ASSURING SUSTAINABLE SUPPLY THROUGH RISK MANAGEMENT

D.M. KAMAU

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Study leader: Prof. A.M. Smit

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ABSTRACT

In today's highly competitive global marketplace, organisations are under pressure to find new ways to minimize risk and maximize profits. Profits can increase by reducing the cost of inputs or increasing price of the outputs. Hence, procurement contributes by reducing the cost of inputs by sourcing materials at lower costs. Consequently, this creates a challenge to the buyer as supply risk issues are more likely to occur with lower cost sources that might include new suppliers or unreliable sources. Unfortunately, logistics planners, too, drive new initiatives intended to be cost effective such as "Just-in-Time" (JIT) manufacturing. This adds an additional challenge to the buyer of ensuring uninterrupted supply while the system has actually eroded the supply buffer that would have enabled achieving the goal of low cost supply at lower risk. Hence, supply managers have to deal with the ever-increasing challenges in pursuit of a balance between supply risk and lower cost of supplies while ensuring sustainable supplies.

For these reasons, this study aims to develop an implementation plan for the supply risk management. The plan developed from a case study undertaken at Safripol, a large manufacturing chemical company located in Sasolburg, South Africa. The complete study of the implementation plan, from the literature to empirical studies, were conducted by various means, including a study of journals and procurement textbooks, analysis of the supply data of Safripol, an experiment of a proposed plan, and a survey.

The literature study initially discusses various approaches suggested by other writers and finally concludes with a proposition of a seven-step process. The process starts with (1) human resource allocation, (2) supply base categorisation, (3) vulnerability assessment, (4) evaluation of the implication, (5) cost/benefit analysis, (6) risk treatment, and it finally ends with the strategic alignment (7). These steps address the major issues that are critical to successful implementation of supply risk management, particularly in large manufacturing companies like Safripol.

However, the empirical study went further to investigate the application of the seven-step process. This involved commissioning of a multi-disciplinary team to review the process. The team applied the seven-step process in conducting a full assessment and evaluations of supply risks for four selected suppliers of specific material. The team

composed of Safripol employees who are involved in the supply chain of the specific material reviewed.

In addition, the analyses of the steps were captured, and stored in a tool developed in Excel worksheets. That enabled the process to be systematic, repeatable and easier to apply. Populated worksheets resulted in a formal knowledge resource database that will enable Safripol to manage supply risk plans and execute action plans in case of supply interruptions.

Finally, the study indicated that the seven-step process is practical and applicable to Safripol. In addition, the study found that the process adds value in managing supply risks. Thus, the study achieved its goal of developing an implementation plan for supply risk management. However, the study concludes by providing future fields of study and recommendations in an effort to contribute further to development of supply risk management.

Keywords: Risk management, Supply risk, Implementation plan, Sustainable supply, Supply assurance

ABBREVIATIONS

BBBEE	-	Broad Based Black Economic Empowerment
ERM	-	Enterprise Risk Management
ERP	-	Enterprise Resource Planning
IMS	-	Integrated Management System
IRM	-	Institute of Risk Management
MRO	-	Materials, Repair and Operations (Labour and Services)
OHS	-	Occupational, Health and Safety
RAB	-	Replacement Asset Base or Spares Inventory
SOLT	-	Site Operations Leadership Team
SPM	-	Supplier Performance Management
SPM	-	Supplier Performance Management
SRM	-	Supplier Risk Management
TICA	-	Technology Improvement for Competitive Advantage
UPS	-	Uninterrupted Power Supply

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CHAPTER 1

NATURE AND SCOPE OF THE STUDY

1.1 INTRODUCTION

The aim of this study is to investigate an implementation plan for supply risk management. The study is conducted in a petrochemical manufacturing facility in South Africa with the objective of improving the competitive advantage through sustainable supply.

The risk of supply interruptions and cost escalations are increasingly putting businesses under pressure in meeting expected financial performance. Notably, the current economic conditions are not favourable due to rising inflation from 5,0 percent in 2007 to 9,3 percent in 2008 (Statistics SA, 2008). In addition, the volatility in crude oil and Rand/Dollar exchange rate are bearing negative impact on the profitability of the businesses.

Furthermore, the inability of Eskom to meet the electricity demand has also exacerbated the situation resulting in decline in foreign investment and shortfall in overall production; hence, adding further pressure on the rand and supply uncertainties (Statistics SA, 2008). As a matter of fact, many organisations were not prepared for the interruptions in electricity supply. If one had supply risk management in place in this case, perhaps the impact would have been minimised. For example, in situations where electricity supply is crucial in achieving optimum production one could have procured a generator or uninterruptible power supply (UPS) units at low cost before the prices escalated as the demand increased and saving substantially on capital outlay as well as loss on production. All these constraints put together, therefore, call for better management in the supply chain.

In the case of Safripol, the prevailing economic conditions in conjunction with expected increases in competition from China and the Middle East, the situation is going to be

challenging, yet manageable. One way of managing the challenges is by managing the supply risk.

Supply risk does not only impact on sales, but also on the goodwill of the organisation. Goodwill of the organisation is an important determinant of the value of an organisation; also customers feel comfortable dealing with a reputable supplier. At the same time, investors scrutinise the management systems to ensure sound management skills and systems that will ensure high probability of return on investment. The goodwill of the company can be undermined by the uncertainties in the supply chain which may result in loss of business. Such uncertainties can result in failure to achieve the goal of delivering returns on the investment and creating value for the stakeholders. Therefore, supply risk management provides managers with a management tool to ensure the goodwill of the organisation is not damaged.

However, supply risks are dynamic, and organisations should have a management program to monitor and control supply risks. This is necessary due to the ever-changing economic and political environment in which the organisations operate. One such change is the recent introduction of Broad Based Black Economic Empowerment (BBBEE). One of the elements of BBBEE codes is the Preferential Procurement which requires sourcing from organisations contributing to uplifting of the previously disadvantaged groups. The challenge created by the BBBEE codes in this regard is that eight out off the twenty points in preferential procurement, must be from women and/or black owned enterprises. Hence, the majority of such suppliers are new enterprises and mainly in the line of commodities. Thus, the buying organisation looking at a reliable supply source will tend to look at the history of the supplier which the BBBEE supplier might not have. Therefore, the sourcing organisation will need to be creative in order to achieve that goal while ensuring minimal supply risk.

Nevertheless, organisations that are looking at sustainability and that want to increase competitive advantage through preferential procurement will have to move from the comfort zone of a gentleman's agreement to a more sophisticated supply risk management initiative that will ensure sustainable supply assurance.

In summary, the ability of the company to generate profits is hugely dependent on uninterrupted plant operation and sustainable supply of raw materials. While the economic and political environments are continuously changing the profitability will

depend largely on business process re-engineering. Therefore, this study looks into one way of business process re-engineering by investigating an implementation plan for supply risk management.

1.2 PROBLEM STATEMENT

There are two problems that motivated this study. One of them is the prevailing slow down in global economic growth that is making every organisation look for ways to manage and even reduce their cost in order to deal with the declining sales. Procurement has a task of sourcing at lower costs or reducing total cost of ownership without compromising the quality. It is known that the cost of goods or services can be affected by various risk factors which are discussed in chapter two. Thus, the most effective and comprehensive way of managing cost of inputs is by implementing a supply risk management process.

The second problem concerns the know-how of managing supply risk. Since supply risk management is an intricate process and requires resources both human and capital, the challenge is how to implement it at justifiable costs. However, the processes involved in supply risk management are relatively new to the procurement people. Furthermore, most organisations are familiar with risk management in areas that were traditionally covered by insurance policies but not in the supply chain. Consulting firms such as Marsh, McKinsey, Aberdeen, and so on, provide consulting services in supply risk management, but the cost involved is too high and at the same time the returns on investment are not appreciated, until the worst case scenario occurs. That results in ad hoc management of supply risk and uncoordinated effort rather than creating a repeatable process. Unfortunately, organisations need supply risk management systems more when the profit margins are shrinking and that is the time the focus is on cutting cost.

Therefore, this study endeavours to develop an implementation plan that will overcome the challenge of cost and know-how and yet remain comprehensive enough for application with the existing resources available.

1.3 PURPOSE OF THE STUDY

In the quest to achieve the goal of the study there are certain criteria that will need to be met in the process of developing an implementation plan for supply risk management. The following objectives need to be achieved during the study to meet the goal:

- Develop a scientific process for managing supply risk;
- Develop the ability to identify, interpret and make informed decisions on supply risk;
- Standardise the process of risk management; and
- Demonstrate the application of the process using a sample of suppliers in Safripol's supply database.

The study resulted in a documented process and formed the basis for future improvement in the supply risk management system.

1.4 BENEFITS TO THE COMPANY

The development of an implementation plan for supply risk management is expected to support medium and long-term goals with respect to supply assurance. In addition, it will provide:

- The guideline for assessing, evaluating and monitoring supply risk;
- The basis for benchmarking performance;
- Confidence in the measurement of supply risk;
- The basis for negotiating better supply conditions and terms;
- Knowledge of best practice in supply risk management; and
- Resources for developing supply strategies.

All in all, the documented implementation plan will be a resource and point of reference to anyone interested in the subject.

1.5 SCOPE OF THE STUDY

The study is conducted at Safripol (Pty) Ltd, one of the petrochemical companies located in Sasolburg, South Africa. It addresses the challenges of operational management discipline in the subject of the supply chain. The scope is limited to

developing and demonstrating, with a sample of existing suppliers, the application of the supply risk management process.

1.6 RESEARCH METHOD

This study consists of two phases, namely:

- a literature review; and
- an empirical study.

1.6.1 Literature review

The literature review consists of researching the relevant journals, books and the internet regarding risk models, views and theories available and applicable to this study. It provides the foundation for the development of an implementation plan in supply risk management.

1.6.2 Empirical study

The empirical study consists of a case study of the proposed implementation plan. The case study is compiled from the information obtained from the experiment conducted to test the practicality and applicability of the proposed implementation plan; and too, the relevance of it to the company. Currently, Safripol has approximately five hundred suppliers in its database and the record does not contain information on their risk profile nor contingency plans in case of supply interruption. The study, therefore, seeks to understand the approaches suitable for managing the supply risks and its applicability to Safripol. This is done by means of collecting information, review of the proposed supply risk management process by a multi-disciplinary team, and gauging the relevance of its application from the participating team.

Finally, the result of the literature study and the case study are discussed and conclusions drawn and recommendations made.

1.7 RESEARCH LIMITATIONS

The limitations of this study are:

- The concept of supply risk management is new to the study population and hence, influences opinion subjectively.
- The implernentation plan is not yet fully tested to provide enough grounds to support the view of the extent to which it can avert the perceived risk.
- It is not in the scope of this study to address the methods and options for risk treatment comprehensively, but rather to indicate some of the strategic choices; and
- The data and risk inforrnation used to dernonstrate the application are not thoroughly investigated since that is not the objective of this study.

1.8 LAYOUT OF THE STUDY

The study starts with a description of the nature of the study with background information in chapter one. Chapter two reviews the literature available on supply assurance and how to mitigate risk. In chapter three the researcher covers the empirical study conducted with the sample of the population gathered from the supply base of Safripol. In chapter four the study gives conclusions of what the literature indicates as compared to what was found from the case study. It ends with recornmendations towards the implementation of the findings.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Although the concept of risk management is not new, its practice is not yet embraced fully by the procurement function of most businesses. This is reflected by the rare usage of the term supply risk management. Although that is not enough indication of the meagre extent of application, supply risk management is also not adequately covered in purchasing textbooks while it remains an important area of supply management. In fact, according to Munda (2008:para.3), there has been disproportionate emphasis on financial risks and a neglect of operational risk which includes supply risks. Nevertheless, the majority of the large and medium-sized organisations carry out formal risk management in areas that are regulated by the legislation leaving out other areas to ad hoc risk management. However, organisations that are leaders in best practices have enterprise-wide risk management as a strategic component for survival and development (Waring & Glendon, 2001:4). This is reflected, for example, in organisations employing a director of risk management or subsuming a range of decisions under the risk management function. In that case, supply risk becomes an integral part of the enterprise-wide risk management programme.

It is for that reason that this chapter discusses supply risk management and reviews some of the literature available on this subject. But before attempting to navigate through the complexities of risk and risk management, it is important to gain clarity on what risk means. This is dealt with in the next section.

1.2 DEFINITION OF RISK

According to Valsamakis *et al.* (2008:26), risk often has contextual meaning and thus no single definition can cover all the possible meanings. For example, in actuarial science risk has statistical interpretation while in insurance the term risk may be used to describe the subject of the policy (the property or liability that is insured) or the peril that

is insured under the contract. Hence, Valsamakis *et al.* (2008:27) define risk as the variation of the actual outcome from the expected outcome. However, this definition is drawn from the perspective of enterprise-wide risk management in the context of pure risk.

Other authors define risk in terms of decisions taken. For example, Sitkin and Pablo (1994:10) defined risk as characteristic of a decision based on the extent to which there is uncertainty about whether potentially significant disappointing outcomes of decisions will be realised. In a similar view, Ratnasingam (2006:108) suggests risk perception refers to a decision based on the assessment of risks inherent in a situation and includes uncertainties, negative consequences and the probability of adverse outcomes. The orientation of these definitions can be traced to pure risk, as the authors talk of negative consequences. Nevertheless, all types of undertaking or decisions have a potential for events and consequences that constitute opportunities for benefit or threats to success. In case of supply risk it is concerned with both positive and negative aspects of risk.

Furthermore, Francis and Armstrong (2003:375) suggest that "risk entails a threat posed by the failure of corporate decisions", or, drawing on Rousseau and Shperling (2003:563), whose definition of risk refers to the volatility in a situation where alternative outcomes can occur, positive as well as negative, each with measurable probability. These definitions have orientation from speculative risk that deals with volatility and decisions taken under the circumstances. In addition, the institute of risk management defines risk as the combination of the probability of an event and its consequences (IRM, 2002:2). That can cover both pure and speculative.

Supply risks fall under speculative risks which Juttner *et al.* (2003:200) reckons it comprises of any risks for the information, material and product flows from original supplier to the delivery of the final product to the end user. March and Shapira (1987:1404) define supply risk as "the variation in the distribution of possible supply chain outcomes, their likelihood, and their subjective values". In simple terms, supply chain risks refer to the possibility and effect of a mismatch between supply and demand.

Certainly in analysing the definitions cited above, it is evident interpretation depends to some extent on particular orientation of the discussion. Notwithstanding such

qualification, however, there is still evidence of nonconformity, rather than disagreement, concerning certain fundamental tenets when defining risk. In view of that, it makes sense to standardise where possible and bearing in mind the scope of risk management. If supply risk management falls under the portfolio of enterprise-wide risk management then the key term to be defined is "risk" regardless of all other specific risks. It can be argued that the definition proposed by the institute of risk management is adequate as it addresses likelihood of occurrence and impact which are the underlying determinants of risk measurement. However, two explicit concepts within this definition of risk are likelihood and impact. Likelihood or probability, within a supply management context, is a measure of how often a detrimental event that results in a loss occurs. Impact, on the other hand, refers to the significance of that loss to the organisation. Therefore, risk is perceived to exist when there is a relatively high likelihood that a detrimental event can occur and that event has a significant associated impact or cost.

In summary, therefore, supply risk is the probability a detrimental event will occur and that event has a significant impact or cost consequences. With this definition in mind the concept of supply risk management can be addressed but not without understanding the supply management concept first. The next section explains this equally important concept of supply management.

2.2 SUPPLY MANAGEMENT OVERVIEW

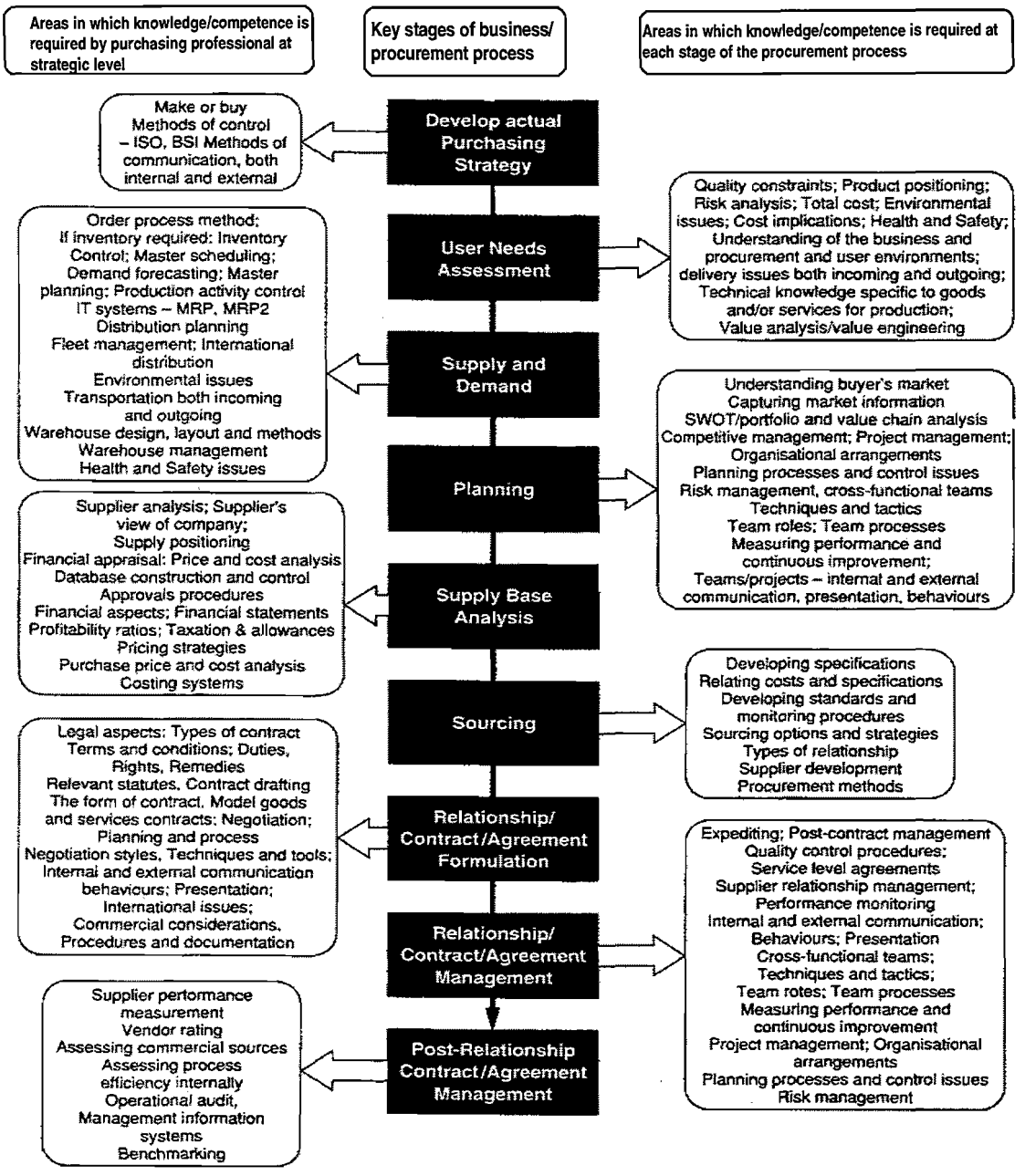
Supply management involves several key stages and activities. These key stages and activities are shown in Figure 2-1 below. It is important to note that at each of these stages or activities there is inherent risk that could affect the supply. For example, in developing a supply plan certain assumptions are made about future performance which introduces an element of uncertainty. There is a risk that the supply will not turn out as expected, arising directly from the uniqueness of the supply. Successful or uninterrupted supply requires these risks to be managed. Effective supply management aims to reduce the risk in two ways: either by developing a supply plan, which by thorough design and planning minimises the inherent uncertainties or by implementing a supply chain strategy which enables the suppliers to respond better to deviations as they occur. The first of these is only limited in efficiency, as it is not possible to eliminate risk entirely from the supply plan (Turner, 1993:195). Sometimes, to do so can be more

expensive than the possible impact of the risk itself. Thus, for example, when developing a supply strategy there is a need to do "what if" analysis that might uncover the underlying risks. Furthermore, without going into details of each stage and activity it will be appreciated that this overview diagram highlights the need for risk analysis particularly during the user needs assessment stage, planning stage and sourcing stage. These are singled out as they are the initial stages where requirements are assessed and suppliers are selected. Uncovering inherent risk at an early stage will prevent rework and even achieve outstanding performance.

The question that remains unanswered at this stage is how to conduct risk assessment and prepare contingent plans to deal with perceived risk. It is the objective of this study to develop the process that will link up with these activities in supply management.

Hence, with these logical steps in mind, from developing a supply strategy to managing post contract relationships, and an understanding that supply risk can occur at any stage, it becomes evident that supply risk management is an integral part of the entire supply process. Since supply risk can also be approached from an enterprise-wide perspective, implying that procurement could be handling the activity but it is not the functional owner of the process then it is important to understand the general risk approaches that other functions could be applying. This is covered in the next section of general risk management.

FIGURE 2-1: SUPPLY MANAGEMENT



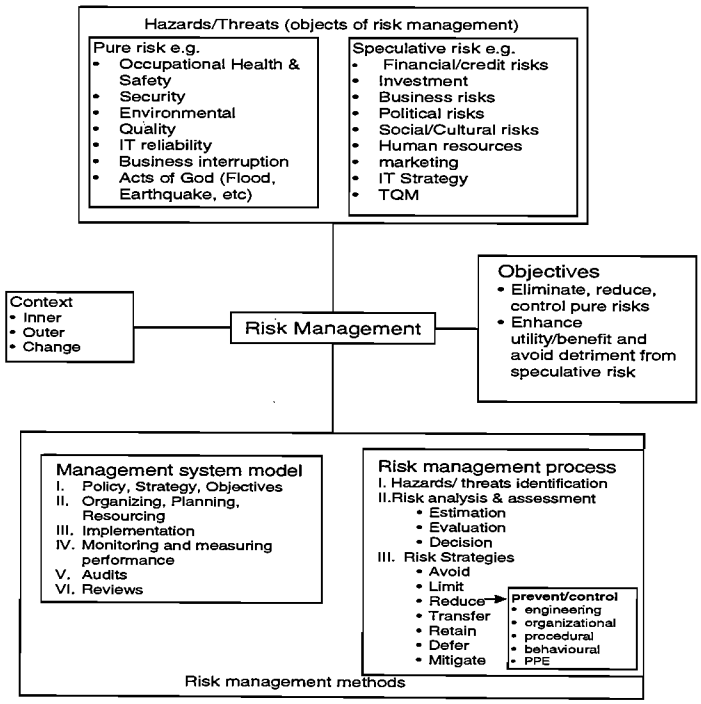
Source: Bailey *et al.* (2005:90)

2.3 GENERAL RISK MANAGEMENT

Supply risk management cannot be viewed as a function pertaining only to the procurement department as it contributes to the enterprise-wide risk management. Consequently, the knowledge of enterprise-wide risk is essential when assessing a supplier as the supplying company is affected by all enterprise-wide risks. However, this poses a challenge as procurement personnel are never the ones in charge of enterprise-wide risk management in their own companies and thus not required to have knowledge and experience in that area. It would therefore help to understand the overall enterprise-wide risk management approach. An example of the scope of enterprise-wide risk is shown in Figure 2-2 below.

In this example of enterprise-wide risk management, risk is categorised as pure and speculative risk (Waring & Glendon, 2001:4). Pure risk refers to risks such as occupational health and safety (OHS), environmental, floods, fires and so on. On the other hand, speculative risks are risks such as financial, business, information technology and so on. Figure 2-2 outlines more of these examples and broadly highlights the approach to risk management.

FIGURE 2-2: SCOPE OF GENERAL RISK MANAGEMENT



Source: Waring and Glendon (2001:6)

In addition, this scope of risk management identifies four key dimensions, namely, objects of risk, risk contexts, risk management objectives, and risk management methods. This approach provides senior management of organisations with a strategic and integrated approach to risk management. While some risk practitioners would suggest that the block labelled "Risk Management Process" is sufficient to cover the extent of risk management; that is a narrow scope for enterprise-wide risk management and does not cater for the level of executive management.

It will be recalled that, the definition of risk had to do with the context in which the risk is observed, either pure or speculative. In this regard, the objects of supply risk management are speculative risk. Therefore, it helps to understand that the objective, in this case of supply risk, is to maximise the benefits whether the risk is negative or positive unlike the case of pure risk.

Another important point to note is that the context(s) in which risk are perceived to exist and to which risk management responds, set the scene for identifying and understanding relevant hazards and threats and analysing the corresponding risks (Waring & Glendon, 2001:7). This is very important in uncovering inherent risk as the inner context will trigger associations such as organisational structures, culture, or power relations, and so on. The outer context may bring notions of markets, regulations, or technology and so on.

The above dimensions will not be complete without risk management methods which comprise of systems and processes. These are very important for efficient and effective management of risk. In addition, risk management is a component of the overall management system and thus risk assessment is crucial to determining priorities for development of policy, strategy and objectives; and in organising, planning and resourcing.

It is worth noting that this framework for enterprise-wide risk management gives a clear indication on how important it is to deal with risk in a holistic manner. In case of a supplying company any of the risk, pure or speculative, can have detrimental effects on fulfilling its obligation to the buying company. Therefore, this study will take into consideration the four dimensions explained above; that is, the objects of risk

management, the risk context, the risk management objectives, and the risk management methods.

In addition, the Institute of Risk Management of South Africa suggests some key principles applicable to implementation of enterprise-wide risk management. These principles follow directly from the King II Report (2002):

- Establish formal board accountability for risk management;
- Develop a framework of enterprise risk management for the organisation;
- Establish organisational structures for enterprise risk management;
- Establish a structured process of risk assessment;
- Develop a risk based control environment;
- Establish a system of risk monitoring;
- Establish a process of risk reporting;
- Embed the process of enterprise risk management into the organisation;
- Establish an assurance process for key risks and for the risk management process; and
- Incorporate the risk related aspects of integrated sustainability reporting into the enterprise risk management framework (Valsamakis *et al.*, 2008:15).

In conclusion, the above principles are in line with the scope of risk management discussed earlier and support the four dimensions. It is important also to note that the King II Report (2002) was developed to deal with corporate governance. Suppliers that have a corporate governance system in place will have an added advantage since it's much easier to assess and evaluate the risk level and to monitor their performance. However, the challenges lie with suppliers that do not subscribe to these principles. Then the supply managers will have to be more thorough in assessing supply risk. That leads to the next equally important issue of how risk is assessed and evaluated.

2.4 GENERAL RISK ASSESSMENT

According to Waring and Glendon (2001:22), there are two broad approaches to risk assessment, namely, the heuristic and scientific approach. Although heuristic or 'rule-of-thumb' approach may include some form of quantification, generally it is qualitative and subjective relying on individuals' collective judgement. A scientific approach, however,

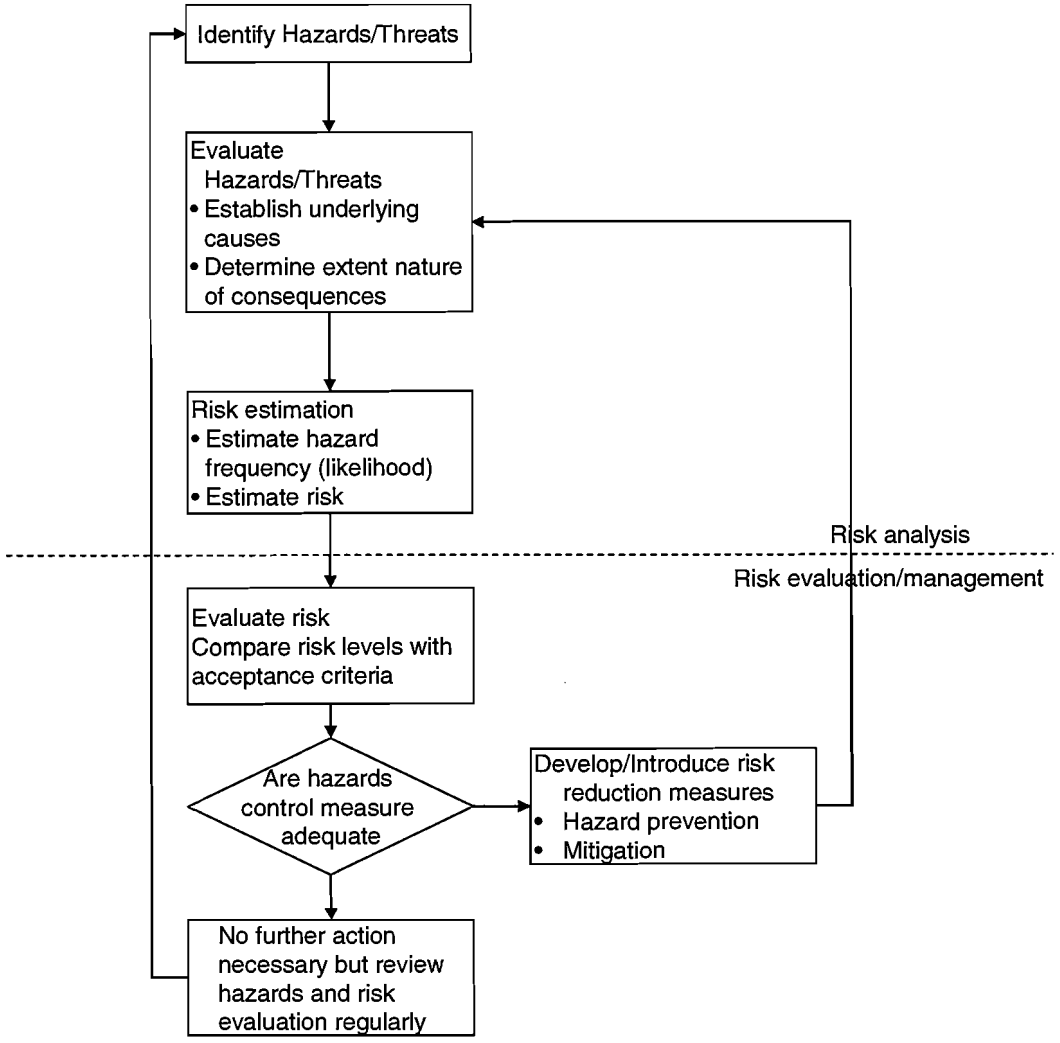
employs qualitative modelling and generally requires formal training in the mathematics used.

Regardless of the approach utilised in conducting risk assessment the goal is to support the process of making informed decisions. That goal can be achieved by following the methodology shown in Figure 2-3 below. The general procedure of this methodology is to:

- define the boundaries of what is to be assessed;
- identify and describe the hazards or threats;
- analyse effects of hazards or threats and consequences;
- estimate the likelihoods of occurrence;
- estimate risk values;
- evaluate risk values by assigning them to risk categories; that is, the overall probability of damage high, medium or low;
- decide whether the risk is acceptable or unacceptable by comparing risk values to acceptance criteria; and
- decide whether control is required; and if so, what and how (Waring & Glendon, 2001:26).

Taking the above points and Figure 2-3 into consideration, it will be seen that this approach breaks down risk assessment into smaller manageable tasks. These tasks provide step-by-step, simple actions that can be converted into repeatable processes.

FIGURE 2-3: GENERAL RISK ASSESSMENT METHODOLOGY



Source: Waring and Glendon (2001:25)

Finally, the methodology described above can be applied in any context of risk management. The approach is simple and logical for application by anyone and for that reason it should not be repulsive to the procurement personnel who are not experts of risk management. The goal is to find the right approach that will add value to the current practice. The next section discusses the progress in the area of supply risk management.

2.5 BACKGROUND OF SUPPLY RISK MANAGEMENT

As risk management continues to emerge as an important contributor to most fields of management decision and control, it is also slowly evolving in supply discipline (Ritchie

& Brindley, 2007:303). Brindley (in Ritchie & Brindley, 2007:303) suggests that global competition, technological change, and the continuous search for competitive advantage are the primary motives behind organisations turning towards risk management approaches. Similarly, Christopher and Lee (in Ritchie & Brindley, 2007:303) recognise the increasing risks in the supply chain context and the need for new responses to manage these. Underlying these developments in supply risk management (SRM) is the imperative to devise and develop appropriate assessment and evaluation techniques and direct strategic decisions. Chen and Paulraj (2004:136) argue that "the scientific development of a coherent supply management discipline requires that advances be made in the development of measurement instruments." Such instruments are essential to developing meaningful and practical supply risk management systems.

Although it can be argued that risk management approaches have been implicitly practiced in the management of supply chains over a long period of time, it is not until more recently that a concerted effort has been made to study these in a more logical and coherent manner (Ritchie & Brindley, 2007:303). However, most of the literature focuses on level of utilisation while most organisations are not equipped with knowledge of implementation. In one of the studies Aberdeen Group (2005:8) attributes the slow adoption of supply risk management to a lack of skills. In another study, Juttner (2005:120) concluded that whilst more than 44 percent of the respondents expect supply vulnerability to increase, and hence the risk too, the concept of supply risk management itself is still in its infancy. However, given the widely acknowledged vulnerabilities of today's complex supply chains, one might expect the concept to have a clear meaning and a rich tradition of empirical findings and managerial approaches. On the contrary, according to Juttner (2005:120), a close examination of the literature reveals that a more systematic and structured approach to conceptualising vulnerabilities and supply chain risks can be traced only to recent studies (for example, Harland & Brenchley, 2001; Johnson, 2001; Norrman & Lindroth, 2002; Sheffi, 2002; Svensson, 2000, 2002; Zsidisin *et al.*, 2000). Notwithstanding that, Juttner (2005:122) argues individuals and organisations might have a strong temptation to return to normality after major supply crises, but it remains an academic responsibility to establish supply chain risk management as an important area of applied research.

The application of supply risk management in Safripol is not different from the trend observed in other organisations and as discussed above. Certainly, it can be argued that the process is integrated into other supply processes. Then the issue of a lack of skills to implement as a stand alone process or improving the effectiveness should not arise. The opposite could also be true, that the reason why the process is informal is because of lack of know-how. It is for these reasons this study endeavours to develop an implementation plan for supply risk management to harness the experience and tacit knowledge from the purchasing personnel who for many years have managed to keep the supply flowing without interruptions. To sustain that level of performance and still cope with the issue of employee turnover and skills transfer, it will definitely require formalisation of the process. Organisations stand to benefit more by using a formal system that is equipped with instruments for measuring and supporting informed decision-making and educating the supply personnel. These will be dealt with later in the study, but before doing that it is important to understand the factors that constitute the risk supply process. The next section discusses the supply risk factors.

2.6 SUPPLY RISK FACTORS

The context(s) in which risks are perceived to exist and to which risk management responds, set the scene for identifying and understanding relevant threats (Waring & Glendon, 2001:26). Risk can emanate from inner or outer context of the organisation and the changes in those contexts. The inner context comprises issues relating to organisational structures, resources, culture, power relations, risk recognition/perception, strategies and motivations as well as meaning of success. The outer context refers to issues associated with economies and markets, public policy, regulation, standards, social, historical and political climate, technology, physical conditions as well as climate (Waring & Glendon, 2001:8). These are potential risk sources and organisations need to monitor and plan ahead of the changes taking place in order to remain sustainable. Supply managers are tasked with the role of taking the above into consideration when planning material supply. However, it will be recalled earlier in the analysis of a suitable definition for supply risk that supply risks comprise any risks in the information, material and product flows from the original supplier to the delivery of the final product for the end user. In simple terms, supply risks refer to the possibility and effect of a mismatch between supply and demand. Hence, Juttner *et al.*

(2003:200) argues that risk sources are the environmental, organisational or supply chain-related variables that cannot be predicted with certainty, and that impact on the supply outcome variables. However, Aberdeen Group (2005:9) suggests supply uncertainties arise from:

1. **Supply market**: which include supply and capacity constraints, changing tariffs, increasing energy and material costs, natural disasters, transportation price increases and delay increases;

2. **Supplier**: This includes supplier financial and operational performance which is constantly changing. This requires organisations to thoroughly assess new supply sources and constantly monitor changes in suppliers' health and performance in various areas including financial (claims, financial stress, profitability), regulatory compliance and operations (capacity, lead times, quality, service levels);

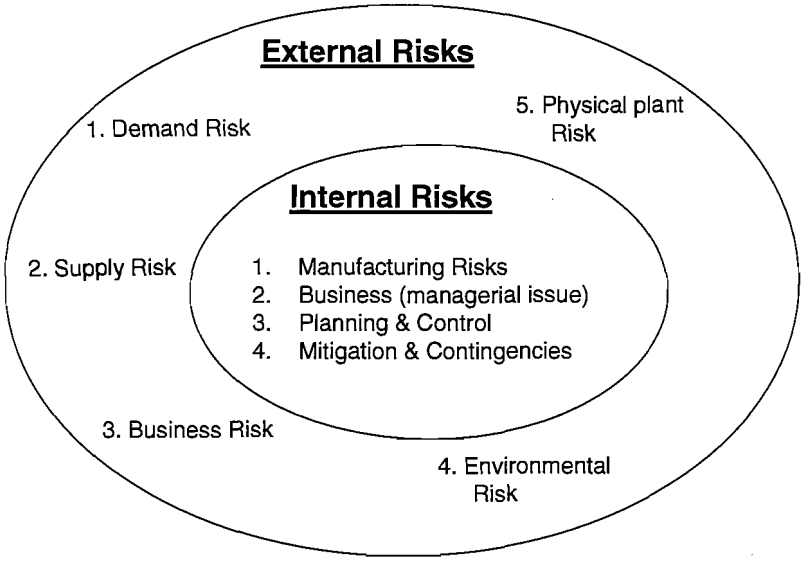
3. **Regulatory**: The regulatory requirements for reporting and controlling (for example, King II Report for corporate governance), environmental responsibility (for example, ISO 14000 & 18000) require enterprises to more thoroughly assess their supply management processes and suppliers to ensure compliance; and

4. **Supply strategy**: Ironically, the most widely accepted "best practices" have made organisations more vulnerable to supply disruption. These are, for example, low-cost country sourcing, lean and Just-in-Time (JIT) inventory, vendor-managed inventory (VMI) and integrated supply relationships, supplier rationalisation, and outsourcing have led to greater efficiency, improved responsiveness and lowered supply cost structures. However, these new strategies have also removed inventory and redundancies from the supply chain, amplifying the impact of unanticipated events, such as acts of God (for example, hurricanes, earthquakes, and so on), supplier bankruptcy, or even a missed shipment.

Similarly, Kiser and Cantrell (2006) claim that many companies struggle with the question of what constitutes supply risk and suggest two general types of supply risk drivers, namely, external risks; that is, those emanating from outside the buying company's control, and internal risks which are the risks within the buying company's control. These drivers can be visualised best with the help of Figure 2-4, shown below;

developed for the purpose of this study and followed by an explanation of the risk factors for each driver.

FIGURE 2-4: RISK DRIVERS



Source: Own compilation

In the argument posed by Kiser and Cantrell (2006) it suggests external risk drivers constitute:

1. **Demand risk**: which include unpredictable or misunderstood customer or end-user demand;
2. **Supply risk**: These relate to any disturbances in the flow of product within the supply chain, from raw material to parts on the receiving dock;
3. **Environmental risk**: Originate from shocks outside the supply chain and typically are related to economic, social, political and climatic factors;
4. **Business risk**: These relate to factors such as suppliers' financial or management stability and acquisition and divestiture of supplier companies; and
5. **Physical plant risk**: Relate to the condition of a supplier's physical facility, environmental, health and safety issues, operational effectiveness, and regulatory compliance.

Indeed, these external drivers impact on what supply management has mostly been concerned with: gaining access to material sources and moving that material from its origin to the purchaser's warehouse or shop floor. Although they are outside the buying company's control, it adds value to understand the environment in which materials are

sourced. That not being all, other forces are also in play such as internal risk drivers, which sometimes influence the effect of external drivers.

Certainly, risk areas overlap and disasters often occur because of a combination of factors. A good example would be an anonymous company that imports craft products from China and supplies these to large retailers. The customers created a demand risk by threatening large fines if the supplier did not fulfil the supply agreement for the products they purchased. Nevertheless, the supplier was also being squeezed by supply-side risks. The supplying company had not allowed for the time it took for the manufacturers in China to retool and build their products nor had it taken into account the time to cover weather or other delays transporting them to U.S. ports. To top it all, it also had an internal source of risk resulting from lack of a proper planning process that would have identified those external drivers (Kiser & Cantrell, 2006).

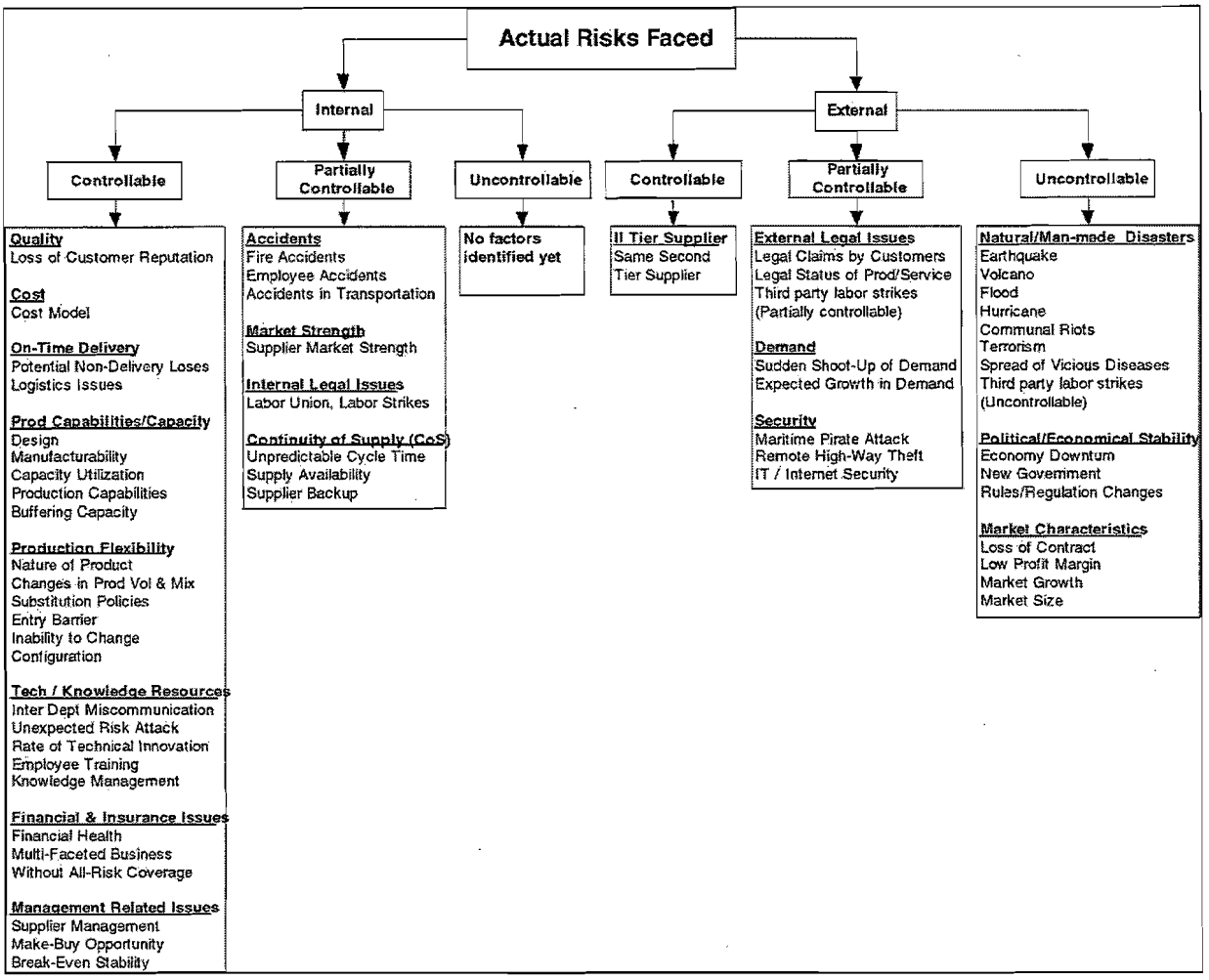
However, internal risks provide better opportunities for mitigation because they operate within the control of the purchasing company. These internal risks generally fall into the following categories:

1. **Manufacturing risks**: These are caused by disruptions of internal operations or processes;
2. **Business risks:** Caused by changes in key personnel, management, reporting structures, or business processes, such as the way purchasers communicate to suppliers and customers;
3. **Planning and control risks**: These are caused by inadequate assessment and planning which amount to ineffective management; and
4. **Decisions, mitigation and contingency risks**: These result from making uninformed decisions or not having contingency plans in place (Kiser & Cantrell, 2006).

In addition, various authors have made efforts to list risk factors that are likely to affect the supply chain. Such authors include Wu *et al.* (2006:354) whose suggestions of risk factors are shown in a self explanatory Figure 2-5 below. Like Kiser and Cantrell, Wu *et al.* start by classifying risk in two categories: internal and external; and further, sub-divides each category into three sub-categories, namely, controllable, partially controllable, and uncontrollable. In all these sub-categories a list of the risk factors associated with each are presented as shown in Figure 2-5 below. More suggestions of

the risk factors, by various authors who have covered the topic of risk factors, are included in Table 2-1 below.

FIGURE 2-5: RISK FACTORS



Adapted from: Wu *et al.* (2006:354)

In summary, there is general consensus among the authors on what constitute risk factors and many have suggested similar factors. Nevertheless, there is a view of the context from which the risk is perceived. For example, Safripol's main raw materials are ethylene and propylene gas which is supplied by neighbouring Sasol plant via pipeline. That means the risk factors arising from this supply arrangement are both pure and speculative; that is, there is material risk and supplier risk. Secondly, Sasol is a first-tier supplier and locally situated. Sasol in turn gets its feedstock from the oil refineries which would be a second-tier supplier. Certainly, there are numerous risks associated with the second and even third-tier suppliers, and trying to cover too many external factors can

paralyse the implementation. Therefore, the approach should take cognisance of the level of implementation to make it practical and manageable.

From the above, it can be concluded that the result of all the risk factors, both internal and external, is the total risk for a given supply chain. To arrive at that total risk, however, organisations must undertake a risk management process to identify the vulnerabilities in each of the risk areas, the circumstances that create the vulnerability, the probability of occurrence, and a process to mitigate the risk. By assessing the total risk, managers can analyse the situations and assign resources to improve risk mitigation efforts.

TABLE 2-1: RISK FACTORS

Source	Suggested risk factors include
Cooke (2002:31-34)	Risks of supplying market from, or over-dependence on a foreign plant, especially during times of political tension, and risk stemming from increased regulation
Dickson (1996:5-17)	Quality; delivery, price, production facilities and capacity, technical capability, financial position, management and organisation, performance history, warranties and claim policies, procedural compliance, communication systems, operating controls, and labour relation records
Seaman. and Stodghill (1998:66-69)	Impacts of labour law and trade policy; different corporate cultures; and complex management structures between vendor and supplier.
Stafford *et al.* (2002:27-40)	Natural disaster and technology failure
Treleven and Schweikhart (1998:93-114)	Price, inventories, schedule, technology, and quality
Van der Vorst and Beulens (2002:409-430)	Changes in markets, products, technology, competitors and governmental regulations
Wagner (2003)	Supplier integration and communication
Zsidisin (2003:14-25)	Capacity constraints, cycle time, disasters, financial health of suppliers, legal liabilities, currency fluctuations, management vision, market price increases, incompatible information systems, and product design changes
Zsidisin and Ellram (2003: 15-29)	Unanticipated changes in the volume requirements and mix of items needed, production or technological changes, price increases, product unavailability, and product quality problems

Adapted from: Wu *et al.* (2006:353)

Therefore, for the purpose of this study and to overcome that initial challenge of assigning resources or even accessing additional resources, this study proposes to start the process by selecting a few risk factors that are obvious, measurable, and information can be accessed easily to facilitate initialisation; for example, quality, price, delivery, and so on. These will be referred to as primary risk factors; then later advance to the more demanding ones that require extra effort and even additional resources such as market research intelligence, financial analysis, country analysis, second-tier suppliers, and so on. These will be referred to as secondary risk factors. Table 2-2 outlines this proposal of primary and secondary risk factors.

TABLE 2-2: PROPOSED PRIMARY AND SECONDARY SUPPLY RISK FACTORS

Primary Factors	Secondary Factors
1. Quality	1. Financial health
2. On-time delivery	2. Demand (Market demand and Buyer demand fluctuations)
3. Cost and Commodity pricing	3. Supply (Supply market and Seller supply fluctuations)
4. Regulatory issues (Environmental Health and Safety, registration with government and professional institutions)	4. Political and economical stability of source country
5. Competition type (Sole or Multi-source)	5. Second-tier supplier (sub-contractors, agency rights)
6. Supplier strength (% balance of trade)	6. Natural and man-made disasters
7. Production capability and capacity	7. Corporate culture
8. Management systems (structures, trade policy)	
9. Technical and knowledge resources (engineering, production capacity)	
10. Security (emergency preparedness)	
11. Litigation issues (past and current)	

One of the challenges of risk management implementation is to access timely factual data of the risk factors to support analysis and decision-making. This study suggests organisations can maintain a list of all known risk factors and prioritise the most

important and measurable ones for a start. By means of continuous improvement the future desired results can be achieved and value added in the long term, hence preventing reactive responses.

In conclusion, it is evident that with careful selection of risk factors based on the nature of the organisation and its type of inputs, the process of risk assessment is manageable. With these risk factors in mind, the next issue is how to manage them, which leads to the process of managing supply risk. This is discussed in the next section of the supply risk management system.

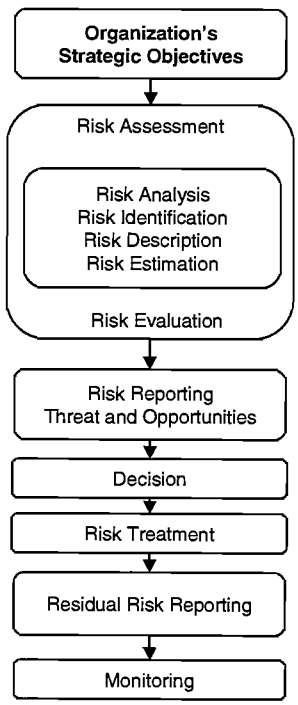
2.7 SUPPLY RISK MANAGEMENT SYSTEM

Applying a risk management system helps a business stay ahead of any market changes and plan for cause and effect risk contingencies, while at the same time providing a baseline for continuous improvement. However, Waring and Glendon (2001:59) argue that, the way people describe management systems reflect their world view and the mental models they have about how the world functions. Although there is agreement about the need for good management systems, there is an absence of a commonly agreed set of constructs and language regarding management systems. The baseline assumption is that any well designed management system should possess the following:

- A systematic framework which connects up all the components;
- A clear policy, strategy and objectives;
- Clear responsibility, accountabilities and authority of individuals;
- Adequate means for organising, planning, resourcing and decision-making;
- Adequate means for implementing plans and decisions;
- A coherent and adequate set of measures of performance;
- Adequate means for monitoring, assessing, auditing and reviewing both the quality of the system itself and its function;
- Adequate numbers and allocations of competent well led people;
- A flow of adequate information to all those who need it;
- Adequate intelligence about the inner and outer context of the organisation; and
- Integration with other management systems in the organisation (Waring & Glendon, 2001:60).

However, the Institute of Risk Management (IRM, 2002:4) argues that a good risk management system focuses on identification and treatment of the risks; and should increase the probability of success, and reduce both the probability of failure and the uncertainty in achieving the organisation's overall objectives. Risk management should be a continuous and developing process which runs throughout the organisation's strategy and the implementation of that strategy. In addition, it should address methodically all the risks surrounding the organisation's activities past, present and, in particular, future. It must be integrated into the culture of the organisation with an effective policy and a programme led by the most senior management; and should support accountability, performance measurement and reward, thus promoting operational efficiency. The risk management methodology proposed by IRM is depicted in Figure 2-6 below.

FIGURE 2-6: RISK MANAGEMENT PROCESS



Source: Institute of Risk Management (IRM, 2002:4)

From the above arguments, it can be concluded that risk management should be a systematic process with clear defined steps that in overall support the organisation's objectives.

In a similar argument, Kiser and Cantrell (2006) concluded many organisations acknowledge increase of supply risk but struggle with the issue of how to manage those vulnerabilities, and thus propose a six-step process. These steps are:

Step 1: Supply base categorisation;

Step 2: Vulnerability assessment;

Step 3: Evaluation of risk impact;

Step 4: Identifying mitigation and contingency actions;

Step 5: Cost / Benefit analysis; and

Step 6: Alignment to business strategy.

Therefore, taking the above into consideration and the previous arguments of a good management system, it can be deduced that a combination of both proposals by the IRM and Kiser and Cantrell should be a satisfactory basis for developing an implementation plan. It should be noted too that, the significant difference in the process by IRM and Kiser and Cantrell is the approach, either top-down or vice versa, but they all lead to the same objective. However, in the process by Kiser and Cantrell the strategy comes last while the IRM process starts from the strategic objectives. This study will adopt, with some variations, the process flow by Kiser and Cantrell which is depicted in Figure 2-7. The next section discusses the proposed supply risk management process.

2.8 PROPOSED SUPPLY RISK MANAGEMENT PROCESS

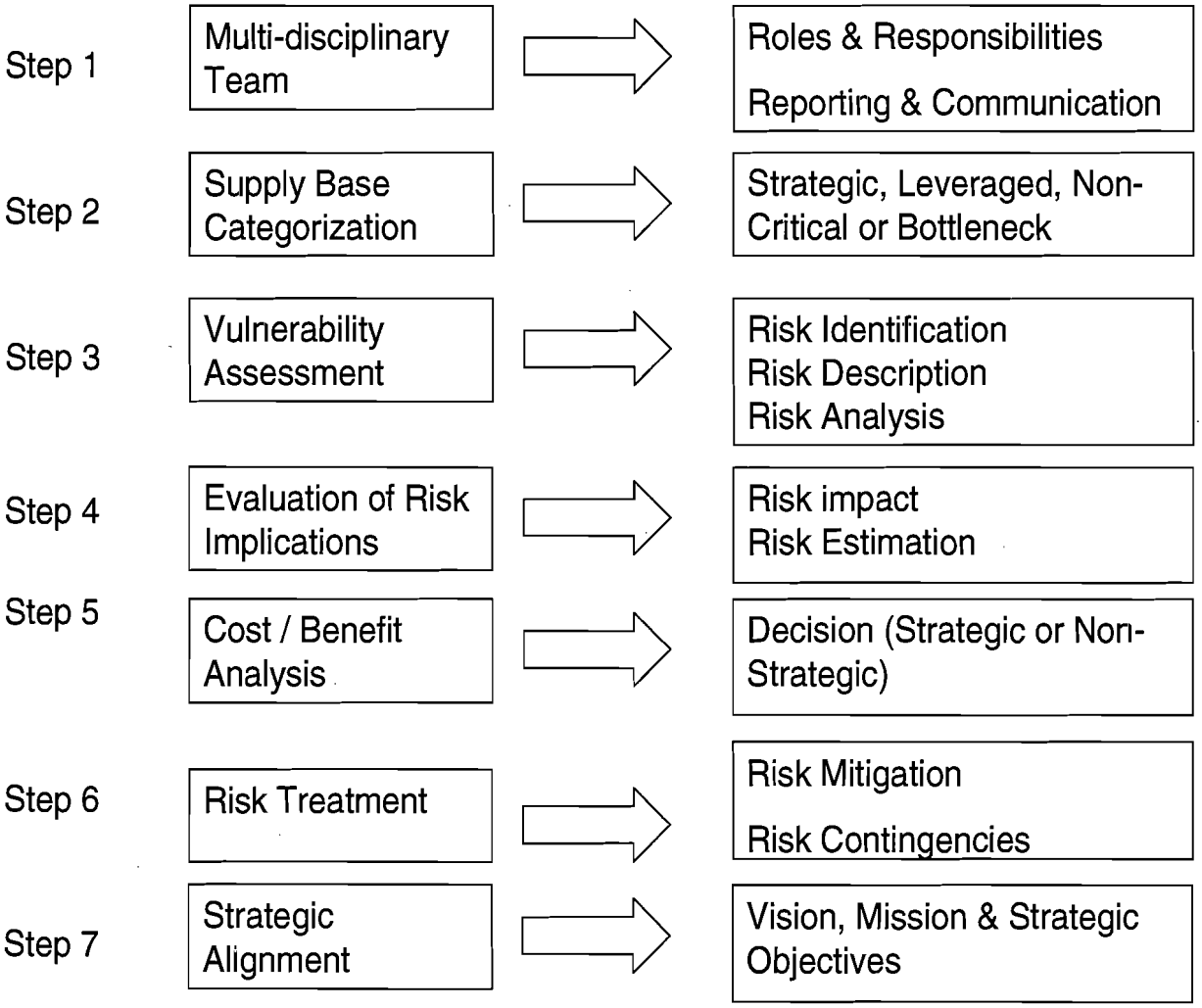
This study proposes a seven-step process, shown in Figure 2-7, which should serve as a guide in implementing a supply risk management process. These seven steps connect up all the components necessary for an effective supply risk management system. The first step is the creation of a multi-disciplinary team, which is discussed in the next section.

2.8.1 Step 1: Multidisciplinary Team

The first step is to define organisational issues so that the responsibilities, accountabilities and authority of individuals are clear. Hence, the multidisciplinary team defines and ranks the risks in the supply chain.

Kiser and Cantrell (2006:5) argue that supply risk management involves external drivers that are under control of suppliers and thus, there is a need to encourage suppliers to provide risk management to the greatest extent possible. The suppliers too can consequently become part of the risk management team. Suppliers are capable of addressing issues of backup manufacturing facilities, stockpiles of raw materials, or even purchasing products from their competitors in the event of shortfall in production. The point here is that any opportunity of a supplier playing a role in managing the risk factor should not be overlooked.

FIGURE 2-7: PROPOSED SUPPLY RISK MANAGEMENT PROCESS



Source: Own compilation

However, before reaching out to the suppliers, there is a need to clarify internally who is responsible for identifying the needs that suppliers must meet; identifying and qualifying potential supply sources; establishing sound commercial relationships; integrating

suppliers in the buying company; and managing supplier performance (Kiser & Cantrell. 2006).

The supply manager, in collaboration with the risk management team, should ensure that the suppliers understand the performance expectations they have to meet. Continuous, documented feedback is essential, and both companies might benefit from formal performance review meetings which again can either alienate or bring a supplier closer, depending on the degree of involvement. In addition, it is important to include clear communication procedures in the risk management process. The team should develop effective communication plans that will help create a corporate culture that embraces the need for effective risk management and the flexibility that is essential in dealing with any disruptions.

The communication procedure should, therefore, continually explore the following questions:

- Are all relevant people included in identifying risk factors and everyone encouraged to participate?
- Are risk issues communicated to all internal stakeholders?
- Are risk discussed with external stakeholders?
- Has a communication strategy been developed in the event that a risk event occurs?
- Has communication procedures and the team, with clear responsibility for ensuring the appropriate people get information and take action when needed, been identified (Kiser & Cantrell, 2006)?

The issue of communication is very important and in fact, involving a multidisciplinary team helps to build synergy and creates awareness and ownership.

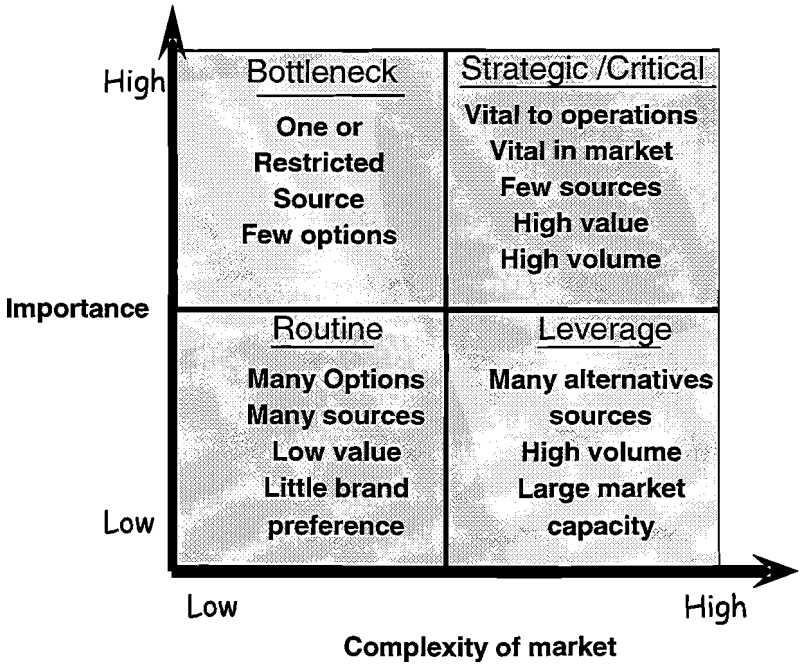
In summary, it is evident from above that the role of the team is not only conducting risk assessment and developing contingency plans but also to develop and strengthen mutual relationships internally and externally through collaboration. Information sharing can help identify potential areas of vulnerability and lead to stronger emergency plans. That leads to the next step of identifying focus areas through categorisation of the supply base, which is discussed in the next section.

2.8.2 Step 2: Supply Base Categorisation

The second step is to gain a thorough understanding of the supply needs of the buying company. That can be achieved by grouping all the products purchased in four categories, namely strategic items, leveraged items, bottleneck items and non-critical items (Kraljic, 2001:410). The four categories of the supply base are illustrated in matrix form shown in Figure 2-8 below. This form of categorisation takes cognisance of the importance versus complexity of the supply market.

In this process data is collected on the key goods or services purchased based on such factors as whether it is a high spend product, whether the material requires in-depth specifications, how many sources of supply are available for the material, and what the effect would be on the business if the material flow was interrupted. More of the variants that are considered in creating the categories are shown in Figure 2-8 below.

FIGURE 2-8: SUPPLY BASE CATEGORISATION MATRIX



Adapted from: Kraljic (2001:410)

The data for these key purchased materials is then compiled and a summary table or matrix created for all the inputs. The team should carefully consider what makes an item strategic. Sometimes a small change can knock a strategic item off the list and reduce the risk. For instance, a certain company started testing the resin it uses in a process to reline old pipes. It had been specifying a special resin that was supposed to seal better

before liquid chemicals are applied. It was available from several suppliers, but it was priced at a premium. Testing revealed no difference in performance when off-the-shelf resin was used instead of the specified one. Hence, the material became a commodity, and the company had much better control of price and supply risks (Kiser & Cantrell. 2006).

Another area that is important to understand is the complexity of the supply market. Kiser and Cantrell (2006) argue that, when creating supply base categorisation the team should try to understand the supplier's organisation. It is vital to know the organisation of each supplier in terms of its divisions, plant locations and the operating units that will be interacting with the buying company. An efficient way of gathering information on the supplier's operations is by making a structured supplier visit. Taking time to visit with a group of internal stakeholders helps to understand some of the risk factors better. Thus planning who to speak to and what to discuss are vital. It is necessary to prepare an audit questionnaire, highlighting the key questions that will draw out the critical information needed to make a detailed assessment. Kiser and Cantrell (2006) suggest inquiry into cost control, systems compliance, operational processes and use of price control contracts, financial controls, and robust supply management techniques.

The information gained from the supplier audit will form the basis of the supplier summary that the team will create. Developing supplier information is an ongoing process as part of the business intelligence process and must include analysing all potential suppliers' technology bases and attributes; ranking suppliers in each material category from strongest to weakest; understanding each supplier's competitive position; and knowing each supplier's long-range business goals (Kiser & Cantrell, 2006).

From the above, it can be concluded that supply base categorisation has two advantages, namely (1) the importance of the supplier becomes clear; and (2) risk areas start to surface and it becomes easy to develop high level strategies for each category.

In summary, an understanding of supply markets and it is complexities gives a snap shot of supply risks, and a further detailed assessment will reveal the actual vulnerability. The next section discusses the ways in which to determine vulnerability in the supply process.

2.8.3 Step 3: Vulnerability Assessment

In the third step, the team will need to conduct vulnerability assessment of the supply process. Yates and Stone (1992:10) argue that should involve identifying potential losses, establishing the extent of losses, understanding the likelihood of potential losses, assigning significance to potential losses, and appraising overall risk. However, in a supply management context, such assessments are considered an important buying activity for purchasing personnel and organisations (Bunn, 1993:38).

The challenge, however, is in identifying potential losses and arriving at the total risk for a specific material. Kiser and Cantrell (2006) suggest the process should begin with building a flowchart for all the material inputs, working backward from the actual material procured to the original material sources. The deeper one goes into each material to understand and capture the processes used by each supply source, the better the uncovering of the hidden risks. These might be the supplier's processes for acquiring raw materials or manufacturing the product. This stage of analysis includes identifying the isolating mechanisms that suppliers use in order to try to retain their customers and keep them from switching to a competitor to protect themselves (Chartered Institute of Purchasing & Supply [CIPS], 2007:para.3). Therefore, a thorough understanding of the entire supply stream is essential before any potential risk can be identified.

In addition, analysis of financial statements provides a very good means of identifying risk. All financial losses have an adverse effect on either the balance sheet or income statement, and an analysis of the organisation's financial statements can therefore prove most useful as a starting point in risk identification (Valsamakis *et al.,* 2008:102). For example, the income statement may show rental expense payments which may indicate the possibility of a contractual liability exposure, or the income statement may indicate a hidden asset if, for instance, long-term rental obligations under a current lease agreement are markedly lower than the market rates. The income statement will also disclose sources of income and thereby processes from which losses, such as liability to third parties in the event of product inefficacy, may arise.

By analysing the relevant ratios, information relating to growth, profitability, efficiency, liquidity, financial leverage and investment, it will become prevalent and hence, the

financial health of the supplier will reveal the capability of the supplier to meet the supply obligations (Östrong, 2004:77). In conducting financial assessment, Valsamakis *et al.* (2008:102) suggests the use of a flowchart method of risk identification coupled with analysis of the organisation's financial statements to provide a systematic procedure for reviewing the suppliers' operations. However, an aspect that should be considered is that the business entity is dynamic and constant changes give rise to new and added risks and thereby continuous monitoring is essential.

Other ways to facilitating vulnerability assessment, according to Turner (1993:115), are by use of (1) expert judgement which uses intuition and awareness; (2) plan decomposition which shows risk inherent in interdependency of activities; (3) assumption analysis in a win-lose analysis which focuses on events that might be detrimental, "considering both events we want to occur but may not, and events we do not want, but may occur"; (4) decision drivers which are influences that might determine whether or not certain events may occur and can be particularly damaging if decisions are made for the wrong reason; for example, political versus technical, short-term versus long-term; and (5) brainstorming which utilises social interaction to enhance the above. These techniques can be applied interactively and in a collaborative manner by a multidisciplinary team in identifying and reviewing risk objects and attributes.

On the other hand, De Waart (2006:31) suggests a flexible approach, by using objects and attributes of risk that will be applicable to different types of risk scenarios. The first step is to identify the objects of risk and the attributes of risk. The object of risks for raw material is the risk of individual raw materials. An attribute, on the other hand, could be a measurable element that contributes to the magnitude of risk and impact. For example, to manage raw material risk, supplier-specific and material-specific attributes must be distinguished. Whereby, the former relates to attributes that are indicative of the supplier's financial stability and its ability to supply materials on time and in the right quantity. However, material-specific attributes address characteristics of the material itself, independent of the supplier. For example, a material with a short shelf-life poses a greater risk to the organisation than those with a long shelf-life. Table 2-3 below illustrates more examples of the object of risk and its attributes. The attribute will thus allow ranking of objects in the risk impact matrix.

TABLE 2-3: GENERIC EXAMPLES OF RISK AND ATTRIBUTES

Risk Object	*Risk Attributes*
Supplier	Quality
	Financial Health
	Physical Location
	Information about manufacturing plants
	Physical condition of supplier's facilities
	Environmental vulnerability
	Freight routing
	Supplier's own risk management efforts (such as fire readiness or disaster plans)
Material	Number of sources (approved suppliers)
	Demand / Usage
	Shelf-life
	Cost
Impact	Downtime / Lead time
	Emergencies premiums
	Inventory levels

In summary, from the above arguments by various authors, there is no disagreement on the approach for conducting risk assessment, and each approach has its merits depending on the context in which the risk is perceived. For the purpose of this study a holistic approach to supply risk management would require a combination of the approaches suggested above. These are: (1) risk identification should begin with building a flowchart for all the material inputs, working backward from the actual material procured to the original material sources; (2) an analysis of the organisation's financial statements; (3) using objects and attributes of risk that will be applicable to different types of risk scenarios; and finally, (4) the interactive application of (a) expert judgement; (b) plan decomposition; (c) assumption analysis in a win-lose analysis; (d) decision drivers; and (e) brainstorming.

In conclusion, it is important to structure the vulnerability assessment in a manner which the team can grasp the internal and external risk factors; and also understand the

processes of suppliers in order to manage supply risk effectively. For the purpose of this study, the primary risk factors shown in Table 2-2 will be utilised to demonstrate the application of the process. Once the vulnerabilities are known the next step is to access its impact. This is discussed in the next section.

2.8.4 STEP 4: EVALUATION OF RISK IMPACT

The fourth step is evaluation of the risk impact whose objective is to quantify the relative risk and impact for each risk object and its attributes. The aim is not to get absolute measures, but to help quantify the risk level, thus enabling the making of informed decisions (De Waart, 2006:32). According to Turner (1993:242), the impact of a risk factor depends on its likelihood of occurrence and the consequences if it does occur. Thus:
Impact of risk = (likelihood of risk) x (consequence of risk)

The evaluation of risk impact requires taking into account all the identified risks and using some sort of risk template assigning a risk score. De Waart (2006:33) suggests a scale of 0 - 100 will be appropriate (where 0 represents the lowest risk and 100 the highest) to provide sufficient spread in the data. For example, material that is sole-sourced will be assigned a higher risk score than dual-sourced material, all else being equal. One can argue that sole-sourced material from a large, healthy supplier is preferable to material that is dual-sourced but has a very short shelf-life and quality issues. It is important when evaluating the impact of a specific attribute to assume that all other attributes are equal (De Waart, 2006:33). Finally, to quantify the total risk of a specific supply, the scores of all attributes of the risk objects are combined and the total score is the measure of the risk.

An alternative method, according to Kiser and Cantrell (2006) is to establish the risk score based on an estimate of probable duration of the disruption and costs to recover. A worst case scenario is considered in assessing the effects of a long period of supply disruption. That is followed by defining the probability of disruption occurrence along with risk costs which lead to an estimated total cost of the risk. A Monte Carlo simulation of the occurrence based on random games of chance will assist in developing variable values at random to simulate a model and can be placed onto a computer spreadsheet to simulate the risk (Kiser & Cantrell, 2006). The result of evaluations for each risk

object are then summarised in a table which could be a risk spreadsheet, a risk and impact matrix, Monte Carlo simulation or any other system based on scenario planning.

For the purpose of this study the risk impact will be evaluated using the risk objects and attributes discussed earlier in the study and rating the impact using a combination of a scale of 0 - 100 and coupled with the cost of disruption. The scoring will be dealt with further in the empirical studies.

In summary, it is evident that, the results of the risk impact evaluations will provide the means for prioritising risks and working comparing the current scenario with the what-if scenario. The result should lead to options of the desired status of risk aversion. The next section discuses the risk treatment process.

2.8.5 STEP 5: RISK TREATMENT PROCESS

The fifth step in the risk management process is analysis of risk treatment options. At this stage, the team is aware of the top priority risks from the previous evaluations and ratings; and therefore, the task now is to brainstorm on the strategies to apply in order to bring the rating down to acceptable levels. Waring and Glendon (2001:9) suggest a number of high level strategies to deal with risk, such as:

1. avoid – that is, withdraw or cease sourcing from that area or supplier;
2. limit – that means, limit scale or scope of exposure;
3. reduce – that is, improve prevention and control measures;
4. transfer – in other words, acquire external insurance via prerniums;
5. retain – that is, maintain internal insurance or risk financing;
6. defer – meaning wait and see before making any decision;
7. mitigate – that is, limit the damage; and
8. share – that is, engage in joint ventures with others.

The above strategies should help in developing further plans for risk prevention and provide the team with clues of further corrective actions to consider coupled with the knowledge of the supplier, the material and the impact.

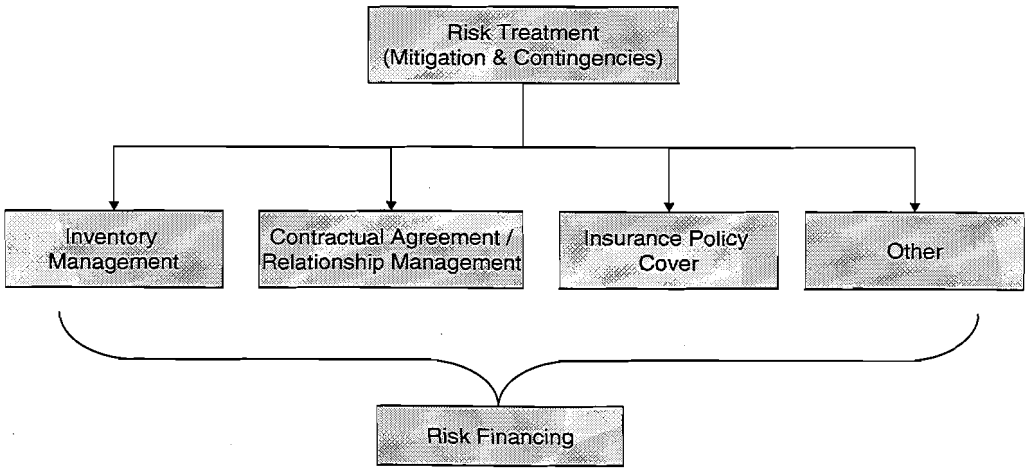
Similarly, Kiser and Cantrell, (2006) argue that, risk mitigation encompasses loss prevention, developing acceptable alternatives and plans to reduce the impact or probability of occurrence of a risk event. Hence, in reducing risk the team can consider

adjusting inventory level, developing a better relationship with the supplier or risk financing, and so on. Inventory management can be used to mitigate supply interruption by creating a buffer. Since this is an important means of cushioning against supply risk but can yet be outfaced by business improvements such as Just-in-Time (JIT) manufacturing and lean manufacturing, it should be carefully explored when considering supply risk management.

However, McDonald (2008:16) suggests that the best way of managing key accounts is by using collaborative approaches which vary from basic relationship, through cooperative, interdependent to an integrated relationship. Strong and sound relationships with strategic suppliers may be the best way of managing the supply risk where the cost of alternative sourcing is not economically feasible. Both organisations should benefit from the relationship by sharing information and long-term sustainability.

In addition, most risk treatment options will have a cost implication and, therefore, it is essential to present the risk assessment in financial terms to facilitate understanding of the financing requirements (Kiser & Cantrell, 2006). A good risk mitigation plan will consider all the cost drivers associated with the risk and describe corrective action steps. By estimating the costs for these actions, a total mitigation cost can be estimated after factoring in the probability of an occurrence. Risk financing can take any of the forms indicated in Figure 2-9 below, and these options can be applied individually or in combination.

FIGURE 2-9: PROPOSED RISK FINANCING



Source: Own compilation

Finally, the team should also look at other options such as an alternative source. Such contingency plans should include actions and precise signals that trigger the action to comrnence efforts to mitigate the risk. The corrective action and timing should be clearly spelled out. For example, should a disruption in the supply of material X occur, a purchase order should be placed with a second supply source within 24 hours to ensure that there will be no disruption in the supply of X.

From the above, it can be concluded that there are numerous options that the team can consider and optimise the plan to serve the purpose of mitigating loss. Therefore, for the purpose of this study, the above strategic options should be adequate and can be applied individually, or in combination, depending on the supply scenario. However, the result of the risk treatment options will, therefore, provide means of comparing the cost to benefit scenario for that protection. The next section discusses the cost to benefit analysis.

2.8.6 STEP 6: COST / BENEFIT ANALYSIS

The purpose of carrying out cost to benefit analysis to ascertain the cost of prevention does not outweigh the benefits of prevention. One way of evaluating the cost to benefits of the current scenario and that of the contingency plan is by use of the net present value (NPV) approach. For example, if a critical material is being manufactured in an area with a high risk of earthquakes or political instability, that risk factor would make it necessary to determine the costs and benefits of possible mitigating actions, such as requiring a second manufacturing site. Then, by comparing the NPV of the supplier being required to prepare a second manufacturing operation in another location and the NPV of qualifying an alternative supply source in another geographic location, it will give a good indication of what is sound and reasonable.

Similarly, organisations invest resources today in preventing or reducing the probability of loss of revenue in the future; and hence, by comparing resource investments today to the probability of loss in revenue tomorrow, supply managers can decide whether or not to make an investment. The supply manager, in collaboration with the team, can generate the analysis of whether the action should be taken and if so, develop a detailed implementation plan.

In conclusion, the net present value approach should be sufficient in comparing the cost to benefits and should provide adequate measure for making an informed decision based on the cost of protection versus the cost in loss. At this stage the team has identified risk treatment options and the corresponding cost to benefits for each option; hence, the choice of the contingent plan should take into account the business objectives. In addition, the contingent plan should operate within the business processes for it to be effective. Therefore, the risk management process should be aligned to business processes, and this is discussed in the next section.

2.8.7 STEP 7: ALIGNMENT TO BUSINESS PROCESSES

The last step in developing an implementation plan for risk management processes is aligning to business processes. The process of alignment embeds the new system into the organisational culture and enhances effectiveness of the management system. The supply risk management process, like any new initiative, requires resources, and since resources are scarce, executive management should perceive the value contribution it will add to the current situation. This can be achieved if the process is developed to match best business practices. According to PeopleSoft (2004:para.6), best practices have the following characteristics: drive measurable change and result in predictable ways; are documented not only in writing but also with data; create sustainable performance and lower cost; ensure effective control across the organisation; empower individuals throughout the organisation; and leverage proven technologies.

However, the desire of any sponsor of a management programme is to outperform competitors in specific operational areas and deliver more value at less cost. According to PeopleSoft (2004:para.6-10), the most successful implementations of business processes incorporate all of the following resources: people, process, information, and technology. Further explanation of these resources is included in Table 2-4 below.

TABLE 2-4: IMPLEMENTATION OF BEST PRACTICE

People	People participating in and driving the activities of the programme must be able to focus their time on value-added strategic work, not just clerical and administrative duties. The strategic focus of the team members should include empirical data gathering and application of analytical tools, improving planning and policy making, negotiation and supplier valuation.
Process	Processes must be simplified wherever possible, creating efficiencies and eliminating excessive rework and unnecessary detail. A key component in process improvement includes automation, which shortens processing cycle times and helps eliminate human errors. Standardisation is also important since consistent treatment of data reduces redundancy and saves time. Standardising data management enables a focus on the analysis of results, which increases transparency of information and allows for more strategic decision making and buyer-supplier interactions.
Information	Fundamental to good decision-making is getting the right information regardless of where it is in the company and whether it is distributed or centralised. To be of value, data must be consolidated into a single source of truth instead of multiple silos and shared as appropriate. For example, all team members need access to supplier performance data and spend analytics regardless of where they are in the organisation.
Technology	Overall, technology supports, automates and reinforces the enablement of recognised best practices across people processes and information. It also serves to consolidate and centralise systems and control.

Adapted from: PeopleSoft (2004:para.6)

In conclusion, aligning to business processes should take account of the best practices and utilise resources effectively in order to add value. The importance of aligning the supply risk management process to incorporate all the components mentioned above in Table 2-4, cannot be overemphasised. These components will simplify, automate, consolidate and standardise the process, enabling it to work better and more productive.

2.8.8 SUMMARY

This chapter has reviewed the literature relating to issues of supply risk management. The discussion of the literature review has clarified a number of issues that are important to developing an effective implementation plan for supply risk management. Among the issues clarified are the definition of supply risk, risk factors and the risk management process.

The literature defined supply risk as the probability that a detrimental event may occur with significant impact or cost consequences. Clearly, two concepts of probability and impact or cost consequences emerge from that definition and this are important in evaluating and quantifying risk. Furthermore, the literature review highlighted the need to express risk impact in financial terms. This is particularly important as any initiative requires resources and the justification for use of resources should translate in terms of financial benefits.

On the issue of risk factors, the literature indicates numerous sources of risk and the associated risks. This can be overwhelming to address in an initial implementation and thus the study suggest: (1) selecting primary risk factors, which are measurable and information can be accessed; (2) perceiving risk from the context (that is, inner and external context and the changes within the context); and, (3) creating association of the object of risk and the risk impact. Approaching assessment from this angle facilitates breaking down the big block of risk sources, such as supplier to specific issues about the supplier; for example, quality system. In addition, understanding the supply chain of a specific material is important and for that matter the literature recommends the use of a flowchart that maps out the material flow, from the shop floor back to the supplier sources. This kind of approach enhances the process of uncovering the inherent risk.

Furthermore, the literature has shown that supply risk management can be a set of seven-step processes. These are: (1) multi-disciplinary team; (2) supply base categorisation; (3) vulnerability assessment; (4) evaluation of risk implications; (5) cost to benefit analysis; (6) risk treatment; and, (7) alignment. These steps are arranged in logical sequence to enable their application to become a repeatable process that will improve on efficiency and effectiveness gradually. The importance of each of these steps in managing supply risk cannot be overemphasised and each has it is merit as

indicated by the literature review. Finally, it can be concluded that the review of the literature has given yield to an implementation plan for supply risk management; and thus, has fulfilled its goal. The next section discusses the empirical studies.

CHAPTER 3

EMPIRICAL STUDY

3.1 INTRODUCTION

This chapter discusses a case study conducted in Safripol whose main focus was to conduct preliminary testing of the proposed implementation plan for supply risk management. The method used for testing, obtaining data, analysis of the data, and the results are also discussed. The testing follows from the preceding chapter on the literature review where a seven-step process was developed. These steps are: (1) selection of a multi-disciplinary team; (2) supply base categorisation; (3) vulnerability assessment; (4) evaluation of risk implications; (5) cost to benefit analysis; (6) risk treatment; and (7) alignment.

To test the application of these steps, the study conducted reviews of four supplies. However, the literature highlighted some approaches and issues, within each step, which are useful in the assessment and evaluations of supply risks and were applied where applicable. Hence, this study seeks to test the application of those approaches in establishing the relevance of the proposed implementation plan. Therefore, the empirical study intends to fulfil two objectives, namely, to:

1. demonstrate the practicability and applicability of the proposed seven-step process; and,
2. verify the relevance of it in managing supply risks.

In order to achieve these objectives, the study conducted a survey to obtain feedback from the participants in the review. To do that, risk information and data of the supplies (materials and suppliers) is required to complete the analysis. This was gathered and processed through the review process by the teams involved. However, the results of the analysis are not in the scope of this study, and therefore, they are attached in the **Appendix B**. The method of the experiment and the survey are discussed in the next section.

3.2 STUDY METHOD

The experiment of the seven-step process was conducted by means of reviews of each step through actual assessment and evaluations of supply risks. Hence, the study commissioned four multi-disciplinary teams that included employees of Safripol and in some instances representatives of the supplier. The teams were composed of personnel from procurement; production (users of the materials), engineering, logistics, finance, warehousing, and a supplier representative. Each team had seven to eight people who were then introduced to the seven-step process followed by participation in the assessments and evaluations. The selected employees were on the level of managers and supervisors; and the selection was based on the role and/or involvement with the material or supplier under review.

Furthermore, the seven-step process took two to three sessions plus further information and data gathering outside the review sessions. The reviews took the form of working through the steps; generating ideas through brainstorming; verifying those ideas and documenting the agreed information. An Excel worksheet was used for capturing the information and the analysis of it. The tool was designed to facilitate sequential flow of the process: storage of the data and a point of reference to the information gathered from the literature in the form of flash cards.

Prior to the review of the seven-step process the teams were informed about the objective of the exercise and the need for feedback. Instructions on completing the questionnaire were explained and copies of the questionnaire distributed at the end of the review. Only one questionnaire per participant was permitted. A copy of the questionnaire is attached in **Appendix A** and the next section discusses its design.

3.3 QUESTIONNAIRE

The questionnaire was designed to measure the application and relevance of the seven-step process in managing supply risk. It was also designed to gauge the perceived value contribution by those impacted by supply risk issues; that is, the team members involved in the review. Furthermore, questions were adopted to meet the unique requirement of the study.

In addition, the questionnaire consisted of two parts: namely, Part A which was meant to measure the application and relevance of each step; and, Part B which was meant to measure the overall applicability of the seven-step process.

Part A of the questionnaire had two general statements, applicable to each step of the process and participants were required to rate on a five-point-scale with end points of strongly disagree and strongly agree. These statements are:

A. This particular step is practical and applicable to the process of managing supply risk.

B. This step adds value to supply risk management.

However, Part B of the questionnaire had only one statement intended to give an indication of the overall view of the process; that is, whether it is practical and applicable. Similarly, the response to the statement was rated on a five-point-scale.

Finally, the participants were required to indicate the number of reviews they took part in. That was meant to gauge the influence of the level of exposure to the process because some people were involved in more than one review process. The next section discusses the process used to gather data and processing of it.

3.4 INFORMATION AND DATA GATHERING

The data required to complete the empirical study is obtained from the survey of the participants who took part in the review exercise of the proposed implementation plan. The reviews were set up to analyse one supply for each of the four categories (that is, noncritical, bottleneck, leveraged and strategic supply) by means of applying the seven-step process. The supplies selected for the review exercise are those considered best representative of the category as described in the literature study. The teams reviewed the categorisation and agreed on the supply to be further analysed.

In addition, the review of the proposed seven-step process required gathering of information about the material procured; suppliers of the material; and the associated risk factors and their impact and probability of occurrence. There are numerous sources and ways of gathering this information but for the purpose of this study, three sources of information were considered; these are:

1. employees (People);
2. enterprise resource planning [ERP]; and,
3. suppliers.

The major source of information is the people who work with the material and suppliers. This is a primary source of information that is a result of experience and sometimes it is not documented. Although this source can be subjective, it is crucial in putting the process into motion and lays the foundation for future improvement. Similarly, suppliers are another potential source of information and should be utilised as much as possible. Nevertheless, there are also limitations of accessing factual information and the issues of bargaining power play. Hence, suppliers need to be handled with care not to cause more vulnerability at the expense of risk management. On the other hand, the enterprise resource planning can provide factual information but it is limited to what has been captured. In this case, supply risk has not been in the picture and therefore it hardly carries sufficient information for the purpose of this study. Therefore, this study utilised the three sources of information concurrently.

Since the objective of the study is to develop an implementation plan for supply risk management, the review team was advised to make an educated guess where the information was not available and / or highlight it for further investigation. In addition, since the review process is preliminary testing in the development stage, only limited reviews could be done within the given time. Therefore, it is important to manage the reviews within a reasonable time frame without compromising the quality. The results of the review process are attached in **Appendix B**. However, the focus of this empirical study is to verify applicability and relevance of the seven-step process. This is discussed in the next section.

3.5 RESULTS OF THIS STUDY

Four review teams were commissioned and all participants provided feedback. Only one questionnaire was allowed per participant and thus a total of 17 questionnaires were received. Table 3-1 below shows the number of participants per department for each of the supply reviewed. Due to confidentiality reasons, the material reviewed has been referred to as supply A, B, C and D. It will be noticed that the number of questionnaires, for example, from procurement are only two while for each review there were two people from procurement. This is because it is the same two people who took part in all the reviews. Likewise, engineering had two people who took part in three reviews and one person represented finance in all three reviews. Furthermore, only one feedback per person was allowed regardless of the number of reviews involved in. In other words, the number of questionnaires represents the number of people who took part in the testing.

Table 3-1: Number of participants per department

Roles / Departments \ Supplier	Supply A [Noncritical]	Supply B Leverage]	Supply C [Bottleneck]	Supply D [Strategic]	Number of Questionnaires
Executive Management					
Procurement	2	2	2	2	2
Production				2	2
Engineering	3	3	3		7
Logistics				2	2
Financial		1	1	1	1
Warehousing	1	1	1		1
Supplier Representative	1		1		2

From the above Table 3-1, it can be concluded that there was fair representation of the departments and in two reviews supplier representatives participated. These are supplier A (for noncritical supply) and C (for bottleneck supply) who have long relationship with the company; locally situated; and, they are keen for a sustainable partnership. However, in the case of supply B, (that is, leveraged

supply) which is an imported product, it was not necessary to have a supplier representative for that exercise while with supply D (which is strategic supply) it is too important to the company, and the supplier could not be involved at this stage of testing. Therefore, with this representation it was adequate for the review to proceed and provide some insights to the way forward in supply risk analysis and contingent planning.

The statistical analysis of the feedback from the reviews followed and the number of responses to each statement was converted to a percentage of the total number of responses. The results are tabulated in Table 3-2 below. The table shows both Part A and B of the questionnaire and the resulting percentage of the response to each step and overall. For example, in step 1, the respondents were supposed to indicate their level of agreement with two statements; that is:

A. This particular step is practical and applicable to the process of managing supply risk.

B. This step adds value to supply risk management.

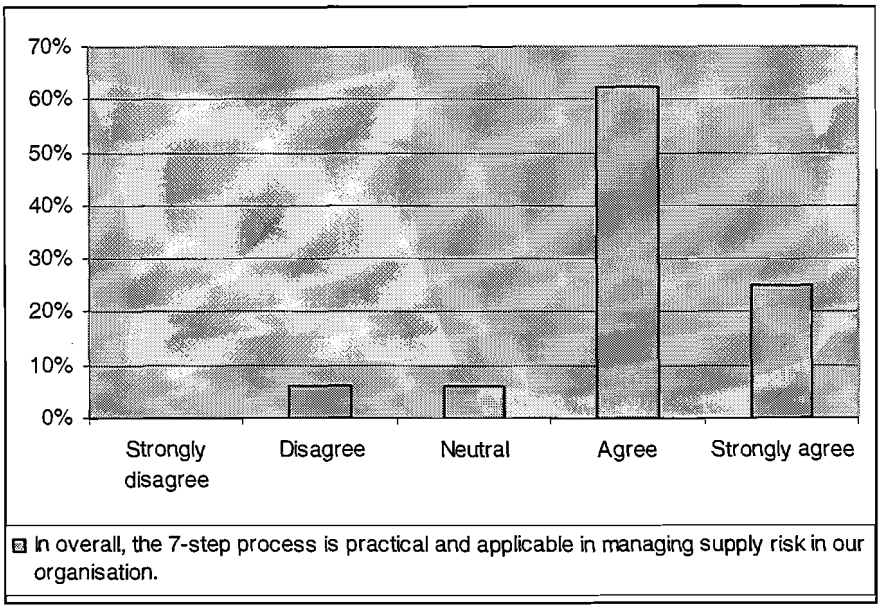
Hence, the results of the responses to both Part A and Part B are shown in the Table 3-2 below.

Table 3-2: Results of the survey

Part A			Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Step.1	Multi-disciplinary team	A	0%	0%	20%	67%	13%
		B	0%	0%	25%	56%	19%
Step.2	Supply base categorisation	A	0%	0%	19%	69%	13%
		B	0%	0%	25%	63%	13%
Step.3	Vulnerability assessment	A	6%	19%	19%	50%	6%
		B	0%	0%	6%	63%	31%
Step.4	Evaluation of risk implications	A	0%	0%	19%	56%	25%
		B	0%	6%	13%	69%	13%
Step.5	Cost to benefit analysis	A	0%	0%	19%	75%	6%
		B	0%	0%	25%	63%	13%
Step.6	Risk treatment	A	0%	0%	0%	88%	13%
		B	0%	6%	0%	88%	6%
Step.7	Alignment to business processes	A	0%	0%	0%	75%	25%
		B	0%	0%	6%	88%	6%
Part B							
In overall, the 7-step process is practical and applicable in managing supply risk in our organisation.			0%	6%	6%	63%	25%

From the results of Table 3-2 it can be seen that, 50 percent to 88 percent of participants agree that each of the steps is practical and applicable; and also that it adds value in managing supply risk. However, it is important to note that the response to step 3 indicates questionable variation, since only 50 percent thought it's practical and applicable while 19 percent are neutral and another 19 percent disagree. Contrary to that, 31 percent strongly agree and 63 percent agree that step 3 adds value. This disparity may be attributed to the challenge of vulnerability assessment. It will be recalled that the literature is not specific on how to do assessment and it is an area that can result in paralysis due to the depth and breadth of analysis. However, with risks identified and their implications known, the other steps (5, 6 and 7) are easy to deal with, which is reflected by high consensus of agreement ranging from 75 percent to 88 percent. Finally, in view of the whole process 63 percent agree it is practical and it can be applied with 25 percent strongly agreeing. Only 6 percent disagree and others are neutral. The distribution of the responses, in percentages, is depicted in Figure 3-1 below.

Figure 3-1: Results of the overall opinion



From the above Figure 3-1, it can be seen that, the distribution of the opinion is skewed towards the right indicating the participants tend to agree that the process is practical and applicable. Nevertheless, it is important to this study to know whether the level of exposure to the process has influence on the opinion. Thus, some participants took part in three reviews and their feedback was distinguished by indicating the number of reviews. That gave yield to the results shown in Table 3-3 below.

Table 3-3: Results of the level of exposure

Description	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Overall opinion from four participants who were involved in only one review	0%	25%	50%	25%	0%
Overall opinion from 12 participants who were involved in up to three reviews	0%	0%	8%	75%	17%

The results shown in Table 3-3 indicate 50 percent of participants who took part in one review are neutral on the issue of whether the seven-step process is practical and applicable, while 25 percent agree and another 25 percent disagree.

However, the participants who took part in three reviews, 75 percent agree it is practical and 17 percent strongly agree while only 18 percent are neutral. The distributions of the two groups are shown in Figure 3-2 below.

Figure 3-2: Results of the level of exposure

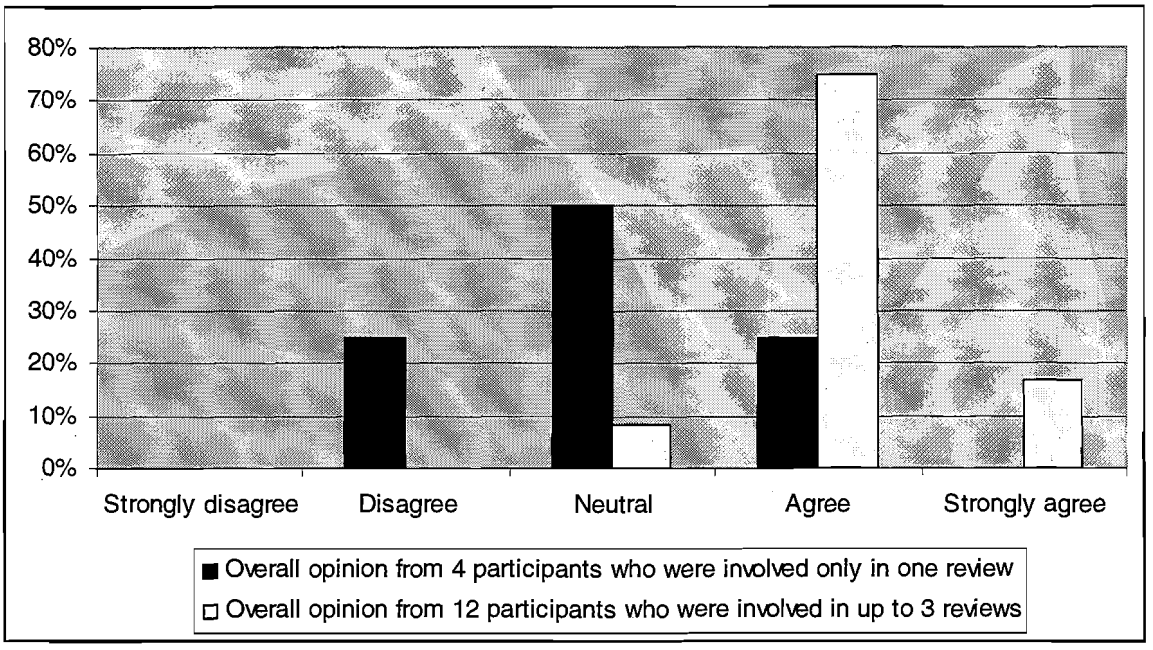


Figure 3-2 indicates that, the distribution of the responses from the participants who took part in one review is concentrated around neutral response. However, the distribution of those who participated in three reviews is skewed to the right showing a high level of agreement.

Therefore, it can be concluded that the level of exposure to the seven-step process helps developing deeper understanding of its application and practice. Hence, the results of the survey can be summarised by saying that, the seven-step process is practical and applicable in managing supply risk. However, continuous improvement is necessary particularly on assessment of vulnerabilities (that is, step 3). In addition, the level of exposure can be improved by providing training to create awareness and motivation. The need for developing and equipping facilitators of reviews with adequate

knowledge to be able to break the barriers which the teams may face in the analysis cannot be over-emphasised.

Finally, from the above it can be concluded that the empirical study has fulfilled its objectives; that is (1) to demonstrate the practicability and applicability of the proposed seven-step process; and, (2) to verify the relevance of it in managing supply risks. That leads to the next chapter on the conclusion and recommendations.

CHAPTER 4

CONCLUSION AND RECOMMENDATIONS

4.1 INTRODUCTION

The purpose of this study was to develop an implementation plan for supply risk management. However, in the quest to achieve that goal the study set out four goals that needed to be met; that is, (1) to develop a scientific process for managing supply risk; (2) to develop the ability to identify, interpret and make informed decisions on supply risk; (3) to standardise the process of risk management; and, (4) demonstrate the application of the process using a sample of suppliers drawn from Safripol's supply database.

Hence, from the literature study a seven-step process was developed. This process was further put to the test by applying it in review of supply risks for four supplies. A team of managers and supervisors who are involved in the use or supply of the material worked through the seven-step process. The results of the reviews are documented in a case study attached in **Appendix B**.

Furthermore, the participants of the review process provided feedback to a survey intended to find out whether the process was practical and applicable to the management of supply risk. This in turn provided insights into practical aspects of the proposed implementation plan, and the findings of both studies (literature and empirical) are concluded in the next section.

4.2 CONCLUSIONS

This study has clearly shown that, supply risk can be managed by implementing a seven-step process. The literature identified seven essential steps for managing supply risk which are: (1) selection of a multi-disciplinary team; (2) supply base categorisation; (3) vulnerability assessment; (4) evaluation of risk implications; (5) cost to benefit analysis; (6) risk treatment; and, (7) alignment. These steps are arranged in logical

sequence to facilitate systematic application and enhance the learning of the process. Certainly, these steps provide:

- a scientific process for managing supply risk;
- the ability to identify, interpret and make informed decisions on supply risk; and,
- standardise the process of risk management.

In addition, the literature study clarified a number of issues that are important in developing an effective implementation plan for supply risk management. Among the issues clarified are the supply risk factors; sources of risks; and, the process of managing risks. At the same time, supply risk was defined as the probability that a detrimental event may occur with significant impact or cost consequences. It is important to remember this definition when conducting an analysis of the supply risks because it sets the boundaries of the depth of analysis.

On the other hand, the empirical study has clearly shown that, the proposed implementation plan (seven-step process) is practical and applicable in the management of supply risk. This came from the result of the survey conducted with teams commissioned to apply the seven-step process. The feedback clearly indicates over sixty percent of participants agree that the process is practical and applicable. In addition, the study has shown that, this process adds value to the management of supply risk. However, the study also indicates that, the level of exposure influences the view of the users. The participants who took part in up to three reviews agree that it is practical and applicable while those who took part in only one were neutral.

From the study perspective, this implementation plan for supply risk management can be concluded by highlighting the fact that, the most critical goal of purchasing and supply management is to ensure continuity of supply (Zsidisin *et al.,* 2004:410). Hence, managing supply risks as shown in this study will provide benefits, such as:

- guideline for assessing, evaluating and monitoring supply risks;
- basis for benchmarking performance;
- confidence in the measurement of supply risks;
- basis for negotiating better supply conditions and terms; and
- resources in knowledge of supply risks to use in developing supply plans.

Hence, the literature review shows that, supply risk management is one part of an organisation's overall or company wide risk management programme. Furthermore, it emerges from the case study that, supply risk management can support business strategy formulation by providing critical knowledge resources of supply risks and even enable proactive management of the risks. However, the process also complements other supply management processes, such as supplier performance management; supplier relationship management; management of supply base (that is, strategic, leveraged, bottleneck and noncritical supply); and so on. Therefore, it can be concluded with confidence that, this study has achieved its objective of developing an implementation plan for supply risk management that can be applied in practice.

4.3 ACHIEVEMENT OF THE STUDY'S OBJECTIVE

The purpose of this study has been achieved, in so far as it has shown that it is possible to implement a risk management process by following seven-steps. These steps are: (1) the selection of a multidisciplinary team; (2) categorisation of supply base; (3) assess vulnerability; (4) evaluate risk impact; (5) decide on risk treatment action; (6) analyse the cost to benefits; and (7) aligning to business processes.

The following objectives and requirements have also been fulfilled:

1. A scientific process for managing supply risk has been provided in the seven-step process.

2. The ability to identify, interpret and make informed decisions on supply risk is provided by the following steps:
    - Step 3 serves to identify supply vulnerability;
    - Step 4 aids in interpreting the risks; and
    - Steps 5 and 6 provide enough grounds to make informed decisions.

3. It provides a standardised methodology for risk assessment, evaluation and control.

4. Key supply risks have been identified and grouped as primary and secondary risk factors in order to simplify the application in the initial stage of implementation.

5. The study has demonstrated the application of the process using the top four high spend supplies in each of the categories of supply.

Finally, this study has achieved its objective of developing an implementation plan that will help in managing supply risks. In addition, recommendations have been proposed and are discussed below.

4.4 RECOMMENDATIONS

The following recommendations emerge from this study:

1. Since the case study has demonstrated the application and it has shown that it is practical, the processes should be rolled starting with the high spend areas.

2. During the initial implementation it is recommended to use the primary risk factors identified in the study and later implement the secondary factors. This will enable the implementation teams gain experience gradually and to allow time for further development of measuring methods for the secondary factors.

3. It is highly recommended that the current ERP system be configured to provide the essential and reliable historical supply data. This should include supplier performance in deliveries, quality issues, supplier details, price, and so on.

4. The study suggests use of categorisation as demonstrated in the case study to create priorities and focus areas. This will optimise use of resources (in time and money) in managing the supply base.

5. It is recommended that, the vendor application and approval policy should solicit commitment, from the suppliers, to transparency and information sharing.

6. The study recommends the risk management process to tap into the experience and wealth of information in incident investigations in other departments, such as occupational health and safety, quality, customer service, and so on, to accelerate skills development and eventually the implementation of it.

4.5 FUTURE RESEARCH

In an effort to contribute to further development of supply risk management, this study suggests further research in the following areas:

1. The literature study highlighted numerous supply risks which were grouped into primary and secondary risk factors depending on the level of difficulty in their measurement. Thus, its suggested further study should be done to develop measurement methods especially with the secondary risk factors.
2. As seen from the study, there are various ways of conducting vulnerability assessment, which is a drawback and require further research to improve the effectiveness and efficiency of the process.
3. The consequences and the cost of supply disruption. This is necessary because without a realistic estimate cost/benefits analysis it will not be realistic. The cost of disruption for inventory items differs significantly from that of direct items. Raw materials will also have a different cost impact depending on the production processes involved and the product manufactured.
4. A study of risk treatment should be done to improve contingency plans and enhance the quality of the decisions.
5. In addition, research can be conducted to determine whether proactive supply risk management has a significant effect on organisational performance. This type of research would analyse when and what steps the company should take when a supply risk is discovered and collect that data over time to gain insight into how the supply risk is best addressed.

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APPENDICES

APPENDIX A : QUESTIONNAIRE

PLEASE COMPLETE THE FOLLOWING QUESTIONNAIRE.

INSTRUCTIONS:

Please answer by marking with an "X", in the relevant box, whether:

A. This particular step is practical and applicable in managing supply risk

B. It adds value in reducing supply risk

	Part A		**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
Step.1	Multi-disciplinary team	A					
		B					
Step.2	Supply base categorisation	A					
		B					
Step.3	Vulnerability assessment	A					
		B					
Step.4	Evaluation of risk implications	A					
		B					
Step.5	Cost to benefit analysis	A					
		B					
Step.6	Risk treatment	A					
		B					
Step.7	Alignment to business processes	A					
		B					
	Part B						
Overall, the seven-step process is practical and applicable in managing supply risk in our organisation.							

How many reviews have you taken part in? 1 ☐ 2 ☐ 3 ☐ 4 ☐

APPENDIX B : CASE STUDY

Introduction

The literature review, in chapter 2, looked at various suggestions put forward by different authors on the subject of supply risk management. Finally, from the suggestions a seven-step process for managing supply risk was developed. Further to that, a case study was conducted to check whether the process is practical and applicable to Safripol. This was done by means of reviewing each step, through actual assessment and evaluation, for four supplies drawn from the Safripol database. Due to confidentiality reasons the supplies used in the case study are referred to as supply A, B, C, and D, each representing the four categories of supply, that is, noncritical, leveraged, bottleneck and strategic supply respectively. Next is a brief discussion of the results for each step.

Step 1: Multi-disciplinary Team

The literature emphasised the importance of a multi-disciplinary team and the role it plays in managing supply risks. Nevertheless, supply risk management is not confined to the purchasing department only; hence, involving others increases enterprise wide accountability and ownership. Therefore, four teams of 7 to 8 people were commissioned to participate in the review. These are people who use or handle the supply of the material assessed. In two instances, supplier representatives were involved as shown in Table B-1 below. However, it will be noticed that the executive were not involved directly in the review but it should be remembered the literature emphasised the importance of gaining their support. Hence, at this stage information was shared and the results especially those concerning strategic supply in an effort to gain implementation support.

Figure B-1: Review teams' composition

Roles / Departments \ Supplier	Supply A [Noncritical]	Supply B Leverage]	Supply C [Bottleneck]	Supply D [Strategic]
Executive Management				
Procurement	2	2	2	2
Production				2
Engineering	3	3	3	
Logistics				2
Financial		1	1	1
Warehousing	1	1	1	
Supplier Representative	1		1	

The above shown teams were first introduced to the process and made aware of the background of the exercise, then followed by application of each step. In addition, the developer of the process facilitated all the reviews by guiding through the process and providing theoretical support while the teams brainstormed, analysed, and collectively decided to the best of their knowledge. The teams also assigned responsibilities to the various functions (including process owner, communication, control and monitoring) of the final contingent plan. The next task of the teams was to categorise the supply base, which is discussed in the next section.

Step 2 Supply Base Categorisation

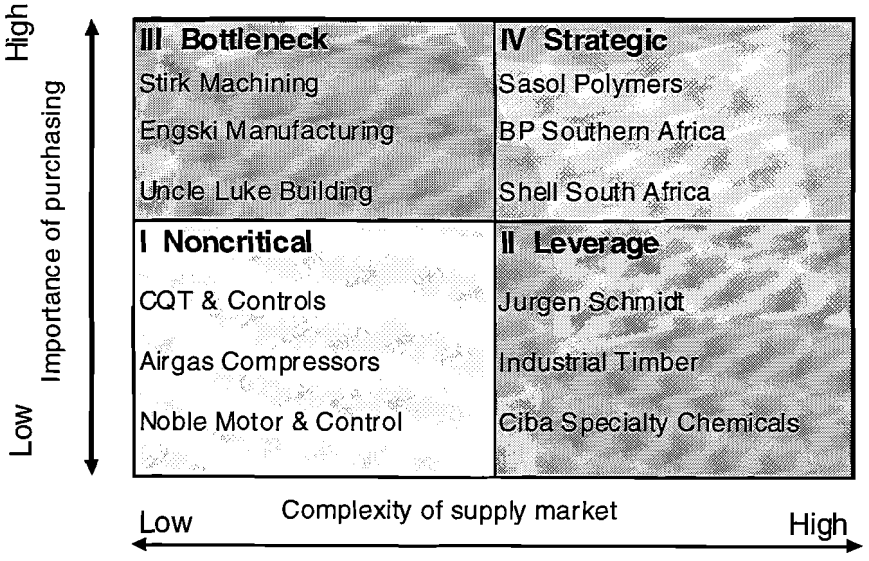
The second step of the process for managing supply risk is categorisation of supply base. This was done by categorising twelve suppliers into four categories, in accordance to the characteristics identified in the literature study. To assist the teams in brainstorming the appropriate category, questions shown in Table B-2, were used as a guideline in assessing and evaluating the relative importance and the market complexity involved with specific supply.

Table B-1: Categorisation Criteria

Category:	Characteristics to consider: (if any of the answer is no consider another category)
Strategic	oIs it vital to operations? oIs it important to the market? oIs it sourced from sole supplier? oIs it of high value? oIs it of high volume?
Leverage	oAre there many alternatives? oAre there many sources? oIs it of high volume? oIs it of large market capacity?
Noncritical	oAre there many options? oAre there many sources? oIs it of low value? oIs it of little brand preference?
Bottlenecks	oIs it one or a restricted source? oIs it of many options? oIs it of low value?

In addition, various issues were discussed including the limiting factors such as compliance to regulatory requirements and what it takes to qualify an alternative source. Taking all that into consideration, the teams finally settled on what is the most appropriate supply category for each of the twelve high ranking supplies. These are shown in Figure B-2 below. However, the selection of twelve suppliers is based on the Pareto principle which suggests that, 20 percent of the suppliers will have an 80 percent impact on the company performance.

Figure B-2 Supplier categorisation



From the above Figure B-2, the teams selected one supplier and the material supplied by that supplier. In case more than one material is supplied then the one with the highest spending is selected and these are referred in this case study as supply A; supply B; supply C; and supply D, and represent noncritical, bottleneck leverage, and strategic supply respectively. The reason for selecting only one material is to ensure the analysis is specific regarding the risk of material and, therefore, not too broad to cause an endless exercise. It should be remembered that, there are two components of risk; that is, the risk of supplier and the risk of the material which need to be addressed separately.

In summary, this step can be repeated with all the other suppliers and the results are important knowledge of the supply base that supply managers can effectively utilise in negotiations and in managing relationships with suppliers. The selected supplies are analysed further in the next step.

Step 3: Vulnerability Assessment

The starting point for vulnerability assessment is identifying risk attributes related to each supply. The assessment is similar to conducting a pre-qualification audit for a first-time supplier where, all critical issues that can affect supply are considered. However, with the help of the risk factors identified in the literature review, (see Table 2-2), and the teams' knowledge of the supplier and the material, the teams developed a risk profile for each supply under review. A sample of an extract of the risks, identified for supply A and C are shown in Table B-2 below. Only a few are discussed here because the aim of the study is to demonstrate the application of this step.

Table B-2: Extract of supply risks identified for supply A and B

Category:	Risk object:	Risk attribute:
Supply A	Supplier	On-time delivery
		Buffer capacity
		Management and organisation
		Currency fluctuations
		Financial health
		Warranties and claims
	Material	Switch over to alternative supplier
		Long cycle time
		Price fluctuations
Supply B	Supplier	On-time delivery
		Buffer capacity
		Capacity constraints
		Currency fluctuations
		Technical knowledge and resources
		Litigation issue
		Financial health
	Material	Long cycle time
		Price fluctuations
		Demand
		Environmental vulnerability
		Transport and freight routing

To elaborate on how the above risk factors were indentified, two examples will be used. That is, for example, the team looked at the issue of on-time delivery for supply A and argued that since this an agent who imports the equipment from overseas and the delivery periods are six to eight weeks, that could be a problem if the equipment is required in a period shorter than that. In addition, there have been instances of late deliveries but the frequency could not be ascertained. However, the supplier is relatively very small hence, long-term sustainability is questionable; hence, issue of supplier strength. In terms of material, there is no other source that has been approved. Similarly, supply B is directly imported from an overseas manufacturer and thus a 1st tier supplier. Hence, physical location was identified as an issue because physical audit will be a challenge because of the location. It was recalled that there were issues with airfreight as the supplier did not use the contracted courier despite being instructed.

Thus, the team felt it is necessary to address the risk of transport and freight routing. For all the risks highlighted, the teams had a reason behind it that justifies the decision taken. The same applies to supply C and D; and any other supply.

At this point it was pointed out that, in future the identification makes use of the results of incident investigations in occupational health and safety, production, customer complains, and so on, to tie up on issues relating to supply. Hence, in future this process should be linked to other root cause investigations to automatically trigger the supply risk management process. Currently, such supply issues are dealt with in isolation and it needs to be streamlined.

Finally, the above analysis provides a list of the risks with high probability of occurrence. However, the literature indicates that sometimes it is not possible to eliminate all the risks, thus priorities need to be set from the above list for further analysis. Sirnilarly, the sarne can be done to all other supplies and if the same supplier or material is involved, then, reference is made to previous analysis. The next task was to assess the impact of the risks identified which is discussed in the next section.

Step 4: Evaluation of Risk Impact

It will be recalled from the literature study that supply risk was defined as the probability of a detrimental event occurring with significant impact or cost consequence. Hence, with this in mind, the next step tackled by the review teams was to estimate (or calculate where the data is available) the probability of such an occurrence. Therefore, the teams assessed each risk and assigned a probability value. For the purpose of this study, three values were used, that is, 1, 2, or 3. This means, for example, if the probability is low then a value of 1 was used, or otherwise if it is high, a value of 3 was assigned. For ease of reference, this is shown in the form of a chart depicted by Table B-3. It shows the rating and what it represents.

Table B-3: Probability rating chart

Probability rating:	Represents:	Frequency of occurrence to total number of orders
1	Low	Less than 30%
2	Medium	30% - 60%
3	High	More than 60%

In addition, the frequency is determined by the number of occurrence to the total number of orders of that specific supply. For example, if the risk is "on-time delivery" then the number of late deliveries can be compared to the total number of orders issued to that supplier.

Similarly, the other determinant of the impact is the consequence of the detrimental event. To determine this, the study choose to use arbitrary values 1, 5 and 10 representing low, medium and high consequential effects. These represent three scenarios in case of supply interruption. The worst case is loss in production which is a high consequential effect and the lowest is interference with scheduling but can be accommodated. These are shown in Table B-4 below.

Table B-4: Consequence rating chart

Consequence rating:	Represents:	Description:
1	Low	Affects schedule but can be accommodated
5	Medium	Causes operational inefficiency
10	High	Causes loss in production

From the above Table B-4, it will be seen that these scenarios are not difficult to notice and they happen from time to time though they are never recorded or even if they are, the data could not be obtained immediately. Hence, the teams had to make an educated guess at least for a start. The reason for using rating values of 1, 5, and 10 is to make the degree of severity conspicuous. The worst case scenario with supply

interruption is loss in production; hence, the deliberate use of a rating of 10 to signify seriousness.

With this rating, the teams assigned the probability and the consequential effects to each of the risk attributes identified earlier. Then, calculating the product of the two and deriving the impact of an event in case it occurs. An extract of the results are shown in Table B-5 below.

Table B-5: Extract of risk impact evaluation for supply C and D

Category:	Risk attribute:	Probability [P]	Consequence [C]	Impact [P x C]
Supply C	On-time delivery	2	10	20
	Regulatory compliance	2	5	10
	Management and organisation	2	5	10
	Quality	2	5	10
	Capacity constraints	2	1	2
	Financial health	2	1	2
	Long cycle time	2	1	2
	Price fluctuations	2	1	2
	Production capability	1	1	1
	Technical knowledge and resources	1	1	1
	Warranties and claims	1	1	1
	Switch over alternative supplier	1	1	1
Supply D	Price fluctuations	3	10	30
	Capacity constraints	2	10	20
	Currency fluctuations	2	5	10
	Demand	2	5	10
	Environmental vulnerability	1	10	10
	Litigation issue	1	1	1
	Constrained / limited supply source	1	1	1

From the above Table B-5, it is evident that price fluctuations, for example, in supply D has higher impact than other risks. Thus, the results of the impact allow ranking and prioritising of the risks for each supply. From the ranking generated, the teams decided

to select the two highest ranking risks for each category and analyse further. However, this does not mean that the others are ignored entirely but rather a matter of priority.

In order to create a clearer picture than the one portrayed by the impact, the teams worked out the cost consequence associated with each of these high ranking risks. The results are shown in Table B-6 below.

Table B-6: Cost consequence of supply interruptions

Category:	Risk attribute:	Impact [P x C]	Cost Consequence
Supply A	On-time delivery	10	R338,571
	Financial health	10	R338,571
Supply B	Currency fluctuations	15	R507,857
	Transport and freight routing	10	R338,571
Supply C	On-time delivery	20	R4,740,000
	Regulatory compliance	10	R338,571
Supply D	Price fluctuations	30	R507,857
	Capacity constraints	20	R507,857

The costs of the consequence shown above in Table B-6 are the figures of losses incurred per day in case of supply interruption. According to production personnel, the cost of plant shutdown is R7.9 million per day and also, the plant runs at a capacity of 70 percent. Thus, taking these into consideration and the effect of individual risk attribute, which can either affect the operational inefficiency or plant shutdown, the cost consequence is calculated by factoring in the probability of occurrence. Hence, the teams worked out and the results are as shown above. It should be noted also, different risk factors affect operational inefficiencies differently and that can range from 5 percent to 25 percent. The lowest recorded asset utilisation is 45 percent due to various reasons from equipment breakdown to blockages. Hence, the figures above have resulted from considering all the cost drivers.

With the cost consequences established for the identified top ranking risk for the supplies under review the teams looked at the comparative cost of managing the risks and were based on the options available for treating that specific risk. Hence, the next step is to start making decisions on the strategies to apply in dealing with the risks

posed by the supplies under review. This is dealt with in the next section of risk treatment.

Step 5: Risk Treatment

At this stage the review team were able to comprehend the significance of the impact and start to value the need for prevention. However, the literature indicated various high level strategies for treating supply risk. The first thing is to decide whether any measures should be taken or not. Hence, using these options the teams deliberated and decided on the option most appropriate for dealing with the risk. It must be pointed out that the team composition is suited to provide strategic directions which the supply manager should develop further into detailed action plans. These are shown in Table B-7 below.

The Table B-7 shows two levels of risk treatment options: the first level is based on the generic risk management options (that is, avoid, limit, reduce, transfer, retain, defer, mitigate or share) discussed in the literature review, which the teams discuss and apply individually or in combination. Given the cost consequence and the probability of occurrence, deciding which to use becomes easier and based on facts. However, the quality of the decision can be improved even more by supporting the probability figures with statistics. Nevertheless, in the absence of such fact the teams can estimate to the best of their knowledge.

Table B-7: Risk treatment for selected top priority issues

Category:	Risk attribute:	Cost Consequence	Risk treatment option
Supply A	On-time delivery	R338,571	Improve prevention and control measures.
	Financial health	R338,571	Improve prevention and control measures.
Supply B	Currency fluctuations	R507,857	Maintain internal insurance or risk financing.
	Transport and freight routing	R338,571	Improve prevention and control measures.
Supply C	On-time delivery	R4,740,000	Limit scale of scale exposure.
	Regulatory compliance	R338,571	Improve prevention and control measures.
Supply D	Price fluctuations	R507,857	Engage in co-operation to: 1) share risk; or, 2) joint efforts to prepare supply continuity plans.
	Capacity constraints	R507,857	Engage in joint ventures with alternative supply sources

The risk treatment options, shown in the above Table B-7, are very general in nature, and at this stage cannot be quantified in terms of cost of implementing. Hence, the teams developed 2nd level options with more practical details which allow estimating the cost. These are shown below in Table B-8. The purpose of first developing 1st level risk treatment options is to keep discussion going on by breaking the information to small packages that the teams can grasp easily and work through the details.

Table B-8: 2nd Level risk treatment options

Category:	Risk attribute:	2nd Level risk treatment options
Supply A	On-time delivery	Set key performance indicators and rewards/penalties.
	Financial health	Give incentive for shorter payment terms in exchange for lower costs
Supply B	Currency fluctuations	Maintain internal insurance or risk financing.
	Transport and freight routing	Impose contractual obligations
Supply C	On-time delivery	Develop another source
	Regulatory compliance	Conduct compliance audit annually
Supply D	Price fluctuations	Top management should lead development of supplier relationship and manage it through mutual co-operation; and/or develop long-term (+/-5 years) supply contract.
	Capacity constraints	Invest in joint ventures of alternative supply sources.

The teams deliberated on various risk treatment options for each risk factor and with the help of risk impact and its consequences discussed earlier, the teams came up with the most appropriate interventions for each supply. It can be seen from the above Table B-8 that, the 2nd level risk treatment options provide the ability to quantify in terms of the cost involved in implementing. Hence, the teams further analysed the cost and benefits of prevention as indicated below.

Step 6: Cost / Benefit Analysis

In the evaluations of risk impact, the teams calculated the cost of consequence (see Table B-5), which is actually the cost of the benefits in case the risk treatment option is applied to prevent supply interruption. On the contrary, the risk treatment option has a cost which is calculated by taking all the cost drivers into consideration. With the help of financial people the net present value (NPV) were calculated for each of the top priority risk attributes per supply, as shown in the Table B-9 below. The NPV was used because this cost is actually an investment to prevent future loss.

Table B-9 Cost to benefits

Category:	Risk attribute:	Benefit [Cost Consequence]	Cost [Cost of risk treatment [NPA]	Cost / Benefit [%]
Supply A	Set key performance indicators and rewards/penalties.	R338,571	Negligible	_
	Give incentive for shorter payment terms in exchange for lower costs	R338,571	Negligible	_
Supply B	Maintain internal insurance or risk financing.	R507,857		0.03
	Impose contractual obligations	R338,571	Negligible	_
Supply C	Develop another source	R4,740,000	R10,000	0.01
	Conduct compliance audit annually	R338,571	Negligible	_
Supply D	Top management should lead development of supplier relationship and manage it through mutual co-operation; and/or develop long-term (+/-5 years) supply contract.	R507,857	R100,000	0.20
	Invest in joint ventures of alternative supply sources.	R507,857	R500 Million	985

From the above Table B-9, it can be seen that a number of the interventions suggested have negligible cost because they can be done by procurement without incurring additional cost. However, these tasks should be included into the goals that procurement will be measured against, while in other areas like development of joint ventures it will require substantial investment which the top management will decide. However, the team estimated such an initiative will cost +/-R500 million. Definitely, that will be handled under financial processes for investments and business development. What is important to this process is to bring the risk to the attention of top management for strategic planning.

It will also be seen that the ratio of cost to benefits for developing another source or to strengthen the relationship with the supplier is comparatively very small. Therefore, top management should comfortably endorse such expenditure because it makes valid business sense. Hence, it can be summarised that if any intervention needs to be taken against supply risk it must be cost effective. That leads to the last step of the proposed supply risk management process which is aligning to business processes.

Step 7: Alignment to Business Processes

The seven-step process results in a contingent plan that should be applied to monitor and control the supply risk. A summarised contingent plan for the reviews conducted by the four teams is shown in Table B-10 below. It will be seen that, the plan clearly spells out who the responsible owner is and who should be notified when the risk level exceeds the set threshold level. In addition, the authoriser is included to make sure there is compliance with the policy. Another important aspect of the plan is the timeframe within which the mitigating action should be taken.

Table B10-10: Contingent plan for supply A

Process:		**Supply Risk Management**		**Date: 20 April 2009**		**Revision:01**
Process owner:		**Supply Manager**				
Supply:		**A**				
Indicator:	**Threshold Limit**	**Item**	**Frequency**	**Responsibility**	**Corrective action:**	**Procedure / Standard**
	Performance level	**What to check**	**When to check**	**Who checks**		
Late delivery	Less than 1% late delivery.	Order receipts	Upon delivery	Storekeeper	Report to buyer immediately	Goods receipt procedure

Table B10-11: Contingent plan for supply C

Process:		**Supply Risk Management**		**Date: 20 April 2009**		**Revision:01**
Process owner:		**Supply Manager**				
Supply:		**C**				
Indicator:	**Threshold Limit:**	**Item**	**Frequency**	**Responsibility**	**Corrective action:**	**Procedure / Standard**
	Performance level	**What to check**	**When to check**	**Who checks**		
Audit report	Less than 1% non-compliance to legal issues	Contractor audit	Annually	Team made up of procurement, Occupational health and safety, and engineering	Stop business until proves compliant	Labour and services procedure

Nevertheless, a good contingent plan requires monitoring in real time to ensure the risk level does not exceed the set threshold. Hence, the teams decided on what would be practical to measure and monitor for specific risk. For example, the risk of on-delivery the number of late deliveries can be measured and probability of failure calculated. With that, a trend line can be developed and monitored. However, in most cases the consequence will not change unless there is a re-design of process or equipment. Therefore, with the help of the analysis of the previous steps, the teams decided on the probabilities as shown in Table B-10 above.

Finally, the review teams agreed that, this process is aligned to the long-term objective of continuous improvement to sustain competitive advantage. Hence, the issues that require improvement include the use of technology to support the process. Certainly, the use of technology will enhance the process and improve monitoring activity. Secondly, the enterprise resource planning (ERP) needs to be configured to support data gathering and ensure integrity of the data. Furthermore, there is a need to improve on supply risk metrics and the methods of measuring to ensure success in management of supply risks. However, it can be concluded that, even though this was a preliminary testing of the implementation plan for supply risk management, it has yielded results that are applicable to business needs and thus, it has proved that the study was a success.

SUMMARY

The study has shown that, the steps that were identified in the literature review as essential for managing supply risk, have actually proven to be logical and applicable. They provide a step-by-step, repeatable process for managing supply risk. The only challenge experienced is in risk assessment and treatment because of the overwhelming variants that one has to deal with. It is recommendable for a start to focus on the primary risk factors and progressively advance to the secondary risk factors that will demand more effort and resources. Overall, it can be concluded that, the case study has clearly shown that the seven-step process is practical and can be applied to manage supply risks.