Resilient Sustainable Supply Chain Management
A Conceptual Framework

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Abstract: A resilient-sustainable supply chain has become a unanimously important research agenda in business as global supply chain is facing an increased number of risks and disruptions. In such a situation in order to be competitive and sustainable a supply chain needs to be resilient. Literature related to supply chain sustainability and resilience in an integrated fashion is sparse, rather issues are presented separately and no empirical work has yet been done to develop a resilient-sustainable supply chain management (RSSCM) framework. A resilient-sustainable supply chain management (RSSCM) framework is formulated and measurement scale for resilience and sustainability is developed in this study. The study combines the stakeholder theory and resource based view in line with sustainability and resilience in developing a theoretically grounded, comprehensive framework of resilient-sustainable supply chain management.

1 INTRODUCTION

For a sustainable supply chain, a balance of economic, social and environmental factors has emerged enormously important as customers are demanding sustainable supply chain and products (Carter and Rogers, 2008). Sustainability in supply chain is often threatened, as the world business has become highly competitive and uncertain. Unforeseen events often disrupt business and the supply chain which challenge supply chain continuity (Manuj and Mentzer, 2008; Kleindorfer and Saad, 2005). In case of disruptions and uncertainties supply chain needs resilience capacity to get back to original state after disruptions (pettit et al., 2010; Christopher and peck, 2004) and more specifically, to prepare for unexpected events, respond to disruptions, and recover from them to continue its operation and to sustain Christoper and peck, 2004; Ponomarov and Holcomb, 2009). In the situation of frequent disruption in the supply chain without resilience capacity, sustainability is hard to achieve (Folke et al., 2002). As a result it is crucial to investigate whether the supply chains need resilience to be truly sustainable? A number of researchers (Carter and Eston, 2011; Pagell and Wu, 2009; Seuring and Muller, 2008) conducted research on sustainable supply chain management (SSCM) and on supply chain resilience (Ponomarov and Holcomb, 2009; Xu, 2008; Christopher and peck, 2004; Pettit et al., 2010; Sheffi and Rice, 2005). It is chalked out from intensive literature survey on sustainable supply chain management and supply chain literature that no comprehensive research has yet been conducted integrating supply chain resilience and sustainability though some authors (Folke et al., 2002; Fiksel, 2003; 2006; Martin, 2004) mentioned conceptually that supply chain resilience is a precondition for supply chain sustainability without any clear framework. In this theoretical lacuna the basic premise of the research is to show the relationship between supply chain resilience and supply chain sustainability through a framework which we termed as resilient sustainable supply chain management (RSSCM) model. The model will help a supply chain to be both sustainable and resilient. Further, it is important to develop measurement of resilience and sustainability indicators because without measurement one cannot get better control (Kaplan and Norton, 1996). Hence, the major research questions in this background are:
Q1. What constitutes the RSSCM framework?
Q2. How to measure the elements of RSSCM framework?

2 METHODOLOGY

The aim of the research is to formulate a RSSCM

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model to make a supply chain resilient and sustainable as there is no model in this regard. Moreover, in supply chain management literature there are few initiatives for theory and concept development (Carter and Ellram, 2003). Conceptual theory building method is a way that can create a balance between inductive and deductive research (Meredith, 1993), a good way of building theory through a set of interrelated propositions leading to testable hypothesis (Meredith, 1993). This paper is an attempt to develop a conceptual framework and termed as RSSCM framework through some important propositions derived from literature survey.

The data collection to support this methodology occurred through a rigorous key-word search of the literature on specific terminology such as sustainability, resilience, sustainable supply chain management. The conceptualization as described above was a systematic process of reading scientific papers, additional collection of literature, synthesis, and refinement of framework over a period of nine months. Concepts of two major theories namely stakeholder theory and resource based view have been used to establish the foundation of different links and relationship among the variables in the model. The results of our conceptualization will be presented to 20 supply chain managers of ready-made garments manufacturing and textile companies in Bangladesh to further ensure the validity of our framework as per the process suggested by Yin (1994). Then the refined model will be tested by quantitative analysis of survey data using structural equation modelling.

3 THEORETICAL BACKGROUND

The world has experienced numerous uncertainties arising from climate changes, frequent natural disaster, epidemics, terrorist attacks, resource crisis, regulation and economic ups and downs. These sorts of uncertainties create disruptions and risks in discharging the regular activities of supply chains (Svensson, 2000; Hendricks and Singhal, 2003). In an environment of disruptions developing a sustainable system has become challenging and a good alternative is to develop systems resilience to resist and overcome disruptions effectively (Fiksel, 2003; Fiksel, 2006; Gunderson, 2002). Resilience is echoed when the issue of sustainability is discussed (Martin, 2004) because resilience enhances the sustainability in a turbulent environment (Folk et al., 2002). So, existing literature supports that resilience is a precondition for sustainability. Dragging the concept to supply chain it can also be proposed that in order to develop a sustainable supply chain, supply chain resilience is indispensable. This proposition is the basis of proposed RSSCM model and justified by stakeholder theory and resource based view (RBV).

RBV argues that firms achieve sustainable competitive advantages by deploying its bundle of resources and capabilities which are unique and internal to the firm (Wernerfelt, 1984; Barney, 1986, 1991; Grant, 1991). Further, in an environment of uncertainty and disruptions, organizations can be successful in the competition by overcoming threats and uncertainties effectively (Wernerfelt, 1984). Researchers of the RBV advocated for inclusion of the ability to overcome disruption and contingency as organizational resources and capabilities (Barney, 2001; Priem and Butler, 2001). Correa and Sharma (2003) in their "contingent resource based view (C-Rbv) of proactive corporate environmental strategy" argue that organization's proactive environmental attempt to mitigate environmental uncertainties and complexities is a valuable dynamic capability of a firm and firms need to invest in achieving its tangible and intangible resources for developing capabilities in uncertain business environments. Integrating natural resource based view (N-Rbv) and stakeholder theory Markley and Davis (2007) advocate the need for a capability to mitigate and reduce the environmental uncertainties in supply chain for reducing negative environmental and social impact and to retain higher stakeholder value for high performing sustainable supply chain. This type of dynamic capability is needed for developing a resilient sustainable supply chain management (RSSCM) framework to overcome the uncertain and disruptive events.

Stakeholder theory holds the idea that managers shall take decision considering the interest and impact of all stakeholders. If a balance among the conflicting interests and claims of stakeholders cannot be ensured organizational sustainability will be questioned (Freeman, 1984). As the time passes the attention and interest of all stakeholders is converging towards sustainability of the organization in terms of economic, social and environmental factors (Wheeler et. al., 2003). A sustainable organization tries to maximize economic, social and environmental performance for a sustainable and value based stakeholder relation (Perrini and Tencati, 2006). In order to develop a sustainable supply chain management,

organizations' supply chain shall fulfil economic, social and environmental expectations (Carter and Rogers, 2008; Carter and Easton, 2011) as the sustainable supply chain has now become customer, government and stakeholder requirement (Seuring and Muller, 2008). To Freeman (1984 p. 13-27), with the passage of time organizations are experiencing different types of internal and external changes and challenges from a customers, suppliers, government, competitor, pressure groups and so on. In such situation organizations need the capacity to change of concept, strategy to respond to the environment in an inactive or reactive, proactive or interactive way for managing the environmental uncertainties positively so that it can reduce uncertainties and vulnerabilities (Freeman, 1984 p 13-27). Reduction of vulnerabilities or increase in capability to reduce impact of vulnerabilities which is also termed as resilience (Pettit et al., 2010) is a unique resource for organizations as per the advocates of resource based view (Barney, 2001; Priem and Butler, 2001).

Based on the above theoretical support it can be proposed that supply chains with high resilience are more sustainable in the light of economic, social and environmental aspects and vice versa.

Proposition 1: Supply chains with high resilience are more sustainable in the light of economic, social and environmental aspects and vice versa.

4 LITERATURE REVIEW

4.1 Supply Chain Resilience

Resilience is a multidisciplinary concept. Holling (1973) was one of the prime researchers to identify resilience as the ability of system to absorb changes. After that many authors echoed the concept of resilience as system's ability to recover and get back to the original state (Mitroff and Alpasan, 2003; Ponomarov and Holcomb, 2009; Christopher, 2004). Resilience "is an adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function" Ponomarov and Hollcomb (2009).

To develop a resilient system it is important to understand measurement of resilience because the degree of resilience a system needs is context dependent (Carpenter, 2001). Researchers in different disciplines emphasized on capabilities such as adaptability, diversity, flexibility, efficiency, cohesion, control, connectedness to measure resilience (Pettit et al., 2010; Fiksel, 2003). In supply chain management Pettit et al. (2010) is the first to develop resilience measurement scale based on fourteen major capabilities such as adaptability, flexibility, efficiency, pro-activeness, control etc. and seven major vulnerabilities such as turbulence, supplier disruption, customer disruption etc. But these capabilities and vulnerabilities are antecedents and actually are promoters or inhibitors of resilience of a system and not the actual measures of resilience. Resilience shall be measured by the relative degree such as high resilience or low resilience based on the extent of systems departure from desired state (Holling, 1973; Ludwig, 1996) based on recovery time after disaster or disruptions (Neubert and Caswell, 1997; Ortiz and Wolff, 2002; Falasca et al., 2008), based on reduction of consequences through resistance (Falasca et al., 2008, Masten and Powell, 2003; and based on cost of recovery (Martin, 2004; Vugrin, 2009). The measurement items of supply chain resilience are shown in table 1. In real world scenario it is not possible to have 100% resilience of a system. Again there is no system with zero resilience.

Table 1: Supply chain resilience measurement.

Construct	Item	Reference
Resilience	Departure from desired state	Holling, 1973; Ludwig, 1996; Carpenter, 2001.
	Recovery time	Neubert & Caswell, 1997; Matsinos & Troumbis, 2002; Ortiz & Wolff, 2002.
	Reduction of consequences through resistance	Masten & Powell, 2003; Falasca et al., 2008.
	Cost of recovery	Martin, 2004; Vugrin, 2009.

4.1.1 Supply Chain Disruption

Maintaining an effective supply chain has become challenging and difficult as the business supply chains are facing an overwhelming complexities and unexpected disruptions. The experience of disruptions may take different forms such as delay during transportation, port stoppages, frequent occurrence of natural disasters, weak communication, supply shortages, Demand volatility, quality problem, operational issues and terrorism are few among the lot (Colicchia et al., 2010; Kleindorfer and Saad, 2005; blackhurst et al., 2008). Kleindorfer and Saad (2005) classified three main categories of supply chain disruption: 1stly, operational disruption which envelops equipment

malfunctions and systemic failures, abrupt discontinuity of supply, bankruptcy, fraud, or labor strikes; 2ndly, natural hazards which include earthquakes, hurricanes, storms; and 3rdly, terrorism or political instability. In this way a number of researchers such as Chirstopher and Peck (2004); Sheffi (2005), Wu et al. (2006), Blackhurst et al. (2008), Kleindorfer and Saad (2005) and others discussed about supply chain disruptions and risks which can be better understood from table 2 (see appendix). Supply chain disruptions may be a cause of huge loss for a company and whole supply chain if those are not handled properly and in appropriate time because it may be the result of significant supply chain delays magnifying the rate of stock-outs, failed to meet the demand of customers on time and customer dissatisfaction cost (Rice and Caniato, 2003, p 22). Disruptions in the supply chain are sometimes beyond the direct control of supply chain managers. Some disruptions can be assessed in advance and some are not. Supply chain managers need to be proactive to get signal of disruptions in advance and to develop resilience capacity for mitigating the disruptions (Peck, 2005). Based on the above literature:

Proposition 2: Existence of high disruptions and vulnerabilities in the supply chain leads to lower resilience and vice versa

4.1.2 Supply Chain Capability

Supply chains need to have capabilities to create resilience against disruptions (Christopher and Peck, 2004). Researchers in different disciplines emphasized on capabilities such as adaptability, diversity, flexibility, efficiency, cohesion, control, connectedness to measure resilience (Pettit et al., 2010; Fiksel, 2003; Ponomarov and Hollcomb, 2009). In an uncertain condition dynamic capabilities are difficult to sustain and resilience is inevitable in such condition to achieve sustainability (Eisenhardt and Martin, 2000). Esper et al. (2007) enumerated a number of supply chain capabilities that lead to improved firm performance and sustainable competitive advantage. In the same way Sheffi (2005), Christopher and Peck (2004), ponomarov and Holcomb (2009), Pettit et al. (2010), Tomlin (2006), and others mentioned a number of supply chain capabilities for developing supply chain resilience which is shown by table 3 (see appendix). Based on the above literature it can be proposed that:

Proposition 3: existence of higher capabilities in the supply chain leads to higher resilience and vice versa.

4.1.3 Supply Chain Orientation

Without having a supply chain orientation it is not possible perform the supply chain functions (Min and Mentzer, 2004). So, in order to develop supply chain resilience the capability of smooth conduction of supply chain functions by reducing disruptions, supply chain orientation is very important. Min and Mentzer (2004) mention it is important to have trust, commitment, cooperation, compatability and top management support to implement changes in supply chain in a supply chain oriented organization which is beter understood by table-4. Again, it is important to have top management support and approval of initiatives for disruption risk mitigation (Buehler and Pritsch, 2003). It is possible when there is a supply chain orientation of the organization because supply chain orientation ensures a formal organizational structure strategy and clear policy framework for supply chain activities (Esper et al., 2010).

Table 4: Elements of supply chain orientation.

Construct	Items	Reference
Supply chain orientation	Top management support	Buehler & Pritsch (2003); Min & Mentzer (2004)
	Trust	Min & Mentzer (2004)
	commitment	Min & Mentzer (2004)
	cooperation	Faisal et al. (2006); Min & Mentzer (2004)Tomlin (2006);
	compatibility	Min & Mentzer (2004)

Proposition 4: Supply chains with high level of supply chain orientation have higher resilience and vice versa.

4.1.4 Supply Chain Design

Supply chain design decision can be illustrated as the decision regarding supply chain node density, complexity and criticality (Craighead et al., 2007; Falasca et al., 2008).

When there are a large number of nodes in a limited area the supply chain is said to have a high density level (Craighead et al., 2007; Falasca et al., 2008). In the research of Craighead et al. (2007) and Falasca et al. (2008) it is evidenced that increased density in the supply chain creates more vulnerability.

A less complex supply chain would have fewer nodes and or fewer interconnections between nodes

(Craighead et al., 2007; Falasca et al., 2008). Node complexity also depends on number of nodes both forward and backward chain for example existence of supplier's supplier and sub-supplier increases node complexity and vulnerability (Craighead et al., 2007). Usually increased complexity in the supply chain creates more vulnerability (Craighead et al., 2007; Falasca et al., 2008). However, additional nodes that create buffer in the supply chain reduce vulnerability though it causes increased complexity for example sourcing from multiple suppliers instead of single supplier increases supply chain node complexity but reduce vulnerability and enhance resilience (Falasca et al., 2008).

Node Criticality depends on the relative importance of a given node or set of nodes within a supply chain (Craighead et al., 2007). Existence of node that is very important for example important distributor or supplier on whom others are highly dependent in the Supply chain and the number of such nodes in the supply chain increases supply chain criticality and vulnerability (Craighead et al., 2007). Existence of critical transportation hub during sourcing and distribution for example consolidation of freight is done in Singapore also creates supply chain criticality.

Proposition-5: Supply chains with low density, low complexity and low criticality have higher resilience and vice versa.

Table 5: Elements of supply chain design.

Construct	Item	Reference
Supply chain design	Node density	Craighead et al. (2007); Falasca et al. (2008)
	Node complexity	Craighead et al. (2007); Falasca et al. (2008)
	Node criticality	Craighead et al. (2007); Falasca et al. (2008)

4.2 Sustainable Supply Chain Management (SSCM)

A sustainable supply chain is one that "manage material, information and capital flows and cooperate among all entities in the chain with a view to achieve the economic, environmental and social goals deriving from customer and stakeholder requirements" (Seuring and Muller, 2008). Sustainable supply chain management has got substantial interests to academic and corporate body just over a decade (Corbett and Klassen, 2006; Steafen and Martin, 2008). There are still fundamental issues that need to be addressed to assist business managers and supply chain professionals to achieve supply chain sustainability (Pagel and Wu, 2009). The literature related to supply chain sustainability incorporating economic, social and environmental aspects in an integrated fashion is sparse, rather issues are presented separately (Carter and Rogers, 2008; Carter and Jennings, 2002; Murphy et al., 1996).

Organizations' Supply chains are disrupted by many challenges in this turbulent environment and eventually may become unsustainable. In this regard, it needs to develop resilience to face those uneven and uncertain scenarios (Ponomarov and Holcomb, 2009). It is interesting that no integrated study has yet been conducted incorporating these important antecedent factors for formulating sustainable supply chain management framework.

4.2.1 Sustainability Measurement

Stakeholders demand for sustainability report generated the need for measurement of specific indices. As a result initiatives from different angles put forward to the development of specific indices and their measurement scale. Among those GRI, IchemE, DJSI, TBL and ETHOS corporate social responsibility indicators are related with business level sustainability indicators (Delai and Takahashi, 2011). There are differences in the organizations based on the multitude of product, services and operations which shapes the requirement of indices need for the specific organization for example some customized sustainability indicator sets have been developed by Labuschagne et al. (2005); Wang (2005); Vasileiou and Morris (2006); Hutchins and Sutherland (2008). However, some indicators are commonly used in most cases. For example, regarding social sustainability issues such as health and safety, remuneration, forced and child labour, absenteeism, child labour and forced labour in the chain, compliance of health, safety and human rights by the suppliers. Likewise, regarding environmental sustainability issues such as emission, human health effect, water pollutants, solid waste, waste Recycled or reused, compliance of environmental legislation, performance of suppliers regarding environmental issues, environmental impact of products produced and environmental certification are widely used. Regarding economic sustainability commonly used issues are Sales, Net income and Return on average capital employed.

5 RESILIENT SUSTAINABLE SUPPLY CHAIN MANAGEMENT

The RSSCM model bridges the existent theoretical gap between the relation of Resilience and sustainable supply chain management and asserts the importance of resilience for developing a sustainable supply chain management. Through a wide literature review mentioned on previous sessions we formulate the RSSCM framework shown in figure-1 and define RSSCM as the management of resources with a view to meeting stakeholders' expectations so as to achieve high and subsequent sustainability of organizations supply chain.

The RSSCM model in figure 1 depicts that a supply chain needs to be resilient in order to be sustainable. Here sustainability is measured on the basis of the economic, social and environmental components that are said to be the triple bottom lines of sustainability. Supply chain resilience is influenced by the antecedents of capability, vulnerability, supply chain orientation and supply chain design. Based on the background literature of the model it can be remarked that a supply chain will be resilient and sustainable when it have more capabilities, less vulnerabilities, high supply chain orientation, less complex and less critical supply chain design provided that the chain has the balance of economic, social and environmental components of sustainability.

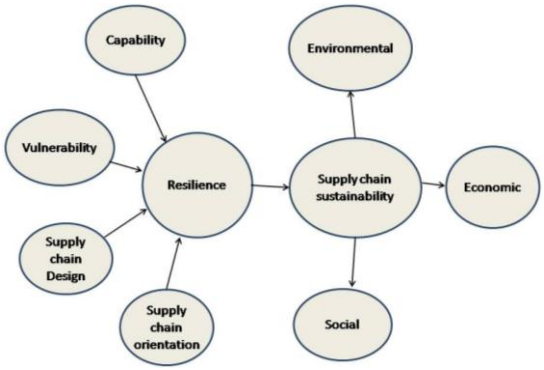

Figure 1: RSSCM framework.

6 DISCUSSION AND CONCLUSION

Supply chains need the capacity of resilience in order to be sustainable which is termed as the concept of RSSCM. A RSSCM model has been developed showing the relationship between supply chain resilience and supply chain sustainability. We define RSSCM as the management of resources with a view to meeting stakeholders' expectations so as to achieve high resilience and subsequent sustainability of organizations supply chain. It is expected that the RSSCM framework will help the supply chain managers to overcome disruptions and vulnerabilities in supply chain and thus help to create a resilient-sustainable supply chain. As the global business arena has become turbulent and uncertainties often disrupt supply chain functions supply chain managers will get ideas regarding mitigation of disruptions. Managers will know the relationship among different variables in the model, how the variables are linked and what are the antecedents and constructs of Resilience and sustainability. Moreover, the paper exclusively discusses the measurement of resilience and sustainability which will also help the manufacturers and supply chain managers to get idea about the degree of resilience and sustainability to set target and improvement needed in specific area in future to be truly resilient and sustainable. This RSSCM model will be refined and different links of the model will be justified based on the data of ready-made garments supply chain of Bangladesh in the subsequent phases of research. Firstly, a field study will be conducted to collect qualitative data from 20 supply chain managers regarding supply chain resilience and sustainability. Based on the field study the model will be refined and then different hypotheses will be tested based on the survey result from 300 respondents. A number of future research areas will be interesting such as which specific supply chain capabilities are needed for the mitigation of specific supply chain disruptions? Along with the triple bottom line elements: economic, social and environmental which are other components of supply chain sustainability? Organizational culture and strategy, supply chain governance and innovation and learning may be considered important components of supply chain sustainability along with triple bottom line components. Investigation of these areas will be worthwhile to develop an integrated framework for supply chain sustainability.

REFERENCES

Barney, J. 1986. Strategic factor markets: Expectations, luck and business strategy. *Management Science* 32: 1231.

Barney, J. 1991. Firm resources and sustained competitive advantage. *Journal of management* 17, 771

Barney, J. 2001. Is the resource-based "view" a useful perspective for strategic management research? Yes. *Academy of Management Review* 28, 41.

Brush, T. H. 1999. Toward a contingent resource based theory: the impact of information asymmetry on the value of capabilities in veterinary medicine. *Strategic Management Journal* 20, 223.

Blackhurst, J. B., Scheibe K. P. and Johnson. D. J. 2008. Supplier risk assessment and monitoring for the automotive industry. International Journal of Physical Distribution and Logistics Management 38, 143.

Blos, M. F., Quaddus, M., Wee, H. M and Watanabe, K. 2009. Supply chain risk management (SCRM): a case study on the automotive and electronic industries in Brazil. Supply Chain Management 14 (4): 247.

Buehler, K. S. & Pritsch. G. 2003. Running with Risk. *The McKinsey Quarterly* 4: 40

Carter, C. R. 2011. Sustainable supply chain management: evolution and future directions. *International journal of physical distribution and logistics management* 41, 46.

Carter, C. R. 2008. A framework of sustainable supply chain management: moving toward new theory. *International journal of physical distribution and logistics management* 38, 360.

Carter, C. R. & Ellram, L. 2003. Thirty Five Years of The Journal of Supply Chain Management: Where Have We Been and Where are We Going? *The journal of supply chain management*, 39, 27.

Carpenter, S., Brian Walker, & Eries, J. M. & Abel, N. 2001. From metaphor to measurement: resilience of what to what? Ecosystems, 4, 765

Christopher, M. & Peck., H. 2004. Building the resilient supply chain. International Journal of Logistics Management, 15, 1.

Christopher, M., Peck, H. Rutherford, C & Juttner. U. 2003. *Supply Chain Resilience.* Cranfield Centre for Logistics and Supply Chain Management. Cranfield.

Corbett, C. J., & Klassen, R. D. 2006. Extending the horizons: Environmental excellence as a key to improving operations. *Manufacturing and service operations management* 8 (1): 5.

COLICCHIA, C., DALLARIA, F. & MELACINI, M. 2010. Increasing supply chain resilience in a global sourcing context. *Production planning and control*, 21, 680.

Correa, A. A., & Sharma, S. 2003. A contingent resource-based view of proactive corporate environmental strategy. *Academy of Management Review* 28, 71.

Craighead, C. W., J. Blackhurst, M. J. Rungtusanatham, & R. B. Handfield. 2007. The severity of supply chain disruptions: design characteristics and mitigation capabilities. *Decision Sciences* 38 (1): 131.

Delai, I & Takahashi, S. 2011. Sustainability measurement system: a reference model proposal. Social responsibility Journal. 7 (3): 439

Epstein, M. J., & Wisner. P. S. 2001. Using a balanced scorecard to implement sustainability. *Environmental quality management*. (Winter): 1.

Esper, T. L., A. E. Ellinger. T. P. Stank. D. J. Flint & M. Moon. 2010. Demand and supply integration: a conceptual framework of value creation through knowledge management. *Journal of the Academy of Marketing Science.* 38 (1): 275.

Faisal, M. N., D. K. Banwet, & R. Shankar. 2006. Mapping supply chains on risk and customer sensitivity dimensions. Industrial management + data systems 106 (6): 878

Falasca, M., C. W. Zobel & D. Cook. 2008. A Decision Support Framework to Assess Supply Chain Resilience. Proceedings of the 5th International ISCRAM Conference.Washington DC, USA.

Fiksel, J. 2006. Sustainability and resilience: toward a systems approach. *Sustainability: Science*, Practice, and Policy. 2 (2): 14.

Fiksel, J. 2003. Designing resilient, sustainable systems. *Environmental Science and Technology* 37(23): 5330.

Folke, C., S. Carpenter, T. Elmqvist, L. Gunderson, C. Holling & B. Walker. 2002. Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. *Ambio* 31 (5): 437.

Freeman R. E. 1984. *Strategic Management: a Stakeholder Approach.* Boston. MA: Pitman

Grant, R. M. 1991. The resource-based theory of competitive advantage. *California Management Review* 33(3): 114.

Gunderson, L., & L. J. Protchard. 2002. *Resilience and the Behavior of Large-Scale Systems*. Washington, DC: Island Press.

Hutchins M J & Sutherland J W. 2008. An exploration of measures of social sustainability and their application to supply chain decisions. *Journal of cleaner production* 16: 1688.

Holling C S. 1973. Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*. 4:1.

Islam, M. A., & C. Deegan. 2008. Motivations for an organisation within a developing country to report social responsibility information: Evidence from Bangladesh. Accounting, Auditing and Accountability Journal 21 (6): 850.

Jin, B. 2004. Apparel industry in East Asian newly industrialized countries: Competitive advantage, challenge and implications. *Journal of fashion marketing and management* 8 (2): 230.

Kaplan R S & Norton D P. 1996. Using the Balanced Scorecard as a Strategic Management System. Harvard Business Review 74: 75.

Kleindorfer, P. R., & G. H. Saad. 2005. Managing Disruption Risks in Supply Chains. *Production and operations management* 14 (1): 53.

Kolk, A. 2006. Sustainability, accountability and corporate governance: exploring multinationals reporting practices. Business Strategy and the Environment 17 (1): 1.

Labuschagne, C., Brent, A. C. & Erck, R. P. G. 2005. Assessing the sustainability performances of industries. Journal of Cleaner Production 13: 373.

Ludwig, D., B. Walker, & C S. Holling. 1996. Sustainability, stability and resilience. *Conservation Ecology* 1:1.

Manuj, I. & Mentzer, J. T. 2008. Global supply chain risk management strategies. International journal of physical distribution and logistics management, 38, 192.

Martin, S. 2004. The cost of restoration as a way of defining resilience: a viability approach applied to a model of lake eutrophication. Ecology and society, 9, 8.

Meredith, J. 1993. Theory building through conceptual methods. *International journal of operations and production management* 13, 3.

Mittelbach, G. G. 1995. Perturbation and resilience: a long-term, whole-lake study of predator extinction and reintroduction. *Ecology* 76, 2347.

Murphy, P. R., Poist, R. F. & Braunschwieg, C. D. 1996. Green logistics: comparative views of environmental progressives, moderates, and conservatives. *Journal of Business Logistics* 17, 191.

Neubert, M. G. 1997. Alternatives to resilience for measuring the responses of ecological systems to perturbations. *Ecology* 78, 653.

Ortiz, M. 2002. Dynamical simulation of mass-balance trophic models for benthic communities of north-central Chile: assessment of resilience time under alternative management scenarios. *Ecological modelling* 148, 277.

Pagell, M. & Wu, Z. 2009. Building a more complete theory of sustainable supply chain management using case studies of 10 exemplars. The journal of supply chain management, 45, 37.

Pettit, T. J., Fiksel, J. & Croxton, K. L. 2010. Ensuring supply chain resilience: Development of a conceptual framework. *Journal of Business Logistics* 31, 1.

Perrini F & Tencati A. 2006. Sustainability and stakeholder management: the need for new corporate performance evaluation and reporting systems. Business Strategy and the Environment 15: 296.

Ponomarov, S. Y. 2009. Understanding the concept of supply chain resilience. *International Journal of Logistics Management* 20 (1): 124.

Priem. R. L., & Butler, J. E. 2001. Is the resource-based "view" a useful perspective for strategic management research? *Academy of Management Review* 26, 22.

Seuring, S. 2008. From a literature review to a conceptual framework for sustainable supply chain management. *Journal of cleaner production* 16, 1699.

Sheffi, Y. 2005. A supply chain view of the resilient enterprise. *MIT Sloan management review* 47, 41.

Singh, R. K., Murty, H. R., Gupta, S. K. & Dikshit, A. K. 2009. An overview of sustainability assessment Methodologies. *Ecological Indicators*. 9. 189.

Schoenherr T, Rao Tummala V. M. & Harrison T. P. 2008. Assessing supply chain risks with the analytic hierarchy process: Providing decision support for the offshoring decision by a US manufacturing company. *Journal of Purchasing and Supply Management* 14: 100.

Svensson, G. 2000. A conceptual framework for the analysis of vulnerability in supply chains, *International Journal of Physical Distribution and Logistics Management*. 30 (9): 731.

Tang, C. S. 2006. Robust strategies for mitigating supply chain disruptions. *International journal of logistics* 9, 33.

Tomlin B. (2006) On the Value of Mitigation and Contingency Strategies for Managing Supply Chain Disruption Risks. *Management Science* 52: 639.

Vugrin, E. D., Camphouse, R. C. & Sunderland, D. 2009. *Quantitative Resilience Analysis Through Control Design*. New Mexico: SandIA REPORT for the United States Department of Energy.

Veeramani, 2007. Sources of India's Export Growth in Pre- and Post-Reform Periods. *Economic and Political Weekly* 42, 2419.

Weick, K. E. 1999. Conclusion: Theory construction as disciplined reflexivity: Tradeoffs in the 90s. *The Academy of Management review* 24, 797.

Wernerfelt, B. 1984. A resource based view of the firm. *Strategic Management Journal* 5, 171

Wheeler, D. 2003. Focusing on value: Reconciling corporate social responsibility, sustainability and a stakeholder approach in a network world. *Journal of general management* 28 (3): 1.

Wu T, Blackhurst J & Chidambaram V. 2006. A model for inbound supply risk analysis. Computers in Industry 57: 350-365.

Xu, J. 2008. Managing the Risk of Supply Chain Disruption: Towards a Resilient Approach of Supply Chain Management. ISECS International Colloquium on Computing, Communication, Control, and Management.

Yin, R. K. 1994. Case Study Research, 2nd ed., Sage, Thousand Oaks, CA.

Zsidisin, G. A. Melnyk, S. A. & Ragatz, G. L. 2005. An institutional theory perspective of business continuity planning for purchasing and supply management. *International journal of production research* 43 (16): 3401

APPENDIX

Table 2: Supply chain disruptions.

Supply chain disruptions	Reference
Natural disasters	Christopher & Peck (2004); Sheffi (2005); Kleindorfer & Saad (2005); Schoenherr (2008); Wu et al (2006); Blackhurst et al (2008); Xu (2008)
Fluctuations in currencies,	Peck (2005); Blackhurstet et al. (2008); Manuj & Mentzer (2008)
Economic downturn	Xu (2008)
Fluctuation of raw material price	Xu, (2008)
Piracy and theft	Peck (2005); Sheffi (2005); Colicchia (2010); Blackhurst et al. (2008)
Labor disputes, strikes, sabotage	Peck (2005); Sheffi (2005); Kleindorfer & Saad (2005); Wu et al. (2006); Blackhurst et al. (2008); Xu (2008)
Political and regulatory factors both home and host country (political instability)	Peck (2005); Kleindorfer & Saad (2005); Wu et al. (2006); Blackhurst et al. (2008)
Product quality (Defection in product, damage, wrong component or material)	Schoenherr (2008); Wu et al. (2006); Pujawan & Geraldin (2009); Blackhurst et al. (2008); Manuj & Mentzer (2008)
Competition	Haider (2007; Schoenherr (2008)
Operational failure due to malfunction of machinery and equipment	Kleindorfer & Saad (2005)
Lack of Raw material availability and Dependence on offshore sourcing	Blackhurst (2006); Wu et al. (2006); Pujawan & Geraldin (2009) ; Haider (2007), Nuruzzan (2009), Craighead (2007), Peck (2005)
Interrupted Utility supply	Ahmed (2009)
Skill shortage of human resources	Haider (2007); Wu et al. (2006)
Supplier disruption	Peck (2005); Sheffi (2005); Kleindorfer & Saad (2005); Tomlin (2006); Schoenherr (2008); Wu et al. (2006); Blackhurst et al. (2008); Xu (2008)
Customer disruption	Gaudenzi & Borghesi (2006)
Infrastructure problem	Peck (2005); Schoenherr (2008); Blackhurst et al (2008)
Non-Comply social & environmental factors	Islam & Deegan (2008)
Delay for disruption in port and customs	Colicchia (2010); Blackhurst et al (2008)
Survival (bankruptcy, lawsuit by customer)	Manuj & Mentzer (2008)

Table 3: Supply chain capabilities.

Supply chain capabilities	Reference
Product customization	Ducols (2003)
Supplier contract flexibility regarding time	Fiksel (2003); Peck (2005); Sheffi (2005); Tang (2006)
Multiple sources of supply	Cranfield (2002, 2003); Fiksel (2003); Peck (2005); Tomlin (2006)
Alternate distribution Channels	Peck (2005); Tang (2006); Blackhurst et al. (2005), Klibi (2010),
Customer orientation & shortage response action	Kilbi et al. (2008); Braunscheidel & Suresh (2009); Ji & Zhu (2008)
Production postponement	Ducols (2003)
Backup capacity (materials, assets, utility, labor, inventory)	Cranfield (2002, 2003); Fiksel (2003); Peck (2005); Sheffi (2005); Tomlin (2006), Klibi (2010), Christopher & Peck (2004)
Labor productivity	Ahmed (2009)
Quality control and Checking Defection	Kleindorfer & Saad (2005)
Business intelligence	Cranfield (2002, 2003), Sheffi, 2005; Blackhurst et al (2005);
Product and Process Improvement	Fiksel (2003); Peck (2005); Sheffi (2005), Tang (2006)
Collaboration &Real time information exchange	Peck (2005); Blackhurst et al. (2005)
Supplier relation and improvement	Zsidisin & Ellram (2003); Stevenson & Spring (2009)
Forecasting and predictive analysis	Peck (2005); Sheffi (2005), Blackhurst et al. (2005)
Learning orientation and culture	Tang (2006); Braunscheidel & Suresh (2009), Manuj & Mentzer (2008)
Security, monitoring and early warning signals	Peck (2005); Sheffi (2005), Craighead et al. (2007)
Forward and backward integration	Manuj & Mentzer (2008), Ponomarov & Holcomb (2009)
Market share improvement	Pettit et al. (2010)
Compliance of social and environmental issues	Islam & Deegan (2008)