Risk and supply chain management: creating a research agenda

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Abstract

Purpose – The aim of this paper is to develop a research agenda for risk and supply chain management. This is achieved by reviewing the literature on supply chain risk and locating it within the general literature on risk.

Design/methodology/approach – A review of the general literature on risk and the specific literature on supply chain risk was undertaken.

Findings – The paper shows that there are a number of key debates in the general literature on risk, especially in terms of qualitative versus quantitative approaches, which need to be recognised by those seeking to apply risk theory and risk management approaches to supply chains. In addition, the paper shows that the application of risk theory to supply chain management is still in its early stages and that the models of supply chain risk which have been proposed need to be tested empirically.

Research limitations/implications – This is a literature review and, therefore, is based on secondary rather than primary sources.

Practical implications – The paper proposes a research agenda aimed at developing models of supply chain risk management based on combining the wider theory and practice of risk management with the needs and practices of supply chain management.

Originality/value – This paper brings together the literatures on general risk and supply chain risk; and identifies key issues and research questions which need to be addressed in applying risk management to supply chains.

Keywords Risk analysis, Risk management, Supply chain management

Paper type Research paper

Introduction

Over the past two decades, supply chain management has come to be seen as a key component of organisational competitiveness and effectiveness (Porter, 1985; Womack and Jones, 2005). In the same period, most large, and many small, organisations have put a great deal of effort into improving their own and their suppliers' supply chain performance (Burnes and Dale, 1998; Christopher, 2005; Hines *et al.*, 1999). To a large extent, much of this effort has been aimed at improving the efficiency, i.e. lowering costs, of supply chain operations (Kilgore, 2003; Radjou, 2002). However, as Hendricks and Singhal (2005) argue, in developing supply chain strategies which focus on cost reduction, organisations have ignored or played down the risks from supply

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chain disruptions. Cousins *et al.* (2004) suggest that there are two main types of supply chain risk to which companies can become exposed: technological risk – over-reliance on a single or limited source of a product, process or technology; and strategic risk – over-reliance on a single or limited number of suppliers. Cousins *et al.* also suggest that some of the measures which companies take to improve the efficiency of their supply base, such as de-listing under-performing suppliers, may increase their exposure to technological and strategic risk by increasing their reliance on the remaining pool of suppliers. As Hendricks and Singhal (2003) note, the failure to manage supply chain risks effectively can be very costly. They found that, on average, major supply chain disruptions can reduce the stock market value of a company by 10 per cent. Indeed, moving beyond supply chain risks and looking at the risks faced by organisations in general, Hood and Young (2005) maintain that many organisations may have gone out of business because of their failure to adopt effective risk management strategies (e.g. Railtrack, Barings Bank and Enron).

In order to examine risk and supply chain management, this paper will address three questions:

(1) What is risk and risk management?

(2) Is risk an important issue for supply chain management?

(3) What approaches are available for managing supply chain risk?

The paper begins by reviewing the general literature on risk and then proceeds to examine the literature on supply chain risk and its management. The paper concludes by proposing a research agenda aimed at developing models of supply chain risk management based on combining the wider theory and practice of risk management with the needs and practices of supply chain management.

Defining and managing risk

What is risk?

The word "risk" derives from the early Italian word *risicare,* which means to dare (Bernstein, 1996). However, its meaning has evolved over time and appears to mean different things to different people depending on their individual perception of the world (Frosdick, 1997). The study of risk began in seventeenth century and is associated with the French mathematicians Blaise Pascal and Pierre de Fermat, who sought to apply mathematics to gambling (Frosdick, 1997). Their work led to the development of probability theory, which lies at the heart of the concept of risk (Bernstein, 1996). Though risk was associated solely with gambling for many years, by the early nineteenth century, the term risk, with its anglicised spelling, had been adopted by the insurance industry in England (Moore, 1983). However, it was only in the 1950s and 1960s, with major developments in technology and the increasing size and internationalisation of organisations, that risk and its management became of concern to the wider business community (Grose, 1992; Snider, 1991).

Though interest in risk and supply chain management is relatively new, interest in risk and purchasing can be traced back to Robinson *et al.*'s (1967) work on the BuyGrid, model and, most especially, to Williamson's (1979) work on Transaction Cost Economics (TCE). Williamson argued that the risk of transaction costs between a customer and a supplier increasing was dependent on the level of uncertainty in the relationship. For example, the more dependent a customer is on a particular supplier,

i.e. the greater the cost of switching to another supplier, the less certain the customer is that the supplier will not act opportunistically to raise prices, unless other factors, such as contractual arrangements, prevent this. Williamson's view of transaction uncertainties is in line with more general definitions of risk. For example, Moore (1983) maintains that there are two basic components of risk. The first is risk as a future outcome, which can take a number of forms, such as a supplier raising prices. The second component is the probability that a particular outcome may occur. In terms of TCE, the less regulated the relationship is, the greater the probability of opportunistic behaviour. Therefore, risk embraces both the range of outcomes that might occur and the likelihood of their occurring.

A key component of risk is choice. Bernstein (1996) maintains that risk is about choice: ... the actions we dare to take, which depend on how free we are to make choices, are what the story of risk is all about. It has been argued that if a customer chooses to develop and invest in a long-term relationship with a supplier, it can bring significant benefits (Burnes and Dale, 1998; Burnes and New, 1996; Womack *et al.*, 1990). However, if either partner defaults or attempts to take advantage of the other, the risks can also be significant (Cousins *et al.*, 2004). Therefore, as Moore (1983) notes, risk encompasses both the possibility of loss and the hope of gain. Nevertheless, in looking at how organisations perceive risk, it is the negative connotations of risk – loss rather than gain – which seem to preoccupy managers (Hood and Young, 2005; March and Shapira, 1987). This is especially the case with large engineering projects, such as petro-chemical plants and nuclear power stations, where the consequences of failure can be catastrophic (Frosdick, 1997). Not surprisingly, this is also the area where most work has been carried out on formal risk assessment procedures. In the UK, the Royal Society (1992) established a working party to investigate risk and risk assessment. It stressed the negative elements of risk, defining it as ... a combination of the probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequences of the occurrence (Royal Society, 1992).

Many others have also stressed the negative side of risk:

- Lowrance (1980) describes risk as a measure of the probability and severity of adverse effects.
- Rowe (1980) defines risk as the potential for unwanted negative consequences to arise from an event or activity.
- Simon *et al.* (1997) perceive risk in terms of the likelihood of an uncertain event or set of circumstances occurring which would have an adverse effect on the achievement of a project's objectives.

Moore (1983) stresses that the perception of risk is often context-dependent:

> ... when terms like high risk or low risk are used, the meaning commonly depends on the starting asset base and the consequences that the occurrence of the risk would have for the asset base of the individual or organisation concerned.

Mitchell (1999) takes a similar view, stating that:

> Risk is, therefore, defined as a subjectively-determined expectation of loss; the greater the probability of this loss, the greater the risk thought to exist for an individual.

Many other writers have also pointed to the subjective nature of risk (Gilovich, 1991; Kahneman and Tversky, 1979; Odean, 1998; Russo and Schoemaker, 1992). These writers raise an important question which many researchers either appear to be unaware of or prefer to avoid: is risk something that can be objectively measured and agreed upon by all concerned, or is it something which is subjective and based on individual perception? In relation to the three research questions stated in the Introduction, the issue of whether risk can be measured objectively or whether it is based on a subjective viewpoint will have a significant impact on how the various parties in a supply chain relationship perceive and attempt to manage risk.

Risk and uncertainty

Whilst they are intimately linked, risk and uncertainty are not the same. Knight (1921) made the simple distinction between risk and uncertainty: risk is something measurable in the sense that estimates can be made of the probabilities of the outcomes. On the other hand, uncertainty is not quantifiable and the probabilities of the possible outcomes are not known. Yates and Stone (1992, however, argue that every conception of risk implies that there must be uncertainty about the prospective outcomes, and that if the probability of those outcomes is known, there is no risk. To an extent, Slack and Lewis (2001) encompass both viewpoints. They describe uncertainty as a key driver of risk but argue that managers are able to measure and change their exposure to risk through the development of prevention, mitigation and recovery strategies. Whilst these do not eliminate uncertainty, they do enable managers to reduce the risks which might arise from uncertainty. The debate on risk and uncertainty is an important one, where different viewpoints clearly exist; however, in this paper, we take the view that whilst uncertainty may not be measurable, risk is both measurable and manageable.

Is risk an objective or subjective phenomenon?

There is a long-standing debate between those who see risk as objective and those who argue that risk is subjective (Bernstein, 1996; Frosdick, 1997; Moore, 1983; Spira and Page, 2002; Yates and Stone, 1992). Lupton (1999) observed that views of risk range between the technico-scientific perspective, which sees risk as objective and measurable, to the social constructionist perspective, which sees it as being determined by the social, political and historical viewpoints of those concerned. Yates and Stone (1992, p. 5) take the latter view, arguing that risk is a subjective construct because ... it represents an interaction between the alternative and the risk taker. They maintain that the nature of any potential loss, its significance and the estimated chance of its occurring are personal to the individuals concerned, e.g. the result of risk-taking can be perceived as positive by some but negative by others. Thus, for Yates and Stone, risk is not an objective feature of a decision alternative. The Royal Society (1992) appeared to adopt a similar view, stating that ... a particular risk or hazard means different things to different people in different contexts ... [and] ... risk is socially constructed. However, the Royal Society (1992) also noted that most engineers and physical scientists tend to see risk as something that is objective, quantifiable and manageable.

According to Bernstein (1996) the argument boils down to one fundamental question: to what extent does the past determine the future?:

> We cannot quantify the future, because it is unknown, but we have learned how to use numbers to scrutinize what happened in the past. But to what degree should we rely on the patterns of the past to tell us what the future will be like? Which matters more when facing a risk, the facts as we see them or our subjective belief in what lies hidden in the void of time? Is risk management a science or art? Can we even tell precisely where the dividing line between the two approaches lies?

Over the years, a number of well-used tools for quantifying and managing risk have been developed. These include: FMEA (failure mode effect analysis), CBA (cost benefit analysis) and RBA (risk benefit analysis). Though accepted and used by many managers, they have been criticised for removing the element of human judgment from decision making by disguising underlying assumptions with mathematical formulae (White, 1995). Adams (1995) clearly illustrates an opposing view of quantifiable approaches to risk decision-making:

> Rarely are risk decisions made with information that can be reduced to quantifiable probabilities, yet decisions somehow get made.

The debate between those who see risk as objective and those who see it as subjective is an ongoing one which will not be resolved here, if indeed it is resolvable at all. It is necessary, though, to recognise that such a debate is taking place and that it does have significant implications for how risk is seen and managed. It is also necessary to recognise that most of those studying supply chain risk do not appear to recognise that there is a debate over its nature. Though most use terms such as perception and perceived (Cousins *et al.*, 2004; Kraljic, 1983; Williamson, 1979), indicating a subjective rather than objective perspective, others write of probability (Harland *et al.*, 2003), indicating a more objective perspective. Nevertheless, the issue of whether risk is a subjective or objective construct does not appear to be acknowledged in the supply chain literature. However, whether one views risk from a subjective or objective standpoint, the key question for organisations is: how can risk be managed?

Approaches to managing risk

There seems to be general agreement on what the risk management process should be. For example, Dickson (1989) defines risk management as "The identification, analysis and control of those risks which can threaten the assets or earning capacity of an enterprise". Similarly, Fone and Young (2000) see risk management as a general management function that seeks to assess and address risks in the context of the overall aims of the organisation. However, as the Royal Society (1992) stated, there is some dispute over whether it is an everyday part of business life or something which is brought out and used as and when it is needed. Most professional bodies which deal with risk take the view that:

> Risk management should be a continuous and developing process which runs throughout the organisation's strategy and the implementation of that strategy. It should address methodically all the risks surrounding the organisation's activities past, present and in particular, future. It must be integrated into the culture of the organisation with an effective policy and a programme led by the most senior management. It must translate the strategy into tactical and operational objectives, assigning responsibility throughout the organisation with each manager and employee responsible for the management of risk as part of their job description. It supports accountability, performance measurement and reward, thus promoting operational efficiency at all levels (IRM/AIRMIC/ALARM, 2002, p. 2).

This is why Tchankova (2002, p. 290), for example, maintains that "risk management has become a main part of the organisation's activities and its main aim is to help all other management activities to achieve the organisation's aims directly and efficiently". Hood and Young (2005) support this view, pointing to the UK public sector where, over the last decade, great emphasis has been placed on integrating risk management into the day-to-day management of national and local government bodies.

According to Cox and Townsend (1998), the actual process of risk management normally begins by assessing two factors: firstly, the likelihood of specific events occurring; and secondly, the consequences should the events actually occur. The Royal Society (1992) took a similar view, defining the risk management process as the making and implementing of decisions concerning risks based on risk estimation and risk evaluation. The objective, according to the Royal Society, is to mitigate the impact of risks by reducing the likelihood of their occurrence and/or the avoidance of their consequences.

Smallman (1996) takes the view that effective risk management does not need to be a highly formalised and structured process, but instead it should be based on good commonsense. Nevertheless, the majority of observers tend to favour a more formal, structured approach to managing risk (Frosdick, 1997; Royal Society, 1992; Steele and Court, 1996; Yates and Stone, 1992). White (1995) argues that though a number of different risk management systems have been put forward, most approaches tend to follow the generic process shown in Figure 1. This consists of three critical stages:

(1) *Risk identification.* Its purpose being to determine all risk factors that are likely to occur on a project.

(2) *Risk analysis.* Its purpose being to understand the likelihood and extent of the most significant risks.

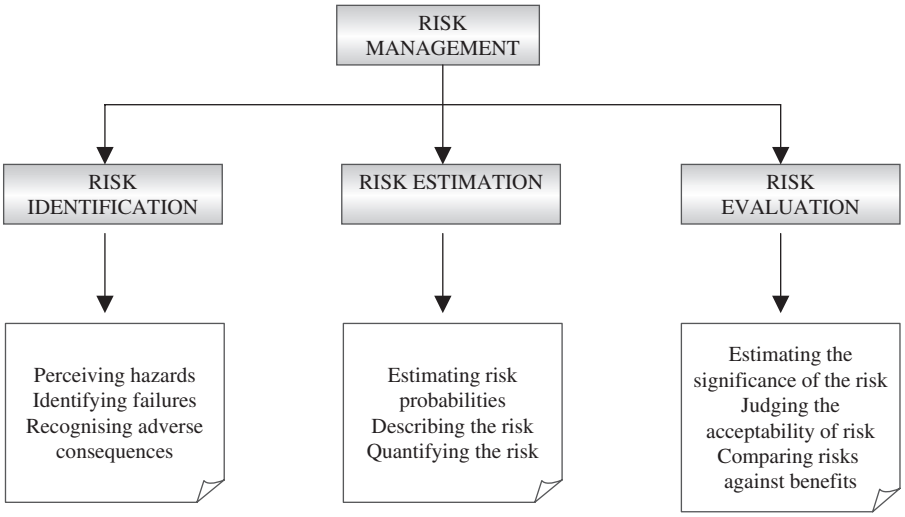

Figure 1.
The risk management process

Source: White (1995, p.36)

(3) *Risk evaluation.* Its purpose being to decide on the most appropriate management response for each risk/combination of risks and which party is most appropriate to manage each of the risks identified.

Simon *et al.* (1997) suggest that, whilst there is a wide range of techniques available to undertake each of the three stages of the risk management process, these can be separated into three groups:

(1) *Qualitative techniques.* These seek to identify, describe, analyse and understand risks.

(2) *Quantitative techniques.* These seek to model risk in order to quantify its effect.

(3) *Control techniques.* These seek to respond to identified risk in order to minimise risk exposure.

Zsidisin *et al.* (2004) adopt a similar view, arguing that the main techniques fall into four categories: formal, informal, qualitative and quantitative. Frosdick (1997) takes a slightly different approach to categorising the various tools and techniques for risk assessment. He argues that they can be categorised under the broad headings of intuitive tools (such as brainstorming), inductive tools (such as FMEA), and deductive tools (such as accident investigation and analysis).

Going back to the earlier discussion of the nature of risk, the various risk assessment tools and techniques can also be categorised as to whether they use subjective measures, objective measures, or a combination of both. In the latter category, one of the most detailed tools for risk assessment is the Comprehensive Outsource Risk Evaluation (CORE) system, which was developed by Microsoft and Arthur Anderson (Michalski, 2000). The CORE system identifies 19 risk factors, which are categorised into four families:

(1) infrastructure;

(2) business controls;

(3) business values; and

(4) relationships.

Each family is weighted based on its importance to the company's long-term business strategies. Risk is analysed objectively using financial data, and subjectively, by using measures such as the strength of the relationship between the firms, or through a combination of objective and subjective measures (Michalski, 2000).

Though the CORE system, and other similar systems, seek to combine quantitative and qualitative measures in an attempt to address the subjective-objective argument identified earlier, this does not appear to impress either camp. Those who believe that risk assessment is basically a quantitative process argue that the use of subjective measures undermines the usefulness of the quantitative measures, and, in any case, it is possible to quantify those elements classed as subjective (Mayo and Hollander, 1991). Not surprisingly, those who take a subjective approach maintain that quantitative measures offer a misleading exactitude because at their root they rely on subjective interpretations (Frosdick, 1997). This disagreement was clearly evident in the Royal Society's (1992) study, where there were strongly divergent views between the physical and social scientists on this issue.

Therefore, though risk assessment is seen as important, and though there is general agreement about the risk management process (Figure 1), there is much debate and disagreement as to the validity and usefulness of the tools and techniques which have been developed to operationalise the process (Frosdick, 1997; Lupton, 1999). Nevertheless, in practice, as Hood and Rothstein (2000) found, top business leaders tend to prefer approaches to risk management which combine subjective and objective measures because this allows them some freedom of manoeuvre rather than being pushed into taking decisions based solely on numerical analysis. Another reason why top managers may wish to keep their options open is that, as Hendricks and Singhal (2005) maintain, risk can impact differently on different stakeholders in a business. For example, the personal risk to an individual foreign exchange trader of speculating on currency fluctuations may be small but the risk for the person or body whose money is being used for the speculation may be large. Therefore, managers may need to balance the interests of different stakeholders rather than seeking to minimise risk altogether. In any case, given that there is no consensus as to the most appropriate strategies for managing risk, even if it were possible to calculate the nature and likelihood of a particular risk, it is unlikely to be clear how best to respond to it (Beck, 1992; Douglas, 1985; Fischhoff *et al.*, 1981; Giddens, 1990; Hood and Young, 2005; Plough and Krimsky, 1987; Wildavsky, 1985).

In summary, therefore, the study and application of risk management has a long antecedence. In terms of organisations, it tends to be associated with avoiding loss rather than seeking advantage, and though the process of risk management is well developed, there is much disagreement as to whether it is a subjective or objective process, or a combination of both. In addition, given the potential for stakeholder conflict and the lack of agreement as to risk reduction strategies, there is a tendency for managers to seek to keep their options open rather than adopting prescriptive approaches to risk management. The next section will address risk in relation to supply chain management. This is an area where the issue of risk has only relatively recently been addressed and where the approach to risk management appears to be underdeveloped.

Risk and supply chain management

The importance of risk for supply chain management

There is considerable evidence that failure to manage supply chain risks effectively can have a significant negative impact on organisations (Mitchell, 1995). As Hendricks and Singhal (2005) showed, not only can the failure to manage supply chain risks effectively lead to a sharp downturn in an organisation's share price, which can be slow to recover, but it can also generate conflict amongst the organisation's stakeholders. Cousins *et al.* (2004) identify the wider consequences of a failure to manage risks effectively. These include not just only financial losses but also reduction in product quality, damage to property and equipment, loss of reputation in the eyes of customers, suppliers and the wider public, and delivery delays. There is also evidence that economic, political and social developments over the past decade appear to be increasing the risk of supply chain disruptions as supply chains are getting longer and more complex and are involving more partners due to the increase in global sourcing (Hendricks and Singhal, 2005). Also, the threat of terrorism, such as 9/11, military action, such as the war in Iraq, disease, such as the foot and mouth outbreak in the UK,

and natural disasters, such as hurricane Katrina which devastated New Orleans, all have the power to disrupt, or cause uncertainty in, supply chains (Elliott, 2005; Peck and Juttner, 2002). In addition, we now appear to be living in an era of rapid change in technologies and product markets, and increasing customer expectations in terms of better products, lower prices and quicker response times (Hallikas *et al.*, 2002; Handfield and Nichols, 1999). Add these all together and it can be seen that the potential risks facing supply chains are growing significantly.

As Table I illustrates, research into aspects of supply chain risk is not new. Landmark studies in the 1960s and 1970s led to the development of the BuyGrid model by Robinson *et al.* (1967) and TCE by Williamson (1975, 1979). As mentioned earlier, TCE is concerned with the financial exchange and investments between a buyer and supplier, with part of the costs being associated with managing the buyer and supplier relationship (Williamson, 1975, 1979). For example, some of the costs of a relationship to a supplier could be the investment in machinery or technology in order to supply the buyer. These costs could be very high and could expose the supplier to considerable risk should the customer choose to go elsewhere. However, they are a cost the supplier has to incur if they wish to do business with the customer. From the customer's point of view, this type of situation might make it difficult to find, and costly to switch to, another supplier. In such a case, the risk arises that the customer or supplier might indulge in opportunistic behaviour, i.e. a customer might take the opportunity provided by the supplier's dependency to negotiate a price reduction or the supplier might take the opportunity caused by the customer's dependency to increase prices. In the former situation, the transaction costs for the customer might be lower whilst in the latter they might be higher. TCE predicts that as investments become more specific to the buyer and supplier relationship, and as transaction uncertainties increase, the relationship will move towards a more long-term contract in order to safeguard the position of both parties. Hence, TCE implies that long-term relationships may reduce uncertainty or risk (Williamson, 1975, 1979).

The BuyGrid model (Robinson *et al.*, 1967; Wind and Webster, 1972) describes the behaviour of buyers in three different purchasing situations:

(1) *The straight rebuy* – where the product being purchased is the same as was ordered previously.

(2) *The modified rebuy* – where some aspects of the product specification have changed, e.g. price.

(3) *The new task* – where an entirely new product or service is being purchased.

Research field	Writers
Marketing/economics	Williamson (1975, 1979) and Mitchell (1995, 1999)
Organisational buying behaviour	Robinson *et al.* (1967), Wind and Webster (1972) and Valla (1982)
Strategic management	Ruefli *et al.* (1999)
Purchasing and supply management	Kraljic (1983), Smeltzer and Siferd (1998) and Zsidisin *et al.* (2004)
Purchasing strategy selection	Hallikas *et al.* (2002)
Operations management	Lewis (2003)

Table I.
Research into aspects of risk and supply chain management

Robinson *et al.* argued that the level of risk involved for the purchasing organisation increased with the newness of the task involved, i.e. rebuys involve relatively low levels of risk whereas new tasks involve relatively high levels of risk. Robinson *et al.* illustrated how risk varied in these three purchasing situations by breaking down the purchasing process into eight progressive stages, ranging from problem recognition to performance review. Anderson *et al.* (1987) compressed these into three dimensions of the purchasing process: information needs; newness of the task; and consideration of alternatives. Following on from Robinson *et al.*, they argued that new tasks would score high on all three dimensions, modified rebuys would score moderately and straight rebuys would score low on all three dimensions. Consequently, the greater the information needs, the newness of the task, and the requirement to consider alternatives, the greater the risks involved.

Building on these earlier studies, many researchers have sought to investigate or explain the relationship between risk and supply chain management (Eisenhardt, 1989; Hallikas *et al.*, 2001; Harland *et al.*, 2003; Karjalainen *et al.*, 2003; Kraljic, 1983; Macintosh, 2002; Pilling and Zhang, 1992; Puto *et al.*, 1985; Ragatz *et al.*, 1997; Zsidisin *et al.*, 2000). For example, TCE underpinned Krause's (1999) study of customers' use of supplier development to improve supplier performance in order to reduce the impact and probability of risk. In a similar manner, Zinszer (1997) used the BuyGrid model to explain customers' reactions to supplier failures in different industries and for different types of products.

Therefore, the relationship between many aspects of risk and supply chain management has been well documented, especially in the literature on industrial buying behaviour (Feldman and Cardozo, 1975; Levitt, 1965; Sheth, 1973; Wind and Webster, 1972). Research in the 1970s indicated that perceived risk and the choice of risk-handling strategies are significant elements in industrial buying decisions (Peters and Venkatesan, 1973; Sheth, 1973). More recent research by Carr and Smeltzer (1997) identified the willingness to take risks as a key component of strategic purchasing. Similarly, Smeltzer and Siferd (1998) maintain that managing risk is central to purchasing management. Perhaps, the most established body of work dealing with risk and industrial purchasing comes from the work of the IMP (Industrial Marketing and Purchasing) Group (Ford *et al.*, 2003). Grounded in the field of industrial marketing, the IMP Group built on Williamson's TCE approach to show that inter-organisational relationships are interactive as opposed to being purely reactive and that an interaction is both interpersonal and inter-organisational. The Group's work has shown that a key component of managing networks of interactions (i.e. supply chains) is the development of strategies to reduce the risks posed by the inappropriate behaviour or performance of particular network members (Ford, 1980; Gadde and Håkansson, 2001).

Recently, a number of writers have sought to move the focus of attention away from analysing and managing risk at the level of individual customers and suppliers and towards the understanding and management of risk at the level of the entire supply chain (Cousins *et al.*, 2004; Harland *et al.*, 2003; Lewis, 2003). Harland *et al.* (2003) maintain that the increasing globalisation, complexity and dynamism of supply chains are leading to greater exposure to risk from political and economic events. They argue that disruption to supplies in one country can quickly spread through an entire global supply chain. An example is the sharp increase in world oil prices caused by the disruption of US oil production brought about by hurricane Katrina (Elliott, 2005).

Given this, Harland *et al.* recommend that risk management should focus on positioning the organisation to try to avoid such events, and to develop strategies to manage the impact of them should avoidance not be possible. However, their supply chain risk model is still at an early stage of development. They argue that more and better tools are needed to assist in risk assessment and management at the supply chain level and not just at the level of the individual firm, though they also acknowledge that it is very difficult to develop such tools. The model by Cousins *et al.* (2004) builds on recent initiatives concerning the greening of supply chains. Consequently, their model specifically concentrates on threats posed to supply chains by environmental risks. Their model seeks to relate the damage that exposure to environmental risks can cause for a firm – financial loss, loss of reputation, etc. – to the actions a firm can take to avoid or minimise such risks – information-gathering, training programmes, joint technology development initiatives, etc. However, the Cousins *et al.* model, like the Harland *et al.* model, is still at an early stage of development.

As the foregoing examination of the literature shows, there is a high level of awareness of the potential dangers posed to supply chains by exposure to risk. However, there appear to be two weaknesses to the literature on risk and supply chains discussed above. The first weakness is that it ignores or does not seem aware of the wider literature on risk. For example, Williamson's (1975, 1979) work is primarily concerned with the cost of transacting business between two parties, which is affected by risk, but it does not seek to explore risk theory *per se*. Likewise, Robinson *et al.*'s (1967) BuyGrid is concerned with the purchasing process and how this is affected by risk, but it does not seek to locate it within any wider theory of risk. As an example, as discussed earlier, one of the most crucial debates in the risk literature is between those who see it as an objective phenomenon and those who see it as a subjective phenomenon. This debate does not appear to surface in the literature on supply chains and risk, yet, in terms of the ability to identify the level of risk and respond appropriately, it is a crucial issue. The second weakness relates to the usefulness of measures of risk provided by the literature. For example, most writers tend to follow Robinson *et al.*'s (1967) use of very broad bands of risk, i.e. low (rebuy), medium (modified rebuy) and high (new task). In a world where products, services and customer preferences are changing constantly, so fast, almost every purchase situation could be classed as high risk (new task), thus undermining the usefulness of such broad categorisations. Regardless of the ability of organisations to define the level of risk, they still need to be able to manage it. However, as the next section will show, though approaches to managing risk can reduce some risks, they may also increase others.

Approaches to managing supply chain risk

As Table II shows, writers have identified a wide range of approaches for managing risk. Although their focus varies, most of these approaches appear to fall within the broad categories of relationship management (Puto *et al.*, 1985) or strategic/proactive purchasing (Smeltzer and Siferd, 1998), which in turn overlap with each other. Puto *et al.* (1985) identify supplier relationship development as an important risk-handling strategy. They argue that the necessary conditions for the adoption of effective risk-reducing strategies include loyalty to existing suppliers, the characteristics of the buying situation and the buyer's perception of the procurement problem.

Approach	Writers
Closer working relationships with suppliers	Zsidisin *et al.* (2000), Zsidisin and Ellram (2003) and Eisenhardt (1989)
Purchasing partnerships	Ellram (1991a, b)
Supplier quality/auditing/certification programmes	Smeltzer and Siferd (1998), Newman *et al.* (1993) and Zsidisin (2003)
Supplier improvement programmes	Smeltzer and Siferd (1998)
Multiple sources of supply vs single sourcing	Treleven and Schweikhart (1988), Kraljic (1983) and Zsidisin (2003)
Inventory management	Krause and Handfield (1999)
Communication and early involvement of suppliers in strategic decisions.	Krause (1999)
Buffers	Newman *et al.* (1993)
Strategic alliances	Zsidisin *et al.* (2000)
Risk sharing/knowledge transfer	Eisenhardt (1989), Zsidisin *et al.* (2000) and Krause (1999)
Focus on core competence	Zsidisin *et al.* (2000)
Product differentiation	Lonsdale (1999)
Entrepreneurial/risk taking	March and Shapira (1987) and Lonsdale (1999)
Proactive supply management	Smeltzer and Siferd (1998) and Kraljic (1983)

Table II.
Risk management strategies

Mitchell (1995) also contends that loyalty to existing suppliers is a risk-reducing strategy. In addition, Zsidisin *et al.* (2000) and Zsidisin (2003) draw attention to such initiatives as partnership formation, building strategic alliances, supplier development and developing supplier performance measurement systems. In a similar vein, some authors show how agency theory can be used to develop risk-sharing strategies (Eisenhardt, 1989; Zsidisin and Ellram, 2003). Agency theory offers a number of approaches to managing risk, including co-operation – working together for mutual benefit to reduce conflict; and information-sharing – to reduce the risk of either party trying to take advantage of the other.

Though many writers see relationship management as the key to risk management, others point to the need to take a more strategic/proactive approach to the supply base as a whole. Smeltzer and Siferd (1998) and Newman *et al.* (1993) argue that an effective long-term strategy for dealing with supply risk requires consistent monitoring and auditing of a supplier's processes to check that they conform to the required standards. Their research showed that auditing and certification of supply bases significantly improved the overall quality of processes and the end product.

Mitchell (1995) suggests that other risk-reducers include: choosing a leading company in the field, using an approved list of suppliers, multiple sourcing, visiting supplier operations and establishing good communications with suppliers. Zsidisin *et al.* (2000) also advocate the use of multiple sources of supply as a risk reduction strategy in some cases. Rather than advocating multiple sourcing, Lonsdale (1999) advocates product differentiation as an essential tool for managing risk. Lonsdale maintains that increasing the variety of products, particularly in fast-moving markets such as fashion, offers customers a wider choice and reduces the risk of building high inventories of obsolescent products. This approach is also promoted by Krause and Handfield (1999), who argue that inventory management can be an effective and economical strategy for reducing supply chain risk.

As can be seen, there are a number of approaches advocated for managing or reducing risk. However, there is one overriding drawback to the many approaches on offer: what one person sees as a means of reducing risk, another sees as a means of increasing risk. Two of the most widely-cited approaches to managing risk are single sourcing and building long-term partnerships. Treleven and Schweikhart (1988) argue that single sourcing exposes companies to less risk and facilitates effective communication by reducing the number of suppliers a customer has to deal with. In contrast, Zsidisin *et al.* (2000) and Kraljic (1983) argue that single sourcing can lead to over-dependence on one source of supply, with the risk that the supplier could exploit their position and take advantage of the customer. Similarly, there is conflict in the literature as to whether building long-term relationships with suppliers reduces or increases risk. Zsidisin (2003), Eisenhardt (1989) and Ellram (1991a, b) all argue in favour of such relationships as a means of effectively managing risk. Against this view, Smeltzer and Siferd (1998), Pilling and Zhang (1992) and Lonsdale (1999) all maintain that long-term alliances can enhance risk by creating a situation where the customer becomes over-dependent on one supplier.

One explanation for these differing perspectives is, as Mitchell (1995) implies, that many approaches to risk reduction may be situation-dependent. This is illustrated by Newman *et al.*'s (1993) study of the use of buffers as an approach to dealing with supply uncertainty. According to Newman *et al.*, buffers can include inventories, quoted lead times and excess capacity cushions. However, buffers, they argue, should only be used on a short-term basis because they are expensive, build inefficiencies into production processes, and can produce new and different types of risks. Consequently, depending on the situation, buffers can be seen either as a means for reducing risk or a cause of increased risk. Therefore, rather than broad-brush approaches to managing risk, what is required is a contingency model of risk which shows when and how particular approaches are effective. However, as was shown in the previous section, though there have been attempts to construct such models – (Harland *et al.*, 2003; Cousins *et al.*, 2004) – these are still in the early stages of development and offer the same broad-brush approaches as most other writers.

Summary and conclusions: towards a research agenda

This paper sought to address three key questions:

(1) What is risk and risk management?

(2) Is risk an important issue for supply chain management?

(3) What approaches are available for managing supply chain risk?

This paper has shown that the study of risk and methods of managing it have a long history. However, as we have discussed, there is much dispute as to the nature of risk, and though risk management is a well-understood subject in some areas of organisational life, e.g. finance, only relatively recently has risk management been seen as an important issue for supply chain management, though work on aspects of purchasing and risk stretches back to the 1960s. Nevertheless, there appears to be broad agreement that the risks and consequences of supply chain disruption are growing, and cannot be understood and managed solely at the level of the individual customer and supplier. Unfortunately, in examining approaches to managing supply

chain risk, and the research on purchasing which underpins much of this work, two important shortcomings have been identified, namely:

(1) In the main, the literature on purchasing and risk, and supply chain management and risk fails to draw on or locate itself within the wider literature on the theory of risk and the practice of risk management (Cousins *et al.*, 2004; Kraljic, 1983; Robinson *et al.*, 1967; Williamson, 1975, 1979). Even where reference is made to the wider literature on risk, e.g. by Harland *et al.* (2003) and Lewis (2003), this tends to be relatively cursory in nature. The failure to locate the work on supply chain risk in the wider literature is most clearly shown by the absence of any discussion regarding its nature, such as the subjective/objective debate. For example, Harland *et al.* (2003) tend to use the term probability – implying some form of objective measurement, whilst Cousins *et al.* (2004) tend to use the term perception – implying some form of subjective assessment. However, neither appears to discuss or acknowledge the debate over the nature of risk.

(2) Though the general literature on risk offers a wide range of tools and techniques for managing risk, these do not appear to have been adapted for use in managing supply chain risk. Rather, what appears to be on offer is a narrow range of general prescriptions on how to reduce risk (Mitchell, 1995). Prominent among such general prescriptions is the advice to adopt single sourcing (Treleven and Schweikhart, 1988) and to develop long-term relationships (Ellram, 1991a, b; Zsidisin, 2003). However, there is some dispute about whether these really do reduce risk (Lonsdale, 1999; Kraljic, 1983; Smeltzer and Siferd, 1998). In addition, as Harland *et al.* (2003) found when attempting to develop a risk assessment tool, translating general advice into an approach that can be used by managers in their own situation is very difficult. One reason for this could be, as Mitchell (1995) argues, that little work has been done to relate risk-reduction strategies to the situations in which they are most effective. It may well be the case that, as Newman *et al.* (1993) found in terms of the use of buffers to reduce risk, these general approaches are less general than their proponents realise, and that they are actually contingency approaches which are appropriate to some situations but not others.

There is no doubt that managing supply chain risk should be an important activity for most organisations. Nor is supply chain risk likely to reduce in the near future – rather the reverse, given the increasing trend towards globalisation. Unfortunately, the present state of research and advice seems to be inadequate to the challenge (Lewis, 2003; Zsidisin *et al.*, 2004). Though there have been some commendable attempts to construct models and tools to understand and manage supply chain risk, e.g. Cousins *et al.* (2004) and Harland *et al.* (2003), these are as yet underdeveloped and do not connect with the main body of literature on risk. If supply chain risk is to be adequately studied and if managers are to be offered tools and techniques that go beyond generalisations, a three-pronged research agenda is required:

(1) Research into supply chain risk must be located within the broader study of risk. It is clear from the above review of the current situation that there is a lack of understanding of the nature of risk among many supply chain researchers. The following questions highlight areas for further research:

- How do other disciplines of research on risk inform our understanding of risk in the supply chain?
- How can we incorporate key concepts of risk and risk management from other disciplines into the supply chain arena?
- What are the implications of the subjective-objective debate regarding the nature of risk for development of tools and frameworks for supply chain risk management?

(2) There is a need for broad and in-depth empirical research into how risk is managed in supply chains. The topic appears to generate a lot of assumptions and even more speculative advice, but not a great deal of actual research into how organisations are managing risk in this area. This could be developed through empirically based research by conducting case studies to investigate the following:

- How do companies are manage supply chain risk?
- What processes and techniques do companies use to identify and analyse risk in their supply chains?
- How do companies benchmark their supply chain risk processes against those of their competitors'?
- How do companies evaluate their supply chain risk profile and develop risk contingencies?

(3) Progressing from this understanding is the need to devise robust and well-grounded models of supply chain risk management, which incorporate risk management tools and techniques from other disciplines of research. However, these can only be constructed on the basis of the research into theory and practice suggested in 1 and 2 above.

Risk is an ever-present aspect of organisational life, whether the risk concerns investment decisions, recruiting and developing people, the launch of new products and services, or the management of supply chains. In some areas of organisational life, especially the financial area, risk management seems to be well-developed and understood (Hood and Young, 2005). In the area of supply chain management, risk is less well understood and less well developed (Lewis, 2003). This does not mean that it cannot be better understood and managed, but it does mean that it will need a concerted research effort to accomplish this.

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Further reading

Lyons, T. and Skitmore, M. (2004), "Project risk management in the queensland engineering construction industry: a survey", *International Journal of Project Management*, Vol. 22 No. 1, pp. 51-61.

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