



Supplier development with benchmarking as part of a comprehensive supplier risk management framework

Supplier risk
management
framework

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Abstract

Purpose – The purpose of the paper is to present and empirically support a theoretically sound, operational, and easy-to-implement supplier risk management framework that focuses on supplier development using a benchmarking approach.

Design/methodology/approach – The paper develops a five stage framework for supplier risk management, entailing supplier risk identification, assessment of supplier risks, reporting and decision of supplier risks, supplier risk management responses, and supplier risk performance outcomes, that builds on the conceptual approach of Ritchie and Bridley and the approach of the Association of Insurance and Risk Managers (AIRMIC). The operation of the framework is illustrated in a single case study of a UK firm.

Findings – The paper contributes to research in operations management and particularly in risk management in the specific field of supplier risk management. The study presents details of one of the later stages of the risk framework (i.e. management responses stage) and enhances understanding of how the development of suppliers can be conducted so as to create a viable supplier base.

Research limitations/implications – As an analytical method, the use of factor analysis generally requires metric scaled data, but ordinal-scaled data were applied to it. Therefore, two-factor solution with non-metric multidimensional scaling was confirmed. In addition, the operation of supplier risk framework is demonstrated within one firm only. Further case studies are therefore needed to strengthen the research findings.

Practical implications – Managers can use the supplier risk management framework to develop firm-specific risk management programs, and to create management responses that influence and improve their relationships with suppliers. The framework is fully operational, easy to implement; and facilitates proactive supplier risk management, rather than reactive crisis management.

Originality/value – The study goes beyond the conceptual discussion of supplier risk management, and demonstrates the activities a firm can undertake in response to supplier risk ratings and assessments.

Keywords Risk management, Benchmarking, Factor analysis

Paper type Research paper



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Introduction

Connecting with reliable and trustworthy suppliers has become a key factor for successful organisations. Therefore, supplier decisions are important, but difficult, due to the challenges firms face in today's business environment. These challenges include the increased competition from international as well as from domestic sources (Hill, 2007). The situation becomes even more complex, because, at the same time, various catastrophic events such as terrorist attacks, earthquakes and floods have reinforced the awareness of vulnerability along the entire supply chain for manufacturing firms (Knemeyer *et al.*, 2008), down-stream in dealing with customers and up-stream in dealing with suppliers (Juettner, 2005).

Manufacturing firms respond to this situation through active management of their suppliers including the management of risks inherent to the supplier. Kearney (2005) study has revealed that approximately 90 percent of organisations attach great importance to the risk management of their supply chains, because the organisation's purchasing activities have a considerable influence on its financial performance. The objective is to develop long-term relationships with low-risk suppliers, because these can prevent firms from struggling in the prevailing dynamic business environment (Hartley and Choi, 1996).

Prior research in operations management has created numerous rating mechanisms, frameworks, and approaches relating to supplier risk (Steele and Court, 1996; Harland *et al.*, 2003; Cousins *et al.*, 2004; Ritchie and Brindley, 2007a,b; Hallikas *et al.*, 2004; Association of Insurance and Risk Managers, AIRMIC, 2002). Early work focused on assisting firms with supplier rating, evaluation, and selection (Muralidharan *et al.*, 2002). These approaches used mainly descriptive criteria for assessing suppliers (e.g. delivery time or price variations) and focused on supplier ability to deliver. However, a broader and more realistic view of suppliers means considering a number of different risks in supplier assessment (Zsidisin, 2003b; Chopra and Sodhi, 2004; Kleindorfer and Saad, 2005; Manuj and Mentzer, 2008).

In addition to considering a comprehensive set of supplier risks, firms need to undertake the right activities to manage supplier risks, which the literature refers to as management responses (Ritchie and Brindley, 2007a,b). Among these responses, supplier relationship development mitigates some of the potential threats a firm faces from supplier risks (Ritchie and Brindley, 2007a). Supplier development can be defined as "... any activity that a firm undertakes to improve a supplier's performances and/or capabilities to meet the buyer's short-term or long-term supply needs" (Krause, 1997). Supplier development aims at improving supplier performance and enlarging the firm's supplier base with viable partners (Krause *et al.*, 2007). Although supplier development is part of the conceptual supply risk frameworks by Ritchie and Brindley (2007a), little was done to translate the conceptual work into an operational approach which addresses all risk management phases. The latter approach would offer firms guidance on how to conduct an effective supplier development program that builds on established risk assessment methods (monitoring, classification and representation of the risk structure of the supply base). Ritchie and Brindley (2007a) found evidence that firms search for partners that are experienced in relationship development. Having no experience becomes crucial for firms when making decisions about their suppliers and undertaking related actions to improve the performance of the supplier base.

In this paper, we present a theoretically sound, operational framework that focuses on supplier development by means of a benchmarking approach. Using a case study of

a UK firm, we demonstrate the operation of the framework. Through incorporating risk categories and risk management response into supply chain management, we address what Ritchie and Brindley (2007a, p. 319) describe as work that is "... timely and reflects both theoretical imperatives and practitioner requirements."

Literature review

For firms, the creation of a comprehensive risk management system requires knowledge of the risk types to which it is exposed. Risk is the danger that a decision leads to negative deviations from set goals (Zsidisin, 2001). In other words, risk is the product of the probability of occurrence of a possible loss and the resulting damage (March and Shapira, 1987). Recent legal regulations (e.g. the COSO report in the USA, the Turnbull Report in the UK, and 1998 German legislation KonTraG) already require firms to identify, communicate and monitor risks (Pausenberger and Nassauer, 2000). Nevertheless, these regulations ignore the problem of intercompany risk management (Lam, 2003). Thus, these risk management approaches ensure only compliance with government regulations and focus excessively on formal, quantitative aspects. Conversely, a forward-looking risk management approach enables a firm to focus on the intercompany risks, and can thus prevent goal deviations and the associated damages.

Definition and classification of supply chain procurement risks

Firms face many risks along the supply chain, and the purchasing environment has become one of the most important components for generating added value, profitability, and even ensuring survival. For many firms, the value of parts purchased constitutes a large proportion of the product value. Purchasing departments focus on acquiring parts of the "right" quality, in the "right" quantity, at the "right" time and price, and from the "right" source. The assessment of supply risks is particularly important in two cases – when the supplier is new and the firm has not sourced from it before or when evaluating suppliers that deliver critical inbound supplies.

Zsidisin (2003a) defines supply risk as "... the probability of an incident associated with inbound supply from individual supplier failures or the supply market occurring, in which its outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to customer life and safety." Supply risk includes all risk that occurs if the up-stream flow of materials, information, or capital is disturbed (Christopher and Peck, 2004) and can be classified as either external procurement risks or internal operational risks (Eberle, 2005). An empirical study (Kersten *et al.*, 2006) investigated the relevance of external and internal sources of procurement risk and revealed that external procurement risks emerging from the supply side constitute the greatest threat within the industrial sector. Mason-Jones and Towill (1998) present five overlapping categories of supply chain risk types: environmental, supply and demand, process risk and control risk. Juettner (2005) aggregates the risk categories into three risk types and distinguishes between environmental, supply and demand risk types on the one hand, and processes and control mechanisms as a risk amplifier or absorber on the other. A detailed overview of the various risk types in the literature is presented in Table I.

Table I.
Supply chain risks and
the related descriptions

Risk type	Description	Prior research
Price risk	Risk that variations in price impact on the competitiveness and viability of the supply chain, e.g. changed specifications, scarcity of raw materials, and yield	Hirschsteiner (2002), Zsidisin (2001), Zsidisin <i>et al.</i> (2004), and Zsidisin and Ellram (2003)
Quantity risk	Risk that arises from supplier failure to deliver products or services which results in quantity fluctuations	Zsidisin <i>et al.</i> (2000, 2004), Zsidisin (2003b), and Chopra and Sodhi (2004)
Quality risk	Risk that production inputs do not meet quality specifications originates from individual supplier failures, e.g. problems at the plant	Zsidisin <i>et al.</i> (2000), Zsidisin and Ellram (2003), Chopra and Sodhi (2004), and Manuj and Mentzer (2008)
Technology risk	Risk of technology-related issues leading to uncertainty in the supply chain, e.g. supplier is not technologically competitive, updates in the IT landscape, and system compatibility	Chopra and Sodhi (2004), Zsidisin <i>et al.</i> (2000), Juetzner <i>et al.</i> (2003), Zsidisin (2003b), and Zsidisin and Ellram (2003)
Economic risk	Risk that relates to economic issues, e.g. financial issues leading to supply interruptions and possibly insolvency, failure to comply with legal regulations, and strategic issues that ensure competition and strategy implementation	Zsidisin <i>et al.</i> (2000), Cucchiella and Gastaldi (2006), Kleindorfer and Saad (2005), Zsidisin (2003b), and Manuj and Mentzer (2008)
Environmental risk	Risk that arises from uncertainty in supply-chain-environment interactions, e.g. accidents, social-political actions, natural disasters, acts of God	Juetzner <i>et al.</i> (2003), Juetzner (2005), Zsidisin <i>et al.</i> (2000), Christopher and Peck (2004); Zsidisin (2003b), Chopra and Sodhi (2004), Kleindorfer and Saad (2005), and Knemeyer <i>et al.</i> (2008)
Process risk	Risk that occurs if the material or information flow within the supply chain is disturbed, e.g. mismatch of business processes	Christopher and Peck (2004), Cavimato (2004), and Zsidisin (2003b)
Management risk	Risk that arises from supplier attitudes and their ability to anticipate and react to market and industry changes	Zsidisin (2003b) and Juetzner <i>et al.</i> (2003)
Chaos risk	Risk that results from over-reactions, unnecessary interventions, second-guessing, and mistrust throughout a supply chain	Childerhouse <i>et al.</i> (2003) and Juetzner <i>et al.</i> (2003)
Inventory risk	Risk that arises from excessive inventories, which leads to inefficient capital investment, expensive markdowns and unnecessary handling costs	Cachon, 2004, Zsidisin (2003b), Chopra and Sodhi (2004), and Manuj and Mentzer (2008)

Frameworks for supplier risk management

The objective of risk management in the supply chain is to protect organisations from unpredictable events and their adverse effects (Gaudenzi and Borghesi, 2006). Managing supply chain risk is important, because of the increasing number of potential suppliers involved in globalised sourcing and the multiplicity of possible evaluation criteria (Wagner and Bode, 2006). It is for this reason, that supply chain risk management and in particular, supplier risk management, is presently receiving greater attention in both the literature and in practice (Blackhurst *et al.*, 2008; Ritchie and Brindley, 2007a; Spekman and Davis, 2004; Herrmann and Hodgson, 2001). Organisational supplier risk assessment involves identifying potential losses, establishing their magnitude and likelihood, assigning significance to potential losses, and appraising overall supplier risk (Yates and Stone, 1992). Risk management, along with other considerations, dictates the risk taker's behaviour. In the following paragraphs, we present various prior research approaches to supplier risk management, particularly in order to demonstrate their diversity.

A general risk management process embraces different phases:

- Risk assessment consisting of risk analysis and evaluation.
- Risk reporting and decision making.
- Risk treatment.
- Risk monitoring (AIRMIC, 2002).

This framework includes the definition of risk objectives, evaluating the likelihood of occurrence, and the consequences of the particular event. Furthermore, special procedures are proposed to handle the risks (AIRMIC, 2002). In order to ensure the effectiveness of the framework, it needs to be integrated into the organisation's daily routines, proactively, and continuously. This risk management approach provides the transparency needed to create risk awareness among all employees.

Hallikas *et al.* (2004) suggest a similar framework, but they add an initial risk identification phase to the model. In this first phase, it is important to ensure that risk identification and the subsequent assessments align with the supply chain objectives of the firm. The analytic hierarchy process (AHP) method (Saaty, 1990) supports just such an alignment, because it allows for the breaking down of a decision problem (e.g. supplier selection) into hierarchical decision chains in which the elements are weighted and prioritised (Gaudenzi and Borghesi, 2006). The approach is particularly useful in indicating the effects on the overall supply chain strategy of such decisions as shortening the forecasting horizon.

The risk management framework of Blackhurst *et al.* (2008) focuses on risk monitoring which is a later stage of the risk management process. The proposed temporal methodology measures and tracks suppliers and their products with the aim of mitigating supply interruptions. This work is based on a factor weighting approach that calculates risk indices.

Additionally, prior research has developed numerous methods and techniques, which concentrate on categorising and measuring risk as part of supplier risk assessment. The analytical models include a variety of techniques, such as simple weighted scoring methods (Hinkle *et al.*, 1969; Timmerman, 1986), multivariate analysis (Petroni and Braglia, 2000; Lasch and Jancker, 2005), and complex

mathematical programming and neural network models (Weber and Ellram, 1993; Siying *et al.*, 1997; Cook and Johnston, 1992).

Comprehensive supply risk assessment frameworks are intrinsically either qualitative (Svensson, 2004) or quantitative (Gaudenzi and Borhesi, 2006), but a combination of both types in one framework should increase both its scope and value. Steele and Court (1996) provide a conceptual approach to supply risk assessment that consists of determining the probability of a risk event occurring, estimating the likely problem duration and investigating the business impact of the risk event. Within the framework of Harland *et al.* (2003), risk assessment is a necessary and critical aspect of purchasing organisations in their attempts to prioritise the use of resources for managing supply risk. An additional approach to describing the extent and type of environment-related supplier initiatives is based on the possibility of exposure to risk (Cousins *et al.*, 2004). The initiatives are triggered by a combination of perceived losses from inaction and the resources available. With this equation, firms can implement actions for reducing the level of exposure, alter the level of potential losses perceived by key decision makers, and change the sourcing strategy.

Ritchie and Brindley (2007a,b) present a framework for supply chain risk management that explores the links between risk and performance for a firm. The framework has five components, each of which represents a separate risk management strand (Ritchie and Brindley, 2007a):

- (1) risk sources and profile;
- (2) risk and performance drivers;
- (3) risk and performance consequences;
- (4) risk management responses; and
- (5) risk performance outcomes.

The framework has been applied in an empirical setting, but the authors (i.e. Ritchie and Brindley) encourage future research that explores the components in more depth. Risk management depends on the context in which it is applied and important dimensions include trust between the partners, information sharing, personal exchanges, and interactions, rather than the level of sophistication of the approach (Ritchie and Brindley, 2007b).

Building on these prior research approaches, we present in the next section our approach that is operational and balanced across different stages of supplier risk management.

Application of the supplier risk management framework to supplier development by means of benchmarking

The approach to supplier risk management that we pursue in this paper is depicted in Figure 1, which highlights the stages of the framework, based on the work by Ritchie



Figure 1.
Framework for supplier risk management

and Brindley (2007a) and the approach of the AIRMIC (2002). The proposed framework aims at improving the entire risk management process base, and developing the supplier base with the aim of making procurement more predictable and repeatable (Herrmann and Hodgson, 2001). Although the framework is presented in sequential form in both Figure 1 and the related text, it is more a dynamic, agile, and responsive process, which supports loops, bypassing of stages, and other fallbacks in the process. For example, management responses can initiate a different perception of the risk categories the firm faces and that, in turn, requires additional actions while simultaneously revisiting the risk distribution of the various suppliers.

The initial stage 1 is concerned with the identification of risk types and risk drivers. This stage is particularly critical to successful risk management, because it detects organisational exposure to uncertainty (Neiger *et al.*, 2008). Without sufficient knowledge of potential disruptions, appropriate actions that are directed towards avoiding supply chain vulnerability cannot be implemented (Juettner *et al.*, 2003). Firms are exposed to a large number of factors that may affect their business processes (Zsidisin *et al.*, 2000; Zsidisin and Ellram, 2003; Chopra and Sodhi, 2004; Manuj and Mentzer, 2008). Nevertheless, not all risk categories that are known from the literature and practice are relevant to a particular firm in practice. Consequently, the firm needs to decide on the relevant risks under consideration in the corporate procurement strategy. Additionally, the firm must select the group of suppliers which will be assessed. The commodity portfolio matrix indicates that suppliers of critical strategic supplies should be considered for the risk management process (Handfield *et al.*, 2000). Indeed, these suppliers provide products that are strategically important, difficult to substitute, and of major importance for overall production. Thus, disruptions in the flow of these products can exert a major impact on the firm's position in the market (Carr and Kaynak, 2007). Accordingly, in this stage 1, a set of risks is selected that will be used to assess the suppliers.

Subsequently, in stage 2 the assessment of the supplier and associated risks takes place and the ratings are calculated. The process entails measuring the different risk categories and risk drivers as identified in the previous stage. The approach we propose is a "two-sided perspective" rating mechanism that uses internal firm ratings and external supplier ratings. The two independent ratings relate to one supplier, and are eventually combined to represent the supplier risk structure.

Ratings are created based on multi-criteria group decision-making models (Muralidharan *et al.*, 2002; ElMaraghy and Majety, 2008), and the results present a consensus reached through compromise among decision makers. While Muralidharan *et al.* (2002, p. 24) compare several supplier rating methods, three methods are particularly appealing because they are:

- (1) Easy to understand.
- (2) Easy to implement.
- (3) The implementation costs are low.

These are the categorical method (Timmerman, 1986), weighted point plan (Birou and Fawcett, 1994), and AHP (Saaty, 1980). The categorical method can be used with qualitative and quantitative criteria based on equal weights. The weighted point plan method includes weights, but, in fact, both methods are fairly subjective. AHP includes tangible and intangible factors and seems the superior of the three methods, but it

becomes impractical in cases of more than 20 requirements (Avesani *et al.*, 2005). Multi-criteria group decision making is indeed challenging, but Muralidharan *et al.* (2002) conclude that successful applications are simple methodologies, because they are easily understood by decision makers.

The strength of the “two-sided perspective” rating mechanism lies in its participatory nature, through which it considers both the supplier and firm. This approach allows the firm to explore the differences in opinions and to create a richer view of the risk associated with a particular supplier (Muralidharan *et al.*, 2002). Any mismatch between the results of the external and internal ratings is solved by an additional assessment by the firm, using information provided by the supplier. The information can include documentation on newly implemented technology, quality awards received, or compliance initiatives. The objective is to reach agreement on the risk assessment and hence, obtain consistent evaluations (Keeney, 1982). Consequently, the acceptance and support of the assessment exercise by the suppliers is improved.

Stage 3 of the risk framework – reporting and decision – refers to the aggregation, representation, and classification of supplier risk data. Accordingly, the aggregated data from suppliers is represented in such a way that it facilitates a classification into high and low risk suppliers. The risk assessment considers various risks a firm is exposed to in the supply chain. However, in order to make any decision on risk monitoring and supplier development, a reduced number of risk categories is preferred. We suggest, therefore, that multivariate analysis procedures are appropriate, in particular an exploratory factor analysis to reduce the risk categories (Hair *et al.*, 2006; Lasch and Janker, 2005). Using this technique, we benefit from the primary objective, which is that of data reduction, without losing relevant information by describing the overall variation of a set of correlated original variables by a smaller set of new latent variables. The resulting uncorrelated factors, which are ordered by declining variability, are linear combinations of the original variables (and vice versa) (Tabachnick and Fidell, 2007). The factor analysis results in a classification of suppliers ranging from low to high risks.

Stage 4 of the framework consists of the management responses addressing the calculated supplier risk results. These responses are intended to improve the risk performance of the supplier base. They can include information sharing, performance standards, joint reviews, partnership programs, and joint training seminars (Ritchie and Brindley, 2007a). Management responses are enablers of risk migration that support trust building and collaborative relationships among supply chain partners (Faisal *et al.*, 2006). In this paper, we are particularly interested in supplier development as a management response to increase the number of viable suppliers (Krause *et al.*, 2007).

Supplier development includes any efforts undertaken by the firm to enhance the supplier’s product quality and financial performance. Supplier development activities vary in their range, from limited to extensive, and include technical assistance, direct investments into supplier operations, and visiting supplier plants (Krause, 1999).

These development activities frequently result in supplier base reduction (Carr and Kaynak, 2007). Supplier development requires commitment from both firms (manufacturer and suppliers) by investing financial and human capital in the various activities. Consequently, these investments create outcome expectations, and appropriate controls need to be in place to ensure that the appropriate benefits are

achieved (Krause *et al.*, 2007). The outcomes are critical, because the manufacturer must be convinced that investing in a supplier is worthwhile and vice versa. The supplier must be convinced that the investments are beneficial to him (Handfield *et al.*, 2000). In situations in which suppliers do not receive the associated benefits, they may reject further commitments to the development exercise.

Among the various supplier development activities, knowledge sharing is recognized as an important success factor. It facilitates the transition from a general transactional relationship to a cooperative relationship which offers mutual benefits. The timely and effective sharing of knowledge of manufacturer requirements increases the understanding of the relationship (Krause *et al.*, 1998). In an empirical study, evidence was found that knowledge sharing (supported by traditional communication, such as e-mail and face-to-face meetings) relates positively to product quality improvements and financial performance (Carr and Kaynak, 2007).

In order to carry out supplier development, we utilize the benchmarking approach as a tool for continuous improvements in quality and performance (Dattakumar and Jagadeesh, 2003). The approach is particularly appropriate and useful for supplier development, because it facilitates the identification of high performers (i.e. low-risk performers) who may have achieved “best practice” (Camp, 1995) and presents an action plan for performing the improvement steps. The concept of benchmarking evolved over time. While early studies focused on criteria to benchmark, current research is concerned with the benchmarking process and the consolidation of existing works and knowledge (Anand and Kodali, 2008). Indeed, the definition proposed by Anand and Kodali (2008, p. 259) goes beyond Camp (1995) focus on “searching for best practice” and acknowledges that benchmarking is a time and resource-intensive and complex approach:

[...] a continuous analysis of strategies, functions, processes, products or services, performances, etc. compared within or between best-in-class organisations by obtaining information through appropriate data collection method, with the intention of assessing an organisation’s current standards and thereby carry out self-improvement by implementing changes to scale or exceed those standards.

The ultimate goal of benchmarking is to learn from each other and to incorporate process and product advancements (Bagchi, 1997), so that benchmarking enables innovation rather than imitation. Benchmarking is a management field in which practice stimulates research, and progress is driven by firms (Yasin, 2002). The benchmarking approach has been used in more than 43 functional areas, e.g. purchasing, manufacturing, information technology, and spare parts logistics, as presented by Dattakumar and Jagadeesh (2003). Benchmarking exposes a firm’s weaknesses and simultaneously provides bases for action (Bagchi, 1997). It can be triggered by a number of events, like the need for cost reduction or competitive threats, which require more information and subsequent actions (Forker and Mendez, 2001).

The findings of three recent meta-analyses (Yasin, 2002; Dattakumar and Jagadeesh, 2003; Anand and Kodali, 2008) of the benchmarking literature over the period 1980-2002 reveal a diversity of models and steps for the benchmarking exercise. Yet, the analyses showed that benchmarking commonly entails four main steps:

- (1) Planning.
- (2) Analysis.

- (3) Integration.
- (4) Action.

The details of each step are illustrated in Table II (Anand and Kodali, 2008).

In order to use the above benchmarking approach for supplier risk management, the approach needs to fit the overall framework. The planning step builds on the supplier classification in terms of high- and low-risk suppliers. The low-risk suppliers are selected as potential benchmarking partners. Their interest in and willingness to participate in the benchmarking is assumed, and the collection of further data begins. Supplier cooperation is important, because knowledge of the risk structure of the supplier exists, but there is no information on the supplier's internal operations. The latter include which technology is implemented, how prices are calculated, how scheduling is handled, and what catastrophe plans are in place (Choy *et al.*, 2007). Site visits, supplier documentation, and open informative discussions produce the required knowledge of the benchmarking partners (Anand and Kodali, 2008). This step encourages the creation of cooperative relationships that are mutually beneficial. Subsequently, the analysis step determines the competitive gaps between the suppliers.

The integration and action steps of the benchmarking can be viewed as a means of implementing the supplier development process. Based on the results, functional goals for the suppliers are defined and action plans developed. During the definition of the action plans, modifications of best practice are likely to adjust the plans to each supplier's environment (Bagchi, 1997). An important part of the action step is the monitoring of implementation and making any necessary changes.

The final stage of the supplier risk management framework relates to the supplier performance outcomes. The objective is to reduce the inherent risk associated with the suppliers and to enable them to meet the manufacturing company's short-term and/or long-term supply needs. The benchmarking process provides the link between performance and corporate strategy (Bagchi, 1997) and facilitates quality improvements for the supplier base. The literature (Dattakumar and Jagadeesh, 2003; Forker and Mendez, 2001; Krause *et al.*, 2007) stresses the importance of returns from the risk management exercise for all parties involved as a guarantor of continuity, commitment, and success.

Major steps	Benchmarking details
Planning	Identify the benchmarking subject Identify the benchmarking partners and form benchmarking team Determine data collection method and collect data
Analysis	Determine the current competitive gap Project future performance
Integration	Communicate findings and gain acceptance Establish functional goals
Action	Develop action plans Implement action plans and monitor progress Recalibrate the benchmark

Table II.
Benchmarking steps with
details of each step

Source: Anand and Kodali (2008)

Summary

As discussed above, supplier risks are important to global sourcing firms and several frameworks have been developed to guide firms in the management of risk. However, few studies focus on the latter stage (i.e. management responses) of the risk management frameworks as a means of enhancing product quality and supplier-base performance. In addition, Ritchie and Brindley (2007a) call for further work on the components of their risk framework. In order to address this gap, this paper presents a case study aimed at enhancing our understanding of how and why a manufacturing firm implements management responses to develop low-risk suppliers.

Research methodology

In this section, we present the methodological approach adopted for this research.

Research design

The case study research method was chosen, due to the novelty of comprehensive supplier risk management and to obtain insights into how and why organisations develop their suppliers. This method is appropriate for exploring areas in which theoretical knowledge is limited and still developing (Yin, 1981). Case study research is particularly useful in research projects which focus on gaining an in-depth understanding of the dynamics of single settings (Eisenhardt, 1989).

The case study method allows the investigators to get a holistic view of the main characteristics of real-world events and so contributes to our knowledge of individuals, groups, and organisational phenomena (Yin, 2003). Thus, a case study is the preferred method when the research focuses on contemporary phenomena in natural settings in order to reveal the underlying mechanisms. Findings from case studies enable the researcher to answer questions relating to the complexity of events and processes (Benbasat *et al.*, 1987). However, the researcher has little or no control over the events themselves (Yin, 2003).

Case studies employ multiple methods of data collection to gather information from various sources by combining different techniques such as observations, questionnaires, focus groups, and interviews. Thus, case studies may use both qualitative data collection and analysis methods as well as quantitative methods (Darke *et al.*, 1998). Further-more, case studies can be:

- descriptive;
- exploratory; and
- explanatory (Yin, 2003).

Conducting a case study requires careful planning and a judicious use of the researcher's and the case study firm's time. The data collection procedure is usually time-consuming, complex, and difficult (Cavaye, 1996). The researcher should use the available sources for case preparation, e.g. public relations documents, the firm's web page, press documents, and other firm documents. Additionally, names and positions of potential case participants should be obtained before the site visit (Darke *et al.*, 1998). These actions provide the researcher with sufficient background knowledge of the case firm and form the basis for a focused data analysis.

The case study presented in this research is an exploratory study that seeks to explore our risk management approach through supplier development in a single case firm.

An experienced researcher, placed in the company, performed the study over a period of three months. During his stay, he had access to various firm documents in order to help him understand the complex nature of the firm's supplier network.

Research sample

The case study site is a medium-sized manufacturing firm (henceforth referred to as the "manufacturer") with about 400 employees based in London, UK. The company is in the chemical industry and sells high-quality rubber parts. The company has approximately 270 first-tier suppliers that deliver different products for the production process. The first-tier suppliers are small and medium firms located mainly in the UK, but also in other European and Asian countries.

The case study participants are experts and key decision-makers from different departments of the manufacturer: purchasing, production, logistics, process management, information technology, and quality management. The participants are either the department manager or an employee nominated by the manager. Together, with the researcher, they form a multi-disciplinary team of seven people led by the manager of the purchasing department, due to his intensive contacts with the suppliers.

The company had not previously conducted any supply risk management and it was necessary to determine which suppliers should be assessed. Relating back to the framework in Figure 1, supplier selection is part of the initial stage. Indeed, the manufacturer decided to use 17 suppliers of strategic products, and thus pursued the selection strategy in the commodity portfolio matrix.

Questionnaire instrument

Risk data were collected by means of a questionnaire. The development of the questionnaire required the identification of risk types. The researcher presented the experts in the multi-disciplinary team with a list of risk types based on an extensive review of the literature on supply chain risk (Table I). Certain risks (e.g. mistrust among supply chain partners, management failure, and inventory planning failure) were perceived as not relevant in this particular case and were precluded, because the manufacturer did not want to strain the supplier relationships. However, the experts in the multi-disciplinary team indicated that these risk types may be included in future risk management exercises. The team decided to assess each supplier on seven risk types: risks relating to:

- (1) Price.
- (2) Quality.
- (3) Quantity.
- (4) Process.
- (5) Technology.
- (6) Economic.
- (7) Environmental.

The risk types were rated on a five-point ordinal Likert scale from 1 = very low risk; 2 = low risk; 3 = average risk; 4 = high risk; 5 = very high risk.

Table III presents the seven risk types, identified risk drivers, and the related studies. The risk drivers in the questionnaire have only a guiding function to enhance

Risk type	Risk drivers	Literature source
Price risk	Unexpected material price due to allocation problems Unexpected material price due to yield problems Unexpected material price due to specification changes	Zsidisin <i>et al.</i> (2004, p. 402)
Quantity risk	Missing parts due to late delivery Missing parts due to supplier quality defects	Zsidisin <i>et al.</i> (2004, p. 402)
Quality risk	Missing parts due to instability of supplier's country Failure of suppliers to maintain capital equipment Lack of supplier training in quality principles and techniques Transit damage	Zsidisin and Ellram (2003, p. 17)
Process risk	Loss of customer reputation Business process disruption Non-adaptable processes	Zsidisin (2003b, p. 16), Christopher and Peck (2004, p. 4), and Cavinato (2004, p. 384)
Technology risk	Disturbed information processes Incompatible information systems Lacking technical innovation	Chopra and Sodhi (2004, p. 54), Zsidisin <i>et al.</i> (2000, p. 188), and Zsidisin (2003b, p. 16)
Economic risk	Construction failures Insolvency risk Competition risk	Cucchiella and Gastaldi (2006, pp. 704-705)
Environmental risk	Legal responsibility risk Strategic risk Accidents Social-political actions Acts of god	Juettner <i>et al.</i> (2003, p. 201)

Table III.
Questionnaire instrument with risk types and risk drivers

the clarity of the risk types and to enable both the suppliers and the experts to fully understand the dimensions of each risk type. Unlike questionnaires that measure the items in order to calculate the constructs (Churchill, 1979), we were interested only in overall ratings of the seven risk types. The case study firm strongly believed that risk ratings are subjective and they decided to allocate only one overall risk rating to each risk type. It would require substantial knowledge to determine clearly the extent of risk for each risk driver. It was not the aim of this study to determine exact probabilities for each risk type, but rather to obtain an understanding of the risks associated with a certain supplier.

This form of assessment is supported by research in the context of performance measurement (Dess and Robinson, 1984). The latter study demonstrated that subjective data are strongly related to objective data. Indeed, subjective judgments provide a richness and variety of aspects often not obtainable from objective measures alone (White, 1996). The validity of the risk ratings in this study was enhanced through the “two-sided perspective” rating mechanism, because both the supplier and the manufacturer provided ratings on the seven risk types. The final questionnaire was pre-tested for comprehension and clarity in one of the meetings of the multi-disciplinary team.

Data collection method

For the data collection, we used the above mentioned questionnaire and expert discussions. We followed the “two-sided perspective” rating mechanism as outlined above. Thus, the questionnaire was sent to each of the 17 strategic suppliers and also given to the multi-disciplinary team (i.e. the experts). While each supplier had to rate only itself, each expert was requested to conduct 17 different ratings. During the rating exercise, the researcher assisted both suppliers and experts with any questions, problems or concerns. Additional instructions were given to the suppliers, namely to consider already planned or realised risk-reducing actions which were so far unknown to the manufacturer. In total, 17 questionnaires were received from the suppliers after they had been approved by the CEO or a delegated senior executive.

The supplier ratings by the experts in the multi-disciplinary team took place in the form of three workshops, each of which assessed five or six suppliers. The questionnaire was used for guidance during the expert discussion. The result of the workshops was a consensus rating of each supplier.

Consequently, for each of the 17 suppliers, there are two risk ratings that needed to be combined. Each of the risk types was equally important for the manufacturer and thus, equal weights were assumed for all risk types. In another context, decision analysis could have been used to determine the weights (Keeney and Raiffa, 1993). The manufacturer decided not to use the cross-functional team again, but rather to have the team chair-person and the researcher work together to produce the final ratings using experience-based judgements. The final risk ratings were communicated to the suppliers and in most cases no disagreement was noted. Differences in ratings arose when a supplier rated himself better, i.e. on a lower risk level than the multi-disciplinary team. Additional consultations with the suppliers were performed either face to face, or where this was not possible, by telephone or video conference. The objective was to reach agreement on the risk ratings and obtain consistent evaluations (Keeney, 1982). During the consultations, the supplier also had the

opportunity to present additional evidence that justified a lower risk assessment. Two consultations were necessary, because supplier 10 had rated the technology risk lower than the experts and supplier 3 had rated the quality risk lower than the experts. The consultations revealed that supplier 10 had recently upgraded its logistic application and supplier 3 had implemented a new quality management system. In both cases, the risk ratings from the suppliers were accepted and included in the final rating. Table IV presents descriptive statistics of the final (consistent) assessments of the 17 suppliers. Please note the reverse scale, i.e. 1 = very high risk and 5 = very low risk.

Analysis and results

Exploratory factor analysis, based on principal component analysis with varimax rotation, was conducted to identify the risk structure for the 17 suppliers. The objective was to obtain fewer dimensions, which makes the risk management process feasible and manageable. A factor analysis was performed with SPSS 13.0. Standard tests (Bartlett’s sphericity and Kaiser-Meyer-Olkin) were used to determine the appropriateness of factor analysis (Hair *et al.*, 2006) and the results suggest sufficient correlations (Bartlett-test: $\chi^2 = 58.173$; KMO = 0.543). The factor extraction and varimax rotation of the factors resulted in a two-factor solution and both factors explain more than 71 percent of the variance of all seven risk types. The eigen-values for both factors are greater than 1.0; Factor 1 = 2.667, Factor 2 = 2.314. Means, standard derivations, and correlations for the seven risk types are shown in Table V.

The varimax rotation was suitable, because the loadings were greater than 0.6 (Guadagnoli and Velicer, 1988). We also calculated Cronbach’s alpha to determine how accurately the risk types measure the two factors. The test is deemed acceptable if the reliability coefficient exceeds 0.7 (Hair *et al.*, 2006). The values exceed 0.8 for each of the

Risk types	Min	Max	Mean	Median	Mode
Price risk	1	5	3.29	3	3
Quantity risk	1	5	3.24	4	5
Quality risk	1	5	3.41	4	5
Process risk	1	5	3.59	4	4
Technology risk	2	5	3.59	3	3
Economic risk	1	5	3.06	3	4
Environmental risk	2	5	3.29	3	4

Table IV.
Descriptive statistics of the risk types (1 = very high risk and 5 = very low risk)

Risk type	Mean	SD	1	2	3	4	5	6	7
1 Price risk	3.29	1.404	1						
2 Quantity risk	3.24	1.602	-0.0605	1					
3 Quality risk	3.41	1.661	-0.3233	0.8306	1				
4 Process risk	3.59	1.326	0.6065	0.2251	-0.0317	1			
5 Technology risk	3.59	1.004	0.5793	0.0640	-0.1169	0.7571	1		
6 Economic risk	3.06	1.144	0.3777	0.2648	0.1839	0.2642	0.6212	1	
7 Environmental risk	3.29	1.047	-0.3178	0.4407	0.4654	0.1378	0.0630	-0.0675	1

Table V.
Means, standard derivations, and correlations of the risk types

seven risk criteria. The results of the factor analysis are reported in Table VI, which shows factor loadings, eigenvalues, variance explained, and Cronbach's α .

The two uncorrelated factors are linear combinations of the original seven risk types. The first factor can be related to internal firm risks and value-related risks and consists of the risk types of price, process, technology, and economic.

This factor is interpreted to represent four risk types, which can be controlled by a firm and actively managed, so as to reduce the risk levels. Juettner *et al.* (2003) describe organisational risks as those that are within the boundaries of the supply chain partners, but network-related risks as stemming from the interactions between the partners. Factor 1 captures both perspectives and emphasises the financial value aspect. Therefore, we labelled this factor organisational-network value risks.

The second factor can be associated with product-related risks and external risks that are beyond the control of a firm. This factor covers the risk types of quantity, quality, and environment. The risk types captured by this factor are, on the one hand, very specific and detailed, but on the other hand, very abstract as a result of the potential for massive, disruptive events. We refer to this factor as product-centred and disaster risks.

Small sample sizes may affect the stability of the factor analysis solution (Guadagnoli and Velicer, 1988). Therefore, to ensure that the two-factors are stable, certain tests were performed. First, the research team conducted controlled manual tests, in which the data were changed in small iterations and the factor analysis was repeated numerous times. We then used the Wu and Wang (2006) approach, that proposes three decision rules that indicate when a solution is deemed to be unstable: eigenvalue < 1 , loading of less than 0.35 on all item factors, and loading > 0.35 on two or more item factors. Our results fulfil these criteria and we showed that small changes in the assessment of risk types did not change the representation and classification of the suppliers.

Second, we conducted a non-metric multidimensional scaling (NMDS), which confirmed the significance of the factor plot (Kruskal, 1964). The starting configuration of the NMDS was chosen at random. An equivalent representation of the supplier portfolio with a very good stress value (stress value = 0.0589; dynamic increment) was achieved after 26 iterations.

Risk type	Factor 1	Factor 2
Quantity risk	0.1873	<i>0.8922</i>
Quality risk	-0.0706	<i>0.9241</i>
Environmental risk	-0.0400	<i>0.7081</i>
Price risk	<i>0.7894</i>	-0.3453
Process risk	<i>0.8356</i>	0.0837
Technology risk	<i>0.9179</i>	-0.0114
Economic risk	<i>0.6787</i>	0.1900
Eigenvalue	2.667	2.314
Proportion of variance explained (percent)	38.09	33.05
Cumulative variance explained (percent)	38.09	71.14
Cronbach α	0.8211	0.8049
Factor labels	Organisational-network value risks	Product-centred and disaster risks

Table VI.
Loadings of varimax
rotated factors (italics
indicates highest factor
loadings), eigenvalues,
variance explained,
Cronbach α , factor labels

While the factor loadings in Table VI indicate to which factor a certain risk type is attributed, the factor scores are estimates of those which the suppliers would have received on each of the factors, had they been measured directly (Tabachnick and Fidell, 2007). Thus, the factor scores indicate the position of the suppliers in relation to the two risk factors. The factor scores from SPSS 13.0 for each individual supplier are plotted in two dimensions in Figure 2. We use the factor plot to identify groupings of suppliers. Suppliers positioned close to each other have similar risk levels. We identified six clusters as illustrated by the circles in Figure 2.

The origin in Figure 2 represents the average risk of all suppliers. Consequently, suppliers within the clusters A (firm 5) and B (firms 1, 2, 3, 6, 12, 14) represent top performance suppliers, as their risks are below average with respect to the two factors; firms 5, 6, and 12 are furthest from the origin. Thus, cluster A and B firms are potential candidates for supplier relationship development activities. The suppliers in cluster E achieve above-average risk values in terms of all seven risk types. These suppliers should be subjected to increased risk controls, and consideration should be given to whether they should be removed from the supply base. The suppliers within clusters C and D (second quadrant) achieve above-average risk values with respect to the first factor and below average risk values in the case of the second factor. Cluster F (in the fourth quadrant) yields the opposite risk performance levels. For these suppliers, the company needs to carefully consider the future of the relationship. Table VII lists the 17 suppliers classified into six risk clusters.

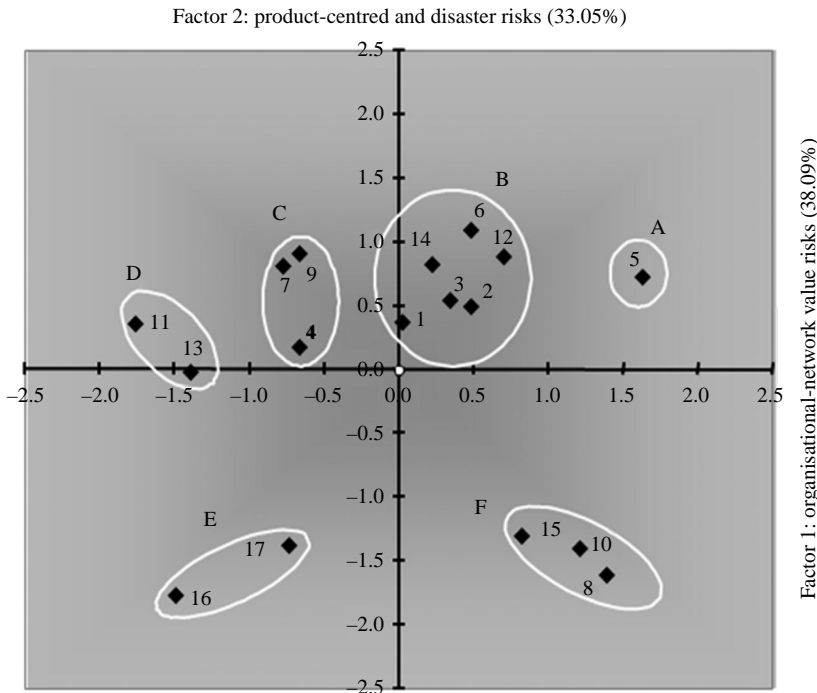


Figure 2. Visual presentation of the different risk clusters for the assessed 17 suppliers

Discussion

This section describes how the manufacturing firm conducted the supplier development process with respect to the selected suppliers. The risk management framework used is also discussed, and finally there is a look at the limitations of the study and future research.

Development of the suppliers using benchmarking

In stage 4 of our risk management framework, activities are designed in order to address the supplier risk identified in the previous stages. Supplier development with benchmarking is now conducted, and we follow the steps described in the related literature (Table II), with respect to planning, analysis, implementation, and action. During the benchmarking exercise, the manufacturer acted as a coordinating party which supported the exchange of benchmarking information between the benchmarking partners.

Planning step

The planning step consists of decisions on the composition of the benchmarking team, the subject, and partners. The benchmarking study is also performed in this step. The benchmarking team consists of the experts from the multi-disciplinary team and some of the benchmarking partners. Each of the suppliers formed a benchmarking team in their companies. The benchmarking partners were selected on the basis of the risk assessment, that is, the factor analysis. The manufacturer decided to develop selected suppliers which already have a low-risk structure. Therefore, suppliers in clusters A and B (Table VII) are considered. Remember, that these are the suppliers in the first quadrant of Figure 2 and from these suppliers, the lowest risk ones are suppliers 5, 6, and 12, because they are furthest from the origin in Figure 2. Thus, these three companies are potential benchmarking partners. An additional examination of the underlying firm data for suppliers 5, 6, and 12 revealed that suppliers 5 and 12 have similar firm characteristics. Both are UK based companies, with similar characteristics in respect of firm size, quantities produced, and manufacturing depth (Sinn, 2006) (i.e. the portion of self-manufacturing, compared to the portion of outsourced manufacturing), number of customers, and market position. Supplier 5 produces plastic mouldings and supplier 12 produces plug connections for the manufacturer. Functional benchmarking means comparing practices at companies with similar process in the same function (Camp, 1995). In order to determine whether two

Cluster	Quadrant	Supplier	Risk-level
A	1	5	Below-average risk for both Factor 1 and Factor 2
B	1	1, 2, 3, 6, 12, 14	Below-average risk for both Factor 1 and Factor 2
C	2	4, 7, 9	Above-average risk for Factor 1 and below-average risk for Factor 2
D	2	11, 13	Above-average risk for Factor 1 and below-average risk for Factor 2
E	3	16, 17	Above-average risk for both Factor 1 and Factor 2
F	4	8, 10, 15	Above-average risk for Factor 2 and below-average risk for Factor 1

Table VII.
Presentation of the supplier risks sorted into clusters with risk levels

companies have similar processes, the firm characteristics are compared. Camp (1995) explains that similar firm characteristics suggest similar processes and that any process deviation facilitates the identification of best practice.

After that, the benchmarking team decided on the benchmarking subject. The manufacturer was interested in technology risk and quality risk and decided to use the results of the factor analysis, in particular the factor loadings in Table VI. Please note, that for the factor organisational-network value risks, the highest loading is on the risk type technology risk and for the factor product-centred and disaster risks, the highest loading is on the quality risk type. The benchmarking team aimed to minimise these two risk types for suppliers 5 and 12. It is important to note that the suppliers are not competitors, and each delivers different intermediate products that are used further within the production process of the manufacturer. Therefore, functional benchmarking seems promising. In functional benchmarking, specific functions are compared at two or more organisations (Fong *et al.*, 1998).

Information on suppliers 5 and 12 was obtained through additional discussions with the benchmarking teams of the suppliers. This information was used subsequently to improve the technological processes of supplier 12 and the quality processes of supplier 5. The assessment of information technology risks associated with supplier 5 showed that it was already using best practice. For example, it had an integrated IT enterprise architecture and a strong record for technical innovation. However, supplier 5 lacked sufficient training in quality principles and techniques, and the transit damage risk of supplier 5 was higher than that of supplier 12. In contrast, supplier 12 has very low transit damage risk as result of best practice in handling and storage processes, but higher technology risks than supplier 5, due, for example, to numerous legacy and stand-alone IT systems.

Next, benchmarking was performed and, finally, a benchmarking report was written. During the benchmarking process, suppliers 5 and 12 identified the business processes in their firms. The site visits to suppliers 5 and 12 were an important factor in collecting data, because they facilitated a more in-depth understanding of the benchmarked processes. The real benefit of benchmarking comes from understanding the practices that improve performance and the sharing of this knowledge between organisations.

Analysis and integration step

The analysis step determined how supplier 5 relates to supplier 12 and vice versa with respect to information technology and handling/storage processes. Traditional flow charts are used to document processes and show the key activities and how each is performed. Flow charts are visualised as diagrams. The flow chart focuses on the activities that have to be performed and how they are to be achieved. The level of detail of business processes description was enhanced by the benchmarking team members through providing them with appropriate process knowledge. During this step, both suppliers identified the current performance gaps. The outcomes of the benchmarking exercise are the identification of differences in practices and the reasons for these differences. At the end of this step, the findings were communicated to the manufacturer in question, and to suppliers 5 and 12, so as to achieve concurrence and commitment.

Action step

In the action step, the development of functional action plans determined the activities for adaptation and achieving best practice. Supplier 12 developed action plans in order to adapt to the best technological aspects of supplier 5, and supplier 5 implemented plans for adapting to the identified better handling and storage processes of supplier 12. Therefore, specific implementation plans, timetables, checklists and status reports were formulated so as to achieve best practice in the handling and storage process at supplier 5. Additionally, two further visits of IT staff from supplier 12 were arranged in order to receive training on the IT system used by supplier 5. The process is conducted in a cooperative manner. It is combined with regular supplier workshops that aim to establish “relational contracts” (Kay, 1993; Lynch, 2006), which extend beyond formal controls. The action plans are paths for continuous improvements of the supplier base into a set of viable suppliers (Anand and Kodali, 2008). While the preceding benchmarking example focussed on developing two of the manufacturing firm’s top suppliers, the development of suppliers in clusters C, D, and F can also be considered. Those suppliers have higher risks in one of the two factors, but may still reveal some specific characteristics that are of value to the manufacturer. A simple decision to terminate relationships with high-risk suppliers might not be possible or be imprudent for strategic reasons.

Reflection on the supplier risk management framework

Our five stage risk management framework is easy to use, understandable, and operational for practitioners and does not require advanced knowledge in operations management.

The first stages entailing supplier risk identification, assessment of supplier risk, reporting and decisions with respect to supplier risk enable the firm to rate, represent, and classify the supplier base into high and low-risk suppliers using multivariate methods. The subsequent stages of supplier risk-management responses and supplier-risk performance outcomes, focus on activities that utilise the risk findings by converting them, where possible, into actions aimed at reducing the risks. The framework utilises benchmarking to facilitate one important management response in particular, namely supplier development. While other management responses are possible, e.g. joint seminars or defining performance standards, the fundamental advantage of the current approach is that it provides a comprehensive, far-reaching, and well-known benchmarking approach for improving business performance by improving the performance of the suppliers. Integrating benchmarking into supplier development and thus, into supplier risk management enables the shift from a past-oriented to a future-focused management approach.

The case study demonstrates that a risk management exercise can create an awareness of the vulnerability of the supply chain processes between buyers and suppliers. In particular, small and medium-sized companies may presently not dedicate sufficient effort to reducing the risk associated with these logistics relationships. This is particularly the case from the perspective of the manufacturer who has not previously undertaken any risk management. Feedback from the supplier and experts in the multi-disciplinary team suggests that the risk management exercise is perceived as successful and leading to higher levels of trust between the partners and to closer relationships. The key element among the different stages is knowledge sharing, which

enables the continuous process of innovation and improvement. Knowledge sharing among suppliers and manufacturer means capturing and disseminating information on risk that emerges and jeopardizes the supply chain. Information sharing allows decision makers to respond in a timely and effective manner to risk occurrences (Simatupang and Sridharan, 2004). As a result, the net value of all partners within a supply chain network should increase and lead to mutual benefits.

Limitations of the study and future work

Although the research was carefully planned and executed, we need to acknowledge several limitations of the study, which are related to data collection and analysis. The first limitation concerns the factor analysis. In general, factor analysis is designed for a metrically scaled data matrix. However, in this study, the factor analysis was applied to ordinal data, because the descriptive analysis revealed high correlations that allow a meaningful application of factor analysis. The results of a factor analysis based on ordinal data require confirmation of the factor plot by the application of multi-dimensional scaling in the non-metric variant. The confirmation of the factor plot using NMDS guarantees the information value of the factor plot for ordinal data.

The second limitation refers to the generalisability of the research results. The single case study presents a project that might have specific characteristics that are not relevant to other cases. It is also possible that the focus on one manufacturing firm in one country (UK) is a source of bias. Future research is encouraged to apply the framework to further case studies as a means of strengthening and enriching the research findings.

Another important extension to this work would be the development of a standardised instrument for supplier risk assessment. Quantitative research, particularly scale development, is needed to define items that measure the various risk types. However, this requires a careful consideration of the risk literature and practice in order to avoid inflexibility in terms of what firms perceive to constitute a risk.

It would also be useful to assess supplier satisfaction throughout the entire supplier risk management process. Although suppliers are integrated into the risk ratings and benchmarking activities, little is known of the effects and impacts of risk management in the supplier companies. Supplier benefits and satisfaction with the process are important factors for the willingness of suppliers to accept and support risk management. The ability to measure benefits and satisfaction would enhance transparency and provide evidence for conducting supplier risk management. Supplier risk management could be simplified by the implementation of an information system (i.e. a decision support system) that supports the collection of supplier risk data and allows the calculation of the supplier risks.

Conclusions

Ensuring the continuity of supply is one of the most critical goals in purchasing and supply management. We have seen that, while business organisations generally attach great importance to the risk management of their suppliers, the existing literature provides little in the way of operational frameworks for effective supplier risk management. This gap is crucial for firms making decisions about their suppliers, particularly in the face of the globalisation of production, where supply chains often

transcend international boundaries and business cultures. We developed a supplier risk management framework with five stages, namely supplier risk identification, assessment of supplier risk, reporting and decision of supplier risk, supplier risk management responses, and supplier risk performance outcomes, all of which focuses on the development of suppliers into low risk performers. Within the framework, we use a multivariate statistical method and a benchmarking approach. The application of the framework was demonstrated through a case study of a manufacturing firm. As expected, the manufacturer was able to identify the low and high risk suppliers, evaluate them, and subsequently, undertake activities to further reduce the risk associated with selected suppliers.

From a research perspective, this study extends the work on supplier risk management and presents details of one of the later stages of the risk framework (i.e. management responses stage). Our study therefore contributes to a cumulative tradition in operations management. We provide the outcomes as a first step in facilitating a greater understanding of how supplier development can be conducted in order to encourage proactive, rather than reactive risk management. From a practical perspective, managers can use the five stage risk management framework to develop firm-specific risk management programs, and to create management responses that influence the relationships with their suppliers, so as to build better relationships with them. Assuming that suppliers would also use the same framework for the risk management of their own suppliers, the risk within the entire supply chain will decrease.

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