Article:
Chen, J, Sohal, AS and Prajogo, DI (2016) Supply risk mitigation: a multi-theoretical perspective. Production Planning and Control, 27 (10). pp. 853-863. ISSN 0953-7287

https://doi.org/10.1080/09537287.2016.1147620

Supply risk mitigation: a multi-theoretical perspective

Jie Chen [a*], Amrik S. Sohal [b], Daniel I. Prajogo [b]

[a] Leeds University Business School, University of Leeds, Leeds LS2 9JT, UK, j.chen2@leeds.ac.uk

[b] Department of Management, Monash University, PO Box 197, Caulfield East, VIC, 3145, Melbourne, Australia

1. Introduction

With increasing outsourcing, buying companies need to assure the supply of products and components in order to continue their own production and it has thus become imperative for buying companies to manage supply risk (Cigolini & Rossi, 2006; Tapiero & Grando, 2006). Supply risk is defined as adverse events in inbound supply that affect the ability of the focal firm to meet customer demand (Zsidisin et al., 2000). Although there has been a significant increase in research activity in this area, the study of supply risk has been considered as 'highly fragmented' and 'disparate'; there is still a lack of 'clear meaning' and 'normative guidance' to managerial practices (Ellis et al., 2011; Manuj & Mentzer, 2008a). A reason for this may lie in the concept of risk itself; as risk is an elusive concept, managing risk requires a better understanding of the nature of risk (Khan & Burnes, 2007). Although the study of risk can be traced back to the seventeenth century (Bernstein, 1996), there still lacks a clear comprehension of risk (Rao & Goldsby, 2009; Zsidisin, 2003), which hindered the formation of well-grounded frameworks of supply risk management (Ellis, et al., 2011; Tang & Nurmaya Musa, 2011).

To address this gap, we demystify the concept of risk in this paper to enlighten the development of supply risk management strategies. First, in discussing the relationships between risk and three closely associated concepts which are uncertainty, variability and trust,

we propose three perspectives in supply risk mitigation, which are the information-based view, knowledge-based view and relation-based view. We then present evidence to support and explain this framework with four case studies composite of two manufactures based in Australia and four suppliers based in China. By linking the concept of risk with supply risk management, this paper contributes to the extant literature in two important ways. First, it contributes to risk management in general by enhancing our understanding of the concept of risk and its association with uncertainty, variability and trust. Second, this paper contributes to the supply risk management literature by proposing three perspectives based on the conceptualization of risk, which adds to the body of knowledge in formulating well-grounded models of supply risk management.

The remainder of this paper is structured as follows. Section 2 provides the theoretical background to our study followed by Section 3 which discusses the case study method. The findings and discussion are then presented in Section 4. Finally, we conclude the paper with its theoretical and managerial implications.

2. Theoretical background

2.1 Risk and uncertainty: an information-based view

In the conceptualization of risk, a very closely related concept is uncertainty. Actually risk and uncertainty are considered as 'of the same species' (Mun, 2004, p. 12) and generally used interchangeably (Ritchie & Brindley, 2007). There has been a long, on-going debate about the differences between these two terms, and distinctions are also suggested. The most influential proposition is that risk implies known probabilities, while uncertainty implies unknown probabilities (Knight, 1921). There are also other views. For instance, uncertainties become risks only if they affect the outcomes of the system (Mun, 2004), or the notion of

risk entails possible loss which is absent from the concept of uncertainty (Kaplan & Garrick, 1981). Nevertheless, risk and uncertainty in general are hardly separable and uncertainty is considered as an element of risk (Yates & Stone, 1992).

In organization theory, uncertainty is understood as a situation caused by 'lack of information'; either it be lack of sufficient information to predict (Milliken, 1987), lack of information in decision-making (Lawrence & Lorsch, 1967), or lack of information about the outcome of a decision (Duncan, 1972). In short, information is the counterpart of uncertainty (Downey & Slocum, 1975). In supply chain contexts, bullwhip effect is a typical example of how lack of information generates supply chain uncertainty (Mason-Jones & Towill, 1998): without information shared between supply chain partners, managers are not sure of the real demand and have to double guess which finally leads to demand amplification.

Information is defined as relevant or usable data (Rowley, 2007). In supply chains, the data is generally categorized into three types (Li et al., 2006): 1) Transactional information such as order quantities, prices, and product specifications. 2) Operational information such as inventory levels, production and transportation capacities, lead times, and shipments schedule, and 3) Strategic information such as market trends, category management and product designs. These three types are also equated with the increasing levels of information sharing (Sahin & Robinson, 2002) from minimum information sharing when there is only transactional information shared to full information sharing when strategic information is shared. A high level of information sharing is also associated with a timely-shared manner; the achieved visibility with full and timely information is an effective way to reduce supply chain uncertainty (e.g. Chiang & Feng, 2007; Lee & Whang, 2000). As information sharing plays a vital role in reducing uncertainty, and uncertainty is an element of risk, we propose:

Proposition 1: High level of information sharing activities in a buyer-supplier dyad is associated with low level of supply risk while low level of information sharing activities is associated with high level of supply risk.

2.2 Risk and variability: a knowledge-based view

In the classic decision theory, the cornerstone of the concept of risk is variance (Shapira, 1995). In their seminal paper, March and Shapira define risk as 'variation in the distribution of possible outcomes, their likelihoods, and their subjective values' (March & Shapira, 1987, p. 1404). The innate association between risk and variance lies in the fundamental statistical attributes of variance. In statistics, variance refers to the extent to which data is dispersed around its mean: the wider the dispersion, the greater the variance. High variance lowers the confidence of the observed value closer to the mean and thus is an indicator of unpredictability (Fredendall & Melnyk, 1995; Melnyk & Handfield, 1998). In operations management, variation is regarded as 'the quality of non-uniformity' which has a negative impact on a process (Hopp & Spearman, 2000, p.249). Deming even proposed that the key aim of management is to control variation (Deming, 1986). Mapes et al.(2000, p. 794) also state that 'the fundamental drivers that lead to simultaneous improvements in productivity, customer lead-time, delivery reliability and quality consistency are all aspects of reduced variability and uncertainty within the operating system.'

Control of variance drives the quest for knowledge (Anderson & Rungtusanatham, 1994). In a supply chain, Germain et al. (2008) define supply chain variability as 'the level of inconsistency' in the flow of goods into, through and out of the firm (p. 559). Studies have shown that supply chain knowledge such as transportation and production scheduling, hard and soft technologies and supplier quality control will enhance the material flow evenness and thus reduce the variability (e.g. Germain et al., 2001). Knowledge and expertise shared

between supply chain partners contributes significantly to low variance in operations as indicated in the case of Toyota that has built knowledge-sharing networks with its suppliers (Dyer & Nobeoka, 2000). In addition, knowledge sharing with supply chain partners also enhances a firm's innovation capability which will enable the supply chain to respond promptly to demand variance caused by environmental changes (Wowak et al., 2013).

Although the term 'knowledge' and 'information' are sometimes used interchangeably, they are very different in nature (Nonaka, 1994). Knowledge is in general considered as know-how and skills (Grant, 1996); if information answers 'who', 'what', 'where' and 'when' types of questions, knowledge answers 'how' questions (Ackoff, 1989). Another distinct character of knowledge is that it is deeply embedded in actions and processes (Nonaka, 1994). Although explicit knowledge is transmittable in language, tacit knowledge is hard to communicate and can only be learned through experiences in routines, processes, and practices (Davenport & Prusak, 1997). In supply chain contexts, the key to sharing knowledge or creating new knowledge between supply chain partners is through 'shared experience' such as joint problem solving or joint new product design in which partners work together (Hult et al., 2006). By doing this, tacit knowledge from supply chain partners is bought into a common base on which experiences are shared, knowledge is better understood and new knowledge can be created from coexperiences (Nonaka, 1994).

As knowledge is important to control variance and variance is innately associated with risk, we propose:

Proposition 2: High level of knowledge sharing activities in a buyer-supplier dyad is associated with low level of supply risk while low level of knowledge sharing is associated with high level of supply risk.

2.3 Risk and trust: a relation-based view

As discussed in prior sections, information and knowledge are central to risk management, which indicates an objective, technical view of risk (Renn, 1998). In this view, risk is measureable by quantitative scientific means; statistical data are applied to calculate the probability of the occurrence and the magnitude of the consequences (Lupton, 1999; Yates & Stone, 1992). However, complete information and perfect knowledge are never available (Mitchell, 1995) and the precise objective probability is impossible to establish (Savage, 1954). The technical view of risk has drawn criticism from social science and there has been a paradigm change from the objective side of risk to the subjective side which incorporates human factors into the risk construct (Sjöberg, 2000). This paradigm change is echoed with the recent attention to behavioural operations which focuses on how human behaviour impacts operational success (Bendoly et al., 2010; Bendoly et al., 2006; Gino & Pisano, 2008). For example, Moritz et al. (2013) examined cognitive reflection of the decision-makers in newsvendor problems. Croson and Donohue (2006) found that decision-makers consistently underweight the supply line when making order decisions. All these studies resonate with the statement that risk is inherently subjective to human judgment (Yates & Stone, 1992).

Trust is an important element associated with the subjectivity of risk (Breakwell, 2007). In a world of uncertainty where there is no complete information or knowledge, trust is a leap in faith to deal with risk. Trust has been defined as 'the intension to accept vulnerability' (Rousseau et al., 1998), 'willingness to rely on another's actions' (Mayer et al., 1995), 'a set of expectations shared' (Zucker, 1986), 'feelings of confidence and security' (Rempel et al., 1985), or 'the ability to reliably predict the actions of the other party' (Jap, 2001). Despite the variety of definitions, there is a fundamental association between risk and trust (Lewis & Weigert, 1985); if 'actions could be undertaken with complete certainty, leaving no need for

trust to develop' (p. 970). The level of trust indicates how much risk one is willing to take (Schoorman et al., 2007). Based on the positive expectations or faith, trust simplifies the complexity surrounding a decision-making process and serves as a functional alterative to rational prediction (Lewis and Weigert, 1985).

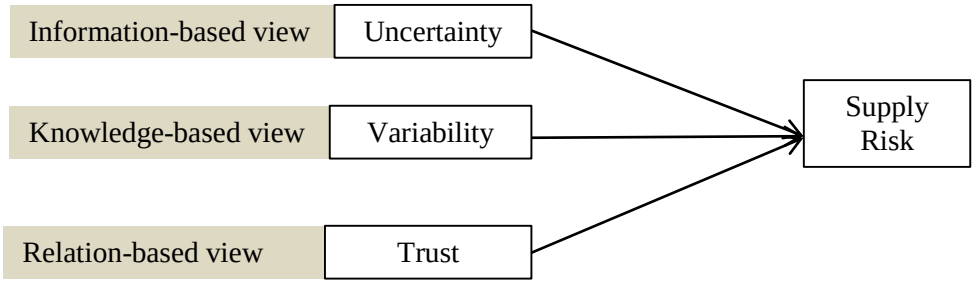
Although partners can reduce complexity based on trust, they are threatened by an inherent relational risk in an exchange relationship, i.e. opportunism (Das & Teng, 1999). Opportunism is defined as 'self-interest seeking with guile'(Williamson, 1975, p.6) which results in detrimental effects on supply chains such as disrupted production and degraded performance (Tangpong et al., 2010). In transaction cost economics, a crucial mechanism in deterring opportunism is relational-specific investment (Williamson, 1985). As such investments cannot be transferred to alternative users, it makes the investing firm highly dependent on the partner to realize the full value of the investments and thus restrained from opportunistic behavior (Das & Rahman, 2010). What underlies these investments is a strong commitment to the relationship, without which partners will not be able to put themselves in such a locked-in situation (Handley & Benton, 2012). Another relational factor in deterring opportunism is goal congruence (Das and Rahman, 2010), seeing the supply chain as a united whole rather than segmented entities (Mentzer et al., 2001). When partners' goals are not aligned, a partner firm trying to accomplish its own goals may behave opportunistically. It may also cause conflicts which will erode trust and commitment in the relationship (Das and Rahman, 2010).

In brief, the above discussion implies a relational approach of managing risk built on trust, commitment and congruent goals. Base on the above discussion, we propose:

Proposition 3: High level of buyer-supplier relationship is associated with low level of supply risk while low level of relationship is associated with high level of supply risk.

In summary, the literature indicates that risk, the concept of which is closely associated with uncertainty, variability and trust, can be mitigated through three perspectives: the information-based view, the knowledge-based view and the relation-based view. This is captured in our framework as depicted in Figure 1. In the following section, we will support and explain these three perspectives applying case studies in which four buyer-supplier dyads are examined.

Figure 1 Theoretical framework



3. Method

A case study methodology was applied in this research. Due to its information richness, the case study methodology is ideal for providing a better understanding of an emerging phenomena in the real world settings and answering the how and why questions (Flynn et al., 1990; Meredith, 1998). A case study can be either exploratory or explanatory (Yin, 1989). The over-arching approach for an explanatory case study is of confirmation (or falsification) of a theory, which is indicated by an existing theory in the beginning (Johnston et al., 1999) and then provide evidence from aggregating cases (Childe, 2011). As we have already developed theoretical propositions based on extant literature, this case study is to explain how events happened and is thus explanatory in nature.

3.1 Case selection

Cases in such an explanatory study are not ‘ sampling units’ in inferential statistics but individual studies used to confirm (or falsify) a theory (Yin, 1989); a ‘theoretical sampling’ is thus preferred in case selection (Eisenhardt, 1989). This study is conducted with a multiple-case design, following the replication logic in which each case is carefully selected so that it either predicts similar results or predicts contrasting results but for anticipated reasons (Yin, 1989). Based on these considerations, four cases (buyer-supplier dyads) were selected to replicate the theory, involving two manufactures based in Australia and four suppliers based in China.

The first two cases provide an example of polar types (Eisenhardt, 1989). They were two dyadic relationships between an Australian sport products manufacturer, SportCo, and its two suppliers in China. SportCo is a top world brand in designing and providing surf hardware and accessories such as board bags, leashes, and surf travel luggage. The company was established in Australia in the early 1990s and gained global recognition very quickly. Over the past two decades, SportCo has become a highly professional provider of surf hardware and accessories for the global market with offices located in Australia, France, Japan, and the USA. SportCo has a number of suppliers located in China, including a major supplier BoardCo in Shanghai and another major supplier FiberCo in Shenzhen. In these two cases, supply risk was explicitly amplified in terms of delivery performance as this was the most salient issue facing SportCo when the data was collected. BoardCo was a high risk supplier in this aspect as SportCo strongly felt that ‘ …not sure when he [BoardCo] is going to deliver it [the order]’. In contrast, FiberCo was a low risk supplier as SportCo considered its delivery performance as ‘great’. We used one buyer in the sample to control in case design (Voss et al., 2002); With the same one buyer, factors such as its supplier management policy and corporate culture which may influence buyer-supplier relationship are held constant across

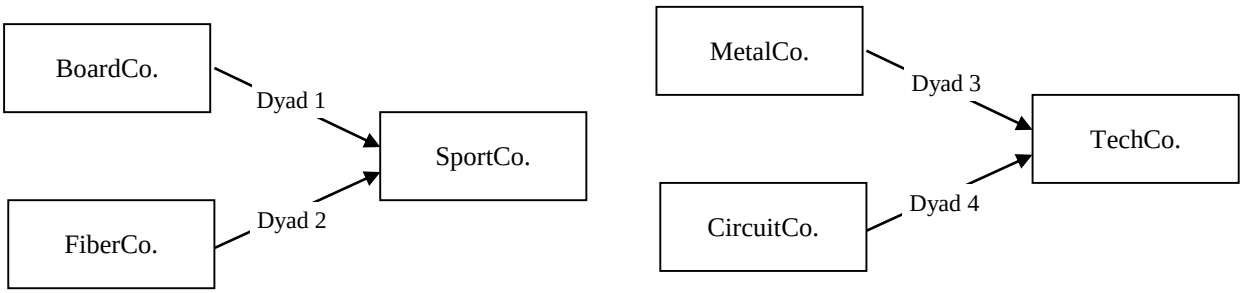
the cases and internal validity is therefore improved. With a 'controlled' sample, these polar cases provide compelling support for the conclusions they derive.

Another two cases provide examples to ensure the findings in the first two cases. To control the sample, we again selected one buyer, a high-tech manufacturer, TechCo, in Australia, and its two suppliers based in China. TechCo is an Australian division of a world leading manufacturer of scientific instruments. Their products are highly customized, and the specific material requirements limit its supply base. TechCo has around 200 suppliers that supply parts of the instruments in different configurations. Besides sourcing locally, the company also sources from North America, Singapore and China. Around 30% of the components are single sourced, which makes the continuity of the supply crucial. To secure the supply and mitigate risks, TechCo has developed close strategic supplier relationships to mitigate the risks which have been successful and it generally considers their suppliers as low risk. Considering the suppliers chosen for SportCo were based in China, we also selected two suppliers of TechCo based in China to reduce the variance that might be caused by country differences. To be consistent with the supply risk examined in the SportCo cases, these two suppliers were selected in terms of their delivery performance. They were considered as low risk in this aspect as both of them have provided reliable performance to secure TechCo's just-in-time supply. The focus of these two cases is to replicate the theory with a change of the context, i.e. from a sport product supply chain to a high-tech product supply chain. These cases also address the topic from other different contexts including the size of the organization and the type of ownership to enhance generalizability. In aggregation, these four cases provide substantial support for the theoretical framework. A summary of the companies is displayed in Table 1 and their dyadic relationships are presented in Figure 2.

Table 1 Profile of Case Study Companies

Company	Position in the supply chain	Main product	Number of employees	Ownership	Location	Informants
SportCo	Buyer	Surf hardware & accessories	Around 80	Australian	Sydney, Australia	Supply Chain Manager, Operations Manager, Agent
BoardCo	Supplier to SportCo	Surfboard, bags	250-350	Private-owned	Shanghai, China	General Manager
FiberCo	Supplier to SportCo	Glass fiber fins	200-300	Private-owned	Shenzhen, China	Director, General Manager
TechCo	Buyer	Scientific instruments	Around 400	Multinational	Melbourne, Australia	Supply Chain Manager, Sourcing Manager, Supply Manager
MetalCo	Supplier to TechCo	Sheet metal	Around 200	joint venture	Shanghai, China	General Manager, Customer Manager
CircuitCo	Supplier to TechCo	Circuit board	3800	joint venture	Shanghai, China	Business Unit Coordinator

Figure 2: Dyadic Relationship Diagram



3.2 Data collection

For each of the cases, the first point of contact was the Australian manufacturers SportCo and TechCo. The researchers met with the supply chain managers in these two companies and outlined the research objectives. With a strong theoretical sampling design in mind, the

researchers then asked the supply chain managers to introduce what they considered to be high risk or low risk suppliers.

Data collection took place on the sites of these six companies. Primary data was collected through semi-structured interviews (See Appendix for interview guidelines). The informants were selected based on the person's knowledge of the firm's supply chain management. As a result, the positions of key informants mainly include supply chain manager, operations manager, business unit coordinator, general manager and director. All interviews were carried out face-to-face and each ran from one to three hours till the saturation point was reached. Altogether, there were fifteen interviews conducted. Plant tours and other materials such as company reports, profiles, website information and follow-up emails were also used for the purpose of triangulation (Yin, 1989).

In analysing the data, we began by synthesizing the material for each case and conducted within case analysis to understand the risk management mechanism within each dyad. Based on the understanding of each case, we then conducted the cross-case analysis to identify similar or contrasting patterns across the four cases, focusing on the different level of information and knowledge sharing and relationship building associated with different level of supply risk. The following section presents the findings from the four supply chain dyads studied.

4. Findings and discussion

Dyadic Case 1: Surfboard Bags Supplier (BoardCo) to SportCo

BoardCo supplies surfboard bags to SportCo. It is a privately-owned business by the General Manager (GM) and was established as a joint venture with a Japanese company over 20 years ago to produce luggage and bags. Later the Japanese capital withdrew and the business became solely Chinese-owned. The Shanghai-based factory produces over 100,000 bags a

year and is heavily export oriented with customers based in the USA, Japan, Australia, Italy and South Korea.

BoardCo has been a supplier for SportCo for over ten years. Although the product quality and price was satisfactory to SportCo, BoardCo was still considered as a high risk supplier due to delivery problem. Late delivery was a burning issue for SportCo; it had already been penalized by its European customers because it failed to deliver products on time. To make things worse, it was not just about delay, but also about the uncertainty of the delivery. SportCo described, *'He [GM of BoardCo] just takes the orders, and we are not sure when he is going to deliver it!'*

The information flow between these two companies was poor. Because the GM of BoardCo could not speak English and other staff in the factory spoke only limited English, there was no direct communication between SportCo and BoardCo but indirectly through a Hong Kong based agent. SportCo described the agent as 'tough' and not actively engaged in the communication process. Hence, SportCo quite often had no idea of what was going on with BoardCo.

There was a very low level of trust in the relationship between SportCo and BoardCo. Even the trust between SportCo and the Hong Kong based agent was low. For example, after talking about a negative response from BoardCo, SportCo commented,

> ...but we have to say, this is not what he [BoardCo] said, this is what the agent told us. Sometimes we have both of them on the phone, and we can hear that he is in the background, yelling, but we can't work out any sign, we have to get it translated [through the agent].

For SportCo, the agent was often ‘a source of negative communications’, which they put ‘a *very big question mark on’*. Without trust in this relationship, some behaviour by BoardCo was interpreted as opportunistic by SportCo. For example, for one particular order due for delivery just after the Chinese New Year, BoardCo asked for an increase in price because many workers had not returned to the factory from their hometown after the end of the Chinese New Year holiday and BoardCo therefore argued that it needed to recruit additional labour. However, with a low level of trust in this relationship, SportCo did not believe that the reason for price increase was genuine and considered as opportunism: ‘We've got commitments to our customer, we have to form supply continuity to our customers. They [BoardCo] know full well that we can't walk out on that order, and that's what they bank on’.

There was a strong impression within SportCo that BoardCo had no commitment to this relationship. It strongly felt that BoardCo ‘*doesn’t like our business’*, and would even be happy if SportCo left the relationship and then it can allocate the capacity to other customers. The Supply Chain Manager at SportCo described the situation:

> *…and if we do walk out, they say, fine, we don't care. Because he can allocate that* capacity to other customers. He is happy, he is prepared to lose us. ... So at the moment is on their terms, or not at all on our terms. That's what looks to us.

There was a lack of goal congruence in this relationship, a sense of supply chain as a ‘united whole’. For example, SportCo has tried to change the lead-time to solve the delivery issues, however this did not work out as illustrated in this quote: ‘We gave [BoardCo] 60 days, he was 30 days late, we gave 120 days, he was 30 days early. Then we asked why did you do that? And he said, oh, it's efficient for me to do all in one run’. For BoardCo, it preferred large production runs to achieve economies of scale. However, orders from SportCo required small runs for over 200 items; there were different models in each item and in each model

there were a number of different sizes and colors. Without a sense of 'being on the same boat' and difficulty in communication, these two companies have not been able to achieve better coordination of the production, which resulted in high delivery risk.

Dyadic Case 2: Glass Fiber Fins Supplier (FiberCo) to SportCo

FiberCo supplies for SportCo glass fiber fins. It is a private business owned by a Hong Kong based family. The Shenzhen-based factory was established by the father with 20 workers in the early 2000 and has become one of the largest manufacturers of glass fiber fins in the world, producing 30 to 40 thousand fins per year. FiberCo's business is largely export-oriented with over 100 customers located overseas in the USA, Japan, Europe, Australia, South Africa, Brazil and Argentina. The factory is now run by the daughter of the original founder who holds the position of Director.

FiberCo has been a main supplier for SportCo for almost ten years and was considered as a very low risk supplier. It delivered products on-time with an assurance of good quality. SportCo was satisfied the operations between these two companies running smoothly.

The information flow in this relationship was good. Growing up in Hong Kong, the daughter speaks good English which has enabled her to communicate directly with SportCo. They communicated through e-mail about every operational problem. FiberCo would inform SportCo immediately if there were any issue relating to quality or delivery. SportCo visited the factory two or three times every year to discuss a wide range of issues from operations to strategies.

There was good knowledge sharing in this relationship. Based on their expertise in fins, FiberCo actively engaged with SportCo in terms of new product design; they were willing to make substantial investments to find new materials to facilitate the design. During SportCo's

visits, the staff from both companies worked together on the design and tackled on any problems raised. Through knowledge sharing, new products have been developed every year.

The commitment in this relationship was very strong. As an evidence, to protect SportCo from its competitors, FiberCo even did not expand its customer base in Australia. As the Diretor said:

> I have already had a very good customer [SportCo] there. *I need to protect them… If* its *customers want to have business with me, I let them go to SportCo. …They* [SportCo] give us the biggest orders. The collaboration between us is most important.

There was also a high level of trust in this relationship. For example, a major concern of SportCo to outsource in China was the loss of IP in which case SportCo's designs being copied or poached. With a trusting relationship established between two companies, SportCo provided FiberCo with its designs without any hesitation, and they also communicated openly about any new product ideas.

In this dyad, there was a very strong goal congruence. FiberCo considered themselves and SportCo as a united whole: 'We are a team. Only when our customers can earn money, we *can earn money'*. Based on this strong relationship, FiberCo made every effort to accommodate SportCo's needs and ensured the supply.

Dyadic Case 3: The Sheet Metal Supplier (MetalCo) to TechCo

MetalCo, located in Shanghai, was established in the late 1990s. The business is export-oriented and all its customers are international companies. After over 20 year's growth and with a focus on good quality and service, MetalCo has become a strategic partner to many world's well-known companies for over a decade. Currently, MetalCo has around 200 employees with an annual sales revenue of around RMB30 million.

MetalCo has been considered as a low risk supplier for TechCo particularly in terms of delivery performance. As TechCo applies lean production in house, MetalCo manages the inventory for TechCo and ships products to Australia which are maintained in a warehouse and delivered to TechCo on a daily basis using Kanban.

There were frequent interactions and communication between MetalCo and TechCo. To facilitate communication, TechCo has set up an office in Shanghai to maintain daily operational contact with its Chinese suppliers. MetalCo visited TechCo's office regularly and proactively, even when there were no problems to deal with. The information sharing between the two companies was timely and sufficient. MetalCo also involved itself actively with TechCo in problem-solving and product design. The Customer Manager at MetalCo emphasized this when he said: 'We are involved in their product design, and whenever there is a problem, we respond immediately, we come together *to solve the problem'*.

Through many years of working together, trust has been build up to a point where MetalCo now manages inventory for TechCo, shipping products to Australia on a weekly basis. MetalCo has a strong commitment to this relationship. From the initial contact with TechCo, what MetalCo looked for was not just an order, but a strategic partnership. It selected TechCo for strategic reasons, ensuring that a good 'match' was established from the beginning. As a strategic partner, MetalCo considered itself as an extension of TechCo, as the GM said, 'I said to them [TechCo], consider our factory as your own factory. The relationship between us is not that of supplier *and customer, but a whole unit.'*

Dyadic Case 4: Circuit Boards Supplier (CircuitCo) to TechCo

CircuitCo, also based in Shanghai, is part of a world leading electronic manufacturing and services provider founded in the US. The China site was opened in the early 2000s and with over 3,000 employees on the site, it conducts R&D, mass production and provides

aftermarket services. CircuitCo put considerable effort in understanding their customers' needs to provide world leading quality products and services.

CircuitCo is considered as a low risk supplier for TechCo. As TechCo's products are highly customized and some materials required are not easily available in the marketplace, the continuity and delivering products on time is a salient risk for TechCo. So far CircuiltCo has performed very well in this aspect.

Communication along the supply chain was extremely critical for the continuity of the supply. As the Business Unit Coordinator at CircuitCo pointed out,

> We need to let them understand our situation and they also need us to understand theirs. The communication must be open and sincere. This cannot be done by the system, we must actively manage our suppliers and actively manage our customers, keep frequent and bi-direction communication.

To achieve the understanding, CircuitCo delegated a global material manager just for the operations with TechCo, because 'Every customer is different, you cannot use the same way to deal with all the customers.' This manager needs to understand the business model of TechCo and find the best way to service them. Besides, CircuitCo also established a dedicated team to work with TechCo. This team meets on a weekly basis with TechCo to discuss materials requirements and production plans on both sites.

CircuitCo demonstrated a strong commitment to its relationship with TechCo. Besides the human resources it dedicated to this relationship, CircuitCo also has other specific asset investments in this relationship, such as new product testing equipment primarily used for TechCo's products. With these investments, CircuitCo increased risk for itself if the buyer leaves the relationship. Therefore, Circuit selectd its buyer who also has a long-term

commitment to the relationship and who can grow together. This 'growing together' is underlined by the strategic alignment of the vision of both companies. The Business Unit Coordinator explained: 'Not all companies who want to buy from us will be our customer. We will see whether they are in line with the vision and strategy of our company, whether the relationship can be long-term.' TechCo has shown a strong long-term relationship commitment right from the start and also provided support the relationship such as transferring technical personnel to the site.

Based on aligned strategies and commitment to a long-term relationship, a high level of trust has been established in this relationship. In some occasions to coordinate the supply, CircuitCo was at the point to start production even without receiving orders from TechCo, and because of the high level of trust, CircuitCo was able to do that which ensured the supply. As the Business Unit Coordinator said: 'We need to have trust between us, without trust, we cannot *continue.'*

Three theoretical perspectives on supply risk mitigation

Table 2 presents the comparative analysis across the four dyads that identified the level of supply risk represented in each dyad as well as the level of information and knowledge sharing and relationship that contributed to the risk mitigation.

INSERT TABLE 2 ABOUT HERE

In terms of the information-based view, as indicated in Table 2, low level of information sharing between BoardCo and SportCo is associated with high level of supply risk, while high level of information sharing between three other suppliers with their buyers is associated with low level of supply risk. As an example, FiberCo could alert SportCo via email anytime when it discerned a change that might impact on the delivery. In contrast, the information

sharing between BoardCo and SportCo was either delayed or not shared at all. Consequently, SportCo had no idea of the status of the delivery, which has been a major risk for this supply chain. In addition, BoardCo shared information with SportCo at a minimum level; only transactional information such as order status was shared. In contrast, FiberCo shared information with SportCo in full; not only transactional information, but operational and strategic information were shared. This enabled SportCo and FiberCo to coordinate production in a long-term plan which mitigated risks in the long run. In brief, the cases indicate that high level of information sharing activities is associated with low level of supply risk while low level of information sharing activities is associated with high level of supply risk. Proposition 1 is supported.

In terms of the knowledge-based view, as indicated in Table 2, low level of knowledge sharing between BoardCo and SportCo is associated with high level of supply risk, while high level of knowledge sharing between three other suppliers with their buyers is associated with low level of supply risk. As an example, as a high technology company, TechCo had high level of knowledge sharing activities with both MetalCo and CircuitCo through working together, for example, they jointly solved problems such as bottlenecks in physical flow which reduced supply chain variability. Also, they jointly developed new products to ensure systems integration and prediction of both lead-time and productivity, which contributed to reduce the variability of flow in the supply chain in a long term. In the case of FiberCo, its expertise in glass fiber helped SportCo to develop better new products, which enhanced product effectiveness, process performance and a smooth flow in the supply chain. In contrast, knowledge sharing was absent between BoardCo and SportCo; there was lack of the scene that the two companies worked together to jointly solve problems or develop new products. Confronting the delivery risk, if these two companies could share knowledge on production scheduling, BoardCo might be able to arrange its production in a way that mitigates the

delivery problem. In brief, the cases indicate that high level of knowledge sharing is associated with low level of supply risk while low level of knowledge sharing is associated with high level of supply risk. Proposition 2 is supported.

In terms of the relation-based view, as indicated in Table 2, a low level of relationship between BoardCo and SportCo is associated with high level of supply risk, while high level of relationship between three other suppliers with their buyers is associated with low level of supply risk. An example of how trust can reduce supply risk is illustrated by CircuitCo; it started production even without receiving formal orders from TechCo, which reduced the risk of late delivery. There was no fear of opportunism in the relationship, as both partners had a long-term commitment to each other. As an indicator, CircuitCo has invested relational specific assets in both human resources and equipment primarily used for TechCo's products. TechCo also set up an office in Shanghai to manage the relationship and transferred their technical team to the supplier's site. Goal congruence distinctively contributes to low supply risk. For example, FiberCo explicitly stated that only SportCo earn money, they could earn money. They did everything they could to work with SportCo to provide the supply to its satisfactory; they not only actively coordinated with SportCo to secure operations such as on-time delivery, the feeling of 'being a team' was so strong that they even turned down a new customer in Australia to protect SportCo's interest, and invested their own money to contribute to new product development. In contrast, BoardCo and SportCo had incompatible goals. BoardCo preferred large runs while SportCo's orders requested small runs. Without feeling 'as a united whole' and only focusing on their own short-term interests, SportCo and BoardCo had not been able to develop a solution to coordinate the production, which finally led to high supply risk in terms of delivery. Their conflicts also significantly reduced the trust between them; SportCo had a strong suspicion of opportunistic behaviour of BoardCo, which caused a vicious circle in the relationship that further increased the conflicts. These

cases suggest that supply risks at operational level such as delivery could be mitigated if the buyer and the supplier have a high level of relationship with trust, commitment and goal congruence. Proposition 3 is supported.

5. Managerial implications

This study has important implications for managerial practice. Managing supply risks with all its complexity and unpredictability is full of challenges. Supplier risk assessment needs to be an integral part in supplier selection. In light of this study, evaluation on suppliers' attitude towards collaboration such as information and knowledge sharing, commitment and goal alignment is vital. Although the traditional performance-based evaluation is important, managing risk, especially in today's world with accelerated changes and unpredictability, requires suppliers to be highly collaborative to enable the supply chain to response fast in a dynamic environment. Therefore in the evaluation process, in addition to collect historical performance data from potential suppliers, it is all the same important, if not more, to observe their behaviour, and find answers for such questions, e.g. Do they actively share information? Are they open to share knowledge? Are they willing to invest relationship-specific assets? Are their strategies aligned with the firm? In this regard, it is important to understand that assessing suppliers' performance is easier than assessing suppliers' behaviour: the former can be assessed without engaging the supplier into any relationship with the buying firms, whereas the latter cannot be done without entering a relationship with suppliers and observing their behaviour in the interactions such as sites visit and face-to-face meetings; it requires more investment in terms of time, energy and human resource, but the payoff will be achieved in the long term.

On the other hand, models of supply chain risk management have been developed in industries with detailed procedures from risk identification, analysis, assessment and

mitigation (e.g. Cigolini & Rossi, 2010; Oehmen et al., 2009); tools and technology are also designed to aid in risk management process (Wu & Olson, 2009; Xie et al., 2009; Yang & Wu, 2009). However the desired completeness in the risk identification and qualitative assessment or developing software and tools to aid the procedures may not be feasible to many companies, especially SMEs due to the costs or resources required (Leopoulos et al., 2006). This study, grasping risks down to its nature, offers managers a generic and holistic approach of supply risk management, i.e. to build trusting relationship with suppliers and enhance information and knowledge sharing in the operations on a daily basis. Even with a well-defined supply risk management procedure or tools in place, this approach is still at the heart of managing supply risk; without a trusting relationship and high level of information and knowledge sharing, the utilization of the tools may not be able to be optimized.

Another implication of the study is that the social aspect (managing relationship) in managing supply chain is not less important than technical aspects (managing information and knowledge). This finding is instructive for managers given that supply chain network has become more and more global where geographical distance between supply chain points having increased significantly and, thus, cultural differences become unavoidable. This situation is particularly applicable for those relationships with partners in geographical or cultural distance. As an example reported in this paper, most of the supplies sourced by Australian firms come from Asian countries, most notably, China. As such, there are competencies which should be embedded in the managerial skills, which may include cross-cultural management and, possibly, multi-lingual.

6. Conclusion, contribution, and limitations

The study reported in this paper set out to examine the concept of risk using three perspectives namely information-based view, knowledge-based view and relation-based view.

Based on a review of the relevant literature, we developed three propositions which have been supported by analysis of data collected from four buyer-supplier dyads – with the two buyers based in Australia and the four suppliers based in China. The study shows that risk can be mitigated by the high level of information and knowledge sharing as well as building trust, commitment and goal congruence in a buyer-supplier relationship.

The key contribution of this study to theory is its aggregation of different theoretical perspectives which is in line with the nature of risk. Considerable research has been done within each perspective of the study, either based on information (e.g. Lee and Whang, 2000), knowledge (e.g. Germain 2001, 2008) or relationship (e.g. Zsidisin et al., 2000); however there still lacks a synthesis of the different views which might be the reason for the 'highly fragmented' and 'disparate' literature (Manuj and Mentzer, 2008a; Ellis et al., 2011). The complexity of risk calls for a holistic theoretical underpinning; the information-based view addresses the uncertainty element of risk, the knowledge-based view tackles the variability element of risk, while the relation-based view takes the leap in faith, trust, to deal with risk. Neither perspective alone may achieve a full comprehension of risk.

The limitations of this study steer directions for future research. The major limitation of the study is that it only included three theoretical perspectives into the framework (i.e. information-based view, knowledge-based view and relation-based view), however as risk is such an elusive concept, this framework is not the least exhaustive. Future studies should explore further dimensions of risk and enrich our understanding of its nature and thus enhance the managerial practice of managing supply chain risks. Another limitation of the study is that previous research has suggested that power plays an important role in a buyer-supplier relationship (Belaya et al., 2009; Crook & Combs, 2007; Nyaga et al., 2013), however this is out of the scope of this study. Future research could be designed to consider different situations of power asymmetry and examine their impacts on risk management.

References

Ackoff, R. L. (1989). From data to wisdom. Journal of Applied Systems Analysis, 16, 3–9.

Anderson, J. C., & Rungtusanatham, M. (1994). A theory of quality management underlying the Deming management method. Academy of Management Review, 19(3), 472-509.

Belaya, V., Gagalyuk, T., & Hanf, J. (2009). Measuring Asymmetrical Power Distribution in Supply Chain Networks: What Is the Appropriate Method? [Article]. Journal of Relationship Marketing, 8(2), 165-193.

Bendoly, E., Croson, R., Goncalves, P., & Schultz, K. (2010). Bodies of Knowledge for Research in Behavioral Operations. [Article]. Production & Operations Management, 19(4), 434-452.

Bendoly, E., Donohue, K., & Schultz, K. L. (2006). Behavior in operations management: Assessing recent findings and revisiting old assumptions. [Article]. Journal of Operations Management, 24(6), 737-752.

Bernstein, P. (1996). Against the Gods: The Remarkable Story of Risk. Chichester: Wiley.

Breakwell, G. M. (2007). The Psychology of Risk. Cambridge Cambridge University Press.

Chiang, W. K., & Feng, Y. (2007). The value of information sharing in the presence of supply uncertainty and demand volatility. International Journal of Production Research, 45(6), 1429.

Childe, S. J. (2011). Case studies in operations management. Production Planning & Control, 22(2), 107-107.

Cigolini, R., & Rossi, T. (2006). A note on supply risk and inventory outsourcing. Production Planning & Control, 17(4), 424-437.

Cigolini, R., & Rossi, T. (2010). Managing operational risks along the oil supply chain. Production Planning & Control, 21(5), 452-467.

Crook, T. R., & Combs, J. G. (2007). Sources and consequences of bargaining power in supply chains. Journal of Operations Management, 25(2), 546-555.

Croson, R., & Donohue, K. (2006). Behavioral Causes of the Bullwhip Effect and the Observed Value of Inventory Information. [Article]. Management Science, 52(3), 323-336.

Das, T., & Rahman, N. (2010). Determinants of Partner Opportunism in Strategic Alliances: A Conceptual Framework. [Article]. Journal of Business & Psychology, 25(1), 55-74.

Das, T. K., & Teng, B.-S. (1999). Managing risks in strategic alliances. [Article]. Academy of Management Executive, 13(4), 50-62.

Davenport, T. H., & Prusak, L. (1997). Working Knowledge. Boston, Mass: Harvard Business School.

Deming, W. E. (1986). Out of the Crisis. Cambridge, Mass: Massachusetts Institute of Technology.

Downey, H. K., & Slocum, J. W. (1975). Uncertainty: measures, research, and sources of variation. Academy of Management Journal, 18(3), 562-578.

Duncan, R. B. (1972). Characteristics of organizational environments and perceived environmental uncertainty. Administrative Science Quarterly, 17(3), 313-327.

Dyer, J. H., & Nobeoka, K. (2000). Creating and managing a high-performance knowledge-sharing network: the TOYOTA case. [Article]. Strategic Management Journal, 21(3), 345.

Eisenhardt, K. M. (1989). Building theories from case study research. Academy of Management Review, 14(4), 532-550.

Ellis, S. C., Shockley, J., & Henry, R. M. (2011). Making sense of supply disruption risk research: a conceptual frameowrk grounded in entactment theory. [Article]. Journal of Supply Chain Management, 47(2), 65-96.

Flynn, B. B., Sakakibara, S., Schroeder, R. G., Bates, K. A., & Flynn, E. J. (1990). Empirical research methods in operations management. Journal of Operations Management, 9(2), 250-284.

Fredendall, L. D., & Melnyk, S. A. (1995). Assessing the impact of reducing demand variance through improved planning on the performance of a dual resource constrained job shop. International Journal of Production Research, 33(6), 1521-1534.

Germain, R., Claycomb, C., & Droege, C. (2008). Supply chain variability, organizational structure, and performance: the moderating effect of demand unpredictability. Journal of Operations Management, 26(5), 557-570.

Germain, R., Dröge, C., & Christensen, W. (2001). The mediating role of operations knowledge in the relationship of context with performance. Journal of Operations Management, 19(4), 453-469.

Gino, F., & Pisano, G. (2008). Toward a Theory of Behavioral Operations. [Article]. Manufacturing & Service Operations Management, 10(4), 676-691.

Grant, R. M. (1996). Toward a knowledge-based theory of the firm. [Article]. Strategic Management Journal, 17, 109-122.

Handley, S. M., & Benton, W. C. (2012). The influence of exchange hazards and power on opportunism in outsourcing relationships. [Article]. Journal of Operations Management, 30(1/2), 55-68.

Hopp, W. J., & Spearman, M. L. (2000). Factory Physics. Boston: Irwin/McGraw-Hill.

Hult, G. T. M., Ketchen, J. D. J., Cavusgil, S. T., & Calantone, R. J. (2006). Knowledge as a strategic resource in supply chains. Journal of Operations Management, 24(5), 458-475.

Jap, S. D. (2001). Perspectives on joint competitive advantages in buyer -- supplier relationships. [Article]. International Journal of Research in Marketing, 18(1/2), 19-35.

Johnston, W. J., Leach, M. P., & Liu, A. H. (1999). Theory testing using case studies in Business-to-Business research. [Article]. Industrial Marketing Management, 28(3), 201-213.

Kaplan, S., & Garrick, B. J. (1981). On the quantitative definition of risk. Risk Analysis, 1(1), 11-27.

Khan, O., & Burnes, B. (2007). Risk and supply chain management: creating a research agenda. International Journal of Logistics Management, 18(2), 197-216.

Knight, F. (1921). Risk, Uncertainty and Profit. New York: Harper & Row.

Lawrence, P. R., & Lorsch, J. W. (1967). Differentiation and integration in complex organizations. Administrative Science Quarterly, 12(1), 1-47.

Lee, H. L., & Whang, S. (2000). Information sharing in a supply chain. International Journal of Technology Management, 20(3-4), 373 - 387.

Leopoulos, V. N., Kirytopoulos, K. A., & Malandrakis, C. (2006). Risk management for SMEs: Tools to use and how. Production Planning & Control, 17(3), 322-332.

Lewis, J. D., & Weigert, A. (1985). Trust as a Social Reality. [Article]. Social Forces, 63(4), 967-985.

Li, J., Sikora, R., Shaw, M. J., & Woo Tan, G. (2006). A strategic analysis of inter organizational information sharing. [Article]. Decision Support Systems, 42(1), 251-266.

Lupton, D. (1999). Risk. London: Routledge.

Manuj, I., & Mentzer, J. (2008a). Global supply chain risk management. Journal of Business Logistics, 29(1), 133-155.

Mapes, J., Szwejczewski, M., & New, C. (2000). Process variability and its effect on plant performance. International Journal of Operations & Production Management, 20(7), 792-808.

March, J. G., & Shapira, Z. (1987). Managerial perspectives on risk and risk taking. Management Science, 33(11), 1404-1418.

Mason-Jones, R., & Towill, D. R. (1998). Shrinking the supply chain uncertainty circle. IOM Control, September, 17-22.

Mayer, R. C., Davis, J. H., & Schoorman, F. D. (1995). An integrative model of organizational trust. [Article]. Academy of Management Review, 20(3), 709-734.

Melnyk, S. A., & Handfield, R. B. (1998). May you live in interesting times…the emergency of theory-driven empirical research. [Article]. Journal of Operations Management, 16(4), 311-319.

Mentzer, J., Dewitt, W., Keebler, J., Min, S., Nix, N., Smith, C., et al. (2001). Defining supply chain management. Journal of Business Logistics, 22(2), 1-25.

Meredith, J. (1998). Building operations management theory through case and field research. Journal of Operations Management, 16(4), 441-454.

Milliken, F. J. (1987). Three types of perceived uncertainty about the environment: state, effect, and response uncertainty. [Article]. Academy of Management Review, 12(1), 133-143.

Mitchell, V. (1995). Organizational risk perception and reduction: a literature review. British Journal of Management, 6(2), 115-133.

Moritz, B. B., Hill, A. V., & Donohue, K. L. (2013). Individual differences in the newsvendor problem: Behavior and cognitive reflection. [Article]. Journal of Operations Management, 31(1/2), 72-85.

Mun, J. (2004). Applied Risk Analysis. Hoboken, New Jersey: John Wiley & Sons, Inc.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. [Article]. Organization Science, 5(1), 14-37.

Nyaga, G. N., Lynch, D. F., Marshall, D., & Ambrose, E. (2013). Power Asymmetry, Adaptation and Collaboration in Dyadic Relationships Involving a Powerful Partner. [Article]. Journal of Supply Chain Management, 49(3), 42-65.

Oehmen, J., Ziegenbein, A., Alard, R., & Schonsleben, P. (2009). System-oriented supply chain risk management. Production Planning and Control, 20(4), 343-361.

Rao, S., & Goldsby, T. J. (2009). Supply chain risks: a review and typology. International Journal of Logistics Management, 20(1), 97-123.

Rempel, J. K., Holmes, J. G., & Zanna, M. P. (1985). Trust in close relationships. Journal of Personality and Social Psychology, 49(1), 95-112.

Renn, O. (1998). Three decades of risk research: accomplishments and new challenges Journal of Risk Research, 1(1), 49-71.

Ritchie, B., & Brindley, C. (2007). Supply chain risk management and performance. International Journal of Operations & Production Management, 27(3), 303-322.

Rousseau, D. M., Sitkin, S. B., Burt, R. S., & Camerer, C. (1998). Not so difference after all: a cross-discipline view of trust. Academy of Management Review, 29(3), 393-404.

Rowley, J. (2007). The wisdom hierarchy: representations of the DIKW hierarchy. Journal of Information Science, 33(2), 163-180.

Sahin, F., & Robinson, E. P. (2002). Flow Coordination and Information Sharing in Supply Chains: Review, Implications, and Directions for Future Research. [Article]. Decision Sciences, 33(4), 505-536.

Savage, L. (1954). The Foundations of Statistics. New York: Wiley.

Schoorman, F. D., Mayer, R. C., & Davis, J. H. (2007). An integrative model of organizational trust: past, present, and future. [Article]. Academy of Management Review, 32(2), 344-354.

Shapira, Z. (1995). Risk Taking : A Managerial Perspective. New York: Russell Sage Foundation.

Sjöberg, L. (2000). Factors in Risk Perception. [Article]. Risk Analysis: An International Journal, 20(1), 1-12.

Tang, O., & Nurmaya Musa, S. (2011). Identifying risk issues and research advancements in supply chain risk management. International Journal of Production Economics, 133(1), 25-34.

Tangpong, C., Hung, K.-T., & Ro, Y. K. (2010). The interaction effect of relational norms and agent cooperativeness on opportunism in buyer–supplier relationships. [Article]. Journal of Operations Management, 28(5), 398-414.

Tapiero, C. S., & Grando, A. (2006). Supply risk and inventory outsourcing. Production Planning & Control, 17(5), 534-539.

Voss, C., Tsikriktsis, N., & Frohlich, M. (2002). Case research in operations management. International Journal of Operations & Production Management, 22(2), 195-219.

Williamson, O. E. (1975). Markets and hierarchies: analysis and antitrust implications. New York: Free Press.

Williamson, O. E. (1985). The Economic Institution of Capitalism. New York: Free Press.

Wowak, K. D., Craighead, C. W., Ketchen, D. J., & Hult, G. T. M. (2013). Supply Chain Knowledge and Performance: A Meta-Analysis. [Article]. Decision Sciences, 44(5), 843-875.

Wu, D. D., & Olson, D. L. (2009). Enterprise risk management: small business scorecard analysis. Production Planning & Control, 20(4), 362-369.

Xie, K., Liu, J., Peng, H., Chen, G., & Chen, Y. (2009). Early-warning management of inner logistics risk in SMEs based on label-card system. Production Planning & Control, 20(4), 306-319.

Yang, H. E., & Wu, C. C. (2009). Effects of image interactivity technology adoption on e-shoppers' behavioural intentions with risk as moderator. Production Planning & Control, 20(4), 370-382.

Yates, J. F., & Stone, E. (1992). The risk construct. In J. F. Yates (Ed.), Risk-taking Behaviour. Chichester: Wiley.

Yin, R. K. (1989). Case Study Research : Design and Methods. London: Sage Publications.

Zsidisin, G. A. (2003). A grounded definition of supply risk. Journal of Purchasing and Supply Management, 9(5-6), 217-224.

Zsidisin, G. A., Panelli, A., & Upton, R. (2000). Purchasing organization involvement in risk assessments, contingency plans, and risk management: an exploratory study. Supply Chain Management: An International Journal, 5(4), 187-197.

Zucker, L. G. (1986). Production of trust: instituitional sources of economic structure. [Article]. Research in Organizational Behavior, 8, 53.

Table 2: Comparative analysis

	Case 1	Case 2	Case 3	Case 4
Information-based	Low • No timely information sharing • Minimum: only transactional information • Indirect communication through an agent due to language barrier	High • Timely sharing information through email • Full: transactional, operational, and strategic information • Direct communication	High • Timely information sharing; visit Shanghai office frequently • Full: transactional, operational, and strategic information • Direct communication with Shanghai office that is responsible for daily operations	High • Timely information sharing via email and Skype • Full: transactional, operational, and strategic information • Direct communication with Shanghai office and TechCo Australia
Knowledge-based	Low • No knowledge sharing	High • Joint problem solving • joint new product development; FiberCo shared its knowledge on the material of fiber with SportCo to develop new products	High • Joint problem solving • Joint new product design; MetalCo shared its knowledge on sheet metal to enable TechCo design products with reliable performance	High • Joint problem solving • Joint plan for material purchasing and production • Joint new product design and product testing
Relation-based	Low • Low level of trust, perceiving high opportunism behavior in this relationship • BoardCo perceived no relationship commitment in this relationship: BoardCo was happy to leave the relationship • Goals not aligned: BoardCo scheduled its production according to its own convenience rather the delivery time of SportCo.	High • High level of trust; SportCo shared its designs with FiberCo. • Very strong relationship commitment; FiberCo did not develop new customers in Australia to protect SportCo's interests. • Goals aligned: considered as a united whole, FiberCo knows only when SportCo can earn money, they can earn money	High • High level of trust; they practiced VMI • Strong relationship commitment, right from the start • Goal aligned: MetalCo considers itself as an extension of TechCo	High • High level of trust: CircuitCo can start production even without receiving orders from TechCo. • Strong relationship commitment: relational specific assets invested in this relationship • Goal aligned: regarded themselves as a single unit.
Supply Risk level	High • Late delivery: SportCo has been	Low • Delivery on time	Low • Delivery on time	Low • Delivery on time

	penalized by their customers • Uncertainty of delivery time: SportCo is not sure when BoardCo is going to deliver			

Appendix Interview questions guidelines

1. General information: get company background

history, # of employees, annual sales, organizational structure, supply base, customer base, etc.

2. Questions for the buyers:

- Tell me the history of the relationship between you and this supplier. When did you relationship start? How did it become your supplier?
- What kind of the relationship between you and this supplier? Give some examples.
- What kinds of information shared between you and the supplier? The mode of communication? How frequent is your communication?
- Are there any knowledge sharing between you and this supplier? Give some examples.
- Do you think there is enough trust in this relationship? Why?
- To what extent do your company collaborate with this supplier? In what aspects?
- How to evaluate this supplier' performance?
- What are the main risks associated with this supplier? Will you describe the risk level high or low?
- What have you done to reduce the risks? Are the practices/strategies successful?

3. Questions for the suppliers:

- Tell me the history of the relationship between you and this buyer. When did you relationship start? How did it become your customer?
- What kind of the relationship between you and this customer? Give some examples.
- What kinds of information shared between you and the customer? The mode of communication? How frequent is your communication?
- Are there any knowledge sharing between you and this customer? Give some examples.
- Do you think there is enough trust in this relationship? Why?
- To what extent do your company collaborate with this customer? In what aspects?
- What are the main risks associated your supplying to this buyer? Will you describe the risk level high or low?
- What have you done to reduce the risks? Are the practices/strategies successful?