A PROACTIVE MEASUREMENT FRAMEWORK FOR SUPPLY CHAIN RESILIENCE (2PM-SCR): A CONCEPTUAL FRAMEWORK

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ABSTRACT: The main aim of supply chain management is to have control over the whole parties involved in the chain, from suppliers to the end customers, creating the seamless flow of goods, information, and money. Any change in the business environment may cause vulnerabilities to the whole chain. Yet, managers still focus on reducing cost and increasing reward. So it is hard to sell risk management as a competitive advantage. This paper questions this approach and argues that in the light of increasing disruptions a different approach is needed to supply chain. Managing the risk of the uncertain future is a challenge that requires resilience. Academics and industry leaders have seen the need to incorporate the concept of resilience on the traditional risk management techniques with that is better designed to cope with extreme complexities, unpredictable events and adaptive threats. However, supply chain risk management metrics are still largely unrefined although selecting the right key performance indicators that ensure resilience would help companies to proactively lead the change. This research aims at providing a blueprint for resilience by identifying and prioritising the main causes of vulnerabilities to supply chains, and then investigating the key performance indicators (KPIs) that would improve resilience. Finally, presenting a framework for categorizing the risks in terms of their driver factors in order to assess the overall impact on the performance of the supply chain (2PM-SCR framework) that assists supply chains to proactively anticipate disruptions and prevent failure occurring. Data collection and analysis using the analytic network process (ANP) will propose the inputs to where the most important potential risks are first identified, and then mitigation measures are developed for application aiming at improving the supply chain overall performance.

Keywords: Supply Chain Performance Measurement Systems, KPIs, Supply Chain Resilience (SCR), Analytic Network Process (ANP), Disruptions, and Vulnerabilities.

INTRODUCTION

Complexity and disintegration are emerging as major challenges in supply chain risk management. It has become more difficult to identify risks as supply chain operations have fallen into the hands of outside service providers, and are therefore less visible. The risks, their identification and impact depend on the position of the companies in the chain, and on the level of analysis they can carry out (Vilko and Hallikas, 2011). Moreover, the events of the last few years from the fuel crisis to the World Financial Crisis to the Political Changes in the Middle East region have highlighted the vulnerability of supply chains in many fields. Disruptions can also result from attempts to create a more efficient, cost-conscious supply chain (SC) environment. In many companies, logistics activities, such as raw materials supply, component assembly, manufacturing, and even product distribution, are outsourced to partners that are located across the world. This structure has created a supply chain-dependent environment in which any disruption can have a much more pronounced effect as it ripples either upstream or downstream in the supply chain. (Ponomarov and Holcomb, 2009).

In a global economy, with supply chains crossing several countries and continents, from raw material to final product, those events can create large-scale disruptions (Craighead et al., 2007). These disruptions are transmitted throughout the supply chain, causing severe negative effects in supply chains leading to unfulfilled orders and customer dissatisfaction. So, it seems that what can be good from the competitive point of view, can cause a disaster on crisis situations; it may be worst if the organizations cannot be
resilient and robust enough to recover the loosened competitiveness. For this reason, it is necessary that supply chains become more resilient to disruption events (Sheffi & Rice, 2005; Tang, 2006).

The problem is that many enterprises leave risk management and business continuity to security professionals, business continuity planners or insurance professionals. However, building a resilient enterprise should be a strategic initiative that changes the way a company operates and that increases its competitiveness (Sheffi, 2005).

Supply chain management practices are enablers to achieve supply chain capabilities or core competences. Morash et al. (1996) defined supply chain capabilities or distinctive competencies as those attributes, abilities, organizational processes, knowledge, and skills that allow a firm to achieve superior performance and sustained competitive advantage over competitors. Therefore, the supply chain practices, through the constitution of capabilities, have a direct effect on supply chain performance. Moreover, supply chain attributes are considered to be the basis of supply chain strategies and the entire supply chain behaviour. Consequently, supply chain attributes will enable the measuring of supply chain performance.

This research aims to assess the supply chain risks and supply chain vulnerability, and to mitigate the risks that may disrupt supply chain operations in order to raise the bar of Supply Chain Resilience (SCR) in the Middle East Region (MER). Four key research questions have been formulated: (1) What are the key SC attributes that will enable measuring SC performance? (2) What are the main risk factors that cause supply chain vulnerability? (3) What are the KPI’s that can ensure the resilience of a supply chain? (4) How to proactively develop resilience into the supply chains as a state-of-the-art.

The paper is organized as follows. First, a literature review related to the SC Performance Measurement System is presented. Next, the articulation of the main stands of risk management within supply chain management context and pointing out the main building blocks of a resilient SC. Finally, an initial view of the 2PM-SCR framework will be presented linking the KPI’s that ensure resilience with the main risk factors.

SUPPLY CHAIN MANAGEMENT

This Market globalization, intensifying competition and an increasing emphasis on customer orientation are cited as the main SCM concerns (e.g. Gunasekaran et al., 2001; Webster, 2002). Furthermore, effective supply chain management is considered to be a building block of a distinctive sustainable competitive edge as a result of the improved inter and intra-firm relationships (Ellinger, 2000). Supply chains comprise all activities associated with the flow and transformation of goods from the raw material stage through to the end user (Handfield and Nichols, 1999). A range of benefits has been attributed to supply chain management, including reduced costs, increased market share and sales, and solid customer relations (Ferguson, 2000).

Chopra and Meindl (2007) explain that a supply chain consists of all parties involved, directly or indirectly, in carrying out a customer’s request. The supply chain generally includes the manufacturers, suppliers, transporters, warehouses, retailers, and even customers themselves. Within each organisation, such as a manufacturer, the supply chain includes all functions involved in receiving and filling a customer request. Morgan (2004) argues that the greatest contribution the concept of the supply chain has made is to encourage managers to think outside the organisation box by recognising the interdependencies that exist between and within organisations and to be aware of the financial and logistic implications of inter-company and inter-national trading. Furthermore, different terminologies prevail as a result of diversity in research contexts. As a result, there is an increasing tendency to use the term supply networks and supply webs as opposed to the notion of supply chains. The advantage of using the former terms over the latter is to emphasize that the links between business partners are not linear and sequential but are instead dynamic, interdependent and flexible.
Recently, it is becoming a generally accepted fact that competition is no longer between organisations, but among supply chains. Effective supply chain management (SCM) has become a potentially valuable way of securing competitive advantage and improving organizational performance (Li et al., 2005).

Baemon (1999) hypothesise that the supply chain depicted includes four echelons (supply, manufacturing, distribution, and consumers), where each level (or echelon) of the chain may comprise numerous facilities. Thus, the complexity of the supply chain arises from the number of echelons in the chain and the number of facilities in each echelon.

**PERFORMANCE MEASUREMENT AND METRICS IN SUPPLY CHAINS**

“You will be able to get information about anything if you are able to measure and express it in numbers” (Lord Kelvin, 1824-1907). One issue which is often tackled but rarely defined is Performance Measurement. It is the process if measuring action which leads to performance. According to Kotler (1997) Organizations reach their targets when they please their customers with greater performance than their rivals, this is according to the Marketing perspective.

Gunasekaran et al. (2001) pointed out that recently a number of firms realized the potentials of SCM. However, they often lack the insight for the development of effective performance measures and metrics needed to achieve a fully integrated supply chain. Moreover, such measures and metrics are needed to test and reveal the viability of strategies without which a clear direction for improvement and realization of goals would be highly difficult.

Neely et al. (1995) define performance measurement as the process of quantifying the effectiveness and efficiency of action. Effectiveness is the extent to which a customer’s requirements are met and efficiency measures how economically a firm’s resources are utilised when providing a pre-specified level of customer satisfaction through metrics able of quantifying both the efficiency and effectiveness of any action. These performance metrics are important indicators for assessing the performance of each of the key processes in the supply chain on selected risk dimensions which are defined by the supply chain participants (Kleindorfer and Wassenhove, 2004).

Kaplan and Norton (1996) observed that a performance measurement system (PMS) should provide managers with sufficient information to address issues such as finance, customer internal processes and innovation and improvement proposing the balanced score card (BSC) method as an important tool contributing to the formulation of strategies defining missions, targets, and the suitable performance measures and targets. The term “metric” refers to definition of the measure, how it will be calculated, who will be carrying out the calculation, and from where the data will be obtained (Neely et al. 1995). The main challenge is to identify the key performance measures that ensures success of an organization besides the factors that will affect the core business processes that create value to customers. Bagchi (1996) recommended some of metrics of a SC system to be implemented categorizing them into the four categories: time, quality, cost, and diagnostic measure. Apparently although this approach is useful, a framework based on different levels of decision making (strategic, tactical and operational) would provide clearer indication on which measures/metrics should be used at different levels of an organization.

Many researchers have proposed new performance measures and metrics considering the changes in markets and enterprise environments. Basu (2001) suggests the use of new emerging metrics defined in five categories: external, consumer, value-based competition, network performance, and intellectual capital. Stewart (1995) stresses that companies that have outperformed their competitors are found to be superior in four key operational areas: (1) delivery performance; (2) flexibility and responsiveness; (3) logistics costs; and (4) asset management. Spokeman et al. (1998) concluded that SC partners do not share a common vision of or react to the same set of metrics. Gunasekaran et al (2001) pointed out that the prospective of SCM in was strongly discovered by many companies from different industries although they lack the vision for the improvement of metrics and measures that will help them to attain the goal of
having a fully integrated chain. Furthermore, a clear way to get insight of objectives would possibly be hard to attain without having these metrics and measures aligned with the company’s strategies.

In conclusion, effective measurements approaches such as balanced scorecard and SCOR model must be used to enhance the effectiveness of the supply chain management. This can be achieved by considering the overall supply chain goals by classifying the metrics as strategic, tactical and operational.

RISKS AND UNCERTAINTY IN SUPPLY CHAINS

An organization’s activities, strategies and goals determine the types of risks the organization is disposed to. The types of risks also depend on which supply chain network the organization is part of and what type of relationships it has with its upstream and downstream suppliers. Supply risks can be specific to a firm due to its unique organization characteristics, industry nuances and the supply chains to which it belongs (Zsidisin et al., 2000). Thus, supply chain risks are not the same for each organization in the supply chain, but there are some risks such as natural hazards, economic crises that can affect an organization, a portion or even a whole supply chain from raw material suppliers to the end customer.

Supply chains in the modern world are complicated networks that are expanding longer and longer distances, which makes them vulnerable to a variety of risks. Global supply chains require highly coordinated flows of goods, services, information and money within and across national boundaries (Mentzer et al., 2001). Events affecting one entity or process may interrupt the operations of other members of the chain. Hence, it is important to investigate cross-border supply chains in the selection and implementation of risk management strategies (Manuj and Mentzer, 2008).

The aim of supply chain risk management is to identify the potential sources of risk and implement appropriate actions in order to avoid or contain supply chain vulnerability (Narasimhan and Talluri, 2009). Kaplan (1996) defines risk by the answer to the three vital questions: (1) “What can go wrong?” (2) “How likely is that to happen?”, and (3) “What are the consequences?” . Wilson (2007) defines a disruption as an event that interrupts the material flows in the supply chain, resulting in an abrupt cessation of the movement of goods. It can be caused by a natural disaster, labor dispute, dependence on a single supplier, supplier bankruptcy, terrorism, war and political instability. Thus, there are numerous causes that can affect the continuity of a supply chain ranging from natural disasters to political instability. Tang (2006a) differentiates between operational risks and disruptions, and states that in most cases, the business impact associated with disruptions is much greater than those with operational risks. Operational risks are the inherent uncertainties in a business environment such as uncertain customer demand, uncertain supply and uncertain cost. Juttner et al. (2003) describe vulnerability as exposure to serious disturbance, arising from risks both within and external to the supply chain, and supply chain vulnerability as the propensity of risk sources and risk drivers to outweigh risk mitigating strategies, thus causing adverse consequences and threatening the supply chain’s ability to effectively serve the end customer. While Sevensson (2000) defined a disturbance as a random quantitative or qualitative deviation from what is normal or expected, and vulnerability as a condition that affects firm’s goal accomplishment determined by the chance of disturbance and the expected negative consequence of the disturbance identifying the inbound and outbound vulnerability dimension under: service level, deviation, consequence, and the trend of disturbances.

Mason-Jones and Towill (1998) and Peck and Christopher (2003) identify three risk groups: (1) internal risks arising from the organization, (2) supply chain risks that are external to the organization but within the supply chain, and (3) external risks that are external to the supply chain and arise from the partners or the environment. On the other hand, Kumar (2009) categorized the types of risks that may cause vulnerabilities to SC into the 3 managerial levels; Strategic, tactical, and operational. Another classification was proposed by Vilk and hallikas (2011) categorizing them under 5 groups; Supply Risks, Security Risks, Operational Risks, Macro Risks, Policy Risks and Environmental Risks. Another classification of risks was proposed by Wu et al. (2006) based on 4 categories; internal
controllable, internally partially controllable, internal controllable, and external controllable. This classification is based on the effect of the disruption occurring and its degree of control.

Christopher and Lee (2004) considers the lack of confidence in supply chain can lead to actions and interventions by supply chain managers throughout the supply chain, which collectively, could increase the risk exposure and lack of efficiency. Moreover, he assumed that the lack of confidence can be as a result of having no confidence in: order cycle time, order current status, demand forecasts given, suppliers’ capability to deliver, manufacturing capacity, quality of the products, transportation reliability, and services delivered. They hypothesized that because there is no visibility of upstream and downstream flows, confidence declines and decisions are considered to buffer the interfaces with inventory to overcome the main reason of the problem which is lack of visibility which can be a barrier for a company to be responsiveness by reacting to customers while the market conditions are changing.

Wu et al (2006) focused of defining the inbound supply risk as the potential occurrence of an incident associated with inbound supply from individual supplier failures or the supply market, resulting in the inability of the purchasing firm to meet customer demand, justifying his view by the evidence that these risks or supply chain failures can be costly and lead to significant delays in customer deliveries.

Sevensson (2000) developed a conceptual framework and a model for the analysis of vulnerability in SC consisting of 3 main principals, 1- sources of disturbance 2- category of disturbance 3- types of logistics flow considering different kinds of logistics flows in term of their complexity, inventory buffers, materials and components.

Although awareness of supply chain vulnerability and risk management is increasing among practitioners, the concepts are still in their infancy and there are insufficient conceptual frameworks and empirical findings to give a clear sense of the phenomenon of risk management in global supply chains (Juttner, 2005, Manuj and Mentzer, 2008).

SUPPLY CHAIN RESILIENCE

To incorporate the concept of resilience into management theory, we will present the use of the term “resilience” in a several of non-business fields and discuss lessons that can be applied to the study of supply chain resilience. The concept of resilience is used extensively in engineering, ecological sciences and organizational research, all of which provide insight into creating a conceptual framework for supply chain resilience.

A very basic definition of resilience can be found in engineering: “the tendency of a material to return to its original shape after the removal of a stress that has produced elastic strain” (Merriam-Webster 2007). Although it may be more desirable for a supply chain not to return to its original status following a disruption, but rather to learn from the disturbance and adapt into a new advantageous configuration.

In the ecological sciences, the definition of resilience is “the ability for an ecosystem to rebound from a disturbance while maintaining diversity, integrity and ecological processes” (Folke et al. 2004). The concept of adaptability is essential to living systems, and based on this systems concept, Fiksel (2003) proposed four major characteristics of resilient systems: diversity, efficiency, adaptability and cohesion.

The concept of resilience in supply chains combines these previous views with the concept of supply chain vulnerability. Resilience now has become an issue of enormous importance in relatively new fields such as risk management and supply chain management, disaster management. At the beginning Resilience is defined by Ponomarlov and Hollcomb (2009) as the 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.

Christopher and Peck (2004a) pointed out that a new competitive edge has emerged for business planning with a higher degree of resilience. Supply chain is often vulnerable to a number of disruptions such as natural disaster, the loss of a critical supplier, accident at plant, act of terrorism, economic downturn (Christopher and Peck 2004; Sheffi 2005; Wu et al. 2006). These increased disruptions and vulnerabilities demand for more resilient supply chain to remain competitive and sustainable (Christopher and Lee, 2004). Otherwise, the consequence will be the discontinuity of supply chain operations which adversely affect both revenue and cost of the whole chain (Ponomarrov and Holcomb 2009).

Resilience capability helps a supply chain to get back to original state followed by disruptions (Petit et al. 2011; Christopher and Peck 2004) and more specifically, to prepare for unexpected events, respond to disruptions, and recover from them to continue its operation (Christopher and Peck 2004; Ponomarrov and Holcomb 2009). However, capabilities are sometimes difficult to identify and even more when they are dynamic and complex.

The degree of resilience and which resilience capability a system needs is context dependent and one shall identify which system configuration and which disturbances are of interest (Carpenter 2001). Carpenter (2001) mentioned that to assess resilience one shall identify which system configuration and which disturbances are of interest. So, in order to deal with resilience it is important to identify the disruption areas and vulnerabilities. Then it is important to determine how the disruptions can be mitigated through the development of capabilities.

Christopher and Peck (2004b) developed an initial framework for a resilient supply chain. They asserted that supply chain resilience can be created through four key principles: 1) resilience can be built into a system in advance of a disruption (i.e. re-engineering), 2) a high level of collaboration is required to identify and manage risks, 3) agility is essential to react quickly to unforeseen events and 4) the culture of risk management is a necessity. Characteristics such as agility, availability, efficiency, flexibility, redundancy, velocity and visibility were treated as secondary factors.

Christopher and Peck (2004b) continued defining other key terms distinguishing between resilience and robustness showing that the two terms are used interchangeably, but in the context of supply chains they can acquire quite different implications. Christopher and Peck (2004b) adopted the dictionary derived definitions to differentiate between the two terms. They found that robustness means strong or sturdy, but does not itself equate to a resilient supply chain. This is because the term resilience is more related to supply chains viewing it as networks, so it is concerned with the ability of a system to return to its original state or move to a new, more desirable state after being disturbed. Implicit in this definition is the notion of flexibility, and given that the desired state may be different from the original, adaptability earns a place in our thinking too.( Martin Christopher and Helen Peck, 2004)

When facing a disruption an established robust supply chain strategy would enable a firm to deploy the associated contingency plan effectively and efficiently. Therefore having a robust supply chain strategy could make a firm increase their resilience. According to Tang (2006), robust strategies will help a firm to sustain its normal operations during disruptions, as well as being able to efficiently manage regular fluctuations even if no disruption occurred.

Tang (2006) proposed nine robust strategies for a resilient supply chain, these nine robust strategies are: postponement, strategic stock, flexible supply base, make and buy, economic supply incentives, flexible transportation, revenue management, dynamic assortment planning, and silent product rollover. These robust strategies enables companies to become less vulnerable if they could reduce their exposure to risk.
Building disaster resilience into contemporary building practices is discussed by Bosher and Murray-Tuite, 2006, defining ten properties of a resilient transportation system, redundancy, diversity, efficiency, autonomous components, strength, adaptability, collaboration, mobility, safety, and the ability to recover quickly.

Agility and flexibility was proposed as an important feature of the SC that can be linked to resilience in order to enable new competencies in order to respond to rapidly changing, continually fragmenting markets. (Carvalho and Machado, 2011)

Based on the literature review on related work on supply chain risks, vulnerability and resilience, it is found that existing work has focused mostly on minimising the negative consequences of risks and recovering the supply chain operations after failure. Therefore, the supply chain resilience is built on passive rescue and recovery thinking. The literature has not adequately addressed the issue of how to design and build resilience in supply chain, so that supply chain risks are proactively prevented in-front instead of post-event rescue and recovery. This paper aims to fill this gap in the literature and aims to develop a 2PM-SCR framework to facilitate supply chains to proactively anticipate disruptions and prevent failure occurring.

RESEARCH DESIGN AND METHODOLOGY

Overall Research Design

The overall research design is outlined in Figure 1 which will be used to guide the PhD work. Key processes of the research include understanding the research context and framing the research problem, literature review, formulating research questions and identifying objectives, research design and methodology, development of the 2PM-SCR framework, evaluation of the framework, and recommendations for the SCM. The idea of the research was inspired from the external environment in the MER, from the Arab Spring to the on-going economic deterioration facing the region. This idea enhanced the background towards developing the idea of resilience in the region. A literature review is being conducted to identify the main factors that cause vulnerabilities to supply chains, and to understand the relationships between SC characteristics and KPI’s (Cabral et al, 2012). The research gap is emerging from the Literature findings. Therefore, the research questions have been set to contribute to the development of a blueprint for resilience in the MER. The research design will also provide guidelines for data collection and analysis in order to contribute to the development and evaluation of a proactive supply chain resilience model – the 2PM-SCR framework.
Methodology for the model development

The main objectives of this study are to identify and prioritise the critical risk factors and KPIs in the MER in order to proactively design and build resilience in supply chains. As there are few existing studies that have adequately addressed the issue of “proactiveness” of supply chain resilience, this study is considered as highly explorative. Therefore, the research methodology for this study in order to implement the vulnerability and capability constructs of the 2PM-SCR Framework, detailed classifications of both constructs must be created. Our initial classifications of resilience factors were first created based on extant literature, then it will be refined and validated by supply chain managers through in-depth interviews for data collection combined with an analytic network process for data analysis in order to validate and develop the 2PM-SCR model.

In-depth interviews are considered appropriate based on the exploratory nature of the study since they can provide the researchers with the opportunity to probe participants’ answers, especially where the researchers want the interviewees to explain or build on their responses. Supply chain managers, as potential interviewees, tend to use words and ideas in a particular way, especially when they deal with cross country/culture global supply chains. The opportunity to probe these meanings through in-depth interviews can add significance and depth to the data obtained (Saunders, Lewis and Thorhill, 2009). An interview template will be designed to provide guidelines for the empirical study. The companies to be solicited for the empirical study operate at a regional level (i.e. Middle East) with a supply chain focus. Participants in the interviews will be supply chain managers.

Data analysis will incorporate the analytic network process (ANP) proposed by Saaty and Vargas (2006), in order to prioritise the critical risk factors and KPIs based on how important supply chain managers think the factors and KPIs can support the design and building of a proactive, resilient supply chain. ANP is a well-known method which can offer pairwise comparisons by taking account of expert judgements to derive priority scales. Limitations of ANP have been identified including the inconsistencies introduced by the linear scale and the need for a large number of pairwise comparisons. However, along with the development of dedicated software tools such as Super Decisions© to facilitate ANP implementation, the efficiency issue is greatly alleviated. ANP is therefore widely used in business management including supply chain decision making (Liu et al, 2013).
The 2PM-SCR framework

Two assumptions are made to provide the necessary foundation in order to build on extant theory. These assumptions will then lead to research propositions offered for future validation as the basis for implementation of the concept of resilience. Our resilience framework is built upon the basic concept of vulnerabilities. Supply chain disturbances can be internal to the company, external to the firm but within the SC, or external, affecting products, services or resources, but all resulting from some type of change (Christopher and Peck 2004a). Accordingly, we adopt the following assumption:

Assumption 1: Forces of change and market dynamics create supply chain vulnerabilities.

Consistent with previous research (Svensson 2002; Peck 2005; Sheffi 2005), we adopt the following definition of supply chain vulnerabilities: “fundamental factors that make an enterprise susceptible to disruptions.” The framework for resilience must take into account those fundamental factors which include all the possible range of disruptive threats.

Second, in order to respond to vulnerabilities, research has shown that a supply chain must develop capabilities that ensure SC resilience. Capabilities are “attributes required for performance or accomplishment” (Merriam-Webster 2007). Literature suggests many different types of supply chain capabilities (Cranfield 2002, 2003; Tang 2006; Rice and Caniato 2003; Fiksel 2003; Lee 2004; Peck 2005; Sheffi 2005). Concepts such as flexibility, agility, adaptability, and visibility are just a few commonly discussed managerial capabilities. Thus, we adopt the following postulate:

Assumption 2: SC Capabilities on the 3 managerial levels (Strategic, Tactical, and Operational) create supply chain resilience.

Supply chain capabilities in this context is defined as: “attributes that enable an enterprise to anticipate and overcome disruptions”. These capabilities could prevent an actual disruption, mitigate the effects of a disruption or even enable a company to attain a more desirable state after a disruption such as development of new products or services, or entering a new market.

The 9 strategies suggested by Tang (2006b) helps a firm to excel under normal operations and recover quickly following disruptions. Moreover, Lee (2004) presents methods to overcome both short- and long-term change based on three key capabilities: agility, adaptability and alignment. The framework should encompass all supply chain processes, relationships and resources that offer capabilities to overcome vulnerabilities.

PROPOSITION 1: Supply chain resilience increases as capabilities increase and vulnerabilities decrease.

PROPOSITION 2: Linkages exist between each vulnerability and a specific set of capabilities that can directly improve balanced resilience.

PROPOSITION 3: Supply chain performance improves when capabilities and vulnerabilities are aligned together with the firms’ KPIs.

PROPOSITION 4: Linking the KPIs with the appropriate proactive sensors of the market dynamics and potential risks will enable robust processes in the SC.

Base on the above considerations, a 2PM-SCR is proposed as shown in figure 2. The 2PM-SCR framework is an integrated cyclical framework that consists of a systematic approach that would act as a hedge against supply chain vulnerabilities in a proactive manner. The model starts by identifying the main causes of vulnerabilities that can arise from 3 main reasons; (1) internal from the company itself, (2) external to the company but internal within the SC, and (3) from the external environment such as political changes or economic crises. The next stage the risk assessment stage that starts with the risk identification, risk analysis, and finally the risk assessment process. Then key KPIs that would ensure SCR must be identified. These KPIs must be linked to the SC capabilities that match the company objectives such as robustness, agility, etc. Those strategies will be aligned with the risk factors in order to create KPIs.
sensors that would be able to sense the market dynamics in a proactive manner. These steps aims at the end to improve the overall performance of the SC, and to be able to get a competitive edge by being proactive. This model works in a continuous circle with no end point in order to achieve the optimum level of long term performance and sustainability. Moreover, because of uncertainty and the unstable conditions that any SC could face, there may be iterative steps or in other words revisiting previous stages in order to be able to meet the ad hocs that would emerge after passing any stage of the model which give the model more flexibility.

Figure 2: The 2PM-SCR framework

CONCLUSIONS

Nowadays, we are facing one of the hardest times on supply chain oriented businesses due to many events recently took place in the Middle East region. Those events include, of course, political changes and re-formation of governments that externally affects consumers' behaviour and markets dynamics. This is directly affecting the supply chain performance in all the sectors. Proving the vulnerability of the supply chain is not only concerned with natural or socioeconomic disasters only but it also considers the internal sources of the company failure to integrate with all other functions in the supply chain. Failure to integrate with supply chain functions is an indicator showing its vulnerability. A big portion of the current indicators show the problem after happening then, usually the supply chain reacts to solve the current internal problems. On the other hand, integration should also be concerned of how far supply chains can cope with external environment and market changes.

The problem we address in this research stresses on the way that supply chain managers and planners are dealing with risks and perils before it become more complicated problems that may face the supply chain due to external and/or internal factors. This research focuses on how managers should work on the 3 managerial levels in parallel. In fact, firms and organisations neglecting risk management to increase
supply chain efficiency are more likely to face crises eventually lead to lose its competitiveness because of its disability to deal with that problem on spot. Meanwhile, building a resilient supply chain foundation should involve the execution of a number of activities not only stressing on the efficiency of supply chain but also focusing on strategic decisions, especially, when it comes to risks that may affect the supply chain competence. In addition, supply chain managers should put into consideration the balance between costs since "cost" is one of the main key performance indicators of a successful supply chain and responsible of creating competitive advantage over the market as well as performance efficiency thus, helping to reach a highly optimized supply chain network. The application of conceptual resilience -whether in corporations or sole proprietorship business units is not solely dependent on the expertise and the initiatives ignited from the logistics or supply chain department; it is extremely crucial to have a cohesive relation between the company's activities, hence companies must synergize its primary and secondary activities together. In other words, supporting functions such as (Human Resources, Information Technology development and business infrastructure) will also have to adopt the concept of resilience to ensure success; thus it will take a lot of effort for a company to be actually resilient. This doesn’t make the managers’ jobs who are seeking this vision easy. On the contrary, it adds to the problem’s sophistication and complexity. So there is an urgent need to explore a 2PM-SCR framework in order to reduce global supply chain risks and improve supply chain overall performance.

The 2PM-SCR is a framework for categorizing the risks in terms of their driver factors in order to assess the overall impact on the performance of the supply chain (2PM-SCR framework) that aims at assisting supply chains to proactively anticipate disruptions and prevent failure occurring. The main objectives of this study are to identify and prioritise the critical risk factors and KPIs in the MER in order to proactively design and build resilience in supply chains. Our initial classifications of resilience factors were first created based on extant literature. The 2PM-SCR conceptual framework will be refined and validated by supply chain managers, through in-depth interviews for data collection combined with an analytic network process for data analysis in order to validate and develop the 2PM-SCR model.

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REFERENCES:


