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Title: Managing Global Food Supply Chain Risks: A Scenario Planning Perspective

A. Deep
Business School, Loughborough University
Loughborough LE11 3TU, UK
Email: a.deep@lboro.ac.uk || Phone: +44.1509 223176

S. Dani
Business School, Loughborough University
Loughborough LE11 3TU, UK
Email: s.dani@lboro.ac.uk || Phone: +44.1509228830

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Introduction

Food is a fundamental requisite for human existence. An agrarian society shows the simplistic form of existence where agriculture forms the core of the society and is the prime means of support and sustenance. That, however, no longer remains the foundation of most of today's developed economies where food chains are increasingly becoming complex and multi tiered. The chains start with agriculture and ends ultimately, with household consumption. But the numbers of entities between these ends encompass geographical, economic, political and social extremes. This compounded over uncertainty occurring from natural disasters, climate changes, epidemics and terrorist threats place the food supply chain in a particularly vulnerable position. The recent Chinese milk scare which left thousands of Chinese babies ill after consuming melamine tainted milk powder produced by the Chinese Sanlu Group required urgent action by New Zealand, United States and the European Union to issue product warnings to contain the spread of melamine related kidney failure amongst infants in other countries. The more recent case of Salmonella outbreak in America traced to peanut butter manufactured at the Peanut Corporation of America, a factory in Blakely, Georgia caused the immediate recall of 2100 products in 17 categories.

As organisations grow they focus on their 'core competencies' and analyse value addition as the prime factor for making make/buy, in-house/ outsource decisions. Vertically integrated companies are becoming increasing rare and lean manufacturing is pushing towards minimum buffer in supply chains . Back in 1958 the pioneer in industrial simulation Prof Jay Forrester predicted "there will come a general recognition of the advantage enjoyed by the pioneering management who have been the first to improve their understanding of the interrelationships between separate

company functions and between the company and its markets, its industry and the national economy". The supply chains of today are a prime example of how this prediction has translated into normal industrial practice. This invariably is leading to a situation of lowest cost but highest risk.

This paper presents a background to the complexity of managing risks in the food supply chain. There are several methods of risk management available in the literature but one which is of interest to this study is the use of scenario planning as a predictive or proactive method to identify and mitigate risks both within the organisation as well as in the supply chains.

Risks Definition

Before we can understand the constituents of supply chain risks it is important to define the term "risk". Risk for the lay terms is understood as being vulnerable and is defined by the Oxford English dictionary 2005 as "a situation involving exposure to danger" .This danger can arise from known or unknown causes. This leads us to the more academically accepted definition of risk described by Frank Knight (1965) using grounded probability as:

Risk = (the probability that some event will occur) X (the consequences if it does occur)

By this definition Knight distinguishes risk from uncertainty as genuine uncertainty can not be assigned well grounded probability. Several authors have thereafter tried to define risks in different terms which include March and Shapira (1987) who define risk "as a variation in distribution in possible outcomes, likelihoods and their subjective values" but agreed that this definition was not the view of risk by most managers. Deloach (2000) defines business risk as a level of exposure to uncertainties that the enterprise must understand and effectively manage as it executes its strategies

to achieve business objectives and create value. Lastly the Royal Society (1992) defines risk as "the probability that a particular averse event occurs during a stated period of time, or results from a particular challenge".

Risk Management

Risk Management: As noted above uncertainties create risks for the proper functioning of supply chains. The implications for any organization faced with potential risks such as contamination, theft, flood and terrorist attacks are huge. Zsidisin et al (2004) and Zsidisin (2003) concluded that most companies recognise the importance of risk assessment programs and use different methods, ranging from formal quantitative models to informal quantitative plans, to assess supply chain risks. However, most companies invested little time or resources for mitigating supply chain risks. Repenning and Sterman (2001), suggest that firms rarely invest in improvement programs in a proactive manner because, "nobody gets credit for fixing problems that never happened". Finch (2004), has tried to create a best practice methodology for generating risk management strategies based on various incidents, but this is limited to the context of Information systems.

According to Sheffi (2004), the two basic elements of resilience are redundancy and flexibility. He says that some companies take a chance and hope that nothing bad will happen, whereas some others invest in building redundancy into the system and prepare a business continuity plan. Companies, which view this as a strategic issue and become more flexible, are resilient and can tackle threats to supply chain disruption. This means that companies are prone to be more reactive even though they have built in a certain amount of flexibility to handle the disruption. This seems to suggest that there may be scenarios when the disruption is unavoidable (due to environmental incidents or fires, for example) and the flexibility helps to react and

bring the situation to a normalcy. But there may be situations when the signs of an impending disruption are seen on the horizon and then decisions are taken to control the situation before it turns out to be a confrontation or crisis. There is another option in which, risk management and mitigation requires a proactive stance wherein a firm's strategy involves using predictive technology to anticipate future disruptions and putting processes and resources in place so as to avoid future disruptions. Thus supply chain risk management strategies can be described as being reactive or proactive. Being reactive is a default position when a risk materialises. This is in effect necessary when a supply chain operates without worrying about risks on a day-to-day basis but reacts to mitigate when the difficulty or disruption strikes This impacts the supply chain members until the situation is resolved, which needs to be done quickly as a delay can cause serious damage even to a large corporation as seen in the Peanut butter Corporation case. In a proactive strategy, potential risks are identified at a supply chain design stage, their probability and impact are assessed and they are ranked by importance. The focus of this exercise is to target the identified risks in order to avoid them. This may not be possible in all cases and hence there is a need to develop and implement contingency plans to minimise the impact if and when the risk occurs. This would appear the most logical process for supply chain managers, but it requires resources, in terms of investment and people, upfront. Hence, if a risk never materializes, it becomes very difficult to justify the time spent on risk assessments, contingency plans, and risk management (Zsidisin et al., 2000). This also leads to evaluating the total cost of an undesirable event occurring against the benefits realized from having strategies in place that significantly reduce the chance and/or effects of detrimental events with supply. Also, it is not always possible to obtain reliable estimates of the probability of the occurrence of any particular

disruption and accurate measures of the potential impact of each disaster. Although, the process of proactively managing the risks looks to be fairly familiar to most of the risk management/mitigation strategies, it is not explicitly cited in the supply chain risk management literature.

Food Supply Chain

High energy prices, poor harvests, rising demands for growing populations, use of biofuels and export bans have pushed up prices. The food supply chains aiming at maximising the 'value creation' are heavily reliant on imports and a multi-tiered supply chains. A simplified version of the food supply chain shown in Figure 1 below illustrates the number of entities involved in the process.

The chain starts with a farmer using farm supplies like machinery, seeds, fertilisers, pesticides etc. The farmers then use logistics providers to transport the food either directly the food processor or indirectly through storage and marketing via a cooperative group or consolidator. The involvement of the farmer is often limited up to the processor and does not extend down to the customer or even the distributor. This limits the traceability and transparency of a typical supply chain.

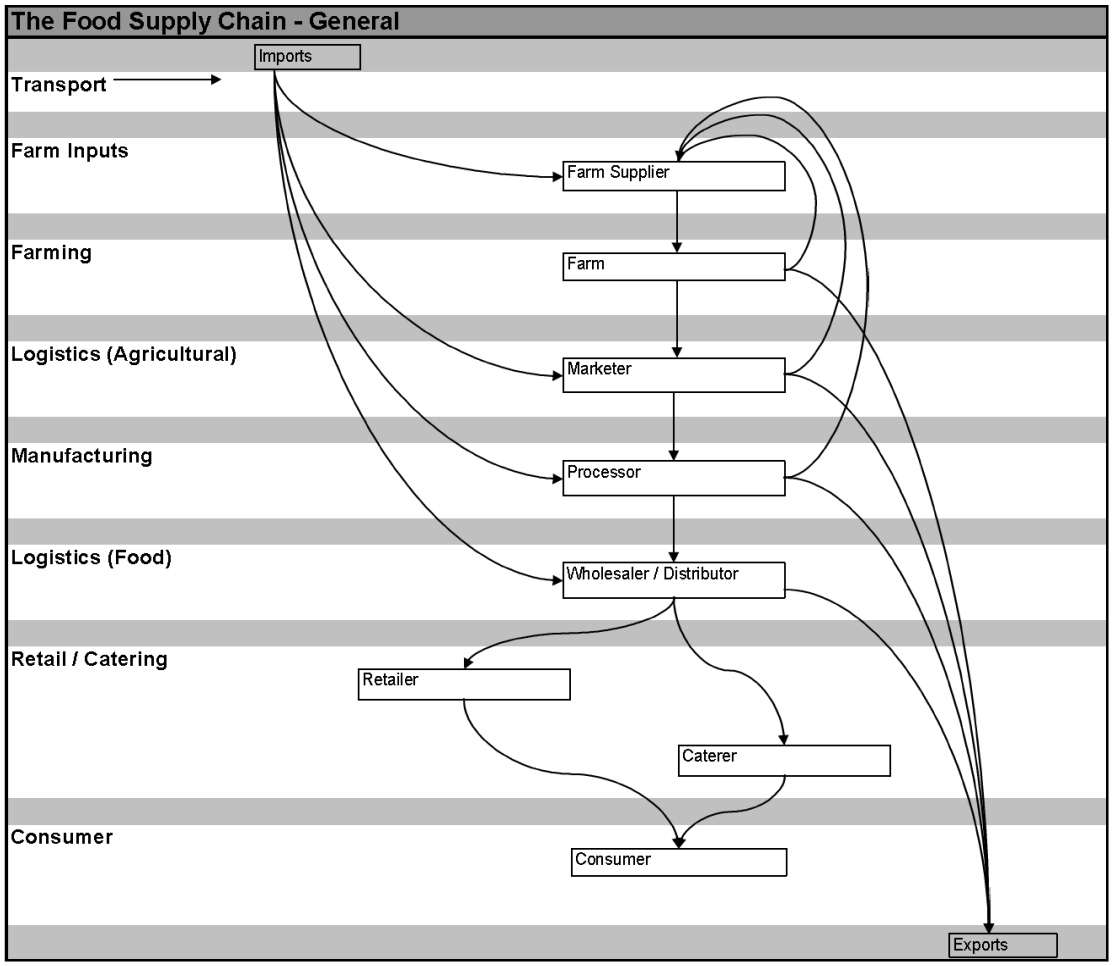

Figure 1: The Food Supply Chain (Source EAFL 2008)

The major forces affecting the traceability are identified by Roth et al (2008) as globalisation, consolidation and commoditisation. Globalisation refers to the movement of the food supply chain model from regional, as witnessed few decades ago, to global in terms of both importing raw materials to reduce cost as well as exports of final products to increase revenue at all levels of the supply chain. Consolidation refers to the growing trend amongst entities within the food chain to combine as many food categories as well as levels of the supply chain in pursuit of higher margins. This has lead to the dominance of huge enterprises at each level. For example within retail Tesco consists of 3278 stores worldwide and employs 440,000 people, Cargill has diversified segments of farm supplies, marketer, storage and

processing. It is currently the largest privately owned company in the US. It operates out of 67 countries worldwide and employs over 160000 people. Lastly commoditisation refers to the distinction between food products as either value added or commodities. Value added goods are those where the specific nature of the food is of central importance to customers for e.g. vegetables, certain meats etc. On the other hand commodity foods are undifferentiated goods for e.g. grain. These compete mostly on price and are aggregated from multiple global sources and standardised.

A simple food item like the Kellogg's nutria-grain bar may include ingredients from US, Italy, Scotland, Denmark, India, Philippines, China

As the food supply chains become increasingly global the inherent risk arising from disruptions in supply, lack of traceability and limited accountability have brought supply chain risk management to the fore.

Food Supply Chain Risks

Despite extensive food safety legislation, increasing customer concerns and its consequential costs imposed on society as a result of frequent food safety and security scares has lead to an increase in the focus on the causes, effects and prevention of hazards. . Helen Peck (2006) in her report on business reliance in the food sector identified a big gap in the preparedness for business continuity management (BCM) as very few companies had adopted a proactive or preventative stance to crisis management and operated mostly in the reactive mode. One of the conclusions of her report was that the drive for efficiency and the just-in-time philosophy used by the food industry has progressively reduced stock levels throughout the supply chain - with the resulting damage to its resilience when an emergency occurs. The consolidation of distribution networks by food manufacturers and the trend towards using 3PL (Third Party Logistics) providers, and reducing distribution sites means

that the loss of a site due to events such as a fire or flood could also cause a disruption in the supply chain. Statistically such events are predictable but as shown by Peck (2006), many managers pointed out that the trend toward fewer and larger production and distribution sites meant that the potential impact was increasing.

Supply chain risks have been classified by Kliendorfer and Saad (2005) in two broad categories. First, risk arising from the problems of coordinating supply and demand and second are risks arising from disruptions to normal activities. Christopher and Peck (2003) on the other hand categorise risks into five categories

1. Internal to the firm:
    i) Process
    ii) Control
2. External to the firm but internal to the Supply network:
    i) Demand
    ii) Supply
3. External to the network:
    i) Environmental

In her report for the Department of Food and Regulations Authority (DEFRA) Peck includes risks in the food supply chain under as the following

- Product contamination & recall
- Loss of access – terrorism
- Loss of access – protesters
- Loss of site
- Reduced capacity
- Loss of people
- Loss of supplier

- Contractual cover
- Dual sourcing
- Market forces

Scenario Planning

History

Scenario planning was described by Ringland as a set of processes for improving the quality of educated guesses and also for deciding what their implications are . Although not formally called Scenario Planning, its origins can be traced in versions of systems thinking employed during world war two. where it was used in conjunction with other complex analysis techniques as a military tool to develop strategies during the war. The history of scenario planning is documented in detail by Schwartz, Ven der Heiden and Ringland but it is generally accepted that scenario planning was pioneered by Hermann Kahn in the Research and Development Institute (RAND) institute set up after the war. In the world of corporate strategists Scenario planning gained popularity after it was used in the 60s and 70s by the Royal Dutch/Shell group from the need to ensure better planning in view of forecasting errors. In his paper Wack argues that forecasts tend to extrapolate current trends which although is mostly a good way to determine conditions in the future it doesn't include the possibility of a major shift in the pattern. This limits the preparedness of organisations against major changes (for ex economic crisis, terrorist attacks etc). In the case of Royal Dutch/Shell scenario planning helped predict a steep increase in oil prices and in turn prepared the organisation for such a change. When the oil prices did go up Shell were prepared and this helped them gain a dominant position in the oil industry.

Definition

Scenario planning has been defined differently by researchers as well as industrialists for many decades but the central theme remains that it involves building scenarios or projections for how the future may unfold, understanding the full complexity of what changes such a scenario would entail and how if might affect the subject of the study. Scenario planning is a qualitative methodology of a strategic planning technique (Dyson, 1992) Scenarios was defined by Herman Kahn (1967) as "hypothetical sequences of events constructed for the purpose of focussing attention on the causal processes and decision points". Another more recent definition follows

"builds plausible views of different possible futures for an organisation based on groups of key environmental influences and drivers of change about which there is a high level of uncertainty." Gerry Johnson and Kevan Scholes (1999)

A crucial point noted by many academics is that scenarios are not predictions for the future but rather plausible futures none of which may actually materialise . Its purpose is more to make managers more aware of how prepared they are about plausible futures and how these scenarios can assist in making sound management decisions resulting in better and more effective choices

Steps of Scenario Planning

Scenario planning has now being adopted as a planning tool across many organisations but there remains ambiguity regarding the exact procedure and other variables like number of scenarios needed ,number and type of people involved etc. Ringland describes different methods for developing scenarios as used by various organisations, namely, The Battelle Institute (BASICS), the Copenhagen Institute for Future Studies (the futures game), The Futures Group (the fundamental planning method), Northeast Consulting Resources (the future mapping method) and Stanford

Research Institute (scenario based strategy development). Shoemaker describes the scenario generation process in detail which is similar in essence to most of the above mentioned techniques and involves the following steps

1. Define the scope
2. Identify the Major stakeholders
3. Identify basic trends
4. Identify key uncertainties
5. Construct initial scenario themes
6. Check consistency and plausibility
7. Develop learning scenarios
8. Identify research needs
9. Develop quantitative models
10. Evolve towards decision scenarios

Regarding the number of scenarios needed it is recommended that only a few scenarios should be investigated, these are arrived from reducing a large number of possible scenarios to a smaller number using internal consistency checks . Two or three scenarios including a 'no surprise' and a 'challenge' scenario are suggested by Van der Heijden (1996). Many of the more formalized approaches target about four or five alternative futures (Eden et al., 1997). The interrelationships among the uncertainties can be modelled using various techniques like intuitive logics, trend-impact analysis, cross-impact analysis and conditional probabilities .

According to Singh (2004) the Scenario Planning method provides a robust method for predicting the future of supply chains. He also suggests that in their research they did not find any published structured study on the future of supply chains using the

Scenario Planning approach. The conceptual model outlined in fig 2 describes a way of linking scenario planning with risk management concepts in the food industry

The Conceptual Methodology

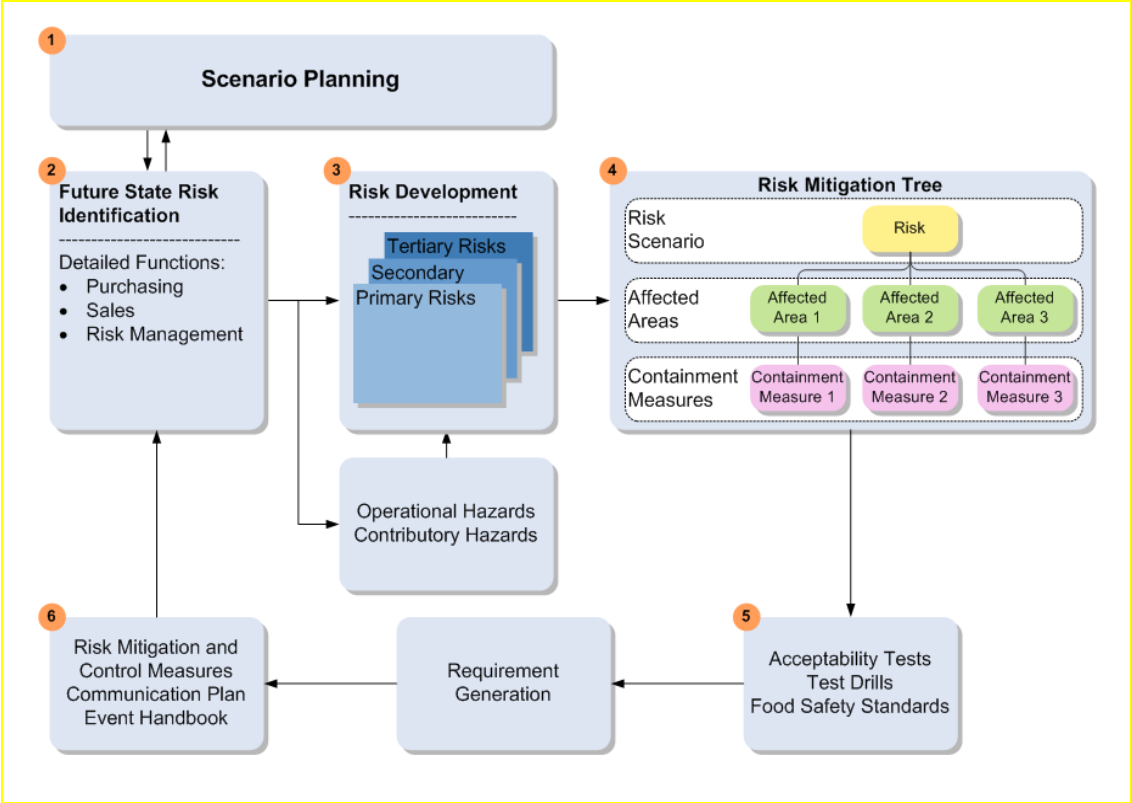

Figure 2

The conceptual model above in its current form (Figure 2) needs to be empirically tested. This will be done as future work in the current project. However to explain its operation a retrospective validation is included for the case of recent Peanut butter contamination.

Retrospective Validation

One of the biggest cases of food product recall in US history is the most recent case of outbreak of illness caused by Salmonella Typhimurium. The food and drug administration (FDA) and Centres for disease control and prevention (CDC) identified the source as peanut butter and peanut butter paste in the processing plant of Peanut

Corporation of America (PCA) at Blakely, Georgia. Since confirming the presence of Salmonella the product recall list has been steadily rising at stands at 2100 products over 17 categories at the time of writing this paper . This contamination has been directly linked to at least 486 cases of Salmonella related illness and eight deaths. The contaminations lead to PCA filing for Chapter 7 bankruptcy on February 13th 2009. Its preparedness in dealing with the situation is highlighted in the following timeline as derived from the Food and Drug Administration (FDA) report.

- On January 9th 2009 PCA stopped production in its Georgia plant for peanut butter and peanut butter paste on confirmation of contamination in those products
- On January 13th 2009 PCA announced a voluntary recall of 21 specific lots of peanut butter and paste produced in Blakely, Georgia dating back to July 1st,2008
- On January 16th 2009 PCA expanded its recall to include all peanut butter since August 2008 and peanut paste since Sept 2009
- On January 28th 2009 PCA announced it was Voluntarily recalling all peanut and peanut products processes in Blakely, Georgia because since January 1 2007 stating “they had a potential to be contaminated with Salmonella”
- On February 12th 2009, the Texas department of state and heath ordered PCA to cease all manufacture and distribution of products from its Plainview, Texas plant and to immediately recall all products manufactured there since 2005.

Another crucial factor in the unfolding of events has been the constant expansion of the list of recalled products clearly highlighting a gap in traceability of ingredients across the supply chain.

It is evident from the above detail that the PCA had not used a detailed scenario planning process to consider loss of reputation due to product contamination. This conceptual model rather than looking at the Scenario planning process itself ,which is

highly documented in literature looks at how the outputs of Scenario planning can be used to drive risk management at an operational level. Using the steps identified in the model we will consider how risk arising from product contamination can be reduced by following steps.

Step 1

Scenario Planning: For any organisation in the food sector the loss of reputation due to product contamination is a very plausible scenario. On a strategic level its effects need to be studied using the scenario planning process described before. But the output of this scenario leads to identification of product contamination as a major risk.

Step 2

Risk Identification: From the scenario the prime risk identified was product contamination. The detailed functioning of the organisation might list the interaction between the different departments and the channels for information flow. For example the channel between sales, purchasing and dispatch is crucial for early containment of the above threat. Looking at the case of PCA the contamination did not lead to any recall before a formal investigation by FDA and the CDC in Jan '09, whereas the initial cases of Salmonella poisoning started in early 2008 This indicates that either the link between Salmonella poisoning was never identified to the products at the Blakley plant or that any earlier information was not handled in a proper manner. Hence, in a hypothetical scenario planning process it is important to develop the right communication processes so that any potential threat is identified at its earliest.

Step 3

Risk Development: Step three identifies the associated risks with the primary risk of product contamination and involves identifying processes which will assist in

identifying all associated products with the primary risk. Secondary risks in the context of this model are risks which occur within the organisation as a direct result of the primary risk. For example a product contamination may result in contamination of other products using similar machinery, freezing storage etc and may also lead to risk of illness within the staff operating on the contaminated product. Tertiary risks are identified as risks resulting from the primary and secondary risks but include external linkages to the supply chain. This in the case of product contamination would include risk of contamination within other processing plants of the organisation using similar products, list of customers (retailers, food processors) for the contaminated product and distribution centres for the contaminated product. In the case of PCA Salmonella which was initially traced to contaminated peanut butter and paste soon spread quickly to peanut granules, peanut meals, dry roasted peanuts, and oil roasted peanuts and eventually the product contamination location was broadened to include the processing facility at Plainview, Texas.

Step 4

Risk Mitigation Tree elaborates on the identification of the three levels of risks and looks at providing easy information to identify and handle the risks. Following from Step 3 the mitigation tree is used to ensure that firstly that adequate processes are in place to quickly identify the dimensions of the risk i.e. the affected areas, for example a feature within the organisation to run where used on all products and ingredients, regularly updated ingredient list, measures for easily identifying customers (retailers, food processors, bakery etc), processes for identification of product categories using similar equipment, freezers, storage facilities etc.

Secondly risk containment/eradication processes like regular inspections, alert procedures for all entities in the supply chain etc.

In the absence of these procedures it becomes difficult to isolate the risk and results typically is stopping the entire production facility.

Step 5

Step5 looks at testing of these procedures and validating the procedures against existing food safety regulations. Test drills are also advocated in available literature as a key measurement technique to establish preparedness. In the case of peanut butter which is a FDA regulated product there are strict guidelines regarding the recall procedures which should be useful when developing and testing procedures.

Step 6

The output of the above exercise will lead to better risk management and control procedures, communication plans better aligned to handle risk in a more efficient manner, an event handbook which increases preparedness of organisations and other similar outputs. These outputs can then be fed back into the risk identification and scenario planning process to develop an efficient and proactive approach to risk management.

Conclusions and Future Work

This model forms the initial part of an EPSRC funded project titled “Developing a supply chain risk methodology using the scenario planning Approach” although at a very conceptual stage validation is possible through retrospective validation. The finished model will be used as part of an action based research targeting the UK food sector. The challenge will be to test its effectiveness as a risk mitigation tool deriving its inputs from scenario planning. Although scenario planning has been widely in use since the 1970s its use is predominantly confined to board rooms and strategic decisions. The challenge of using outputs from scenario planning as inputs to drive

operational and tactical improvements in risk planning is a big hurdle within organisations. Also the effectiveness of scenario planning has rarely been empirically tested in the field of supply chains (Singh, 2004).

This model proposes a structure to translate scenarios into operation changes and offers a proactive tool for the food industry to avoid or minimise disruptions in the supply chain.

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