

# **SUPPLY CHAIN VULNERABILITY**

Executive Report

On Behalf of:

**Department for Transport,  
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## Introduction

Modern supply chains are very complex, with many parallel physical and information flows occurring in order to ensure that products are delivered in the right quantities, to the right place in a cost effective manner. In fact, **supply networks** may be a more accurate term than **supply chains**. In this brochure the terms supply chains and supply networks are used with the same meaning.

The shift towards leaner supply networks during recent years has resulted in these networks becoming more vulnerable. In particular, there often tends to be very little inventory in the system to “buffer” any interruptions in supply and, therefore, any disruptions can have a rapid impact on the supply network.

These disruptions can arise from a number of sources, for example:

- natural disasters (e.g. the Kobe earthquake, which affected supply networks across the globe, or, more recently, foot and mouth disease, which has affected the livestock haulage industry, the tourist industry, etc);
- terrorist incidents (e.g. events in the USA on 11<sup>th</sup> September 2001)
- industrial or direct action (e.g. the fuel price protest of September 2000, which very rapidly impacted on almost every supply network in the U.K.);
- accidents (e.g. a fire in a component supplier can have such a serious impact on manufacture that they are forced to shut down operations, such as Toyota in 1997 – due to problems at its supplier of brake-pressure proportioning valves);
- operational difficulties (e.g. production or supply problems at one supplier can impact every organisation in the supply network).

Owing to the close interrelationships between many supply networks, the impact of such disruptions can be far reaching.

Companies have been aware of the need for disaster recovery and emergency planning for some considerable time, particularly in areas such as information technology and production plants. Business risk is now receiving increasing attention by companies (and their insurers) particularly as regards the loss of market share and the time, and cost, of re-entering a market after a significant disruption to supply.

The robustness of supply networks is thus recognised as being critical both for individual organisations and for the economy as a whole. The purpose of this brochure is to present initial research led by Cranfield School of Management, in consortium with Heriot-Watt University and the Business Continuity Institute, into this area. The aim of this research was to examine the business requirement, the state of knowledge, the tools that may be appropriate and “best”, or “current”, practice in the supply chain vulnerability area.

## Background to Supply Chain Vulnerability

The concept of the supply chain as a network of inter-related entities that combine to enable the satisfaction of customer demand is well established. Various definitions of supply chain management exist and the one that we have adopted for the purposes of this report is:

*“The management of upstream and downstream relationships with suppliers and customers in order to create enhanced value in the final market place at less cost to the supply chain as a whole.”*

For many, if not the majority of ultimate consumers, their knowledge and understanding of supply chains is limited. Even amongst those who work in industry and commerce, unless their responsibilities lie within the specific functions that are touched upon by the supply chain, that knowledge is usually only sketchy.

This lack of knowledge is not surprising given the complexity of today's typical supply chain. Yet, as we will argue, the complexity of the chain - which is tending to increase rather than diminish – brings with it higher levels of risk and hence vulnerability.

Supply chains that comprise hundreds or possibly thousands of companies, extending over several tiers, present numerous risks. Broadly, those risks can be classified into two types : risks arising within the supply chain and risks external to it.

Risk within the supply chain arises from interaction between constituent organisations across the supply chain. It is caused by sub-optimal interaction and co-operation between the entities along the chain. Such supply chain risks result from a lack of visibility, lack of 'ownership', self-imposed 'chaos', just-in-time practices and inaccurate forecasts.

External risks arise from interactions between the supply chain and its environment. Such interactions include disruptions caused by strikes, terrorism and natural catastrophes. Any disruption at any stage in a supply chain that can be linked to environmental causes is ascribable to external risks.

Together, supply chain risks and external risks impact the vulnerability of the supply chain. In addition, although both supply chain and external risks have independent sources, simultaneous occurrence of both risks and interactions between them intensifies the damage to the supply chain. Thus, supply chain vulnerability can be defined as 'an exposure to serious disturbance, arising from risks within the supply chain as well as risks external to the supply chain'.

Consequently, supply chain risk management aims at identifying the areas of potential risk and implementing appropriate actions to contain that risk. Therefore it can be defined as : “the identification and management of risks within the supply chain and risks external to it through a co-ordinated approach amongst supply chain members to reduce supply chain vulnerability as a whole.”

## **Factors contributing to supply chain risk**

Whilst risk has always been present in the process of reconciling supply with demand, there are a number of factors which have emerged in the last decade or so which might be considered to have increased the level of risk. These include:

- A focus on efficiency rather than effectiveness
- The globalisation of supply chains
- Focussed factories and centralised distribution
- The trend to outsourcing
- Reduction of the supplier base
- Volatility of demand
- Lack of visibility and control procedures

These factors are considered below in more detail.

### **A focus on efficiency rather than effectiveness**

The prevailing business model of the closing decades of the twentieth century was very much based upon the search for greater levels of efficiency in the supply chain. Experience highlighted that there was significant opportunity in many sectors of industry to take out significant cost by focusing on inventory reduction. Just-in-time (JIT) practices were widely adopted and organisations became increasingly dependent upon suppliers. This model, whilst undoubtedly of merit in stable market conditions, may become less viable as volatility of demand increases. The challenge in today's business environment is how best to combine 'lean' practices with an 'agile' response.

### **The globalisation of supply chains**

There has been a dramatic shift away from the predominantly 'local for local' manufacturing and marketing strategy of the past. Now, through offshore sourcing, manufacturing and assembly, supply chains extend from one side of the globe to the other. For example, components may be sourced in Taiwan, sub-assembled in Singapore with final assembly in the USA for sale in world markets.

Often the motivation for off-shore sourcing and manufacturing is cost. However, that definition of cost is typically limited to the cost of purchase or manufacture. Only rarely are total supply chain costs considered. The result of these cost-based decisions is often higher levels of risk as a result of extended lead-times, greater buffer stocks and potentially higher levels of obsolescence – particularly in short life-cycle markets. A further impetus to the globalisation of supply chains has come from the greater increase in cross-border mergers and acquisitions that we have witnessed over the last decade or so.

## **Focussed factories and centralised distribution**

One of the impacts of the implementation of the Single Market within the European Union and the consequent reduction in the barriers to the flow of products across borders has been the centralisation of production and distribution facilities. Significant scale economics can be achieved in manufacturing if greater volumes are produced at fewer sites. In some cases companies have chosen to 'focus' their factories – instead of producing the full range of products at each site they produce fewer products exclusively at a single site. As a result, production costs may be lower but the product has to travel greater distances, often across many borders. Incidentally, at the same time, flexibility may be lost because these focussed factories tend to be designed to produce in very large batches to achieve maximum scale economics.

Simultaneously with this move to fewer production sites is the tendency to centralise distribution. Many fast moving consumer goods manufacturers aim to serve the whole of the Western European market through a few distribution centres, for example, one in north-west Europe and one to the south.

## **The trend to outsourcing**

One widespread trend, observable over many years, has been the tendency to outsource activities that were previously conducted within the organisation. No part of the value chain has been immune from this phenomenon, companies have out-sourced distribution, manufacturing, accounting and information systems for example. In some cases these companies might accurately be described as 'virtual' companies. There is a strong logic behind this based upon the view that organisations are more likely to succeed if they focus on the activities in which they have a differential advantage over competitors. This is leading to the creation of 'network organisations'; whereby confederations of firms are linked together – usually through shared information and aligned processes – to achieve greater overall competitiveness. At a practical as well as a theoretical level this idea has many attractions, for example, the large supermarket chains run parallel own-account and third-party distribution systems partly to spread the risk of disruption, particularly from industrial action. However, in reality outsourcing also brings with it a number of risks, not least being the potential loss of control. Disruptions in supply can often be attributed to the failure of one of the links in the chain and, by definition, the more complex the supply network the more links there are and hence the greater the risk of failure.

## **Reduction of the supplier base**

A further prevailing trend over the last decade or so has been a dramatic reduction in the number of suppliers from whom an organisation typically will procure materials, components, services, etc. In some cases this has even extended to 'single sourcing'; whereby one supplier is responsible for the sole supply of an item. Several well-documented cases exist where major supply chain disruptions have been caused because of a failure at a single source. Even though there are many benefits to supplier base reduction it has to be recognised that it brings with it increased risk.

Sometimes a consolidation of the supply base happens through merger and acquisition. Since the rate of merger and acquisition has increased so dramatically over recent years, it follows that supply base reduction will have accelerated if for this reason alone.

## **Volatility of demand**

It is undoubtedly true that the level of market turbulence has increased bringing with it a reduction in the predictability of demand. There are many reasons for this increased demand volatility. Shorter life cycles, often driven by technology change, means that the risk of obsolescence increases. Higher levels of competitive activity leads to marketing-led disturbances to demand in many consumer markets, e.g. promotions, sales incentives and the like. Increasing variety within product ranges further fragments demand and makes forecasts less reliable. Many supply chains also have in-built features which contribute to the 'chaos' effect, for example, rules on economic batch sizes or order quantities, re-order level based inventory management systems and so on.

Because companies are still largely forecast driven, with long planning horizons and long lead-times of response they are increasingly vulnerable to wild swings in demand. In 2001 one of the world's leading producers of electronic network equipment, Cisco, announced a US\$2 billion write off of inventory because of a dramatic fall-off in demand for its products.

## **Lack of visibility and control procedures**

Paradoxically, a consequence of supply chain risk is a lack of confidence in the supply chain amongst its members, but it is also this very lack of confidence that adds to supply chain risk! Lack of confidence in a supply chain leads to actions and intervention by managers throughout the supply chain which collectively can increase the risk. This risk spiral exists everywhere and the only way to break the spiral is to find ways to increase confidence in the supply chain. To do so organisations need to understand the elements of supply chain confidence – visibility and control – the lack of which will increase supply chain risk.

'Visibility' refers to the ability of all members of a chain to see from one end of the pipeline to another; an undistorted view not clouded by intermediate inventories or other barriers to vision. Lack of visibility forces supply chain members to rely on forecasts and to build buffers which themselves only worsen the situation. Unfortunately it is often the case that members of the supply chain do not have detailed knowledge of what is happening in the rest of the chain – for example, information on finished goods inventory, material inventory, work-in-process, demand levels, production plans, capacity, yields, order status and so on.

Supply chain control refers to the ability to respond to disturbances in appropriate ways. Problems arise when disturbances are not recognised in time and when there is a time lag for the remedial action to take effect. What can sometimes happen is that the intended remedial action actually worsens the situation!

The factors identified above are present to a greater or lesser extent in most supply chains today. For this reason it is apparent that organisations need to be aware of where the vulnerabilities are in their supply chains, the sources of risk and how that risk can be managed (and of course reduced wherever possible).

## Conclusions

The key findings from this research into supply chain vulnerabilities are:

- Supply chain vulnerability is an important business issue.
- Little research has been undertaken into supply chain vulnerabilities.
- Awareness of the subject is poor.
- There is a need for a methodology for managing supply chain vulnerability.

Recent events, not least those of September 11<sup>th</sup> 2001 in the USA and the UK's Foot and Mouth Disease outbreak, highlighted that supply chain disruptions have a major impact upon advanced, industrialised economies. Whilst these were exceptional events, this research uncovered numerous, smaller scale incidents capable of creating wide-ranging and unforeseen disruption.

On the one hand, contemporary developments in business thinking have in many instances reduced supply chain vulnerability to 'everyday' supply chain risks by improving their internal efficiency and the effectiveness. However, these same measures have reduced resilience to 'exceptional' external disruptions.

Whilst many of the concepts behind the trends appear sound in themselves, unintended side-effects again point to a lack of understanding of the true nature of modern supply chains and their vulnerabilities. The findings of this research underline the fact that these increasingly lengthy supply chains are in truth supply networks connecting businesses, industries and economies.

Consequently, the diverse range of effects triggered by even a modest incident can fail to lead to underlying weaknesses being diagnosed if they are considered in isolation and not as part of the wider, overarching system. In effect, current understanding is underdeveloped and only capable of looking at pieces of the supply chain vulnerability jigsaw, without the ability to connect those pieces and see the wider picture.

Business continuity and risk management, particularly with regard to information systems, appears to be fairly well understood and applied within individual organisations. The same is not true in terms of risk management in supply chains. Where awareness exists, a major impediment to the application of supply chain continuity management is the lack of an integrated programme of action or access to an appropriate 'tool kit'.

Dealing with supply chain vulnerability appears to require a change management approach, i.e. one that employs the '3-P' approach of, Philosophy; Principles; and

Process. Such an approach recognises that the 'right' philosophy for tackling supply chain vulnerability depends on the culture, structure and business drivers dominant in an industry sector. Against these qualifying criteria, it was possible to identify four issues that foster success in supply chain continuity management:

- Risk awareness among top managers
- Risk management as an integrated part of supply chain management
- Each individual employee in each entity must have
  - a) risk awareness and
  - b) understanding of his/her role in the processes.
- Understanding that changes in business strategy change supply chain risk profiles.

Determining the appropriate practices to manage the supply chain vulnerability issue appears to be context specific, dependent amongst other things on the supply chain's response to the need for operational excellence. Recognising this situation it was possible to identify the following principles:

- Risk considerations should influence the supply chain design and structure
- Risk management should be based on a high level of supply chain visibility and understanding amongst all entities
- Risk management should be based on clear performance requirements and lines of communication between all entities
- Supply chain risk management should be based on process alignment and co-operation within and between the entities

At a tactical level, a set of activities should be carried out to prepare for and handle disruptions. These activities form the processes.

- Risk identification process (e.g. product / supplier / supply chain related)
- Risk assessment process (e.g. likelihood v impact v cost)
- Supply chain continuity management and co-ordination processes
- Processes to ensure learning from experiences

Failure to consider these 3-Ps and develop the appropriate techniques and tools for managing supply chain vulnerability is a significant barrier to successful implementation. Beyond that, there are clearly identified conflicts of interest that are also likely to make implementation difficult, these aspects need further consideration if they are to be overcome. There are of course some 'planned' rather than 'accidental' disruptions that no amount of contingency planning will ever be able to eliminate completely, because determined 'disruptive agencies' whether terrorist, protestors or disgruntled employees will adapt their behaviour accordingly.

For a copy of the full report, please contact:  
Tracey Stickles: 01234-751122  
t.brawn@cranfield.ac.uk