

Full Length Research Paper

Supplier selection in global uncertainty: Using a case study approach to identify key criteria required for building resilience in the supply chain

Maleghemi Olusegun C.

The Nest Innovation Technology Hub, Lagos, Nigeria.

Received 24 April, 2020; Accepted 11 September, 2020

The rise in disruptions to supply chain is a major concern to most organizations. Supply chain managers need an innovative framework to respond to them. This research considers the supplier selection stage a strategic point to act. With careful selection, resilience is built in their operations. However, the challenge becomes what criterial factors to consider in the selection process, especially with global uncertainty. This paper makes use of multiple case studies, interviews and literature to answer this question. The result identified four major criteria: Steady information dissimulation via real-time data integration, robust disruption management plan continuously improved with experience, useful cooperation and alliances agreements and the interests of government and their regulators in the sector. The result also identifies issues which procurement managers need to address, internally. In conclusion, it accepts that it is possible to build a system which responds positively and mitigates the effects of disruptions, but this requires redesigning the process of supplier selection, after taking a macro-level re-evaluation of the supply network.

Key words: Disruptions, supply chain, suppliers, resilience, uncertainty.

INTRODUCTION

In a jointly released report by leading researchers done in 2010, Accenture confirmed the “critical importance” of the Supply Chain to 89% of the executives they surveyed (Naslund and Williamson 2010). 51% of those surveyed stated that their investment into Supply Chain Management (SCM) had increased significantly over the last three years. Stock and Boyer (2009) also observed a rapid increase in articles published and dissertations after the initial “surge” in the middle 1990s. The supply chain has thus become one of the most widely discussed subjects amongst organizations.

The supply chain is seen not just as a source of product and services, but also of innovation, information, and competitive advantage (Langley and Holcomb, 1992; Cooper and Ellram, 1993; Lambert, 2008). Some literatures also reveal that the adoption of various supply chain model has translated to increased costs savings and profit boost. This is as a result of improved process performance, reduced redundancies, lower inventory levels, shorter lead time and lessened demand uncertainties (Fisher, 1997; Lee et al., 1997; McCarthy and Golicic, 2002; Lambert et al., 2005; Sabath and

E-mail: oc.maleghemi@gmail.com.

Author(s) agree that this article remain permanently open access under the terms of the [Creative Commons Attribution License 4.0 International License](https://creativecommons.org/licenses/by/4.0/)

Fontanella, 2002; Naslund and Williamson, 2010). Naturally, most of the recent activities in the study of the Supply Chain have bordered around improving efficiency and effectiveness (McCarthy and Golicic, 2002; Lambert et al., 2005). This is expected, considering the resource spent within the Supply Chain. Reports show that most companies spend as much as 50-80% of their total turnover on supply chain activities (Telgen, 1994).

However, activities within the supply chain do not always proceed as expected. "Events" take place which affect the flow of these components and service along the chain. Regarded as risk, it can be defined as:

"Unexpected events [that] might disrupt the flow of materials on their journey from initial suppliers through to final customers" (Waters, 2007: 7).

When it is negative, the impact could be devastating to the organization's objectives. Martha and Subbakrishna (2002), Kleindorfer and Saad (2005) and Tang and Nurmaya (2010) observed that they do not just stop at delivery delays or shortages but create an increase in expenses due to manpower and resources wasted in communication, co-ordination and monitoring activities. This ultimately affects the objectives of the business and shareholders' earnings. Works from Hendricks and Singhal (2003, 2005) show that the news of a supply chain disruption has a greater negative effect on the share prices of a company's stock than announcements of plan closure, delay in production development or reduction in capital expenditure. Kilgore (2004) also confirmed this. It is understood that most of these studies have revolved around operational risk. These are regularly re-occurring events which tend to be predictable (Brindley, 2004; Wagner and Bode, 2006). Very few have considered uncertainties which are unpredictable. There is a clear difference between risk and uncertainty. According to Waters (2007):

"Risk means we can list the events that may happen and can give each a probability.

Uncertainty means that we can list the events that might happen in the future, but have no idea about which will happen or their relative likelihood" (Waters, 2007: 17).

Tang and Nurmaya (2010) however provided an expansive description:

"...refer to (i) events with small probability but may occur abruptly and (ii) these events bring substantial negative consequences to the system" (Tang and Nurmaya, 2010).

These events that used to be rare have suddenly become commonplace. Also, it tends to negatively affect the supply chain. A typical example is the Taiwan earthquake of September 21, 1999. Unexpectedly, the earthquake affected the Hsinchu Industrial park and sent shock

waves through the global semiconductor market (Baum, 1999; Veverka, 1999, Crothers, 1999). The damage caused the supply disruptions of core-components for processors.

A classic case that reflects "accidental" disruptions is the Albuquerque fire at Philips' microchip office on March 17, 2000 (Latour, 2001; Norrman and Jansson, 2004). While the fire may be classified as an accident, the impact meant the disruption to supplies of millions of chipsets for the market. It affected both Ericsson and Nokia. However, while Nokia moved on, by engaging secondary facilities and suppliers, Ericsson did not have the structure in place to respond and could not meet production demands worldwide. Hence, they lost out and eventually had to quit the multibillion-dollar mobile phone sector entirely (Mukherjee, 2008).

These two highlight the importance of having the supply chains prepare for these rare-case events. Very recent research shows that these "low-probability" events are the second and third most reason given by managers for supply chain disruptions. Together, they account for close to 35% of supply chain disruptions. New sets of activities are required to restore the supply chain and ensure that components are delivered to purchasers. According to Tidd and Bessant (2018), this can be achieved through "sophisticated and active management" study. As a result, this research intends to study disruptions, and develop an adoptable framework. To this end, the work attempts to provide answers to the following Research Questions (RQs):

RQ1: How can we identify and select suppliers that will respond positively to disruptions?

RQ2: How can we establish a selection baseline which builds resilience in the supply chain arm of an organization?

Using a case study approach, this article observes supply chain activities in the aftermath of disruptions and attempts to uncover those fundamental criteria to watch out for. The analysis is strategic rather than operational. The focus is on those disruptions caused by unpredictable ecological events and unpredictable accidental incidents.

LITERATURE REVIEW

According to Tang and Nurmaya (2010), it is easy to see two clear activities into risk studies. One school attempts to understand the outcome of risk occurring (Rice and Caniato, 2003; Christopher and Lee, 2004; Hendrick and Singhal, 2005; Spekman and Davis, 2004), while the other looks at finding a holistic action to control and mitigate its effect. This focuses on two areas: Expected (Brindley, 2004, Wagner and Bode, 2006) and Unexpected risk (Christopher and Lee, 2004; Kleindorfer and Saad, 2005; Quinn, 2006, Tomlin, 2006; Deane et

al., 2009). Tang (2006) used the terms "Operation risk", to separate events faced by organizations in their daily activities from "Disruptions". Byrne (2007) argued that most risks are operational and controllable. This article focuses on the uncontrollable. The uncontrollable (Disruptions) are events which are difficult to predict and cannot be controlled or reversed by human activities or intervention. Sheffi (2005) used the words Low-Probability-High-Impact to describe them and classified them into three:

- (i) Natural phenomenon (e.g. Fires, Earthquakes)
- (ii) Accidents (e.g. technology failures and breakdowns)
- (iii) International incidences (terrorism, ill-will by insider/outside)

Wagner and Bode (2006) stated that due to the increase of globalization in supply chain operations, local events seem to have increased global repercussions on supplies and businesses. With the overall increased attention, several articles and books have looked at the dealing with disruptions in order to control the negative effect it has (Juttner et al., 2003; Rice and Caniato, 2003; Sheffi, 2005; Waters, 2007, Craighead et al., 2007). Most agree that there are peculiar challenges in dealing with disruptions: Because these events rarely occur, it is impossible to recommend building costly systems or implementing strategies that erode business profitability. In general, most authors have asked that resilience be included in the supply chain structure (Sheffi, 2005; Waters, 2007). Waters (2007) identified that this (design of a resilient supply chain) is generally achieved by "normal practice" of good logistic management but that present trends in supply chain management have eroded it. One particular trend widely accepted and adopted is "Lean". The heart of lean is the Just-in-Time operations. Originally observed in the Toyota Production system, JIT reduces waste by making sure that activities are done at the right time, with minimum waste and maximum quality (Womack et al., 2007). Suppliers come in at the time needed, not earlier or later.

Kleindorfer and Saad (2005) developed a conceptual framework called SAM (S-Specify source, A-Assess, M-Mitigate). The outcome of Kleindorfer and Saad (2005) work produced a Disruption Risk Management (DRM) framework which consisted of ten key principles. However, they noted that their suggestions were difficult to implement and suggested further research. Most real world practices follow two approaches: excessive redundancy or flexibility (Sheffi and Rice, 2005). Redundancy involves the use of inventory, safety stocks or multiple sourcing to manage disruptions (Tomlin, 2006; Keindorfer and Saad, 2005). They recommended flexibility, stating that it would help to build resilience and could even lead to improvement. The flexibility was not to replace the entire lean strategy but to co-exist with it. Many authors have written extensively on the strategic

importance of the selection process to any supply chain (Choi and Hartley, 1996; Karpak et al., 2001; Giunipero et al., 2006; Cousins et al., 2008; Wu, 2009). According to their work, it practically determines the competitive edge and success story for organisations in various sectors. This ranges from the aerospace, to automobile, Information technology, even to the agricultural sector.

Initially, supplier selection was done haphazardly with little structure in decision making. Also, organisations accessed most of the material needs from numerous sources and price was the main criteria (Cousins et al., 2008). However, the emergence of the several systematic models changed this. This list of criteria is increasingly complex, and several tend to conflict with each other. In order to deal with these complexities, several models have been proffered. Lee et al. (2001), based on a literature review, observed two main categories. These are mathematical programming (MOP, LP, MIP) and weighting models (AHP, ANP, and Linear scoring model). De Boer et al. (2001) reviewed and summarized the decision making techniques discussed in literature, from as far back as Weber et al. (1991) down to 2001. Their work covered all the stages in the selection process framework developed by De Boer et al. (2001). Because most Supply Chain managers try to consider both the qualitative and quantitative factors, there has been a preference for multi-criteria decision (MCD) methods. Lee et al. (2001) advocated for combinations of different methods, and at different stages in order to select suppliers. In general, Literature on supplier selection (De Boer et al., 2001; Choi and Hartley, 1996; Weber et al., 1991; Ha and Krishnan, 2008) concludes that the selection process may involve different types of criteria, combination of different decision models, group decision-making and various forms of uncertainty. With all the various techniques and models developed, there is a general consensus that no single method is best, as they all have their advantages and disadvantages in specific scenarios and particular sectors. Ulusoy (2003), observing trends in Turkey's manufacturing industries, recommended multiple-sourcing for the vital parts and making the system as "lean" as possible. An extraordinarily detailed extension work by Meena et al. (2011) proposed an algorithm which selects optimum number of suppliers for components. The basis for their calculation was the quantitative effect any disruption, from any part of the Supply Chain, would have on the overall business. Although getting an optimal number is ideal, it makes several assumptions. It considers all disruption probability as equal and the only relevant criteria used was the "importance of the component" supplied. This can be difficult to assess. Also, it assumes that as soon as a supplier is affected by disruption, there is no remedy for the situation and the business relationship closes. It does not also determine what factors are to be used in selecting these selected numbers. Combined with the geographical distributed

Table 1. Methods available for carrying out research.

Method	Form of research question	Control events?	of Focus on contemporary events?
Experiments	How, why	Yes	Yes
Surveys	Who, what, where, how much, how many	No	Yes
Archival analysis	Who, what, where, how much, how many	No	Yes/No
History	How, why	No	No
Case study	How, why	No	Yes

Source: Yin (2009).

suppliers today, the ability to manage several partners effectively diminishes.

Guido et al. (2009) suggested using the TCA for the selection process and giving suppliers specific guidelines on actions to take during disruptions. Although financially acceptable, disruption management and knowledge transfer is unidirectional. This kills opportunity for input from one end. Sawik (2011) formulated a mixed integral program that used a Value-at-Risk and conditional Value-at-Risk approach to select a supplier. This model is very effective in selecting the least risk-prone supplier, but tends to prioritize risk. Making this the decisive factor is in error because it will be difficult to determine if and when the high “priority” disruption will occur. Hence, the advantage of high quality and low cost may be lost on events that may never occur. Also, the model is complex and requires a lot of variables and computing power to properly use.

RESEARCH DESIGN AND METHODOLOGY

The Interpretivism paradigm approach was used for this research. This choice implies the use of reason and arguments in seeking truth and knowledge. The intention is to use case studies to develop a platform for dealing with the research question. Tidd and Bessant (2018) and Bessant et al. (2005) suggested “observing trends” which can complement and sit-together with “steady-state” innovations when dealing with “unsteady-states”. This formed the basis for the choice. The primary study used is the recent Tsunami in Japan. The available information online makes it particularly suitable.

The research also considers the Philips factory fire incidence at their factory in Albuquerque. This will help make the analysis more robust and add information in areas where there are gaps. Several interview sessions were conducted to help gain useful and insightful opinions from experts in this field. This includes both business executives who understand organizational activities and professionals from the academia. As this is an applied science which has real world application, their experience was crucial in developing answers which add value to the results of this research. The rationale for choosing this methodology has been justified. It also defines some key terms associated with this method and identifies works which have used it successfully.

Interpretivism paradigm, case study approach

The interpretivism paradigm is particularly suited because it

“involves an inductive process with a view to providing interpretive understanding of social phenomena within a particular context” (Collis and Hussey, 2009: 57). Our application of interpretivism permits us to utilize a small sample of “event” over a period of time. In this research, the case-study resonates about the effect of the tsunami on Supply Chains in Japan over five months (March- July, 2011). According to Yin (2009), the exact methodology depends on (Table 1):

- (i) The type of research question posed
- (ii) The level of control by the investigator on the events
- (iii) The degree of focus on contemporary rather than historic events.

Limitation in research design

Like all research methods, the case study approach has limitations. This includes inherent limitation in the method itself, and limitation as a result of research activities. As a method, the case study approach has limited capacity to address issue of reliability. This is because case studies express and highlight particular information which, in the researcher's view, is relevant. In other words, case studies can lack rigor and suffer from biased views and partial evidence. However, the benefit of using this approach is high. Observing activities in their natural environments ensures that this paper identifies the major criteria needed to answer the research question and proffer adequate recommendations. The solution is expected to be applicable in real world, not theoretical; hence, the restrictions in choice of methodology approach. The inherent limitations can be controlled by using multiple information sources and methods to investigate the research question.

Case-study: The Japanese Tsunami

On the 1st of March, 2011, an earthquake struck the North-east coast of Japan at 1446 local time (0546 GMT). It released a tremor of 8.9-magnitude and was described as the most powerful earthquake ever observed within the region (The Guardian, 2011, BBC 2011a). This tremor resulted in a Tsunami that swept through 35% of the country's landmass. It caused major destructions and disruptions of activities within those regions. Besides the destruction to properties and loss of life, the other major damage was to their power system. The Tsunami affected the cooling system of the Fukushima nuclear reactor and it has heating challenges. This resulted in an explosion and nuclear radiation was released into the atmosphere (BBC, 2011a) (Figure 1).

Effect on the semiconductor industry

In IHS iSuppli's analysis, it is observed that Japan was responsible

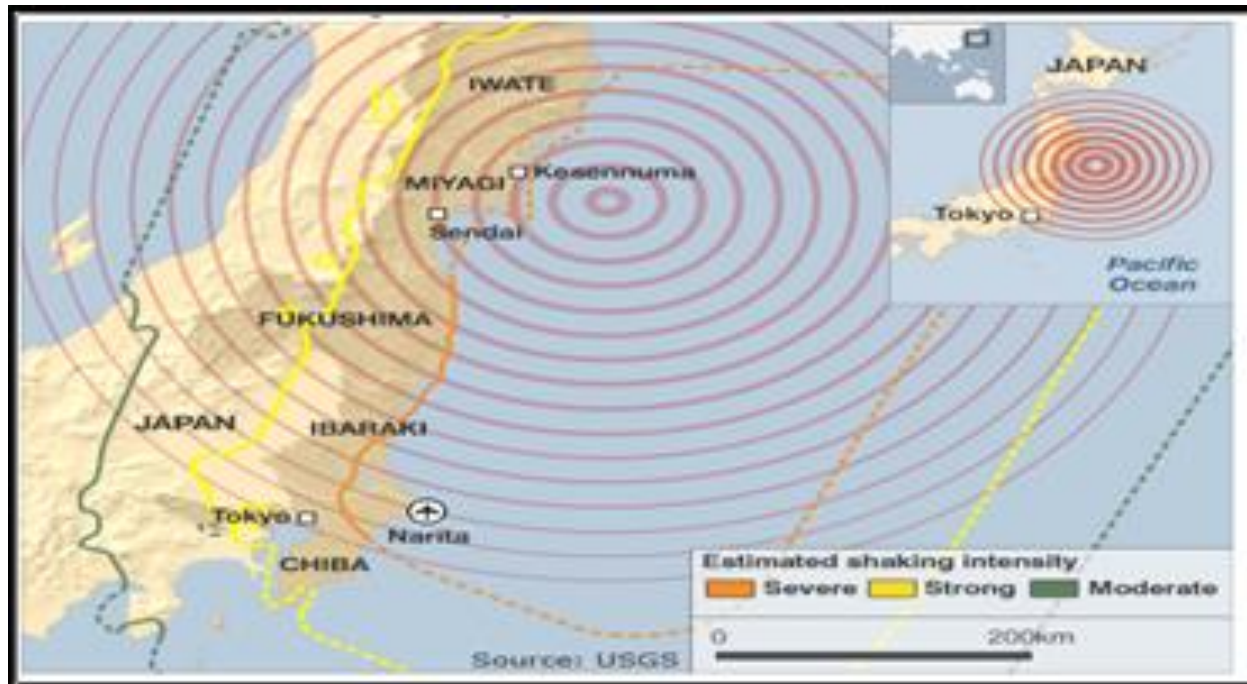


Figure 1. Areas affected by the Earthquake and Tsunami.
Source: BBC (2011a).

for close to 13.9% of revenue generated from electronic equipment globally, in 2010. This is valued at \$216.6 billion compared to \$1.6 trillion worldwide (WSJ, 2008; Electronic Products, 2011). For microchips production alone, they were responsible for global semiconductor production valued at \$63.3 billion, representing 20.8% of the worldwide market (Electronic Products, 2011). One plant belonging to Shin-Etsu produces a fifth of the world's 300-millimeter (12-inch) silicon wafers (Nystedt, 2011). Some other specific products include the NAND flash conductor (40%), DRAM (15%), MEMS (32.5%), which are heavily used in consumer electronics (Supply Chain Digital, 2011; Bouchaud, 2011; DigiKey, 2011).

Impact to the sector supply chain

While describing the impact, Dale Ford, senior vice president for semiconductor market intelligence (SEMI) at IHS said:

"In the history of the electronics Supply Chain, nothing has had such a broad impact as the Japan earthquake, tsunami and nuclear disaster.

...with the impact of the disaster reverberating through the materials, components and equipment segments of the Supply Chain." (WSJ, 2008; Electronic Products, 2011)

Reports revealed that several facilities reported to be in good condition had to shut down as a result of the disruption to their Supply Chain. Suppliers were having challenges getting raw materials produced and distributed (Electronic Products, 2011). The effect was global because companies in other countries and sectors, which depend heavily on Japan supplies, were also affected (Frommer, 2011). None could state when production would resume. Within the sector, there was a downward review of all business forecast. Andrew Lu, an analyst with Barclay Capital (Asia) noted that the shortage of materials would affect the ability to

meet demand. He cited Mitsubishi Gas Company (MGC) as an example. According to him, the expected "3-month" shortage of resin shipment from MGC was expected to put at risk up to half of global output of chips used in Smartphone and tablet computers. This is because they (MGC) controlled 90% of the market and had shut down production (Yasu, 2011). One popular speculation then was that the effect would affect the launch of the highly-publicized iPad- 2 launch (Frommer, 2011).

Effect on the automobile industry

Japan plays a major role within the automobile industry. They were the third largest exporter of global light vehicle in 2010, next to Europe and after China. Together with Korea, they produced 18.2% of the 71,901,200 vehicles made (Reuter, 2011). Studies show that pre-Tsunami Japan had a daily estimated production of 37, 217 vehicles per day. Toyota Motor Corp accounted for 44% of total output, followed by Nissan Motor Co Ltd at about 12 per cent (Reuter, 2011). However, this does not even give the true picture of the sector's importance. According to Dave Andrea, most manufacturers who thought they had no links to the Japan, suddenly found that "several parts, within part, within part" were single-sourced from Japan (Reed and Simon, 2011).

Impact on supply chain

The implication to the sector was global. There were shortages of parts, at virtually every level of the supply chain. Toyota's spokeswoman, Shiori Hashimoto, said the company was struggling to secure around "150" different auto parts (Fast Motoring, 2011). In order to continue production based on available parts, they had to reduce their global production by as much as 50%. Ironically, even internal supply chains were affected. A typical example is the engine supply issues experienced by Nissan. Reports by Nomura

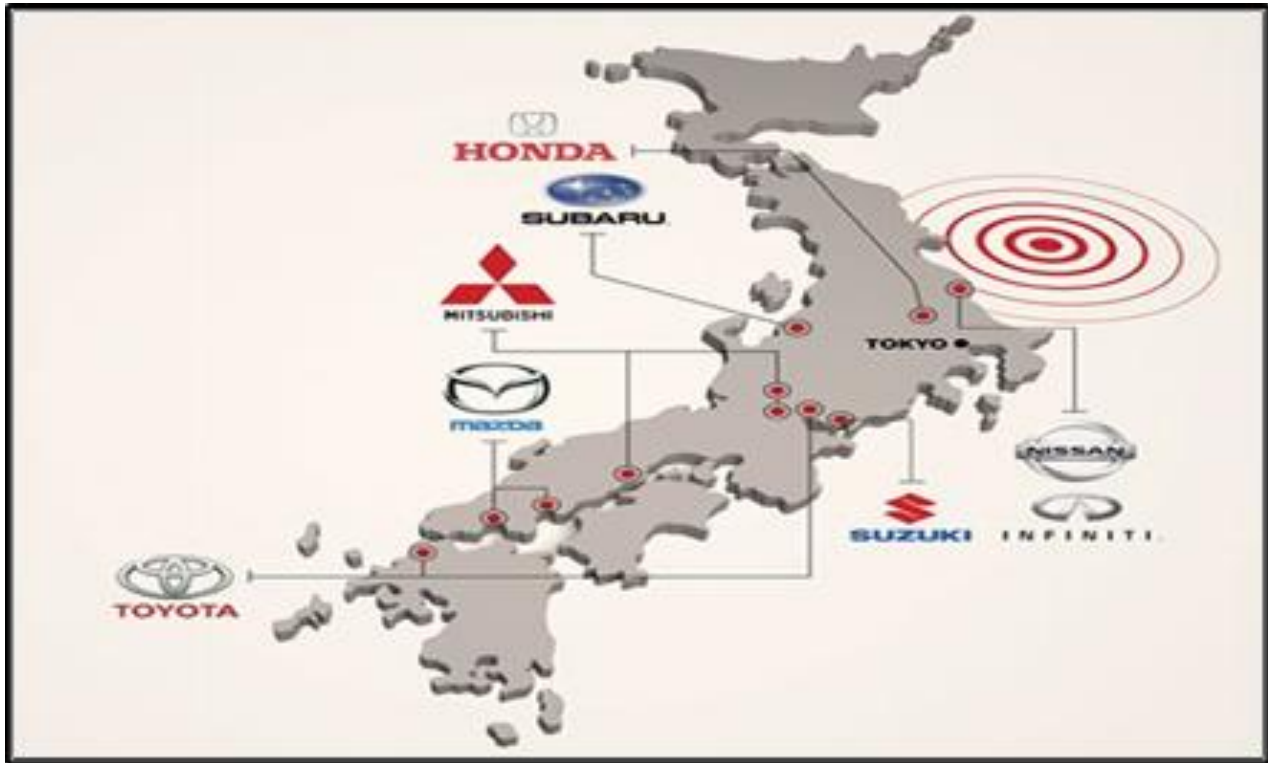


Figure 2. Earthquake centre and geographical distribution of major production facilities of automobile companies.
Source: Fast Motoring (2011a).

show that Nissan's Iwaka factory is responsible for more than 12% of their engine manufacture. Unfortunately, it was in the region affected by the Tsunami (Fast Motoring, 2011). The production of some models had to be stopped and the effect was felt by consumers. Figure 2 gives a map view automobile-manufacturer plants close to the region affected by the Tsunami.

Even components which would have been considered "non-critical" also created challenges. For example, most organisations reported shortage to some paint supplies. Xirallic in particular was in very short supply. A special pigment which gives cars their glistening and shimmering appearance was developed and patented in Japan by a German chemical company, Merck KGaA. The only facility producing the pigment is located in Onahama town. This facility was seriously damaged by the tsunami and also exposed to radiation. Because of availability issues, several automobile orders requiring this paint were unavailable to customers, worldwide (Boudette and Bennett, 2011). These examples highlight the challenges just after the Tsunami. In summary, the disruptions to Supply Chains affected major car manufacturing corporations, globally. Toyota, the world's largest manufacturer, had already lost the equivalent of 260,000 vehicles due to a 20-day suspension at most of its domestic factories (Fast Motoring, 2011) yet it warned that its 14 factory plants in North America and Europe also face the same problem with production (The Guardian, 2011). Nissan reported that between 15 and 20% of its components are shipped in from Japan, and hence, their ability to deliver was severely affected. Many of the world's auto makers, including Ford Motor Co., Chrysler Group LLC, Volkswagen AG, BMW AG, Toyota Motor Corp. and General Motors Co., also reported disruptions and delays to their supplies (Boudette and Bennett, 2011). Malcolm Penn, chief executive of research firm Future Horizons gave a summarily assessment of the impact when

he said the economic and financial effect would "hit hard" within three months when the demands for the quarters could not be met (BBC, 2011b).

Semiconductor sector

In a turn of events, Arthur (2011) released a reviewed forecast suggesting that worldwide purchasing of IT hardware, software, and services would grow by 7.1% in 2011. This is actually an improved forecast. The pre-tsunami forecast was 5.6% and this was revised downward in the wake of the Tsunami incidence. IHS gave a higher post-tsunami forecast, suggesting that the global semiconductor revenue growth would experience a sequential rise of 7.4% within their 3rd quarter trading (IHS Pressroom, 2011). This new forecast has worldwide IT spending growing from \$3.42 trillion in 2010 to \$3.67 trillion in 2011. The computing and hardware segment is poised for the strongest growth, with spending forecast expected to grow by 11.7 and \$419 billion (SEMI, 2011a). Myer Stanley, president and CEO of SEMI, gave the perfect summary to the sectors' post tsunami activities:

"Semiconductor equipment manufacturers will still see a double-digit increase in spending for 2011 following a "phenomenal recovery year" with triple-digit growth in 2010" (McGrath, 2011).

Automobile sector

However, the story is not exactly the same with the automobile industry. Although very little information is available on suppliers, the major automobile manufacturers still reported challenges.

Toyota reported that “30 parts types that had been unavailable are now in ready supply” (Just Auto, 2011a). Ironically, this does not necessarily mean that all supply issues have been resolved. The other big two, Honda and Nissan did not have much better news, with Honda having to cut their China production forecast by 13% (Just Auto, 2011b).

Also, the major challenge many organizations faced with most suppliers, power supply, remained unresolved (The Guardian, 2011). This is unlike the semiconductor industry, which secured an agreement with government exempting them from power sharing cuts. Toyota’s Chief Operating Officer, Toshiyuki Shiga, had suggested a shift in operating schedule to prevent the electricity system from failing during peak periods. This was to meet Government demand of energy savings in order to relieve the strain on the already burdened power system. However, even this agreement developed loopholes as stakeholders stated their plans to boycott the agreement (The Guardian, 2011). The possibility of further breakdown in power infrastructure was high.

According to U.S.A Federal Reserve Chairman Ben Bernanke, Japanese Supply Chain disruption was having widespread effect on other sectors and listed it as one of the “transitory” factors holding back the U.S. recovery (The Guardian, 2011). However, it has not been all bad news. Toyota, at the beginning of July, recognized the challenges they face but reported that operation would be restored in October. This was one month ahead of the initial estimate (Just-Auto, 2011). Also, most of the reported challenges have been resolved. The Xirallic paint facility earlier reported as damaged was being restored and efforts are being geared to build a backup facility.

RESULTS AND DISCUSSION

During the research, five major factors are observed to be crucial, in the rapid restoration of supply chains. These have strategic implications and are listed below:

The importance of communication and information integration

Being able to communicate, either via operations integration with the supplier or advanced reporting tools is essential to the responsiveness of any supply chain. Communication in this case refers to established 2-way access to production data and information. This could be direct or indirect. It is direct when the information is passed across using advanced reporting tool and each party monitors this information separately. Indirect communication implies that the supplier delivers incidence reports at regular interval. This is based on supplier integrity and trust. This feature is significant because the ability to communicate the occurrence plays a key role in understanding the situation and reacting properly. Even when the entire incidence is not understood, it helps to control the situation and build cooperation.

Using statements from Keenan Evans, ON Semiconductor’s senior vice president of Quality, Reliability and EHS, the research observed the benefit of appropriate information dissemination among all parties involved:

“Within the first hour, all global operations were notified of

the events through established messaging and Share Point alert.

...many of the demands would be impossible to meet even under less-pressing time constraints, but diligent communications and customer service were able to restore customer confidence and order schedules”(SEMI, 2011b).

Across board, supplier-associations within the semiconductor industry set up online links with updated repairs and this was available to the public (Mouser, 2011). This extensive list helped in preventing market panic and building a platform for affirmative action. However, this research did not observe the same collaborative reporting amongst automobile suppliers. There were insufficient details on the actual status of 1st and 2nd tier suppliers from within the automobile sector. While it may have been as a result of negligence during this research’s data collation exercise, an interview with a substantive stakeholder also observed this shortcoming. In an interview granted by a trade union official with Honda (Swindon), he said:

“There was no quality information getting back. Car parts were being shipped only part-way and communications were at a halt” (The Guardian, 2011).

Retrospectively, even when suppliers do not communicate information quickly, being able to identify the disruption promptly is essential. This may mean having integrated systems with suppliers. The Philip Fire incidence highlights the importance of integration:

Nokia reported having a system which relayed the production output from their suppliers’ factories. When the fire broke out at Albuquerque, they perceived the disruption even before Phillip informed them. Hence, they had already initiated their crisis management plan. Nokia used this advantage to identify and secure excess capacity at other suppliers’ sites. Ericsson did not notice any glitches to their supplies until they got informed four days after. This affected their ability to respond, and they were unable to secure alternate facilities (Latour, 2001). Most authors argue that strong buyer-seller interaction leads to successful business relationships. Lean innovation (JIT) observes that it is an essential element in building efficiency in the system (Lamming, 1996). Also, Lee et al. (2001) maintain that amongst available alternatives, manufacturers select the supplier that is able to maintain successful relationships. Hence, establishing communication links becomes an issue after agreeing to business partnership. Reason could be:

- (i) Client base size and portfolios
- (ii) Propriety or closed communication system
- (iii) The Organisational culture (in terms of communication).

There is a need to have a disruption management

framework. Although it can have different names (e.g. Crisis Management Plan, Disaster Recovery System), the framework is essentially the same and goes beyond the traditional risk management plans or registers. It does not target any specific event but rather lists a comprehensive set of processes and procedures. These effectively reduce or repair disruptions to supplies to/from customers/suppliers. While most organizations claim to have this in place, those whose systems have proved satisfactory, admit that it only became effective after previous failed attempts. Yu and Qi (2004) noted that the DMP involves dynamically revising the original plan to take into consideration “constraints and objectives of the evolved environment” (2004: 18). One interview participant broke down the activities for dealing with disruptions into three:

- (i) Disruption Prevention: Activities aimed at preventing the incidence before it occurs.
- (ii) Disruption Mitigation: Activities aimed at reducing the adverse effect when it occurs.
- (iii) Disruption restoration: Activities which are aimed at restoring the broken down system. It may require a restructuring of the entire supply network.

He observed that while most organizations develop frameworks to prevent (eliminate risk-factors) disruptions from occurring (e.g. via Kaizen, geo-sourcing), remarkably few have the means to manage their occurrences. This raises a difficult question. Admittedly, “prevention is better than cure and mitigation better than recovery”. Many authors in operational risk accept that it is best to address risk, proactively (Tang and Nurmaya, 2010; Waters, 2007; Kleindorfer and Saad, 2005). According to a second interviewee, usually organizations create risk registers. It lists processes and procedure to deal with challenges as they arise. However, he admits that these systems maintained for the sole purpose of proper documentation of actions in insurance claims, rather than restoring supplies in the short term is grossly inadequate. Disruption management processes and strategy need to be created and maintained. In conclusion, this research argues that there is a need to separate the risk profile of suppliers into two:

- (i) Risk Prevention, based on risk registers and lean operations to improve operational efficiency.
- (ii) Disruption Mitigation and Restoration (DMandR), based on disruption management plan.

From all reports of the tsunami incidence, power was the greatest challenge in restoring production (BBC, 2010b). However, while the automobile industry and their suppliers made attempts at managing what was available, the Japanese Ministry of Economy, Trade and Industry gave the semiconductor industry concession by excluding them from the energy rationing plan (SEMI, 2011b). This concession gave them considerable advantage over other

sectors. With guaranteed supply, there was a higher probability of returning to pre-tsunami production quickly. Careful research has shown the presence, impact and effectiveness of government in some of the most “open-economies” e.g. Singapore (Lim, 1983). Some argue that it becomes prominent in unsteady state or during failures (Medema, 2009; Laffont, 2008). Although this intervention has diverse macro-economic implications, it plays a significant role in restoring the Supply chain after “geographical disruption in collocated sectors” within their jurisdiction. It would be inappropriate not to consider this during the selection stage.

Cooperation and alliances amongst organisations

The ability of suppliers to cooperate amongst themselves via alliances plays a crucial role in producing a positive response to disruptions. Alliance would mean competing organizations coming together to cooperate and collaborate in order to achieve preset objectives. Slowinski and Sagal (2003) state that it refers to business relationships which retains agreed degrees of flexibility. This enables them to handle their independent operation, while fulfilling their joint commitments. In general, this essential component plays duo roles: (1) strategic collaboration for innovation and development in the sector and (2) supportive framework for disruption management. Interactions ensure that there is an improvement in the system because of access to resources. This is useful when dealing with disruption. Water (2007) observed that when companies work in isolation, the potential for risk to cause damages is higher than when there is collaboration. This involves both members of the supply chain, vertically and horizontally.

Other observations: Implication for procurement managers

The research exposed some issues which that suggest that purchasers also have a role to play in disruption management. This report will list them out. It will also discuss their implications in the selection process.

Proprietary technology

One problem identified during this research is the issue of propriety technology and customized parts. Customized parts indicate that the component is specific to organization (purchaser). Propriety refers to instances where individual companies (supplier) control the technology to produce a specific component. Because of these restrictions, restoring production during disruptions tends to be difficult. This increases if the component is produced at a single factory location. Typical examples are the RT resins and Xirralic paint used in smart phones

and tablet PC. Both were proprietary, and in the case of Xirralic, production was limited to a single facility (Schmitt, 2011).

Internally, this raises some questions that require beaming the searchlights on the purchaser. For example, it will be pivotal to determine if the components supplied are common or customized. Customized or proprietary parts increase the risk profile for that supply. This same issue is raised by Sheffi (2005) and Tang and Nurmaya (2010). They suggested the use of interchangeable parts. Already firms like Renault and Nissan are considering it. In a recent report, their Group C.E.O, Carlos Ghosn announced that the use of common adoptable parts may be a key consideration in future designs (Just-Auto, 2011). Japan Automobile Manufacturers Association (JAMA) president, Toshiyuki Shiga, also stated that they would look into the issue of generic parts that allow easy switching between different supplier facilities (Warburton, 2011).

Contractual agreements

One of the interview sessions revealed that some companies promote exposure by placing production restrictions on suppliers. These may be contractual conditions as regards location of production facilities and could even extend to waste disposal clauses. This is especially true for products where there is a potential for IP theft or Black market rip-off. This is interesting because, in this case, the supplier's risk profile increases due to purchasers demand. Internal attempt at providing slacks to accommodate these challenges need to be examined and created. However, for this to occur, proof of alternate facility with spare capacity is necessary. In the Semiconductor and Auto industry, information clearly alludes to the benefits of this:

Texas instrument (TI): *"In the first few days after the earthquake, TI had identified alternate manufacturing sites for about 60% of Miho's work-in-process, and has since increased that to more than 80 %"* (PRNewswire, 2011).

Mark Adams, Vice President purchasing manufacturing group, Toyota, praising some suppliers: *"Where [restoring factories] was not possible, alternative sourcing was (cut) arranged by first-tier suppliers, normally from the same company but another facility. "That is one of the functions they provide to us"* (Graeme, 2011). Generally, most advocates of lean production criticize the idea of having excess capacity (Lamming, 1996). However, risk specialists have made clarification to this.

Summary analysis and reflection

There are two fundamental approaches to managing

disruptions. This includes:

- (i) Strategies and actions aimed at minimising the frequency and severity of risks faced, at both the firm level and across the supply chain.
- (ii) Increasing the capacity of supply chain participants to sustain/absorb more risk, without significant negative impacts, or substantial operational disruptions (Kleindorfer and Saad, 2005).

This research is most relevant to the second approach. It considers the selection process as a strategic point to ensure that the supply chain has the capacity to respond to disruption and tried to find key elements that promote resilience. This research provides the following observations:

- (i) Information Integration is key to effective communication. This, in turn, is a prime factor for supply chain resilience to disruption
- (ii) Evidence of disruption management expertise provides a clear pointer to the responsiveness of a supplier.
- (iii) Collaborative and alliances agreement is strategic to seamless switching between supplier facilities, in the wake of a disruption.
- (iv) Government preference dictates the pace of recovery when the disruption affects multiple sectors of suppliers within a same geographic region

These observations raise a lot of questions which need to be considered during the selection process.

Reflection

The above report has wider implications. It observed the rapid increase in disruptions and its effect on supply chain. It also highlights the need for innovative action to deal with it. This need calls for a different approach to doing things. Tushman and Nafler (1986) noted that effective innovation requires synthesis between needs, possibilities and capabilities. This work has identified needs and offered possibilities. It now requires supply chain managers to provide the capabilities (dedicating resources) to engage the framework suggested and harness its benefits. This report will end with suggestions of two paths organization can take to benefit from this report:

Engage in incremental process-innovation: This work provides an opportunity for process innovation. It recommends that supply chain managers include the identified criteria to the selection process. Innovation experts would consider it incremental because this recommendation would not radically alter the way professional supply chain experts perform selection. Nevertheless, the benefits from this cannot be

undermined. It means that the purchaser can maintain his previous method, while gradually building a disruption-resilient system.

Radical process-innovation: A more radical recommendation will be for supply chain managers to re-evaluate their entire supply chain in order to build resilience. This involves studying and understanding the entire supply structure for component procurement. It would provide an opportunity to review all suppliers (Present) and the benefit is the cost-effective assurance of response during disruptions. Also, it may provide opportunity for other types of innovation, like new product developments. Regardless of the innovative approach organization chosen, the outcome will yield positive results.

Research limitations

Quantitative input

There is an absence of quantitative input from multiple stakeholders. This would have helped identify several sublime elements which this general approach did not observe or consider.

Generalization

The outcome of this research provides broad recommendations, which are not specific to any particular sector.

Time frame

The timeframe for this research is relatively short. Although it is sufficient enough to observe organisations that produce swift response and clear criteria were identified, it does not consider some of the long-term effect of these suggested criteria.

Criterion significance

Although the report suggests that each criterion is relevant in selection process, there is no information or research data on the actual weight each should be given in the selection process.

Cultural influence

The main case study (Tsunami) is on a nation (Japan) that has peculiar philosophies and practice e.g. Keiretsu. There are arguments that the Japanese culture has an overbearing influence on the way businesses are operated in that region. This may have influenced the observations in this case study.

Sample implementation

There was no opportunity to implement the recommendation of this paper. This would have helped in locating/identifying more challenges with real-world implementation.

Conclusion

This paper follows from previous work on disruption management. It identifies the current challenges in dealing with disruptions. It took a critical look at the supplier selection considering a strategic point for building the resilience of an organization's supply chain in the wake of a disruption. The research challenge was to identify those "criteria" which are important to observe, during the selection process. The aim was to recognize and select suppliers who will produce positive responses to disruption. The researcher used multiple-case studies, backed by interviews and literature, to answer the question. It identified those critical factors which promote positive response to disruption, and recommended guidelines to confirm them, when selecting potential suppliers. Some key points from this paper include:

- (i) The need to consider not only risk prevention, but risk mitigation and restoration plans in risk profile of suppliers.
- (ii) It emphasizes the importance of proper monitoring of both hard and soft risk-factors in selection.

It outlines the strategic importance of:

- (i) Communication integration
- (ii) Tried and tested disruption plans
- (iii) Cooperation agreements and alliances
- (iv) And political will, in dealing with disruptions.
- (v) It maintains that all this work together to produce the "responses" observed in the case studies.
- (vi) It also recognises the need to look inward during before and during the selection stages. It recommends that the outcome should dictate future activities for supply chain managers.
- (vii) It finally accepts that the issue of disruption management in the supply chain is an innovation challenge. It recommends doing this via the opportunities at the selection stages and suggests process-innovation steps which could either be incremental or radical.

Recommendations

This paper will conclude by making the following recommendations:

- (i) Supply chain managers should embrace this innovative approach and engage the challenges of disruption management from the selection stage. It will ensure that resilience is built into the system.

(ii) There is an increase in calls for a “Risk intelligence database. Supply chain managers should consider this seriously. It will give them access to real time and make it easy to monitor the supply chain structure.

(iii) Also, suppliers should consider the findings in this report and build their operations around the recommendations. This will prove useful because it ensures they can guaranty production when disruptions occur.

For further research, there is a need to observe the strategic importance of each criterion observed to the resilience question. Some of the criteria observed change very quickly. Example includes political environment and legislative policies. Knowing the effect of these changes will ensure that supply chain manager can quickly take decisions that maintain resilience in the system. This will ensure that the “Risk intelligence data” remains useful.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

REFERENCES

- Baum J (1999). Back on track. *Far Eastern Economic Review*. P 25.
- BBC (2011a). Japan earthquake: Tsunami hits north-east. *BBC News* 11 March, 2011. Available at: <https://www.bbc.com/news/world-asia-pacific-12709598>
- BBC (2011b). Japan disaster: Supply shortages in three months. Available at: <https://www.bbc.com/news/business-12782566>
- Bessant J, Lamming R, Noke H, Phillips W (2005). Managing innovation beyond the steady state. *Technovation* 25(12):1366-1376.
- Bouchaud J (2011). Global MEMS Industry Is Relatively Unaffected by Japan Quake Aftermath: Location of Japanese MEMS fabs—and alternative production sites-play important role in shielding industry. Available at: <https://technology.informa.com/394328/global-mems-industry-is-relatively-unaffected-by-japan-quake-aftermath>
- Boudette NE, Bennett J (2011). Pigment shortage hits auto makers. *The Wall Street Journal* P 26.
- Brindley C (2004). Risk focus towards customers. *Supply Chain Risk* 2004:66-78.
- Byrne PM (2007). Impact and ubiquity: two reasons to proactively manage risk. *Logistics Management* 46(4):24-25.
- Choi T, Hartley J (1996). An exploration of supplier selection practices across the supply chain. *Journal of Operations Management* 14:333-343.
- Christopher M, Lee H (2004). Mitigating supply chain risk through improved confidence. *International Journal of Physical Distribution and Logistics Management* 34(5):388-396.
- Collis J, Hussey R (2009). *Business research: A practical guide for undergraduate and postgraduate students*. 3rd ed, Basingstoke: Palgrave Macmillan, ISBN: 9781403992475.
- Cooper MC, Ellram LM (1993). Characteristics of Supply Chain Management and the Implication for Purchasing and Logistics Strategy. *The International Journal of Logistics Management* 4(2):13-21.
- Cousins P, Lamming R, Lawson B, Squire B (2008). *Strategic Supply Management: Principles, Theories and Practice*. Prentice Hall Financial Times 308 p.
- Craighead CW, Blackhurst J, Rungtusanatham MJ, Handfield RB (2007). The severity of supply chain disruptions: design characteristics and mitigation capabilities. *Decision Sciences* 38(1):13-56.
- Crothers C (1999). PC industry hit by Taiwan quake aftershocks. Available at: <https://www.cnet.com/news/pc-industry-hit-by-taiwan-quake-aftershocks/>
- De Boer L, Labro E, Morlacchi P (2001). A review of methods supporting supplier selection. *European Journal of Purchasing and Supply Management* 7(75):89.
- Deane JK, Craighead CW, Ragsdale CT (2009). Mitigating environmental and density risk in global sourcing. *International Journal of Physical Distribution and Logistics Management* 39(10):861-883.
- DigiKey (2011). MEMS supply only slightly affected by Japanese quake: Much of MEMS production in Japan is in southern part of country. Available at: http://www.digikey.com/us/en/purchasingpro/articles/supply-chain/mems-supply-only-slightly-affected-by-japanese-quake.html?WT.z_pp_page_sec=SN
- Electronic Products Dale, F. (2011). News Flash on Japanese Earthquake Impact from IHS iSuppli. Available at: <https://www.electronicproducts.com/news-flash-on-japanese-earthquake-impact-from-ihs-isuppli/#>
- Fast Motoring (2011). Toyota maintain limited output in Japan from May 10 to June 3”. *Fast Motoring* | April 18, 2011. Available at: <http://www.fastmotoring.com/index.php/2011/04/toyota-maintain-limited-output-in-japan-from-may-10-to-june-3/>
- Fisher M (1997). What Is the Right Supply Chain for Your Product? A Simple Framework – Can You Figure Out The Answer?” *Harvard Business Review* 75(2):105-116.
- Frommer D (2011). Apple supply chain temporarily affected by Japan earthquake, but demand stronger than ever. Available at: <http://www.businessinsider.com/gene-munster-apple-supply-demand-2011-3>
- Arthur C (2011). Gartner slashes 2011 PC sales forecast again as consumers stay wary. Available at: <https://www.theguardian.com/technology/2011/sep/08/gartner-pc-sales-forecast-slashed-2011>
- Giunipero L, Handfield RB, Eltantawy R (2006). Supply management’s evolution: key skill sets for the supply manager of the future. *International Journal of Production and Operations Management* 26(7):822-844.
- Graeme R (2011). France: Toyota suppliers shoulder sourcing solutions. *Just Auto: Graeme Roberts* | July 14, 2011. Available at: http://www.just-auto.com/news/toyota-suppliers-shoulder-sourcing-solutions_id112648.aspx
- Guido JL, Cagno ME, Giulio AD (2009). Reducing the total cost of supply through risk-efficiency-based supplier selection in the EPC industry. *Journal of Purchasing and Supply Management* 5(3):166-177.
- Ha SH, Krishnan R (2008). A hybrid approach to supplier selection for the maintenance of a competitive supply chain. *Expert Systems with Applications* 34(2008):1303-1311.
- Hendricks KB, Singhal VR (2003). The effect of supply chain glitches on shareholder value. *Journal of Operations Management* 21(5):501-523.
- Hendricks KB, Singhal VR (2005). An empirical analysis of the effect of supply chain disruptions on long-run stock price performance and equity risk of the firm. *Production and Operations Management* 14:53-68.
- IHS Pressroom (2011). Electronics supply chain to fully recover from Japan disaster in Q3. *IHS Pressroom* | June 20, 2011. Available at: <http://press.ihs.com/press-release/product-design-supply-chain/electronics-supply-chain-fully-recover-japan-disaster-q3>
- Just-Auto (2011). Japan: Toyota ‘normalising’ a month early. Available at: http://www.just-auto.com/news/toyota-normalising-a-month-early_id112489.aspx
- Juttner U, Peck H, Christopher M (2003). Supply chain risk management: Outlining an agenda for future research. *International Journal of Logistics: Research and Applications* 6(4):197-210.
- Karpak B, Kumcu E, Kasuganti RR (2001). Purchasing materials in the supply chain: managing a multi-objective task. *European Journal of Purchasing and Supply Management* 7:209-216.
- Kilgore JM (2004). Why analytical risk mitigation is critical to supply chain design. *Inventory Management Report* 4(4):7-11.

- Kleindorfer PR, Saad GH (2005). Managing disruption risks in supply chains. *Production and Operations Management* 14(1):53-68.
- Laffont JJ (2008). Externalities. *The New Palgrave Dictionary of Economics*, 2nd Ed.
- Lambert D (2008). An executive summary of supply chain management: Process, partnerships, performance. Jacksonville: The Hartley Press, Inc.
- Lambert D, Garcia-Dastugue S, Croxton K (2005). An evaluation of process-oriented supply chain management frameworks. *Journal of Business Logistics* 26(1):25-51.
- Lamming R (1996). Squaring lean supply with supply chain management. *International Journal of Operations and Production Management* 16(2):183-196.
- Langley Jr CJ, Holcomb MC (1992). Creating logistics customer value. *Journal of Business Logistics* 13(2):1-2.
- Latour A (2001). Trial by Fire: a blaze in Albuquerque sets off major crisis for cellphone giants. *The Wall Street Journal*, January 29, 2001. P A1.
- Lee HL, Padmanabhan V, Whang S (1997). Information distortion in a supply chain: The bullwhip effect. *Management Science* 43(4):546-558.
- Lee EY, Ha S, Kim SK (2001). Supplier selection and management system considering relationships in supply chain management. *IEEE Transactions on Engineering Management* 48(3):307-318.
- Lim LYC (1983). Singapore's success: The myth of the free market economy. *Asian Survey* 23(6):752-764.
- Martha J, Subbakrishna S (2002). Targeting a just-in-case supply chain for the inevitable next disaster. *Supply Chain Management Review* 6(5):18-23.
- McCarthy T, Golicic S (2002). Implementing Collaborative Forecasting to Improve Supply Chain Performance. *International Journal of Physical Distribution and Logistics Management* 32(6):431-454.
- McGrath D (2011). SEMI forecast sees 12% tool sales growth. Available at: <http://forum.dft.nl/posts/listByUser/31553.page>
- Medema SG (2009). *The Hesitant Hand: Taming Self-Interest in the History of Economic Ideas*. Princeton University Press. ISBN-10: 0691122962.
- Meena PL, Sarmah SP, Sarkar A (2011). Supplier selection under the risk of supply disruptions. *Proceedings of the 2011 International Conference on Industrial Engineering and Operations Management*, Kuala Lumpur, Malaysia, January 22 – 24, 2011.
- Mouser (2011). Japanese Earthquake Supplier Updates. Available at: http://uk.mouser.com/japanese_supplier_updates/?cm_sp=TopNavT-abs_-_SUPPLIERS_-_Japanese%20Earthquake%20Supplier%20Updates_-_na
- Mukherjee AS (2008). The fire that changed an industry: a case study on thriving in a networked world. *Financial Times* 1(1):10-12.
- Naslund D, Williamson S (2010). What is Management in Supply Chain Management? - A Critical Review of Definitions, Frameworks and Terminology. *Journal of Management Policy and Practice* 11(4):11-28.
- Norrman A, Jansson U (2004). Ericsson's proactive supply chain risk management approach after a serious sub-supplier accident". *International Journal of Physical Distribution and Logistics Management* 34(5):434-456.
- Nystedt D (2011). Wall Street Beat: Markets Recover from Japanese Temblor. Available at: http://www.cio.com/article/678743/Wall_Street_Beat_Markets_Recover_From_Japanese_Temblor?page=2&taxonomyId=3233
- PRNewswire (2011). TI's Japan factories on track for full recovery. *PRNewswire* | March 29, 2011. Available at: <http://www.prnewswire.com/news-releases/tis-japan-factories-on-track-for-full-recovery-118874649.html>
- Quinn F (2006). Risky business. *Supply Chain Management Review* 10(4):5.
- Reed J, Simon B (2011). Car components hit by Japan aftershock. *Financial Times* | March 28. Available at: <http://www.ft.com/cms/s/0/9ac4d7e2-595f-11e0-bc39-00144feab49a,s01=1.html#axzz1WbiqUDsU>
- Reuter (2011). Japan lost autos output to hit 338,000 Friday: HIS. Available at: <http://www.reuters.com/article/2011/03/21/us-japan-quake-ihs-idUSTRE72K65220110321>
- Rice JB, Caniato F (2003). Building a resilient and secure supply chain". *Supply Chain Management Review* 7(5):22-30.
- Sabath R, Fontanella J (2002). The Unfulfilled Promise of Supply chain Collaboration. *Supply Chain Management Review* 6(4):24-29.
- Sawik T (2011). Selection of supply portfolio under disruption risks. *Omega* 30(2011):194-208.
- Schmitt B (2011). Japanese Parts Paralysis: The shiny paint is leaving the building. Truth about cars | May 10, 2011. Available at: <http://www.thetruthaboutcars.com/2011/05/japanese-parts-paralysis-the-shiny-paint-is-leaving-the-building/>
- SEMI (2011a). Japan Semiconductor Industry Responds Successfully to Earthquake/Tsunami Crisis: Semiconductor Industry Exempt from Power Restrictions. Available at: <http://www.semi.org/node/37656?id=highlights>
- SEMI (2011b). Crisis planning and preparation speeding Japan semiconductor recovery. Available at: <http://www.semi.org/node/37546?id=highlights>
- Sheffi Y (2005). *The Resilient Enterprise: Overcoming Vulnerability for Competitive Advantage*. The MIT Press, Cambridge, MA. ISBN-13: 978-0-262-19537-9
- Sheffi Y, Rice JB (2005). A supply chain view of the resilient enterprise. *MIT Sloan Management Review* 47(1):41-48.
- Slowinski G, Sagal AW (2003). *The strongest link: forging a profitable and enduring corporate alliance*. Amacom. ISBN-10: 0814407439.
- Spekman RE, Davis EW (2004). Risky business: expanding the discussion on risk and the extended enterprise. *International Journal of Physical Distribution and Logistics Management* 34(5):414-433.
- Stock J, Boyer S (2009). Developing a consensus definition of supply chain management: a qualitative study. *International Journal of Physical Distribution and Logistics Management* 39(8):690-711.
- Supply Chain Digital (2011). Spotlight on Japan: Questions flood Japan's supply chain after huge earthquake and tsunami. Available at: <https://www.eetimes.com/from-the-edge-of-commsdesign-a-weekend-reader-volume-4/>
- Tang CS (2006). Perspectives in supply chain risk management". *International Journal of Production Economics* 103:451-488.
- Tang O, Nurmaya MS (2010). Identifying risk issues and research advancements in supply chain risk management. *International journal of Production Economics* 133(1):25-34.
- Telgen J (1994). Insight and overview: the challenges of Purchasing Management and Decision Making. Academic address at the University of Twente, Enschede, The Netherlands.
- The Guardian (2011). Powerful earthquakes hit Japan. *The Guardian* March 11, 2011. Available at: <http://www.guardian.co.uk/world/2011/mar/11/japan-earthquake-miyagi-tsunami-warning>
- Tidd J, Bessant JR (2018). *Managing innovation: integrating technological, market and organizational change*. John Wiley & Sons.
- Tomlin B (2006). On the Value of Mitigation and Contingency Strategies for Managing Supply Chain Disruption Risks. *Management Science* 52(5):639-657.
- Tushman ML, Nadler DA (1986). Organizing for innovation. *California Management Review* 3(Spring):74-92.
- Ulusoy G (2003). An assessment of supply chain and innovation management practices in the manufacturing industries in Turkey. *International Journal of Production Economics* 86:251-700.
- Veverka M (1999). *A dram shame*. Barron's.
- Wagner SM, Bode C (2006). An empirical investigation into supply chain vulnerability. *Journal of Purchasing and Supply Management* 12:301-312.
- Warburton (2011). Japan: JAMA mulls common parts move post-earthquake. Available at: http://www.just-auto.com/news/jama-mulls-common-parts-move-post-earthquake_id112115.aspx
- Waters D (2007). *Supply Chain Risk Management – Vulnerability and Resilience in Logistics*. Kogan Page. ISBN-10: 0749448547
- Weber CA, Current JR, Benton WC (1991). Vendor selection criteria and methods. *European Journal of Operational Research* 50:2-18.
- Womack JP, James P, Jones DT, Roos D (2007). *The Machine That Changed the World: The Story of Lean Production-- Toyota's Secret Weapon in the Global Car Wars That Is Now Revolutionizing World Industry*. Simon and Schuster, 2007, ISBN: 0743299795, 9780743299794

- WSJ (2008). Big three seek \$34 billion aid. Available at: http://online.wsj.com/article/SB122823078705672467.html?mod=todays_us_page_one
- Wu LC (2009). Supplier selection under uncertainty: a switching options perspective. *Industrial Management and Data Systems* 109(2):191-205.
- Yasu M (2011). Japan's quake may hurt battery, chip-wafer, LCD-Panel Markets. Available at: <http://www.bloomberg.com/news/2011-03-16/japan-s-quake-may-hurt-battery-semiconductor-wafer-lcd-panel-markets.html>
- Yin RK (2009). *Case study research: design and methods*". 4th ed. Publication info: Los Angeles, Calif.; SAGE, ISBN: 9781412960991.
- Yu G, Qi X (2004). *Disruption Management: Framework, Models and Applications*. World Scientific Publishing Co. ISBN:978-981-256-017-9