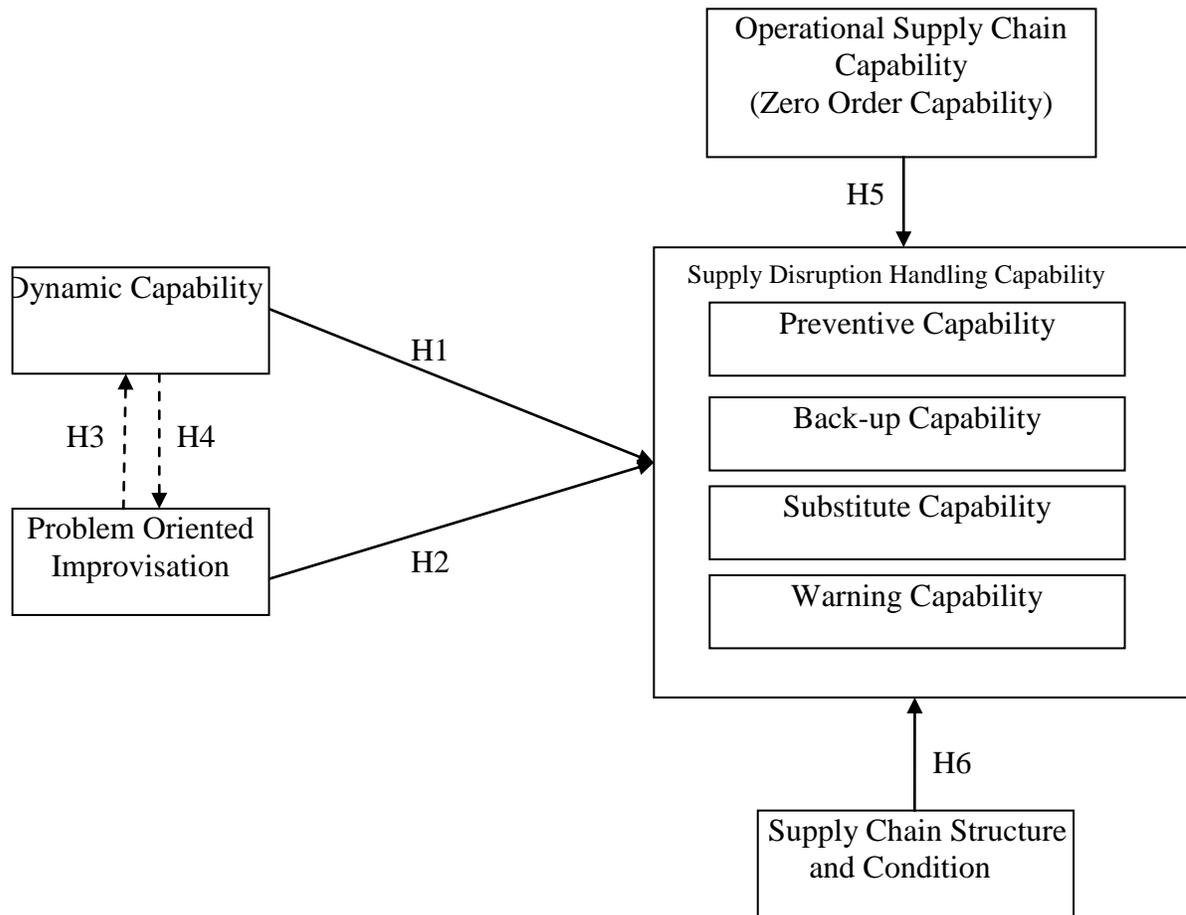
V. SUPPLY DISRUPTION HANDLING CAPABILITIES

Strategy has been defined as an organization matches its internal resources and capabilities with outside opportunities and risks. (Grant, *The Resource-Based Theory of Competitive Advantage: Implications for Strategy Formulation*, Spring 1991) The resources and capabilities

that either belongs to a company or can be handled by a company should be the foundation and starting point when analyzing supply chain risk strategy of the company. 'Supply disruption handling capability' belongs to supply chain risk management capability and particularly refers to the capability to handle supply disruptions. This paper presents the necessary capabilities of handling supply risk including 'Preventive Capability', 'Back-up Capability', 'Substitute Capability' and 'Warning Capability'.

Risk handling is different with common business capabilities. It has to handle the dynamic changing circumstance. Dynamic capabilities help to reorganize and delegate the capabilities and resources of the company when circumstance changes, so better dynamic capabilities can improve supply disruption handling capability. While dynamic capabilities are reflected by the routines and processes in the organization (Grant, 1991), only dynamic capabilities are not enough to handle disruptions in the supply chain since many disruptions' occurrence and pattern are out of expectation. "Ad hoc problem solving (Winter, 2003)" is necessary for risk handling and will affect the function of dynamic capability. I use "Problem Oriented Improvisation" to describe the ad hoc problem solving ability to handle the unforeseen destructed situation without prior preparation or stipulation. The model which reflects this part of relationship is as Fig. 4.

Figure 4. Capabilities of Handling Supply Risk



5.1 Preventive Capability

Preventive Capability means to what extent the firm can prevent disruptions before disruptions happen and how much the firm can take actions to mitigate the disruptions. Due to the cost of building up the capability, we cannot say that the more preventive capability the better. The risks and benefits of the preventing certain disruptions have to be balanced to make sure the resources are spent on the capabilities which will give the firm the most benefit.

5.2 Back-up Capability

Back-up Capability means to what extent the firm can use back-up resources to compensate the shortage of the supply. For example, the stocks of the materials, slack in lead times and redundant production capacities belong to 'Back-up Capability'. Back-up Capability actually includes some preventive capability because certain back-up material will actually avoid or mitigate the disruption.

5.3 Substitute Capability

Substitute Capability means when disruption happens, to what extent the firm can use substitute methods to compensate the shortages of the supply. It includes using substitute component, substitute suppliers, changing the design of the product, etc. All the methods which can mitigate the damages of the shortage of the supply after the disruption happens can be considered as substitute capability. Modular Design and Postponement are the ways to increase Substitute Capability. Lean Production can also improve substitute capability. The flexibility caused by lean production can improve substitute capability when disruption happens. The phenomenon that Toyota Company recovered more quickly from the supplier fire disruption than other companies shows Toyota's high substitute capabilities of Lean production and management. This looks like contradictory to the common sense that lean production can increase the supply risk. The reason is that although Lean Production can improve substitute capability it actually reduces Back-up Capability when pursuing cost reduction.

5.4 Warning Capability

Warning Capability means to what extent the firm can foresee or sense the coming disruption in the supply chain. It is based on the experience, knowledge, communication and information systems, and management style of the firm regarding supply disruptions. For example, if the firm has suffered the same kind of disruption many times, it will enhance the sensitivity of the firm, i.e., increase the warning capability. Good information system can improve the communication among different functional departments in the firm and can improve the warning capability. Warning capability also relates to the process of the firm, e.g., lean production has great warning capability due to the process of business. Without much stock and backup component, the problems in the supply and production procedure can be found and pinpoint more easily and quickly.

How decision-makers perceive risk also affect warning capability. Perceived risk affects the strategy and action of the company. Organization culture also affects warning capability.

5.5 Hypotheses in the Model

1) Dynamic capability and supply disruption handling capability

“Dynamic capabilities are the antecedent organizational and strategic routines by which managers alter their resource base—acquire and shed resources, integrate them together, and recombine them—to generate new value-creating strategies (Grant, Toward a knowledge-based theory of the firm, 1996) (Pisano, 1994) (Eisenhardt & Martin, Dynamic capabilities: what are they?, 2000).” Regarding managing supply disruptions, there are also routines and processes for handling supply disruptions. A firm should have processes and procedures in place to reduce uncertainty. The processes and procedures can also provide information, understanding and knowledge needed quickly (Reich, 2006). The routines and processes of handling supply disruptions exist in either explicit or tacit knowledge form, or both of them. The routines and processes are path-dependent, which is formed by the experience of handling the previous supply disruptions. It also can be learned from other companies’ experience or knowledge. Dynamic capabilities can improve supply disruption handling capabilities.

Hypothesis 1: Dynamic capabilities positively relate to supply disruption handling capabilities.

2) Problem oriented improvisation and supply disruption handling capabilities

Many times, disruptions happen without enough warning and the firms have to handle while they are not well prepared for. In this situation, dynamic capabilities which are normally reflected by routines and processes are not enough to handle the disruptions. “They may be pushed into ‘firefighting’ mode, a high-paced, contingent, opportunistic and perhaps creative search for satisfactory alternative behaviors. (Winter, 2003)” Tomlin (2006) separates mitigation tactics and contingency tactics. Mitigation tactics are taken in advance of a disruption, while contingency tactics are response tactics which are adopted only if a disruption happens (Tomlin, 2006).

In high-velocity markets, to adapt to changing circumstances, routines have to be unstable processes with unpredictable outcomes. This understanding leads to a richer conception of routines, which not only refer to efficient and robust processes (Nelson & Winter, 1982) but also include more fragile and ‘semistructured’ processes that are more effective in high-velocity markets (Eisenhardt & Martin, 2000). Winter (Winter, 2003) presented ‘ad hoc problem solving’ as a possible economically superior substitute for dynamic capability for firms to accomplish change without relying on dynamic capability. Here ‘ad hoc problem solving’ indicates such change behaviors that do not depend on dynamic capabilities; that are largely non-repetitive; and they are not merely reactive or passive and at least ‘intendedly rational’.

Ad hoc problem solving is not routine; especially not highly patterned and not repetitious. It is a response to novel challenges or other relatively unpredictable events from environment. Thus, ad hoc problem solving is a different way to change compared with the exercise of dynamic capabilities (Winter, 2003).

In my model, I use the construct ‘problem oriented improvisation’ to reflect ‘ad hoc problem solving.’ I choose this construct because it closely relates to improvisation in organizational theory while ‘ad hoc problem solving’ has not much clearly related theory to support it. Improvisation is “a just-in-time strategy” (Weick, Substitutes for Strategy, 1987). It deals with the unforeseen event. (Weick, Improvisation as a Minset for Organizational Analysis, September-October 1998)” Improvisation can be done by groups, departments, or firms. It is called ‘organizational improvisation’ (Moorman & Miner, The Convergence of Planning and Execution: Improvisation in New Product Development, July 1998). ‘Organizational improvisation’ means the degree to which the composition and execution of an action converge in time (Moorman & Miner, Organizational Improvisation and Organizational Memory, 1998). Improvisation is very

important for a firm in a turbulent environment that requires action in a time frame that is shorter than a regular planning cycle. (Moorman & Miner, The Convergence of Planning and Execution: Improvisation in New Product Development, July 1998). Rapid environmental turbulence increases the odds that improvisation provides value. Extensive formal plans in such conditions are not suitable because they are time and resources consuming and the guides that are provided to action are counterproductive because the context changes faster than the planning cycle (Eisenhardt & Tabrizi, Accelerating adaptive processes: Product innovation in the global computer industry, 1995) (Moorman & Miner, The Convergence of Planning and Execution: Improvisation in New Product Development, July 1998). Improvisation often arises when disaster happens. Rather than to utilize unexpected opportunities, improvisation are mainly to overcome obstacles. (Moorman & Miner, The Convergence of Planning and Execution: Improvisation in New Product Development, July 1998)

Regarding supply disruption handling, it is important for the firm to have the competency of improvisation to compensate the lack of formal plan. Scientific professionals saw improvisational activity as tools for flexibility and adaptability (Miner, Bassoff, & Moorman, 2001). Improvisation has been widely used in organizational theory; here I use “problem-oriented improvisation” to refer to the organizational improvisation when handling supply disruptions. When disruption happens, there is not much time for the firm to react, so the more improvisation competency the better the performance of handling supply disruptions. Improvisation can increase the ‘supply disruption handling capability.’ For example, improvisation can improve ‘preventive capability’ because when the firm realizes the risk of disruptions, improvisation can make the manager take suitable action quickly which might avoid risk or mitigate the disruption level.

H2(a): ‘Problem Oriented Improvisation’ positively relates to ‘Preventive Capability’.

Improvisation can also improve ‘Substitute Capability’ of the firm. When supply disruption happens, the firm with good improvisation competence can quickly find substitute ways to compensate the shortage of the supply, which can mitigate the bad effect of the disruptions.

H2(b): ‘Problem Oriented Improvisation’ positively relates to ‘Substitute Capability’.

3) ‘Dynamic Capability’ and ‘Problem Oriented Improvisation’

With the experience of handling supply disruptions, firms can not only build up its capabilities to handle supply risks, but also improve the dynamic capabilities of reorganizing and redistributing the resources. Some improvisation can be retained by firms; some problem-oriented improvisational troubleshooting may be proved to be wrong but the team can still draw a lesson from it for future reference. Firms can routinize the observation of its previous improvisational activities to improve the dynamic capability (Miner, Bassoff, & Moorman, 2001) . This is also a sort of learning-by-doing process. As time goes on, more and more experience from improvisation will be routinized and the dynamic capability will be improved.

H3: More “Problem Oriented Improvisation” will relate to more ‘Dynamic Capability’.

Dynamic Capability can also improve the improvisational competence. Firms can plan to improvise. Important resources and skills may be required to get the competence of fruitful improvisation. (Moorman & Miner, Organizational Improvisation and Organizational Memory, 1998) (Crossan & Sorrenti, 1997) (Eisenhardt & Tabrizi, Accelerating adaptive processes:

Product innovation in the global computer industry, 1995) The firms with well dynamic capabilities may have better effect when doing improvisation.

H4: More dynamic capability will lead to more 'problem-oriented improvisation'.

Operational Supply Chain Capability and 'Supply Disruption Handling Capability'

Functional supply chain capability (Operational supply chain capability) means the capabilities of the supply chain to perform basic functions of the supply chain, i.e., the capabilities to make materials, money and information flow to go smoothly along the supply chain. I use Functional Supply Chain Capability (Operational supply chain capability) to refer to the accumulated operational capability of the firms in the whole supply chain.

Better functional supply chain capability can improve the capability of the firm to prevent disruptions. It is easier for the firm with better operational capabilities to respond to the changing circumstance quickly. So there might be more odds for the company to avoid disruptions or mitigate the level of disruptions. When disruption happens, it might be easier for the firm to substitute the shortage of the supply to keep business going smoothly. A firm with better operational capability normally is more organized and has efficient communication system and routines, so the firm can be more sensitive to the coming disruptions, i.e., has more warning capability. Based on extended RBV, the resources and capabilities in the supply chain are important for the focused company to handle supply disruptions.

H5: More Operational Supply Chain Capability leads to more 'Supply Disruption Handling Capability'.

5) 'Supply Chain Structure and Condition' and 'Supply Disruption Handling Capability'

Supply chain structure and condition refers to the structure of the supply chain, i.e., whether it is complex, disordered or well organized, the power of the focused company and the relationships with suppliers. A well-organized supply chain structure can be beneficial to the company to handle supply disruptions since it will facilitate the utilization of the resources in the supply chain to handle the disruptions if the supply chain is well-organized.

In the example about Nokia/Ericsson companies, I mentioned that if the company's suppliers' capability is dedicated to another main player in the industry, it will affect the company's capability to overcome risks in the supply chain. In general, the company with more power in the supply chain (supply chain leader) has the capabilities to affect other suppliers' actions, including how much the supplier will dedicate their remaining resources and capabilities to the firm when disruption happens to the supply. The master company of the supply chain has more bargaining power and will set the rules and routines for the supply chain partners. The company with supply chain power may benefit from utilizing the remaining supply chain resources and capabilities to handle supply disruptions.

Good relationship with suppliers will increase the substitute capability and warning capability of the focused company. When disruption happens, good relationship will facilitate the company to communicate with the supplier and dedicate more remaining resources and capabilities to the focused company. Good communication and trust will improve the warning capability of the focused company.

H7 (a): Supply chain structure and condition affect the 'supply disruption handling capability'.

H7 (b): The more power in the supply chain, the more 'supply disruption handling capability' of the focused company.

H7 (c): Better relationship with supplier will increase 'supply disruption handling capability' of the focused company.

V. CONCLUSION AND DISCUSSION

Main contributions of this paper are as below:

- Presents four supply disruption handling capabilities, i.e., preventive capability, warning capability, back-up capability and substitute capability.
- Presents a practical framework to Risk Management Strategy Analysis based on Dynamic Extended Resource Based View (DE-RBV).
- The relationship between supply disruption handling capabilities and supply disruption handling performance is given.

This paper gives thorough and extensive analysis of supply disruption handling capabilities and its relationship with traditional RBV and dynamic capability theory. The supply risk handling capabilities presented in this paper can help a firm systematically analyze why certain kinds of supply chain practices are good to handle risk in specific situations and find out where capability gaps exist for a firm. The model presented in this paper can clearly analyze why and how some popular practices such as Lean, Global Sourcing, and Single Sourcing etc., can affect supply chain risk. Upon the analysis of how the supply chain strategies and practices affect the supply disruption handling capabilities, managers can decide on using which kind of supply chain strategies or practices (e.g., Postponement, Component Design, etc) and to what extent we should utilize them.

The analysis of this paper focuses on the regularities among supply disruption handling methods. A framework of this generality does not explain the details of how a specific supply disruption handling method work in particular circumstances of the company, instead, the framework provides an outline of the main features of supply chain disruption handling, which may guide future research. Based on this, new supply chain risk management methods can be traced, predicted and organized. It will facilitate the judgment and justification of practitioners on supply chain risk management strategies and practices. This framework provides a frame within which subsequent research can examine the specific supply chain risk management method in particular circumstance in greater detail.

The purpose of this paper is to move away some obscurity and conflicts existing in supply chain risk research area and to build up foundation for further research. Based on this general conceptual model, more operational supply risk management methods will be generated and justified.

Although this paper is a good attempt to dig the underlying mechanism of supply chain disruption handling, due to the limitation of this research, the constructs and models presented in this paper need further theoretical and empirical verification and test.

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