An assessment of supply chain disruption in the gold mining industry in the North West Province

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ABSTRACT

Recent catastrophes such as the earthquake in Nepal, the Japanese tsunami, Icelandic volcanic ash clouds, regular floods and superstorms have brought to light the risks inherent within the modern global supply chain. The supply chain function influences many other business functions and processes that reach beyond the organisation, driven by fast-changing technologies, regulations and ethical standards that present the organisation with a range of strategic opportunities and conversely pose threats that, if left unchecked, could result in costly supply chain disruptions.

The objective of this study was to establish the context in which supply chain disruption in the gold mining industry of the North West Province of South Africa influences both the upstream and downstream supply chain environment. The relevance of supply chain disruption risk sources were assessed and a proposal was subsequently put forward for a Supply Chain Disruption Framework (SCDF) as a tool for management to identify the influences and develop preventative or mitigating strategies for the relevant organisation.

Various concepts relating to supply chain disruption were deliberated; this involved supply chain nomenclature that focused on relevant terminology like supply chain management (SCM), supply chain risk (SCR), supply chain disruption (SCD) and supply chain risk sources (SCRS). The situation within the supply chain disruption construct, with specific focus on drivers of supply chain disruption and sources of supply chain complexity, were investigated. A further focus area was on supply chain agility and the dimensions of agility. The study provided a view on the supply chain and mining industry risk sources that impact on supply chain disruption. Linked to the disruption context, the supply chain risk sources that can cause disruption, should it materialise, were assessed. The impact and likelihood of supply chain disruption were investigated with focus on shareholder value, revenue, costs, profit, brand, incidents and the frequency of disruptions.

This resulted in the proposal of a five-sphere supply chain disruption framework including risk sources based on supply, internal demand, process, relationship management and the environmental landscape spheres. The framework further provides for the assessment

of the impact and likelihood of supply chain disruption aspects. The proposed framework will enable business managers to control and mitigate supply chain disruption.

The findings of the literature review as well as the survey used in the empirical research were summarised and conclusions and recommendations were made towards the establishments of a supply chain disruption framework for the gold mining industry in the North West Province in South Africa.

Recommendations for the implementations of the SCDF as part of the Group Risk Management Process of the organisation were made. Emphasis was given to the identification of risk sources that, should it materialise, could result in supply chain disruption, the likelihood and impact of occurrence, the establishment of guiding policy and procedures, implementation, management, control, reporting and communication of the framework within the organisation.

The limitations and implications for further research were discussed and suggestions were made towards further studies.

Key terms: Supply chain, disruption, supply chain disruption framework, risk sources, mining industry, relationship management, supply chain risk.

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LIST OF ABBREVIATIONS

3PLs	Third-party logistics
BCI	Business Continuity Institute
BEE	Black Economic Empowerment
BOM	Bills of material
CRM	Customer relationship management
CSCMP	Council of supply chain management professionals
GDP	Gross domestic product
ICT	Information and communication technologies
IT	Information technology
H&S	Health and Safety
MCIPS	Member of the Chartered Institute of Procurement & Supply
PRM	Partner relationship management
R&D	Research and development
SC	Supply chain
SCD	Supply chain disruption
SCDF	Supply chain disruption framework
SCM	Supply chain management
SCR	Supply chain risk
SCRM	Supply chain relationship management
SCRS	Supply chain risk sources
SOX	Sarbanes-Oxley
SRM	Supplier relationship management
S&P	Standard & Poor's

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CHAPTER 1

ORIENTATION AND PROBLEM STATEMENT

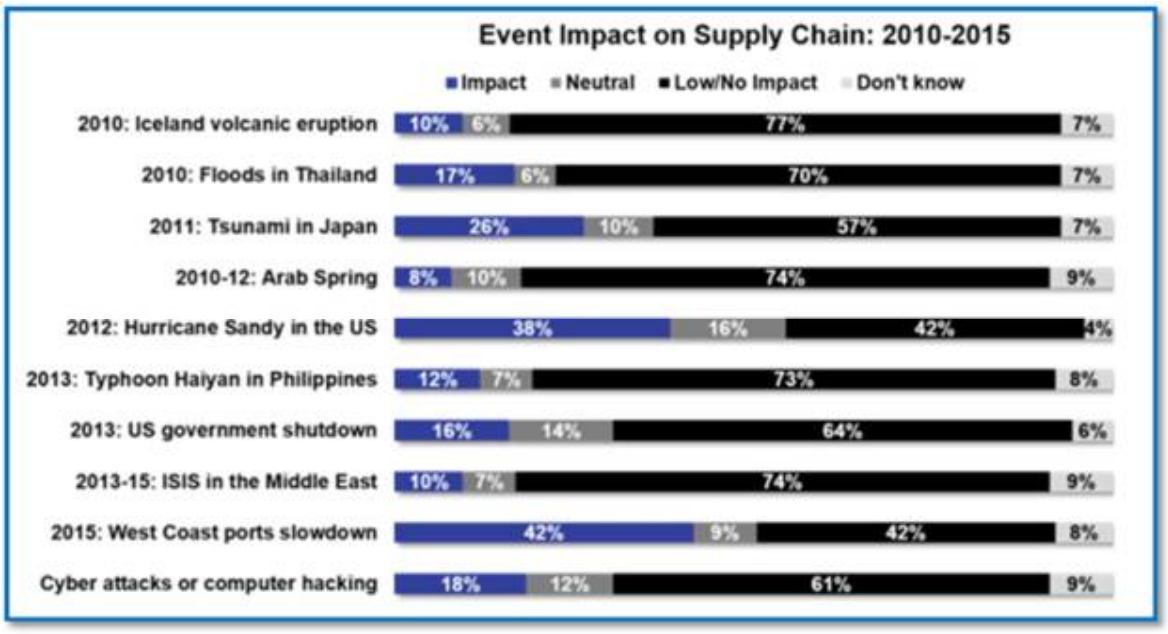
1.1 INTRODUCTION

The significance of the supply chain is captured in the words of three times Pulitzer Prize winning author, Thomas L. Friedman: “supply chains cannot tolerate even 24 hours of disruption. So if you lose your place in the supply chain because of wild behaviour, you could lose a lot. It would be like pouring cement down one of your oil wells” (Sainsbury, 2015:107).

Revilla and Saenz (2013:1124) define “supply chain disruption as unplanned and unanticipated events that disrupt the normal flow of goods and materials within a supply chain.” These disruptions expose organisations within the supply chain to operational and financial risks and substantial losses (Shah, 2009:275).

Recent catastrophes such as the earthquake in Nepal, the Japanese tsunami, Icelandic volcanic ash clouds, regular floods and superstorms have brought to light the risks inherent within the modern global supply chain. Figure 1-1 illustrates the impact of some of these events between 2010 and 2015, demonstrating the significance of supply chain disruption. The impacts reported range from 8% to 42% and in 4% to 9% of the cases the impact is unknown, making it impossible to design a strategy to limit the risk or disruption impact on the supply chain (Cecere, 2015:48). The impacts can be severe, resulting in material events. In 2014, 70% of companies experienced three disruptive events with at least one causing a material impact resulting in financial reporting on the balance sheet (Cecere, 2015:9).

Figure 1-1: Event impact on supply chain: 2010 - 2015



Source: Cecere (2015:48)

The devastating impact of the prolonged industrial action during 2014 in the South African platinum industry had a severe impact not only on the community, but on the mining industry and the supply chains of all stakeholders as well as the South African economy (Burkhardt, 2014; Burkhardt & Janse, 2014; Sidler, 2014). The wildcat strikes that periodically erupted in 2012 have cost platinum and gold producers in excess of R16 billion during that year (Sidler, 2014). The effect of the platinum strike during 2014 had a negative impact on the wider South African economy in that it had both a direct and indirect negative impact. Losses related not only to production foregone, but also to spending that did not take place because mineworkers were not being paid. The loss in potential wages is estimated to be between R4.9 and R10 billion (Burkhardt, 2014; Burkhardt & Janse, 2014). Real consumption expenditure by households rose at a slower pace, growth in spending on consumer durable goods decelerated drastically and real expenditure on non-durable goods, such as food and fuel, contracted during the strike period. The strike also impacted output in manufacturing, petroleum, basic chemicals and iron ore and the estimated lost revenue for these industries were in excess of R9.2 billion (Burkhardt, 2014; Sidler, 2014). The gold sector managed to avoid similar strikes during the 2015 wage negotiations and concluded the process without major industrial action,

but other sectors like the waste management company, Pikitup strike in Johannesburg, the SA municipal workers' strike (Samwu) and the parliament worker (Nehawu) strike is a clear indication of the volatility of the labour situation in South Africa (Gqirana, 2015; Gumede, 2015; Tandwa, 2015).

Another concerning key aspect for all South African industries is the ability of Eskom to provide sufficient power to run production at full capacity. The extent of load shedding had a disruptive impact on business operations, traffic, industry, mining operations, commerce, hospitals and the daily lives of the South African public. The Department of Public Enterprises in a presentation to Parliament during March 2015 presented the cost of load shedding between stages 1 and 3. Stage 1 load shedding costs the economy anywhere between R20 billion per month, R40 billion per month for stage 2 and R80 billion per month for stage 3 load shedding. World Bank data shows SA Gross Domestic Product (GDP) at R4.1 trillion, thus it means that stage 3 load shedding destroyed almost 2% of the country's economic weight (Bisseker, 2015; Pollet *et al*., 2015:16686). A recent technical fault at the Koeberg nuclear power plant resulted that one of its units went offline, which incurred further costs to South Africa and Eskom. According to the energy expert Yelland (cited by Skade, 2015) the estimated cost of unserved energy to the productive economy in SA due to "human error" at Koeberg amounted to R7.5 billion and the cost to Eskom in additional diesel usage resulted in R250 billion per week (Van der Nest, 2015). These are devastating figures for a developing economy such as South Africa that the country and its citizens can ill afford. It also increases the risk of total business disruption, supply chain disruption and collapse of the economy. As far back as 2008 the World Economic Forum identified the risk of supply chain disruption as one of the four important emerging issues alongside systemic financial risk, food and energy security (Bode *et al*., 2011:1). From a South African perspective energy security has become a major force in supply chain disruption. Since 2005, escalating challenges with a shortfall in generation capacity, reliability problems with supply on the national grid and rapidly increasing and unpredictable costs have been the most important visible issue in the electricity supply sector (Trollip *et al*., 2014:8).

The above are just some of the factors that have the potential to disrupt the supply chain to such an extent that it can halt production for prolonged periods (Shah, 2009:277). A

disruption to a key customer, supplier or even a supplier of a supplier, can cause a ripple effect with profound consequences for manufacturers, customers, other suppliers in the supply chain and even entire industries or the country as a whole.

1.2 CONTEXT

Global sourcing and supply chains have massively expanded in recent years and almost all companies source globally, sell globally and have competitors that do the same (Slone *et al*., 2010:64). Global supply chains have become the norm rather than the exception with the result that the supply chain has become a complex set of activities. Supply chain influence many business functions and processes that reach beyond the organisation, driven by fast-changing technologies, regulations and ethical standards that present the organisation with a range of strategic opportunities and conversely pose threats (Hines, 2013:325; Shah, 2009:275; Slone, *et al.,* 2010:65).

In the words of Kofi Annan, former UN Secretary-General: "It has been said that arguing against globalisation is like arguing against the laws of gravity." (Marmolejo, 2013:1). Global trade in its modern form can be traced back to the foundation of the East India Trading Company in 1600 (Hines, 2013:8). Over the decades national companies expanded their sphere of influence to engage in international trade and with this development came infrastructure development to accommodate the growing international trade. Sea, rail, road and air links have developed to support the growing global trade requirements, contrary to the global trend the South African transport infrastructure is dismally failing. Innovations in the information and communication technologies (ICT) have enabled many companies to shift their boundaries of operations yet again (Hines, 2013:9). The last 20 years favoured the dismantling of trade barriers between countries creating an environment for global trade to flourish (Trent & Roberts, 2010:6). The constant need to show improvements, especially cost reduction, has resulted in a search for lower-cost sources of supply that has become a central part of most supply strategies (Trent & Roberts, 2010:3). To produce a product that is in demand by consumers, the raw material and supplies are sourced from a variety of locations throughout the world (Hines, 2013:20). In the supply chain risk management study,

conducted in 2015, by Supply Chain Insights LLC, 34% or the respondents indicated that globalisation will be a top risk driver within the next 5 years (Cecere, 2015:9).

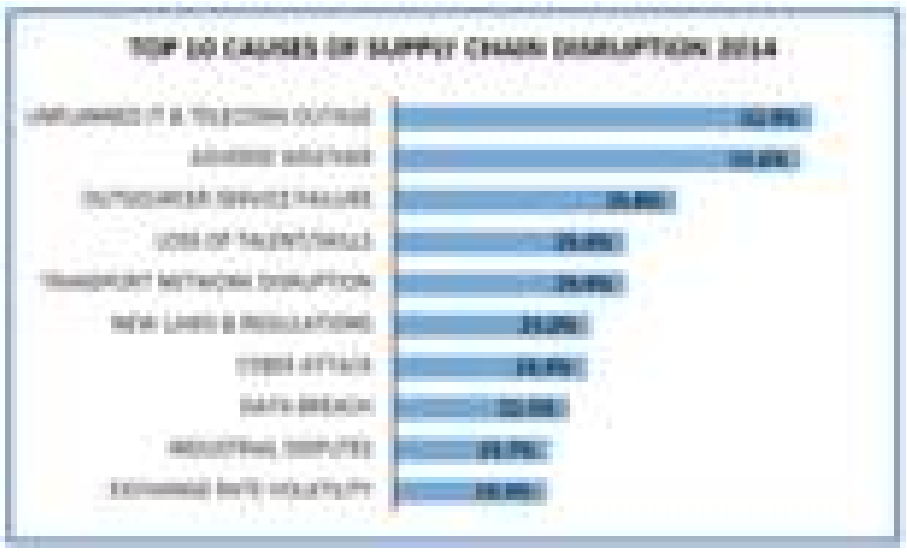
The meteoric rise of globalisation and the impact of macro-environmental changes with the strong drive towards sustainability have consequences for the supply chain (Hines, 2013:325; Trent & Roberts, 2010:7). Companies have a social responsibility to design supply chain strategies that minimise environmental damage and protect natural resources in the country they source from. If they do not comply and uphold these responsibilities it could lead to costly legal action, reputational damage and a negative impact on the economic profit and shareholder value of the company (Hines, 2013:325; Slone *et al*., 2010:12). Socio-cultural shifts and demographic changes opened new market opportunities, but simultaneously accelerated the decline of long established mature industries and products. Product life cycles are becoming much shorter with a need to do everything better, faster and cheaper (Hines, 2013:8; Shah, 2009:11; Trent & Roberts, 2010:3). Managers have to rapidly make decisions, with limited information and with uncertain consequences and the risk of major disruption of the supply chain, all as a direct result of the astounding rate of change in technology, markets, products and services (Hines, 2013:12; Trent & Roberts, 2010:6). The economic impact of global change is far reaching given the economic impact brought on by the end of cheap energy, the increasingly global nature of manufacturing and retail competition, the drive towards green procurement and sustainability (Hines, 2013:325; Slone *et al*., 2010:166; Trent & Roberts, 2010:7). It is indisputable that change is more rapid than a century ago as people communicate more widely, travel further and have access to resources that were either undiscovered fifty years ago or not available in their local environment. The level of political, commercial, macroeconomic and external risks has increased and efficient and effective supply chains are required to manage customer demand and these risks (Hines, 2013:18).

In the past organisations were structured and managed on the basis of optimising their own operations with little to no regard for the operations and needs of their suppliers and customers (Christopher, 2016:240). An arm's-length relationship existed between buyers and suppliers with minor interest for long-term, mutually dependent relationships. A major shift in management thinking has been the recognition that companies no longer

compete as stand-alone entities, but rather as cohesive supply chain networks (Christopher, 2016:239). To take the next step towards supply chain excellence, companies now know they must integrate and collaborate with suppliers to remain competitive. The challenge faced by management is to attain the integration and collaboration with suppliers that has been held at arm's-length for so long, it is not a relationship change that happens overnight. A further challenge is to ensure that the new relationship is based on ethical values within the boundaries of the competition commission guidelines. Organisations realise they have become more reliant on suppliers in terms of innovative power, corporate social responsibility, delivering ongoing cost savings and security of supply (PWC, 2013b:7). In the current environment of global supply chains and outsourcing, organisations recognise that the management of relationships from end-to-end is essential (Christopher, 2016:238). Organisations that effectively align with their key suppliers enjoy reduced risk factors, improved innovation, quality, reliability and cost reductions (Christopher, 2016:239; PWC, 2013b:6).

The organisation's constant drive to enter new markets and at the same time cut costs forced their supply chains to become increasingly long and tenuous (Shah, 2009:275). The net effect is an increase in the probability of disruption within the supply chain. The supply chain systems must ensure continuity and availability of product and services as and when required by customers (Hines, 2013:14). This created chains with longer paths contrasting against a constant drive for faster delivery speeds, resulting in more opportunities for disruption and a much smaller margin of error for a disruption to take place (Shah, 2009:275). Hence supply chains face risks from events beyond normal levels of variability as illustrated in Figure 1-2 (Hopp, 2008:145). The variability of the disruptions manifests in physical damage and non-physical damage. Physical damage remains a major cause and includes adverse weather, natural catastrophe, floods and fires preventing critical suppliers from getting components out into the market. However, the cause of disruption increasingly comes from non-physical sources like Information Technology (IT) and telecommunication failures, cyber intrusion, pandemics, bankruptcy and political unrest. Lean manufacturing techniques and the creation of increasingly global and complex supply chains results in companies being ever-more susceptible to these sources of disruption (Yates, 2015).

Figure 1-2: Top 10 causes of supply chain disruption 2014

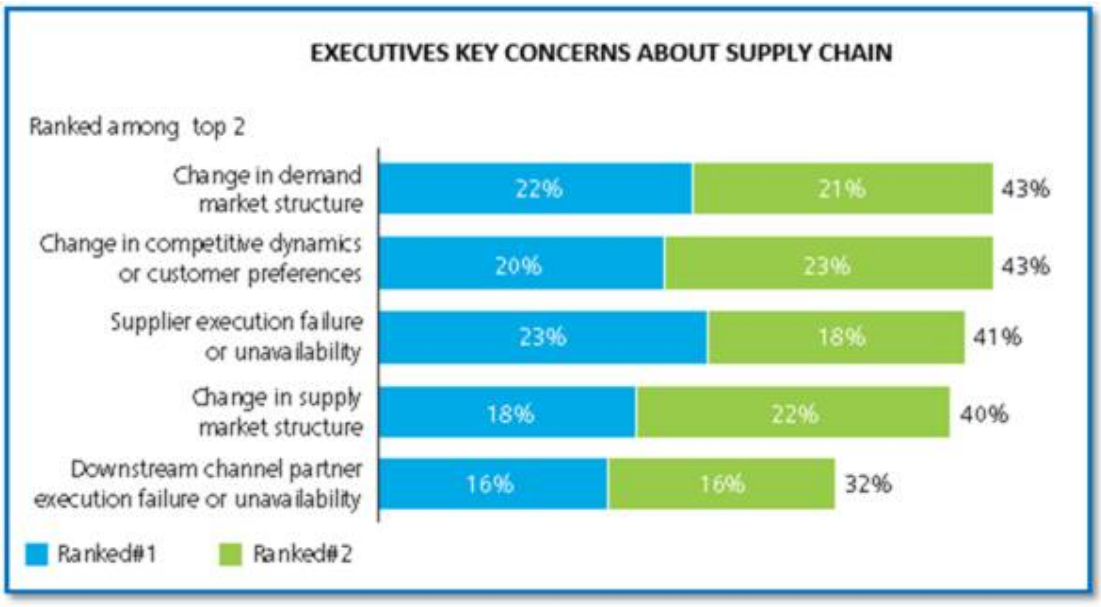


Source: Adapted from Yates (2015)

Unpredictable events like the tsunami in Japan can have a substantial influence on supply chains and the competitive advantage of the organisation, therefore dealing with such risks is a critical part of supply chain management (Hines, 2013:18; Hopp, 2008:145). The value created by supply chains is released through the reliability and responsiveness of the supply chain in providing in demand and supply. Reliability in supply chain terms entails delivering the right product in the right quantity at the right time to the right place at the lowest possible cost. Supply chain responsiveness is the ability to swiftly respond to changing market conditions and requirements. Disruptions affect an organisation's short and long term production and hence profitability and this affects shareholder value negatively (Hendricks & Singhal, 2008:35; Slone *et al.,* 2010:6).

In their 2013 Global Supply Chain Risk Survey, Deloitte Consulting found that executives see a variety of risks in the extended supply chain (Deloitte Consulting, 2013:8). Their top concerns are illustrated in Figure 1-3.

Figure 1-3: Key concerns about supply chain



Source: Deloitte Consulting (2013:8)

Changes in demand market structure are ranked as the highest concern for executives (43%); this includes the consolidation of customer companies or changes in the geographic span of the demand market. Also ranked high (43%) are the changes in competitive dynamics or customer preferences. This involves the availability of new product / service substitutes, a change in channel usage, a reduction in switching cost or a shift in brand preferences. A further concern is supplier execution failure or unavailability, such as suppliers having financial difficulties, non-compliance events or performance problems. Changes in supply market structure are also high on the list of concerns at 40%. This entails the consolidation of existing or potential suppliers or a reduction in supply capacity (Deloitte Consulting, 2013:8). The importance of downstream suppliers in the gold industry supply chain is illustrated in Figure 1-5, providing support and credibility to the concerns expressed by executives.

Potential disasters have created greater demand on organisations to keep their supply chains flexible and integrate disruption risk management into every aspect of supply chain operations (Shah, 2009:276).

1.3 CAUSAL FACTORS

The causal factors for this study were as follows:

- **Not much research** has been done on supply chain disruption factors outside the United States of America (USA), Europe and Asia. Most of the available research relates to the manufacturing and automotive industries within the USA, Europe and Asia with no research on the South African Gold Mining Industry.

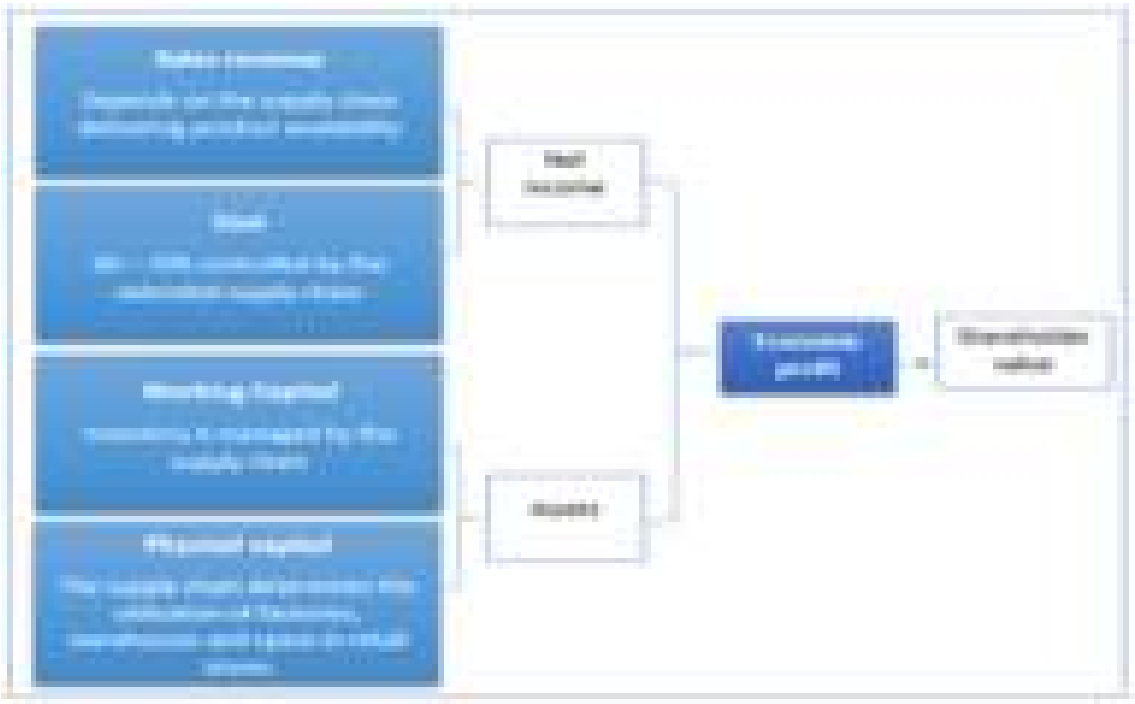
- An **increasing awareness of possible disruption** in the supply chain of the mining industry within South Africa has been brought to the forefront by the unstable political and labour problems at Marikana and the impact of Eskom's ability to provide in the power demands of the mining industry to ensure full capacity for production purposes (Burkhardt, 2014; Burkhardt & Janse, 2014; Sidler, 2014; Trollip *et al*., 2014:8). Another impending problem is the shortage of water supply to the mines as a result of failing infrastructure and the intense drought in South Africa.

- The **rapid changes** within the supply chain environment resulted in a need to show constant improvements and cost cutting on products and services. This has resulted in some less-than-desirable outcomes, creating a new-found awareness and appreciation of supply chain risk (Trent & Roberts, 2010:30).

- There is an **increasing importance** of supply chains as research has shown that supply chain disruption negatively influences shareholder value. Supply chain issues have an across-the-board negative impact on share prices (Hendricks & Singhal, 2008:35).

Perhaps the most important causal factor for this study was the fact that the supply chain drives economic profit and efficient supply chains are thus critical in terms of creating a competitive advantage. The supply chain controls most of the inventory, manages 60 to 70 percent of the cost, is the foundation to generate revenue by providing outstanding product availability as well as managing most of the physical assets of the firm as illustrated in Figure 1-4 below (Slone *et al*., 2010:7).

Figure 1-4: How changes in revenue, cost, working capital and physical capital flow into economic profit and shareholder value.

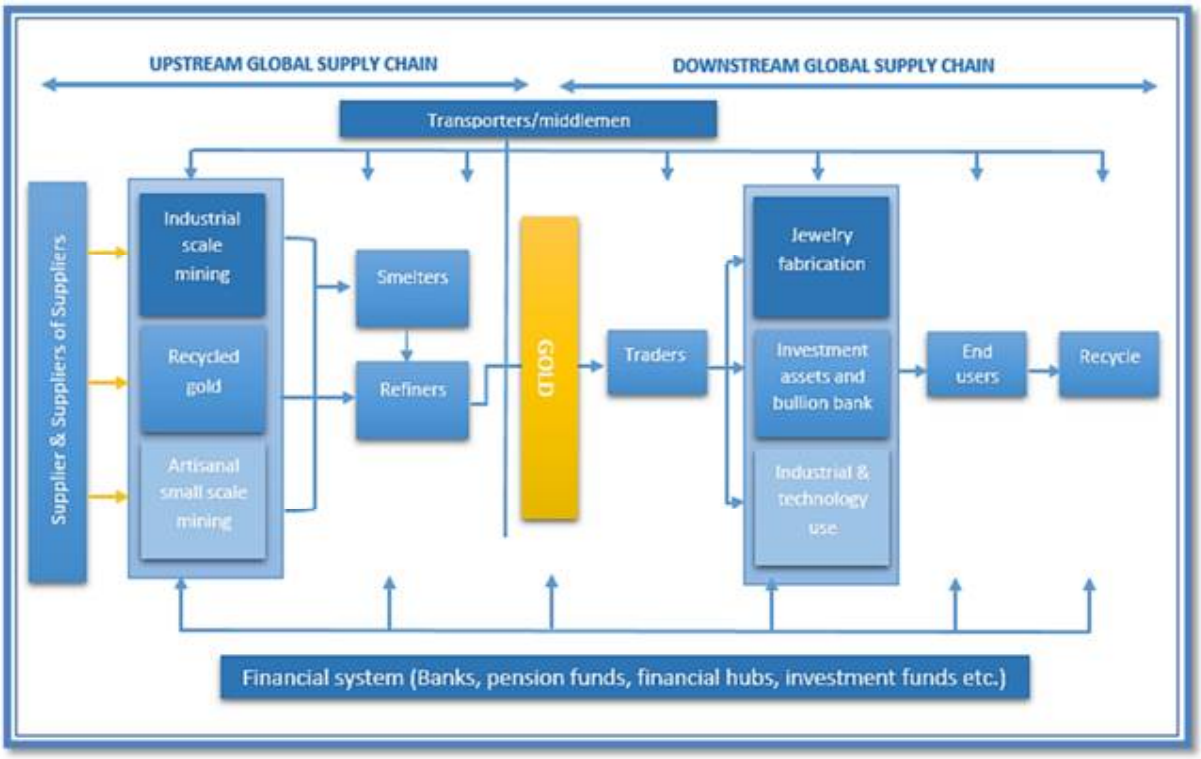


Source: Slone *et al*., (2010:8)

1.4 IMPORTANCE OF THIS STUDY

The empirical study in supply chain disruption for the gold mining industry in the North West Province of South Africa is first and foremost necessary due to limited research available on this topic for this geographical area. The rapid growth and complexity within the supply chain poses a challenge to management in identifying all possible risk sources that can disrupt the supply chain process, should it materialise. Research has substantiated the negative impact of disruption on both the upstream and downstream links within the supply chain (Hendricks & Singhal, 2008:36). As illustrated in Figure 1-5 below the upstream and downstream supply chain for the gold industry is reasonably complex enhancing the possibility of disruption considerably.

Figure 1-5: Visualising the global gold supply chain



Source: Adapted from Ramdoo (2015:2)

Thus, identifying the key disruption risk sources for the internal customers and suppliers of the organisation and estimating the implications to internal customers and suppliers would provide a more complete assessment of the impact of supply chain disruptions. The findings of this study will be important for making an economic case for major organisational changes that are needed to improve the reliability and responsiveness of supply chains. Such organisational changes include integrated planning across various functions, collaboration with key partners in the supply chain, sharing of information, plans and data with important supply chain partners and a change in mindset, behaviour and performance metrics. It will assist supply chain functions to design strategies for avoiding disruptions and / or mitigate the negative impact of supply chain disruptions.

1.5 PROBLEM STATEMENT

Supply chain management (SCM) has become an important part of the business environment and economy with a direct impact on the profitability and share price of the

company (Hendricks & Singhal, 2008:50). The move towards improved efficiency and effectiveness for businesses, organisations and process owners has forced managers to think beyond traditional management techniques utilised in typical functional paradigms. As the supply chain process has become more streamlined, the issue of increased risk and uncertainty has become more important. Increased focus on early identifications of possible disruptions, mitigating risk and building resilience into supply chains can protect companies from supply disruptions, but many companies are inadequately prepared for a major disruption. The rapid development, growth and increased importance of an effective supply chain coupled with the imminent risk factors facing the organisation make it critical for management to design and implement a robust supply chain disruption framework (SCDF) to ensure these risk sources are known and a pro-active management risk strategy is in place to ensure mitigation and contingency plans. Disruptions impact an organisation's short- and long-term profitability, which in turn, negatively affects shareholder value, thus making a pro-active approach critical to maintain competitive advantage in the market (Slone *et al*., 2010:12).

There are various risk sources threatening the gold mining industry's supply chain and there are correlations and links between these factors only applicable to the gold mining industry. The impact of a total supply chain disruption spreads much further than only the specific organisation and suppliers involved, making this relevant to the economic well-being of the wider South Africa. The mining sector represents 18% of the country's GDP; 8.6% direct and 10% indirect and induced confirming South Africa's dependence for sustainable growth on the mining industry (Pollet *et al*., 2015:16686). A negative impact on the mining industry due to disruption will result in a negative impact on the country's GDP. With South Africa's economy only growing at 0.6% and the mining sector with 1.4% during the fourth quarter of 2015 this is something South Africa can ill afford (Stats SA, 2016:9). In 2000 Stephan Malherbe stated in an independent report prepared for the Chamber of Mines of South Africa that the contribution of mining to the economy must be seen as coming, not only from mining operations, but also from upstream and downstream activities and that the industry provides the base for the country's competitive advantage in electricity, chemicals and related industries (Malherbe, 2000:1). In 2015 Srinivasan Venkatakrishnan, chief executive officer of AngloGold Ashanti Ltd,

Africa's top bullion producer, said that steep wage demands and rising power costs could turn South Africa's once thriving gold sector into a "sunset" industry (Govender & Shabalala, 2015:1). The increase in input costs will negatively impact the mining industry in that investors are looking for good returns on their investment; high costs erode profitability and growth opportunities of the organisation as well as the pressure of increased input costs limit growth opportunities due to a lack of funding. It is virtually impossible to attract investors to a company that cannot deliver profitability and growth opportunities to their investors. This confirms the pressure on the gold miners to remain competitive and illustrate the challenges the supply chains within these industries face on a daily basis.

In order to get a balanced and holistic view the following questions need to be answered. Does the gold mining landscape look and react differently to these potential disruptions than other mining industries? What are the key risk sources (factors) that can lead to supply chain disruption? Supply chain disruption is a very real and relevant risk to South African organisations with the potential to stop the production process of many companies. Thus, further research on supply chain disruption risk sources is required in order to establish a supply chain disruption model that is valid and reliable in a gold mining context that can be adopted by business managers as a managerial tool to identify supply chain disruption risk sources and deploy a pro-active management risk strategy.

1.6 RESEARCH OBJECTIVES

The research objectives are divided into a primary objective and several secondary objectives.

1.6.1 Primary objective

The primary objective of the research is to establish a supply chain disruption framework for the gold mining industry that can be adopted by business managers as a managerial tool to identify supply chain disruption risk sources.

1.6.2 Secondary objectives

To achieve the primary objective of this study, the secondary objectives to be realised are:

1.6.2.1 To determine how supply chain disruption is conceptualised in the literature;

1.6.2.2 To outline consistent nomenclature as basis for the literature review and research study;

1.6.2.3 To determine the critical supply chain disruption risk sources that are required to establish a supply chain disruption management business framework in the gold mining industry;

1.6.2.4 To establish which of these disruption risk sources should be included in the proposed new framework as well as the relevance of the identified risk sources within the gold mining supply chain environment;

1.6.2.5 To establish the correlations between the identified supply chain disruption risk sources;

1.6.2.6 To identify recommendations that can be made for future research and practices.

1.7 RESEARCH METHODOLOGY

Research methodology deliberates and elucidates the logic behind research methods and techniques (Welman *et al*., 2005:8). This study was conducted in two phases. Phase one consisted of a literature and theoretical review and the second phase the empirical research and ethical considerations

1.7.1 Literature and theoretical review

A literature and theoretical survey on supply chain disruption risk sources within the gold mining industry in the North West Province of South Africa was conducted. Special attention was given to the internal and external risk sources that have the potential to

disrupt the supply chain of both the organisation and the external inbound supply chain environment.

1.7.2 Empirical research and ethical considerations

To accomplish the research objectives of this study, empirical research was conducted among three main groups:

- the **supply chain employees** with a Patterson job grade of C - lower and above - to ensure junior, mid and executive level employees represent both buyers and management within the gold mining industry. The Patterson job grade is based on predefined criteria that include stress, individual tolerance, length of job and number of responsibilities. This all corresponds to organisational levels and define remuneration levels;

- the **internal clients** of the supply chain function. The clients are reliant on the supply chain function to provide them with the material and services required to conduct their work on a daily basis;

- the **auditors, health and safety, IT and systems department employees** within the gold mining industry. The relevant employees provide support to both the supply chain and internal customers base of the supply chain;

Primary data was then collected in the form of results from quantitative questionnaires sent out to the target population at participating organisations. The questionnaires were formulated to receive independent responses from the individual participants. In terms of the ethical considerations for this study, the questionnaire made it very clear that:

- participation in response to the questionnaire is voluntary without any consequence for refusal to participate;

- the utmost care was taken to protect the participants' privacy and dignity;

- besides an indication as to the department and industry the respondent was working in, no indication of the identity of the employee or the employer were obtained and

- ethical clearance was obtained before distribution of the questionnaire: EMSPBS/02/16-01/23.

Data was analysed to research the context of supply chain disruption in the gold mining industry in the North West Province of South Africa as well as the identification of critical supply chain disruption risk sources required to establish a supply chain disruption management business framework in the gold mining industry. The relevance of the risk sources as supply chain disruption risk sources was also researched. An attempt will also be made to establish correlations between the identified supply chain disruption risk sources.

The results of the data analysis were used to establish whether a robust SCDF should be developed.

1.7.3 Limitations

Limitations are influences that the researcher cannot control. This include shortcomings, conditions or influences that cannot be controlled by the researcher that place restrictions on the methodology and conclusions. The following aspects have been identified as limitations to the study:

1.7.3.1 Sources

The literature and theoretical review is limited to sources that are readily available on the Internet and NWU Library Online Database at the time, as well as publications readily available in libraries in South Africa until 31 October 2016.

1.7.3.2 Research

This study does quantitative research in supply chain disruption, limited to:

- Gold Mining Industries in the North West Province of South Africa participating in this study;
- Employees external to the supply chain within the relevant gold mining industries in the North West Province of South Africa participating in this study.

1.8 LAYOUT OF THE STUDY

The mini-dissertation is divided into four chapters, which will be presented as follows:

CHAPTER 1: Orientation and problem statement

This chapter discussed the background, context of and causal factors to the study as well as the problem statement. It also provides an overview of the research design and layout of the next chapters.

CHAPTER 2: Literature review

This chapter investigates, through a literature review, the basic elements of supply chain disruption with specific focus on the risk sources that has the potential to cause disruption in the supply chain of gold mining companies.

CHAPTER 3: Empirical study

This chapter presents the research methodology by discussing the sampling methods used as well as the compilation of the survey instrument, namely a questionnaire, the study participants and the data collection. The results of the study are also presented and discussed.

CHAPTER 4: Conclusions and recommendations

In the final chapter the conclusions of the study based on the literature review and empirical investigation as well as recommendations for further study are presented.

1.9 CONCLUSION

The concept of supply chain is nothing new although the term might be more recent. Supply chains have existed as long as people have engaged in trade and international trade can be traced back to the Silk Road, a “trade route” developed around 202 BC during the Chinese Han dynasty (Hines, 2013:8). With the rapid development within the supply chain domain the risk profile has increased exponentially. The advent of globalisation has introduced lengthy supply chains as a source of concern in the face of disruption in sourcing, production and distribution of goods and services to a global

customer base. Disruptions may be caused by natural disasters, industrial accidents or acts of terrorism and beyond political risks and regulatory frameworks are commercial risks that have the potential to cause far-reaching disruption. These disasters have created greater demand on organisations to keep supply chains flexible and integrate disruption risk management into every aspect of supply chain operations.

1.10 CHAPTER SUMMARY

The objective of this study was to establish the context in which supply chain disruption in the gold mining industry of the North West Province of South Africa influences both the upstream and downstream supply chain environment. The relevance of supply chain disruption risk sources were assessed and a proposal was subsequently put forward for a SCDF as a tool for management to identify the influences and develop preventative or mitigating strategies for the relevant organisations.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

It's not a matter of "if", but "when" a global supply chain disruption will impact an organisation's customers, financial performance and shareholder value. The next factory fire, power outage, natural disaster, labour strike or political upheaval somewhere in the supply network could wreak havoc on an organisation's time-to-market, revenue forecast and market share assumptions (Dittmann, 2014:4, Hendricks & Singhal, 2008:783).

Over the past few years the size of the supply chain network has increased, dependencies between entities and between functions have evolved, the speed of change has accelerated and the level of transparency and visibility in the extended supply chain network has decreased (Christopher, 2016:230; PWC, 2015a:1). An agile and responsive supply chain is vital for business continuity and it will act as a strategic competitive advantage for the organisation. Managing supply chain risk is critical for all parts of the business, from product, design, development, operations through to people and the internal and external customers. It is thus critical for Supply Chain Management and the wider organisation to rethink their supply chain disruption strategy and explore innovative means to identify possible disruptions and implement robust risk management processes to limit the impact.

This study attempts to establish whether a supply chain disruption context exists and focuses on the relevance of a supply chain disruption framework in the gold mining industry in the North West Province. The author also attempts to determine the critical supply chain disruption sources (influences) that are relevant to establish a supply chain disruption management business framework and the correlations and relationships between the identified disruption sources (influences).

The study of literature contained in this chapter firstly provides an overview of supply chain disruption in general as well as a high level insight in the current situation. In essence the following aspects will be addressed: supply chain nomenclature that includes supply chain management, supply chain risk, supply chain disruption and supply chain risk sources. This is required to provide an understanding of the key concepts that will

be addressed in the study. The subsection will also provide insight on key aspects that have changed the supply chain landscape over the last decade and necessitated a re-look at the disruption phenomena. This include supply chain agility, the supply chain and mining industry risk overview, the impact and likelihood of supply chain disruption and supply chain disruption risk sources found in the literature.

2.2 SUPPLY CHAIN NOMENCLATURE

Despite several publications like Christopher's Logistics and Supply chain Management, Shah's Supply chain management text and cases, Slone, Dittmann and Metzer's The new Supply Chain Agenda and several other publications, advancing the conceptual clarity of the terminology used in the domain of supply chain risk management, there is still no commonly agreed nomenclature due to new and revised terminology being added to the environment on a continuous basis. Consequently, the purpose of this subsection is to outline a consistent nomenclature which will form the basis of the research framework despite the existence of other nomenclatures within the applicable literature and the continuous change within the supply chain environment. The nomenclatures that will be addressed are:

- Supply chain management (SCM)
- Supply chain risk (SCR)
- Supply chain disruption (SCD)
- Supply chain risk sources (SCRS)

2.2.1 Supply chain management (SCM)

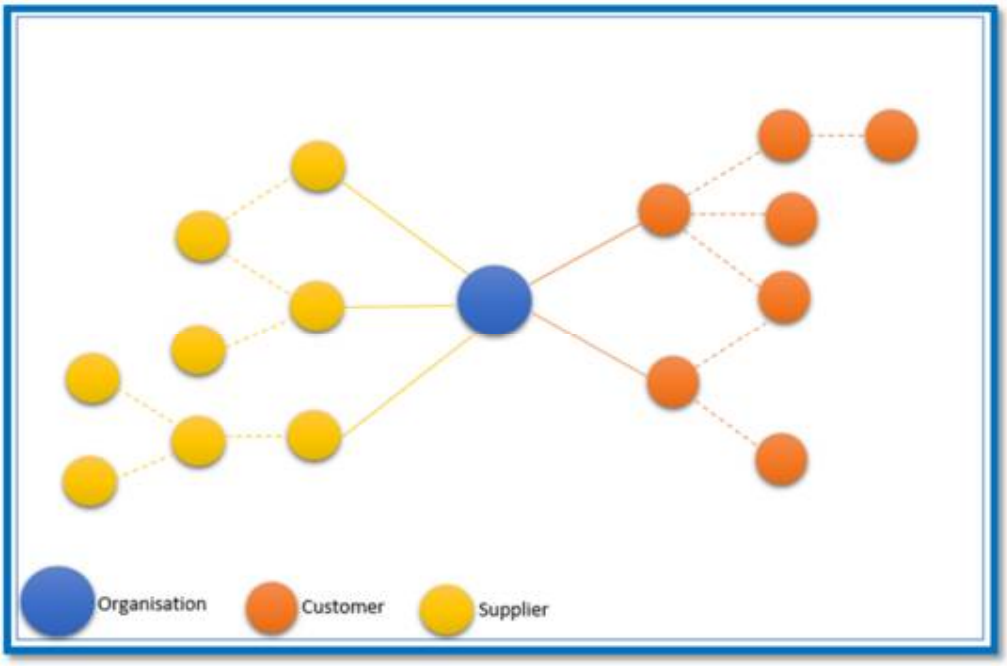
The concept of supply chain management (SCM) has seen a marked change in the 1980's with the emergence of personal computers (Robinson, 2015). The concept of SCM will be briefly derived from the pertinent literature. Supply chain management seeks to attain connection and co-ordination between the processes of various entities in the supply pipeline (Christopher, 2016:3; Shah, 2009:4; Slone *et al*., 2010:5). The focus of supply chain management is on co-operation and trust, thus a significant change from the

traditional arm's-length relationship between buyers and suppliers. Supply chain is no longer just trucks, pallets and warehouses (Robinson, 2015; Slone *et al*., 2010:5). Christopher (2016:3) defines supply chain management as "the management of upstream and downstream relationships with suppliers and customers in order to deliver superior customer value at less cost to the supply chain as a whole." The Council of Supply Chain Management Professionals (CSCMP) defines the supply chain as inclusive of the planning and management of all activities involved in sourcing and procurement, conversion and all logistics management activities (Slone *et al*., 2010:5). Importantly, it also includes co-ordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers and customers. Supply chain management integrates and incorporates supply and demand management within and across different companies (Slone *et al*., 2010:5). Christopher argues that "demand chain management" would be more appropriate than supply chain management. This is based on the fact that the chain should be driven by the market, not the suppliers. He also argues that the word "network" should replace "chain" as there will normally be multiple suppliers and, definitely, suppliers to suppliers as well as multiple customers and customers' customers to be included in the supply chain system (Christopher, 2016:3; Shah, 2009:5). The term "supply chain" however has been widely accepted by both practitioners and academics hence the term will be used throughout the study.

Figure 2-1 illustrates this idea of the company being at the centre of a network of suppliers and customers. This illustrates the importance of the various relationships that must be managed within the wider supply chain process. It is not only the relationship between the organisation and its direct suppliers and customers, but also the relationships of their suppliers and customers that must be managed on an ongoing basis to limit and reduce the risk of disruption. The concept of supply chain management is irrevocably interconnected with the concept of relationship management. Supply chain management cannot exist without the relationship management of the various stakeholders within the supply chain network. According to CSCMP supply chain management entails the planning and management of all activities involved in the sourcing and procurement, conversion and the management of all logistics activities e.g. warehousing, transportation and inventory control (Slone *et al*., 2010:5). A critical

success factor for the effective planning and management of all the activities within the supply chain is the management of the relationships with all stakeholders including suppliers, partners and internal customers.

Figure 2-1: The supply chain network



Source: Adopted from Christopher (2016:4)

The concept of the supply chain network alludes to the relationships that impact the supply chain from a supplier and customer perspective. This solicits the question if these relationships have an impact on the risk profile within the supply chain of the relevant organisation and can it lead to disruption?

2.2.2 Supply chain risk (SCR)

It is important for any study dealing with supply chain disruption to investigate the concept of risk, to define the terms appropriately since it is an extensive construct with a variety of meanings, measurements and interpretations depending on the field of research (Trent & Roberts, 2010:20; Wagner & Bode, 2006:303). Although the objective of supply chain management is to improve supply chain efficiency through concepts like global sourcing and outsourcing, some of the actions taken to improve supply chain

efficiency, increase certain kinds of risk like logistical risk that can result in disruption should it materialise (Trent & Roberts, 2010:20). Table 2-1 illustrates the growing concern of executives that the supply chain risks in their companies are increasing. The table indicates that 42% of the respondents in the survey indicated that their levels of risk have slightly increased and 23% indicated that their risk level has significantly increased. Only 2% of the respondents indicated a significant decrease within their environment confirming the increase in the supply chain risk environment and the need for the identification and visibility of risk sources threatening the organisation. The need to understand supply chain risk has never been greater (Cecere, 2015:1; Trent & Roberts, 2010:112). The supply chain faces risks associated with suppliers failing to deliver on time, quality defect, material shortages and other risks that, should it materialise, can cause disruption (Trent & Roberts, 2010:21).

Table 2-1: Changes in supply chain risk

LEVEL OF CHANGE IN RISK	% OF RESPONDENTS
Increased significantly	23%
Increased slightly	42%
No change	26%
Decreased slightly	7%
Decreased significantly	2%

Source: Trent and Roberts (2010:112)

Supply chain risk refers to the probability of an uncertain or unpredictable event occurring that affects one or more of the stakeholders within a supply chain (Trent & Roberts, 2010:111). The King IV draft report released for comments in 2016 acknowledge the importance of risk and provide a new perspective on risk. According to the draft King IV report, the traditional view of risk is that it is “the effect of uncertainty on objectives” but risk can be seen from various perspectives (IODSA, 2016:18). It is about not knowing what events may or may not occur, the likelihood of an event occurring and the possible effect (positive or negative) on objectives.

Harland *et al*. (2003:52) conclude that supply chain risk is associated with the "chance of danger, damage, loss, injury or any other undesired consequences" resulting in a negative impact on the organisation. Similarly Wagner and Bode (2006:303) consider risk as the negative deviation from the expected value of a certain performance measure, resulting in negative consequences for the organisation. Hence, risk is equated with the detriment of a supply chain disruption in the realisation of harm or loss (Trent & Roberts, 2010:111). In this study risk equates to the detriment of supply chain and more specifically supply chain disruption.

2.2.3 Supply chain disruption (SCD)

The definition applied to supply chain disruption in this study is based on the definition proposed by Revilla and Sáenz (2013:1124). They define "supply chain disruption as unplanned and unanticipated events that disrupt the normal flow of goods and materials within a supply chain." For the purpose of this study, a supply chain disruption is defined as an unforeseen and unexpected disturbance of the normal flow of goods and services within the supply chain, thus an exceptional and abnormal situation in comparison to every-day business. Other terminology might be applied depending on its severity e.g. disturbance, crisis or glitch (Wagner & Bode, 2006:303). The disruption is triggered by an underlying disruptive event or a series of such events.

Perhaps the best possible depiction of supply chain disruption is found in the elucidation by Lynch (2009:17) to take a bucket of water and try to release a single drop of water into the bucket without generating a ripple. The ripples will immediately oscillate back and forth for quite some time. The ripples reach all the way to the sides of the bucket and bounce back, resulting in an infinite number of waves. The bucket represents the world of global trade, the water an infinite number of supply networks that facilitate the movement of products, materials, services, cash and information. The "drop" represents an event and an event at a vulnerable point of the supply chain such as a catastrophic failure at a key point of distribution, could initiate an economic tidal wave (Gurnani *et al*., 2012:319; Lynch, 2009:17 & 55). Lynch goes further to state that customers seldomly understand, nor are they interested in, how their products are manufactured or get to the market (Gurnani *et al*., 2012:319). From a customer perspective the most important

factor is that the product is available as and when they want it, is safe and will not harm them and that it delivers on the expected value (Lynch, 2009:128; Shah, 2009:4). For customers, ignorance is bliss, for companies, ignorance can be devastating. A single drop of water represents not only a change to the environment, but an opportunity to severely disrupt the standard. Any change, regardless of its scale, carries with it the potential for disruptive and / or systemic risk. Irrespective if the change is anticipated, the migration to a new production system, or unanticipated, a pandemic or earthquake, the affected organisation normally has the ability and expertise to manage the risk brought about by change. Supply chains have become more fragile, but at the same time more evolved as they become more geographically extended, technologically advanced and shared by a larger number of stakeholders with different expectations and competing interests (Ellis *et al*., 2010:34; Gurnani *et al*., 2012:319).

2.2.4 Supply chain risk sources (SCRS)

Companies need to identify the sources of supply chain vulnerabilities and develop appropriate risk management strategies. All organisations, especially those with complex supply chains, should attempt to identify all the potential sources of disruption to their supply chains. It should include the internal as well as external sources of disruption that will expose potential weaknesses. According to Neiger *et al*. (2009:154), the risk identification stage is critical to the success of managing supply chain risks as it enables the identification of organisational exposure to uncertainty by ensuring that all the significant activities within the organisation have been identified and all the risks following from these activities are properly defined. Supply chain disruptions can materialise from various internal and external areas to the supply chain and as a result its nature can be highly different. The inability of a supplier to deliver material to a customer and a natural disaster destroying production capacity are situations with different characteristics and therefore entail different effects on the supply chain. In addressing this issue and attempting to demarcate supply chain disruptions, many scholars have proposed classifications in the form of typologies and / or taxonomies of risk (Wagner & Bode, 2006:303). Bailey (1994:4) describes typologies as primarily conceptual while taxonomies are empirical. The derived classes of supply chain disruptions are often labelled as “supply chain risk sources” and will be classified as such in this study.

Various researchers have classified supply chain risk sources, for example Svensson (2000:732) identifies two classes namely quantitative and qualitative. Jüttner (2005:122) proposes three classes: supply, demand and environmental and Chopra and Sodhi (2004:1) describe nine classes: disruptions, delays, systems, forecast, intellectual property, procurement, receivables, inventory and capacity.

Table 2-2 below illustrates the various frameworks available in research to identify the risk sources influencing the supply chain environment.

Table 2-2: Key research in risk sources that could result in disruption

AUTHOR / REFERENCE	FRAMEWORK	YEAR
Revilla & Saenz: Supply chain disruption management: Global convergence vs national specificity	Conceptual Framework Risk Sources: • Market • Supply chain discontinuity • Natural hazards • Socio Economic	2013
Neiger *et al.*: Supply chain risk identification with value-focused process engineering	Value Focused Process Engineering (VFPE) -based supply chain risk identification	2009
Svensson: A conceptual framework for the analysis of vulnerability in supply chains	Classification based on their role in the supply chain as inbound and outbound risk sources Supply chain vulnerability can be classified in terms of sources of disturbance and categories of disturbance. Quantitative & qualitative	2000
Chopra and Sodhi: Managing risk to avoid supply-chain breakdown	Broader perspective based on the nature of the threat, like major natural and man-made disasters, supply risks, forecast, intellectual property, inventory, or capacity	2004
Rao and Goldsby: Supply chain risks: A review and typology	Market sources include those that may not affect all the sectors of the economy as a whole but rather specific industry or market segments, including price and sale collapse due to competition. Supply chain discontinuity refers to a delivery or transportation failure on the part of a main supplier.	2009

AUTHOR / REFERENCE	FRAMEWORK	YEAR
	External sources of supply chain disruptions are natural hazards such as hurricanes, floods or earthquakes. Socio-economic risk sources are those that affect the overall business context across industries, for instance, political And / or economic instability.	
Jüttner: Supply chain risk management understanding the business requirements from a practitioner perspective	Three classes of risk sources: Supply Demand Environmental	2005

According to Shah (2009:277) the cause of the disruption is secondary to defining the portion of the operations it will affect; a flood, hurricane or fire may all have the same effect like a temporary delay in transportation. Thus disruption can be classified on the basis of their effect into six main types as illustrated in Table 2-3 below (Shah, 2009:277).

Table 2-3: Supply chain disruption classification

FAILURE MODE	DESCRIPTION
Disruption in supply	Delay or unavailability of materials leading to shortage of inputs.
Disruption in transportation	Delay or unavailability in transportation infrastructure, leading to restrictions on inbound and outbound movements.
Disruption of facilities	Delay or unavailability of plants, warehouses or office buildings.
Freight breaches	Violation of integrity of cargoes and products, leading to loss or adulteration of products.
Disruption in communication	Delay or unavailability of the information and communication infrastructure.
Disruption in demand	Delay or disruption downstream can lead to loss of demand affecting upstream companies.

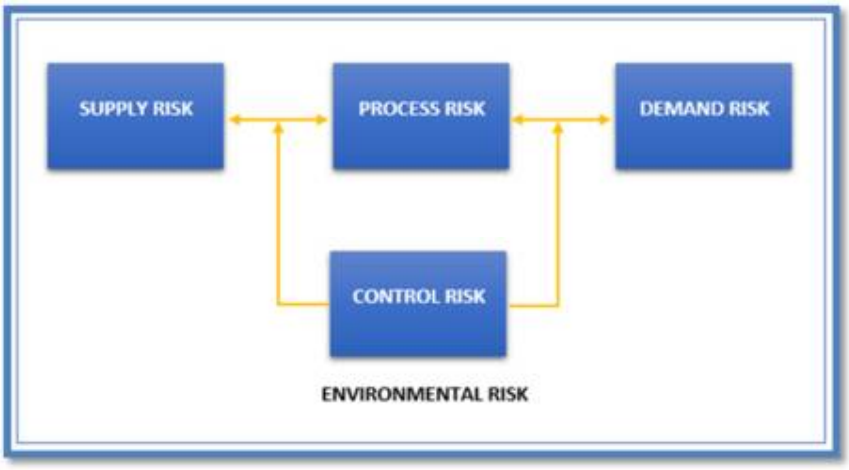
Source: Adopted from Shah (2009:277)

Christopher (2016:221) suggests that in order to identify the risk profile of a company it is worthwhile to undertake an audit of the main sources of risk across the network as illustrated in Figure 2-2. Potential risk to supply chain disruption should be examined from five sources and Figure 2-2 summarises the connection between the fives sources of risk (Christopher, 2016:220):

- Supply risk: How vulnerable is the business to disruptions in supply?
- Demand risk: How volatile is demand?
- Process risk: How resilient are the company's processes?
- Control risk: How likely are disturbances and distortions to be caused by the company's internal control systems?
- Environmental risk: Where across the supply chain as a whole are the company vulnerable to external forces?

Management must understand the risk profile and that it is directly and indirectly impacted by the strategic decisions the company take. The decision to transfer production from Africa to a factory in China should be evaluated in terms of how it may affect vulnerability from the five risk sources described in Figure 2-2 (Christopher, 2016:221). This decision could bring aspects into play that has a negative impact on risk and increase the risk of disruption, like language and cultural barriers, loss of information between the systems and loss of internal control systems.

Figure 2-2: Sources of risk in the supply chain



Source: Christopher (2016:221)

It is evident from the literature that there are many different approaches to the identification and control of supply chain risk sources that could lead to supply chain disruption. However, to the author's knowledge no research exists which specifically relates and applies to the mining industry in South Africa. It is important for senior management to understand that the risk sources and the identification of all the relevant sources should be a priority in order to create mitigation strategies to reduce the risk and limit the impact of supply chain disruption.

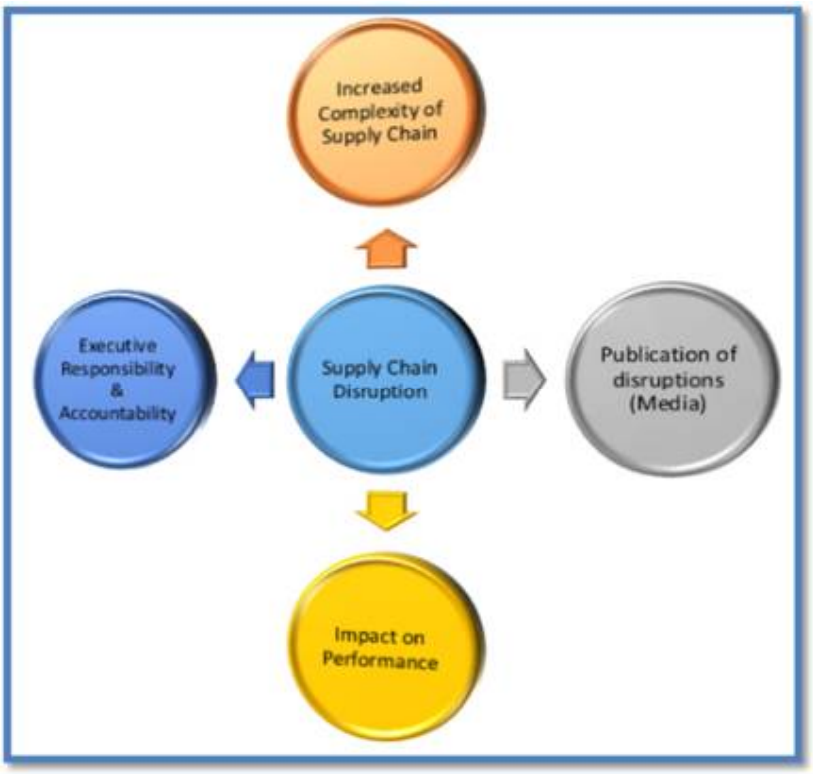
2.3 SUPPLY CHAIN DISRUPTION THE CURRENT SITUATION

Executives are becoming increasingly aware that their company's reputation, competitive advantage, earnings consistency and ability to deliver better shareholder returns are exceedingly dependent on how well they manage supply chain disruptions (Christopher, 2016:215; Gurnani *et al*., 2012:1; Hendricks & Singhal, 2008:783; Slone *et al*., 2010:6; Tang, 2006:452; Wagner & Bode, 2006:301). Although companies have always faced the risk of supply chain disruptions in recent years, the attention it receives has dramatically increased. The increased attention is likely driven by at least four developments as illustrated in Figure 2-3 (Gurnani *et al*., 2012:1).

These developments have become sources of risk that could lead to supply chain disruption if it materialises or if it is not managed and mitigated by the supply chain

network. For instance, a company might suffer disruption if they seek to take advantage of economies of scale in their inbound supply chain by adopting a single sourcing strategy, but due to supplier defaults suffer an increased negative impact on the supply side (Wagner & Bode, 2006:302).

Figure 2-3: Drivers of supply chain disruption



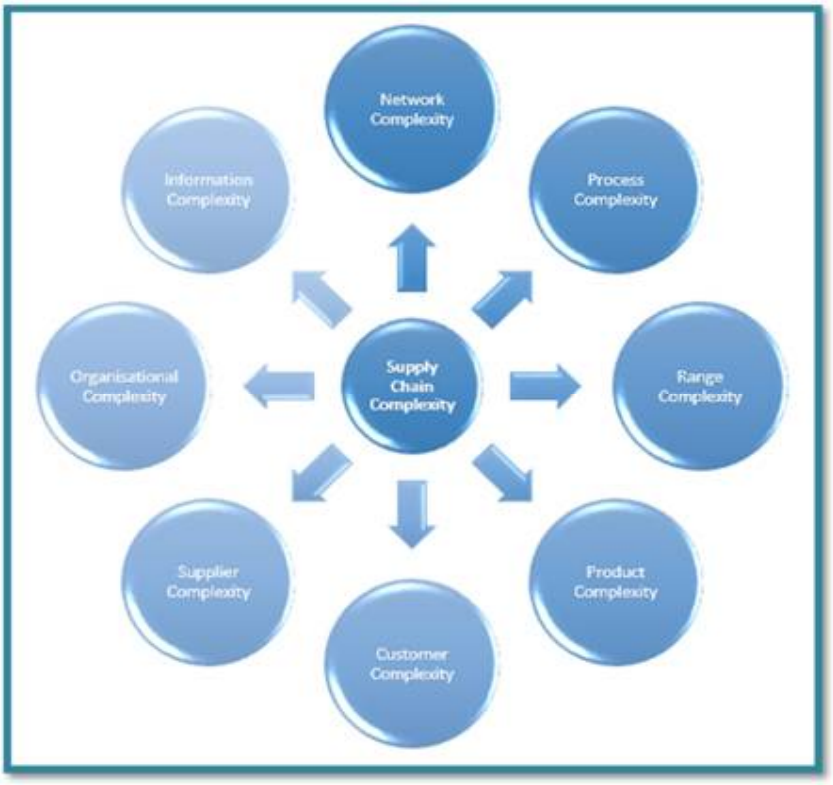
Source: Adapted from Gurnani *et al*. (2012:1)

Firstly, supply chains have become more complex due to globalisation, single sourcing, outsourcing , reduction in the supplier base, the pace of technology changes and the focus on removing slack from supply chains (Cecere, 2015:9; Christopher, 2016:215; Gurnani *et al*., 2012:1; Hines, 2013:9; Slone *et al*., 2010:64; Trent & Roberts, 2010:6; Trkman & McCormack, 2009:247). The impact of globalisation contains aspects like language barriers, systems compatibility issues, geopolitical shifts, longer lead times across multiple tiers of sourcing and supply increases the Bullwhip effect's impact by means of distortion of the demand signal across multiple tiers of the value network (Cecere, 2015:1). Other globalisation aspects that increase complexity within the supply

chain include global customs, foreign regulations and port congestion, political and / or economic instability in the source country and changes in the macro-economy such as exchange rates and commodity pricing (Dittmann, 2014:4). Complexity has created sources of risk that, should it materialise, will cause disruption, e.g. sourcing in low-cost countries could result in disruption if the supplier is unable to deliver as a result of port closures due to industrial action or terrorist attracts.

Christopher (2016:174) identifies a number of sources of the most common causes of supply chain complexity as illustrated in Figure 2-4 and discussed below:

Figure 2-4: Sources of supply chain complexity



Source: Adapted from Christopher (2016:174-179)

- Network complexity: The more links and associations that occur in a network the more complex it becomes. The potential for unexpected disruptions to the supply chain is heightened by the extended networks.

- Process complexity: Every supply chain is underpinned by various processes. This includes internal processes and those processes managed by upstream and downstream partners. The processes have been developed over time, often in a disorganised way with additions and modifications to address current requirements and as a result have become more complex. The speed of systems and technology changes increases complexity. Inability to adapt to technological or product design changes may have a negative effect on the competitiveness of the organisation (Wagner & Neshat, 2009:123). Leadership changes can cause process complexity as new management introduces new processes and a different way of working.

- Range complexity: It is often found that product and service ranges over time grow rather than reduce. The rate of new products and services seems to outpace the rate at which existing products or services are eliminated. This causes complexity in terms of accurate forecasting and inventory management.

- Product complexity: The design of products can have a substantial impact on supply chain complexity. Complexity can arise because the number of components or sub-assemblies is high or because there is little commonality across the bills of material (BOM) for different products. The less the commonality at the BOM level, the less flexibility there is to vary product mix or volume (Christopher, 2016:176).

- Customer complexity: This arises due to too many non-standard service options or customised solutions. Each customer will display different characteristics in terms of their ordering patterns, delivery requirements and size of orders resulting in complexity.

- Supplier complexity: The size of the supplier base add to supply chain complexity by increasing the number of relationships that must be managed as well as increasing total transaction costs.

- Organisational complexity: Organisations usually organise around functions and departments with many levels that tend to be hierarchical in structure. This tends to inhibit agility because they are inward looking with focus on efficiency rather than customer facing with focus on effectiveness. They tend to become “silo” orientated

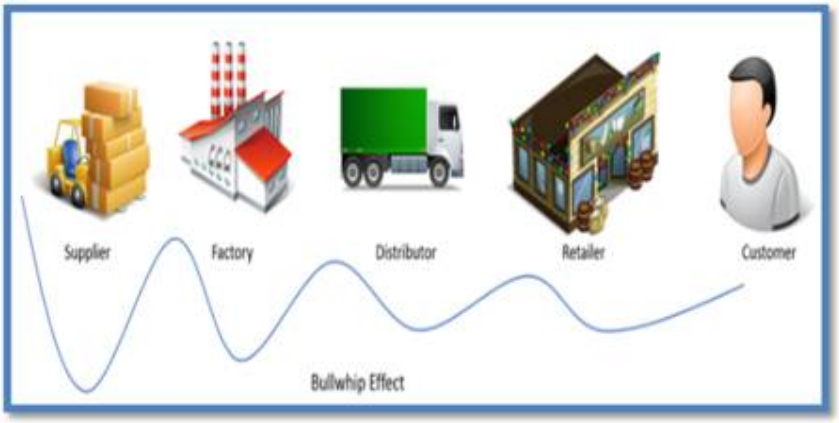
with their own agendas that lose sight of the fundamental purpose of the business to win and keep profitable customers.

- Information complexity: Modern supply chains are supported by the exchange of information between all the entities and levels that comprise the complete end-to-end network. The volume of data flowing in all directions is enormous and not always accurate and can be prone to misinterpretation thus resulting in complexity. The King IV (IODSA, 2016:53) draft report states that the governing body of an organisation should oversee the adequacy and effectiveness of technology and information management including risk oversight of outsourced services and the supply chain for the acquisition of goods and services.

Although many of these strategies have improved performance, these strategies have also increased the risk and made supply chains more prone to disruption. Companies have experienced a change in their supply chain risk profile as a direct result of changes in their business model, examples include outsourcing, the move from regional to global sourcing, shared services and e-commerce and as a result potentially increased supply chain vulnerability (Cecere, 2015:1; Christopher, 2016:215; Lacity *et al*., 2008:28). Areas of vulnerability can result in supply chain disruption that can lead to the total collapse of many organisations and their associated upstream and downstream supply chain structures. Barnes and Oloruntoba (2005:519) describe vulnerability as proneness or a tendency to loss or damage because of existing organisational or functional practices or situations. According to Wagner and Bode (2006:304), supply chain vulnerability is a function of certain supply chain characteristics and the loss a firm incurs is a result of its supply chain vulnerability to a given supply chain disruption. Drivers of supply chain vulnerability include the supply chain structure, the stakeholders involved in the supply side as well as the stakeholders involved in the demand side of the supply chain network with interdependencies between these drivers (Wagner & Neshat, 2009:123). Vulnerability in one stage, e.g. supply chain structure, can influence the vulnerability in the demand side. For instance, lean inventory (supply chain structure) increases the organisation's dependency on the customer and supplier, should an error in inventory planning occur it will affect both the supply and demand side (Wagner & Neshat, 2009:124).

Secondly, due to a number of costly and highly publicised supply chain disruptions the focus on supply chain disruptions has considerably increased. These publications include newspapers, television and social media. Examples include articles in *The Star* newspaper: Saboteurs knock out Telkom facilities, lines (Cox, 2016:9); Oceana imports pilchards to beat local shortage (Mchunu, 2016:19). The media are filled with news of the increase in supply chain disruptions and the fact that many companies are unable to cope with these disruptions (Gurnani *et al*., 2012:1; Wagner & Bode, 2006:301). The media attention and publicity given to the disruptions could result in a change in the upstream supply position generated by a small change in downstream demand creating a Bullwhip effect as illustrated in Figure 2-5 below (Sharma, 2015).

Figure 2-5: Bullwhip effect



Source: Sharma (2015)

In their research Hendricks and Singhal (2008:784) confirmed that supply chain disruptions can cause negative publicity to the affected organisation. Another aspect that has impacted the supply chain during the last few years was the role of social media discussions. In the Business Continuity Institute (BCI) survey conducted in 2015, 15% of the respondents indicated that they have experienced social media discussions that impacted negatively on the supply chain incidents experienced (Business Continuity Institute, 2015:11).

Thirdly, academics and practitioners are deliberating the impact of supply chain disruptions on performance as well as emphasising the need to adopt practices that can

prevent disruptions (Gurnani *et al*., 2012:1; Hendricks & Singhal, 2008:783; Neiger *et al*., 2009:154; Slone *et al*., 2010:6).

Finally, the passage of legislation like the Sarbanes-Oxley (SOX) Act of 2002 makes senior executives more responsible for forecast of performance and protection of shareholder value (Gurnani *et al*., 2012:2). From a South African perspective the King Code of Governance Principles, King III (IODSA, 2009:22) and the King IV (draft King IV of 2016) draft report regulate responsible leadership and the board's responsibility to do sustainable business on an ethical foundation. The King IV draft report extended corporate citizenship to the whole of the supply chain of the organisation (draft King IV, 2016:6). Further to this the governing body of the organisation should ensure that the ethics policy encompasses the relationship with both internal and external stakeholders, including the conduct of organisations within the supply chain (draft King IV, 2016:34). This has heightened the need to identify and manage various risks, including supply chain disruptions.

Gurnani *et al*., (2012:12) also identify further drivers that have an impact on supply chain disruption:

- Focus on efficiency: supply chains have focused too much on improving efficiency by reducing costs. Companies are responding to the cost squeeze at the expense of increasing the risk of disruption (Hendricks & Singhal 2008:779; Tang, 2006:460; Trkman & McCormack, 2009:249).

- Over-concentration of operations: in their endeavour to take advantage of economies of scale, lower transaction cost and volume discounts, companies have over-concentrated their operations at a particular location. Over-concentration reduces the flexibility of the supply chain to react to changes in the environment and leads to a fragile supply chain that is prone to disruptions (Tang, 2006:454; Trkman & McCormack, 2009:250).

- Limited buffers: focus on reducing inventory and excess capacity as well as squeezing slack in supply chains has joined various links so tightly that it leaves little room for errors. Just-in-time delivery, the adoption of "lean" practices and

zero inventory strategies can make the supply chain brittle with no room for manoeuvring in difficult times (Christopher, 2016:215; Tang, 2006:458; Trkman & McCormack, 2009:247).

- Poor planning and execution: poor planning and execution capabilities result in more incidents of demand-supply mismatches. Companies also have limited visibility into what is happening in upstream and downstream supply chain partner supply networks (Neiger *et al*., 2009:156; Tang, 2006:477).

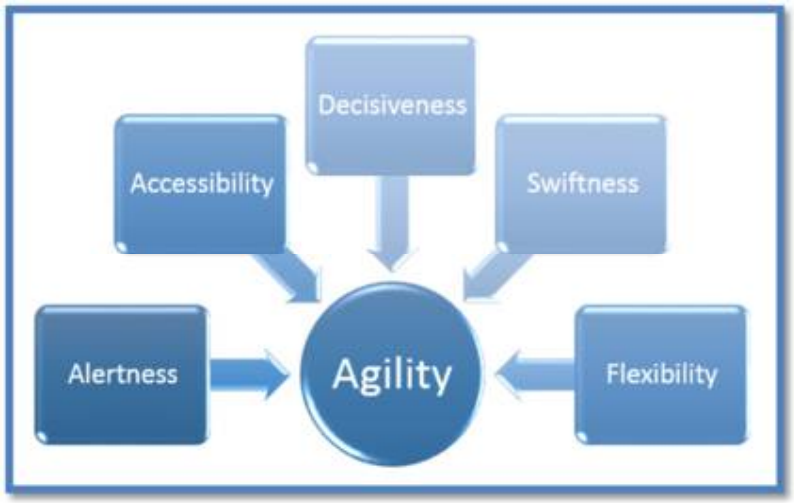
The above-mentioned practices and trends have led to improvements in supply chain performance and profitability without a doubt. Nonetheless, it might have also contributed to supply chains becoming more susceptible and vulnerable to disruptions, this against a backdrop of the increased need for supply chains to be agile and responsive.

2.4 SUPPLY CHAIN AGILILTY

One of the principal challenges facing companies today is the need to respond to ever increasing levels of volatility in demand. The business environment is characterised by constant change, turbulent markets, shorter product life cycles and an increase in demand uncertainty (Christopher, 2016:111; Gligor, 2013:1). The organisation needs to be able to quickly adjust output to match market demand and to rapidly switch from one variant to another, in other words it has to focus its efforts upon achieving greater agility (Christopher, 2016:111).

Agile supply chains look for and anticipate uncertainty, rather than just managing the current environment (Spiller *et al*., 2014:1). Agility can be defined as the supply chain's alertness to internal and environmental changes and the supply chain's capability to use resources in responding to these changes in a timely and flexible manner (Li *et al*., 2008:422). Gligor (2013:22) has identified five agility dimensions that enable the development of a comprehensive definition of the construct.

Figure 2-6: Supply chain agility dimensions



Source: Adapted from Gligor (2013:22)

Alertness, the first dimension of supply chain agility, is defined as the ability to quickly detect changes, opportunities and threats (Gligor, 2013:24). Agile supply chains must be alert to changes within the supply chain itself and within the adjoining environment. Agility manifests itself through sensing emerging market trends, listening to customers and monitoring real demand through daily point-of-sale data (Christopher, 2016:123; Gligor, 2013:26; Li *et al*., 2008:422).

The second dimension of supply chain agility is accessibility, defined as the ability to access relevant data (Gligor, 2013:27). When a change in the supply chain environment is detected through the alertness capability, companies must be able to access relevant data to decide how to provide an agile response (Lu & Ramamurthy, 2012:947). Supply chain-wide information access is recognised as a key requirement for supply chain agility (Vinodh & Prasanna, 2011:5263).

The third dimension is decisiveness, defined as the ability to make resolute decisions (Gligor, 2013:29). According to Gligor (2013:126) both sports and military science research found that agility is dependent on the ability to make resolute decisions using the information available at that specific time. Further to this it is not enough to create the ability to quickly detect changes (alertness) and access relevant information on how to deal with changes (accessibility) in order to develop supply chain agility. Companies

must also foster the ability to make resolute decisions on how to respond to changes (decisiveness), combines the dimensions of alertness, accessibility and decisiveness form the cognitive area of supply chain agility. Not only does these dimensions relate to information processing, but it also allow the organisation to determine what actions to take in response to changes, opportunities and threats (Gligor, 2013:128).

Swiftness emerges as the fourth dimension of supply chain agility and is defined as the ability to implement decisions quickly (Gligor, 2013:24). Christopher (2016:111) suggests organisations must focus on efforts to achieve greater agility, thus they need to be able to quickly adjust output to match market demand and rapidly switch from one variant to another.

The final dimension of supply chain agility identified by Gligor (2013:33) is flexibility. Flexibility is defined as the ability to modify the range of tactics and operations to the magnitude required. Flexibility has long been recognised as a desirable attribute in operations and supply chain management (Christopher, 2016:288; Vinodh & Prasanna, 2011:5263). Christopher (2016:288) suggests structural flexibility as it reflects the ability of the supply chain to adapt or reconfigures its architecture in response to major changes on the demand side or the supply side. Supply chains with high levels of structural flexibility are well able to cope with the levels of volatility which is a feature of the current business environment (Christopher, 2016:289).

It is evident from the above that improving supply chain agility is a potential strategy for mitigating supply chain disruption risks. An agile supply chain allows the organisation and all the supply chain stakeholders to sense, respond quickly to and exploit anticipated or unexpected changes in market demand and in the business environment (Yang, 2013:104). Agility can be the antecedent for competitive advantage and in the long run sustainable competitive advantage for the organisation.

2.5 SUPPLY CHAIN AND MINING INDUSTRY RISK OVERVIEW

The modern more complex supply chain has radically increased risk and management responsibility over the last few years. The introduction of more complex products and services, outsourcing and the globalisation of supply networks have increased risk and

the location of risk has shifted through complex and changing supply networks (Ellis *et al*., 2010:34; Sunjka & Sklar-Chik, 2012:3). According to Wagner and Bode (2006:302), modern supply chains have become more prone to disruptions due to a combination of several factors and trends. This can be contributed to the fact that almost all industries have witnessed fiercer competition and accelerated globalisation of markets. The result, massive pressure to make business processes more efficient and / or more responsive, by outsourcing and offshoring large portions of manufacturing and research and development (R&D) activities, sourcing in low-cost countries, reducing inventories, streamlining the supply base and collaborating more intensively with other supply chain entities. Hendricks and Singhal (2008:784), in their study on the effect of supply chain disruption on shareholder value, determined that industries are affected differently by supply chain disruptions. Supply chain vulnerability can be measured and managed at various levels, predominantly at economy, industry, supply chain or local firm level. Supply chain vulnerability can vary among industries (Wagner & Neshat, 2009:123). Areas of vulnerability can lead to supply chain disruption that can result in total collapse of the organisation and the associated upstream and downstream supply chain structure. From the above it can be presumed that the mining industry has risks associated to the industry that makes it vulnerable to disruption and should the risks materialise, it can cause disruption. To the author's knowledge no research has been conducted on the mining industry in South Africa and the aim of this research is to fill this gap.

There are risks that are external to the supply chain that may arise from natural disasters, terrorism, epidemics, wars or from government-imposed legal restrictions that can result in disruption (Christopher, 2016:216). Similarly there are also internal risks that refer to the risks that arise as a result of how the supply chain is structured and managed and if it materialise can also cause disruption (Christopher, 2016:216). These trends led to the development of Supply Chain Risk Management (SCRM) as a major area for research within the supply chain environment. Supply Chain Risk Management research focus on developing approaches for identification, assessment, analysis and treatment of areas of vulnerability and risk within the supply chain (Neiger *et al*., 2009:154). From a South African perspective some of the man-made risk factors are more probable due to the unstable and highly volatile labour markets increasing the risk of supply chain disruptions.

Based on the above it is important that an organisation on an ongoing basis scan, interpret and act upon events in their environment that can cause disruption (Bode *et al*., 2011:3). It is also important to firstly identify the possible supply chain disruption sources before the organisation can design and implement Supply Chain Risk Management Processes.

Despite the significant increase in supply chain risk it is also important to explore the risk within the mining industry in South Africa as industries are affected differently by supply chain disruptions and supply chain vulnerability vary among industries (Hendricks & Singhal, 2008:784; Wagner & Neshat, 2009:123). The last couple of years were challenging for the South African mining industry with little cause for optimism in the near future. Factors contributing to the negative outlook include a slower than expected rate of economic growth, a prolonged and continuing downswing in commodity prices and increase in short-term volatility, increased pressure on operating models and regulatory uncertainty (PWC, 2015b:3). The mining industry is faced with many challenges. PWC (2015b:16) conducted an analysis from the integrated reports of South African mining companies on the priority risks disclosed during 2014 and 2015. The highest-ranking risk identified in 2014 included: labour relations; sustainable business plans or budgets; the volatility of metal prices and exchange rates; infrastructure access and capacity; the regulatory, political and legal environments; high input costs and skills availability (KPMG, 2016:1; PWC, 2015b:16).

During 2015 most companies' top exposures also included environmental compliance and liquidity risk, further extending the list identified in 2014. Figure 2-7 elucidate the top risks disclosed by mining companies, but are by no means meant to present a comprehensive list of risks faced by the industry. The strained labour relations within the mining industry are well known with extensive media coverage over that last few years. Wage negotiations within the South African mining industry are notoriously violent and the potential for further strike actions with significant losses and stoppages highly likely going forward. All of the risks identified for the mining industry have the potential to cause major disruption within the extended supply chain network.

Mining companies continue to struggle to perform in line with business plans with regular adjustments to production outlooks. This is the case for both current and planned expansion projects. Commodity prices continue to be volatile due to global economic conditions. The result of the volatility could have a negative impact on revenue, profitability, asset values, cash flow, capital and expansion projects. The energy tariff hikes as well as the wage increases had a severe impact on input costs.

With the cost increases well above inflation it created serious pressure on companies in the low commodity price environment. As if this is not enough pressure, investors perceived the operating and capital costs as spiralling out of control (KPMG, 2016:1). The labour legislation in South Africa provide unions with extraordinary strong power, making restructuring difficult and hence alternative methods of cost cutting have to be established to ensure companies remain competitive. Diminished revenues in the sector have kept investors on the side-lines. In an already challenging environment South Africa's credit rating was downgraded by Standard & Poor's (S&P) and Moody's. To add insult to injury the country's outlook was shifted from stable to negative by International Rating Agencies like Fitch Ratings, Moody's Investors Services and S&P, a single notch away from junk status (IRMSA, 2015:7). In a unilateral exploit, the minerals and resources minister gazetted the draft reviewed broad-based black economic-empowerment Mining Charter without consultation or input from mining companies. This caused major reaction within the mining fraternity in the wake of difficult circumstances with mines already locked into a struggle for survival (Creamer, 2016:8). The ever changing regulatory, political and legal environment within the industry is not conducive to investor confidence. Industry experts have described the past four years as anxious for South African mining companies, as commodity prices continued to slide down from record highs reached earlier in the decade.

During May 2016 the High Court gave the green light for class action suits seeking damages from gold companies for up to half a million miners who contracted silicosis and tuberculosis underground (Mail & Guardian, 2016:1). Further to this HIV continues to impact employee health having a negative impact on their ability to work full production shifts with regular sick leave resulting in production losses and strain on the remaining labour force to produce the same output with less human resources (PWC, 2015b:16).

Environmental damage is one of the most serious consequences of mining operations resulting from noise, dust or seepage of harmful substances. Environmental damage poses a serious risk for the health and wellbeing of stakeholders such as employees, contractors and the surrounding communities. Environmental noncompliance could lead to substantial fines, penalties and reputational damage and in a worst case scenario the mining licence could be confiscated and the mine closed by government.

From the above it is evident that the mining industry is under pressure and vulnerabilities and risks exist from an economy, industry, supply chain and focal firm perspective (Wagner & Neshat, 2009:123). All the above aspects increase the input cost on the focal firms within the industry; from environmental aspects like reducing the noise levels, increasing hearing protection, reducing dust exposure, increasing contracted labour to ensure production targets are achieved due to an ailing workforce and obtaining funds to fund capital products in order to increase or maintain production. The only aspect that the mining industry can influence is the cost aspect as the commodity price is determined by the market. In the majority of cases the supply chain have to negotiate the products, material and services (including labour) that impact input cost; from negotiating the prices on the hearing protection to reduce noise exposure to the services contracts that ensure contractors are on site to provide the labour required for production as well as complying to the BEE-requirements set by the government. The supply chain function is central to all activities within the industry and any negative impact due to risks that materialise can cause major disruptions. The importance of risk management is to ensure that the organisation achieve sustainability, making sure the odds favour the organisation's survival and have the ability to capitalise on change. This means continuing to look forward and becoming ever more sensitive to the complex interplay of risk in the supply chain as well as the wider organisational structure. The impact of unplanned and unforeseen events can have a substantial financial impact across the organisation as a whole (Christopher, 2016:215).

Figure 2-7: Risks disclosed by mining companies

RISK DESCRIPTION	MOVEMENT FROM PRIOR YEAR
LABOUR RELATIONS	
The industry has seen reduced labour unrest in 2015 compared to 2014; however, further wage negotiations are expected in the resources sector. Currently, not all key parties look like they will be involved, potentially leading to further strike action (and significant losses and stoppages).	→
ACHIEVABLE BUSINESS PLANS OR BUDGETS	
Mining companies continue to struggle to perform in line with business plans for both current and planned expansion projects.	→
VOLATILE COMMODITY PRICES AND FOREIGN EXCHANGE FLUCTUATIONS	
The market price for commodities continues to be significantly volatile due to global economic conditions that are beyond the control of South African companies. This could have a negative impact on revenue, cash flows, profitability and asset values. Transactions denominated in foreign currencies expose companies to exchange rate fluctuations, which could result in significant accounting volatility.	→
HIGH INPUT COSTS	
Input costs have increased as a result of energy tariff hikes and also from renegotiated wage rates. Cost increases have been more than inflationary and put serious pressure on companies in the current low commodity price environment. Pressure from unions makes restructuring a difficult task and thus alternative means of cost cutting have to be found in many instances.	↑
RELIANCE ON THIRD PARTY INFRASTRUCTURE	
Power shortages remain a key obstacle that could hinder growth in the mining sector in South Africa and elsewhere in Africa. At worst, power outages can impact production and employee safety; at best, it can add significantly to the cost of operations. Bulk commodity exports are reliant on the road, rail and port infrastructure. The unavailability of water in some areas poses a risk.	→
REGULATORY, POLITICAL AND LEGAL ENVIRONMENT	
Regulatory uncertainty is still identified as a significant concern by many companies. The date for Mining Charter compliance has passed and we are now in the period of assessment. The uncertainty surrounding the interpretation of and the enforceability of the Mining Charter metrics and the potential consequences of non-compliance are currently highly topical areas.	→
EMPLOYEE SAFETY AND HEALTH	
Exposure to noise and dust is a significant occupational health risk, especially given the focus on silicosis claims in the industry. HIV and TB continue to impact employees' health.	→
HUMAN RESOURCE SKILLS AND CAPACITY	
Global competition for expertise and skills in technical fields, and the distance of operations from major urban areas are two of the more significant factors that are putting pressure on attracting and retaining skills.	→
LIQUIDITY	
Deteriorating liquidity and cash flow impact on mines' ability to fund capital programmes and also (in particularly acute circumstances) to carry on day-to-day activities. As finance facilities expire, difficulties may be encountered in extending or re-negotiating terms.	↑
COMPLIANCE WITH ENVIRONMENTAL STANDARDS	
A consequence of mining operations is environmental damage resulting from dust, noise or the leakage of harmful substances. Environmental damage can have a knock-on effect on the health and wellbeing of many stakeholders such as employees, contractors and surrounding communities. This could lead to substantial fines and penalties for environmental noncompliance and, in a worst-case scenario, to the removal of mining licences and mine closure.	↑

Source: Adapted from PWC (2015b:16)

Figure 2-7 clearly illustrates that the risk profile in the mining industry in South Africa is not improving at all thus increasing vulnerabilities and the risk of disruption within the industry. Indications are that the risk profile for the risk sources below remains under pressure:

- Labour relations
- Achievable business plans or budgets
- Volatile commodity prices and foreign exchange fluctuations
- Reliance on third party infrastructure
- Regulatory, political and legal environment
- Employee safety and health
- Human resource skills and capacity

In terms of the risk sources below an increase in the risk profile has been noted:

- High input costs
- Liquidity
- Compliance with environmental standards

As mentioned before unlike other industries the mining industry cannot increase the price of their commodity based on the risk factors applicable to the industry; the commodity price is determined by the market. As a result the impact of risk sources like high input costs, liquidity and compliance with environmental standards increase the pressure on the companies to remain profitable and attractive to investors. They focus on the aspects they can influence and control; this typically includes efficiency and cost management and might lead to business decisions and models that can increase vulnerabilities and the risk of disruption. This include but is not limited to globalisation, single sourcing, outsourcing, reduction in the supplier base and the focus on removing slack from supply chains (Cecere, 2015:9; Christopher, 2016:215; Gurnani *et al*., 2012:1; Hines, 2013:9; Slone *et al*., 2010:64; Trent & Roberts, 2010:6; Trkman & McCormack, 2009:247).

The perpetual increasing risk profile in the mining industry combined with increased risk in the supply chain environment underline the opening statement of this chapter: it's not a matter of "if", but "when" a global supply chain disruption will negatively impact an organisation's customers and shareholder value. A systematic approach to supply chain risk is required. The systematic approach includes 4 stages:

Identification: What types of risks are the company exposed to and where are they in the supply chain?

Quantify: What financial impact could these risks have on input cost and profitability?

Mitigate: What strategies / tactics do the company have in place to minimise the disruption to their business?

Respond: How quickly can the company recover from a disruptive event and return to normal operations?

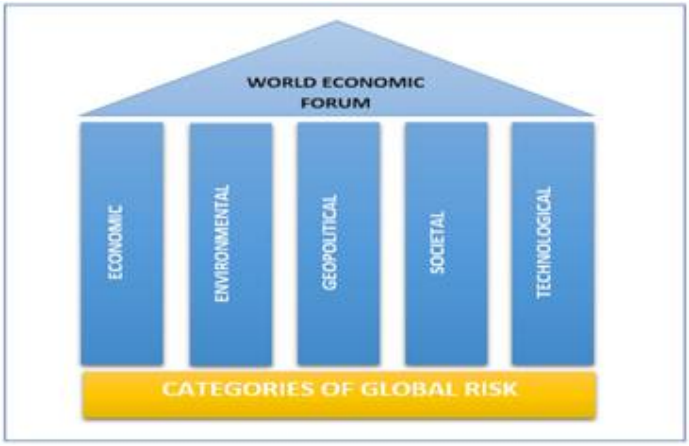
Effective supply chain risk management is not a static exercise or a linear process. In order to be effective it requires constant monitoring, ongoing assessment and the periodic re-evaluation of contingency plans (Schoeman, 2016:62).

The approach should include the identification and a comprehensive understanding of supply chain disruption risk sources that, should it materialise, could cause disruption. It is also necessary to understand the likelihood of a risk source occurring and causing disruption and if it occurs, the impact it has on the organisation.

2.6 SUPPLY CHAIN DISRUPTION RISK SOURCES

Risks are becoming increasingly imminent and materialise in new and sometimes unanticipated and unpredictable ways (Christopher 2016:215). From climate change to the imperative for improved water governance, from large-scale involuntary migration to reviving growth in what is known as the Fourth Industrial Revolution. Risks are affecting the lives of individuals and the functioning of organisations and economies on a global scale. The World Economic Forum categorises global risk as economic, environmental, geopolitical, societal and technological as illustrated in Figure 2-8 below (World Economic Forum, 2016:3).

Figure 2-8: World Economic Forum categories of global risk



Source: Adapted from World Economic Forum (2016:3)

All five of the global risk categories apply to the mining industry in South Africa if compared with the risk disclosed by mining companies in Figure 2-7 above:

- Economical: High impact cost, liquidity, achievable business plans & budget.
- Environmental: Compliance with environmental standards.
- Geopolitical: Regulatory, political and legal environment.
- Social: Human resource skills & capacity, employee health & safety, local host communities.
- Technological: Reliance on third party infrastructure, employee health & safety, human resource skills & capacity, environmental standards

The World Economic Forum conducted a Global Risks Perception Survey and more than 750 experts and decision makers within the World Economic Forum responded. The respondents from Sub-Saharan Africa's top concerns included unemployment, energy prices, the failure of national governance and the failure of critical infrastructure (World Economic Forum, 2016:7). Figure 2-9 depict the summary results of the Global Risks Perception Survey per region based on the most likely global risks for 2016.

As companies extend their global reach to source from other countries for lower-cost goods and services, the search increasingly expose countries to emerging and low-cost countries (Slone *et al*., 2010:64; Trent & Roberts, 2010:43). This is not only true for low cost countries as many companies import modern equipment and technology from first world countries in order to optimise their processes. This has caused the supply chain network to extend globally and as a result exposed companies to the risk prevalent not only in their own country, but in the other regions they source from. Figure 2-9 illustrates the impact, should a company from Sub-Saharan Africa e.g. South Africa, imports equipment via a supplier from North America, the company is not only exposed to the risks threatening Sub-Saharan Africa, but also to the risks, scope, scale and dependent relationships threatening North America and any other regions the equipment must be transported through to reach South Africa.

Figure 2-9: Most likely global risks 2016: A regional perspective

Source: World Economic Forum (2016:5)

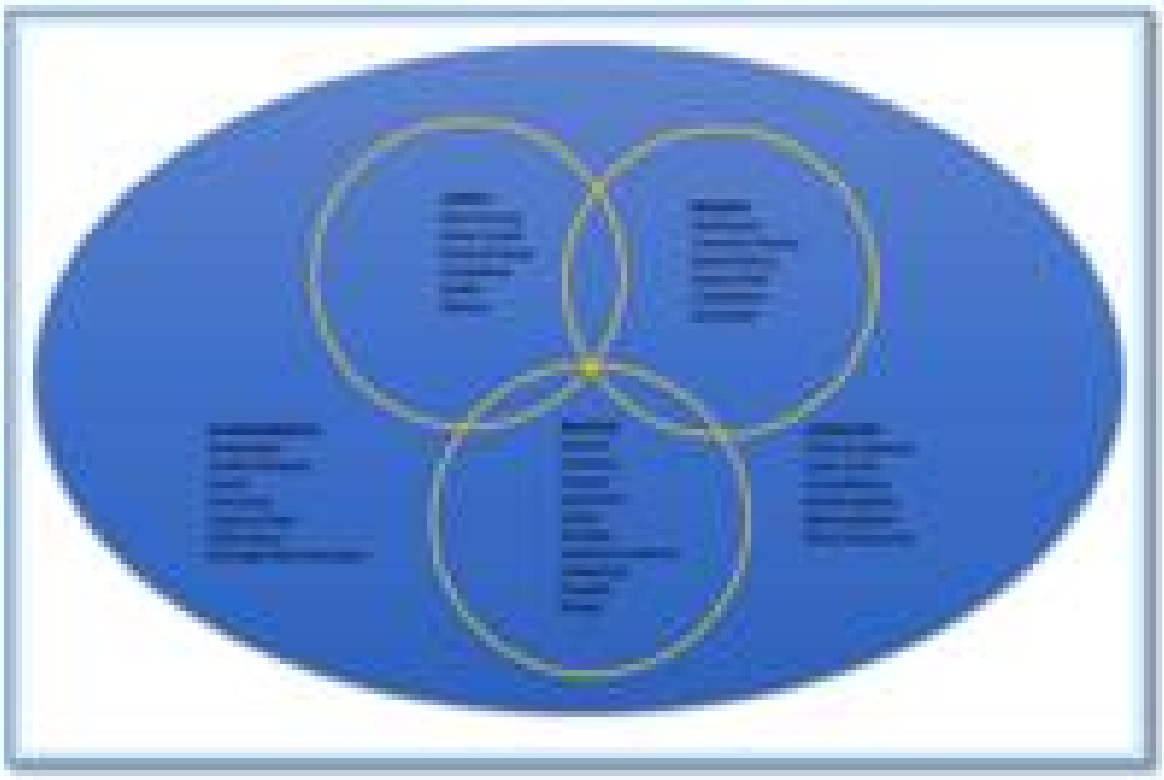
Companies are vulnerable, from environmental to economic and political risk perspectives, even if they do not have immediate presence in the region where the risk arises (World Economic Forum, 2016:67). Should a risk materialise in North America e.g. a terrorist attack, it could cause disruption in all the other supply chain networks connected to the North American network that is reliant on their products from the North

American supplier. The risks that are most likely to occur in the North American network include technological and environmental risks and the risks most likely to occur in Sub-Saharan Africa relates to geopolitical and economic risks. Thus the South African company importing from North America will be exposed to technological, environmental, geopolitical and economic risks. If the product is shipped via Europe, social risk will be added to the risk profile for the South African company, increasing the risk profile and likelihood of disruption even further. It has a spill-over effect on the supply chain network involved in the transaction.

Material flows within the supply chain can be disrupted by unexpected natural or man-made disasters such as earthquakes, fires, floods, hurricanes or equipment breakdowns, parts shortages, counterfeiting, supplier failure, industrial action, economic crisis, bankruptcy, child labour issues, currency fluctuations or by deliberate sabotage or terrorist attacks (Schlegel, 2015:6; Shah, 2009:275). Schlegel (2015:6) categorises the causes of supply chain disruption into “The four spheres of supply chain risk” as depicted in Figure 2-10 below which includes supply, demand, process and environmental landscape

Each of the four spheres has risk sources associated with it that, should it materialise, will cause supply chain disruption.

Figure 2-10: The four spheres of supply chain risk



Source: Schlegel (2015:6)

The four spheres of supply chain risk that could cause disruptions include (Schlegel, 2015:6):

Sphere 1: Supply

These are upstream disruptions caused by failure of the supply base to deliver on time, deliver quality, sustain financial integrity and maintain compliance and resilience.

Sphere 2: Demand

These are downstream disruptions caused by problems in the distribution flows, actions of competitors, product failures, customer insolvency, warehouse and distribution centre issues, demand volatility, transportation lead times, pricing issues, credit issues etc.

Sphere 3: Process

This sphere originates from within a company and its own four walls. This includes time delays, system anomalies, inventory shortages, quality problems, capacity shortages, equipment issues, accounts receivable and payable processing, demand errors, intellectual property management, supply chain security and supply chain visibility.

Sphere 4: Environmental landscape

According to Schlegel (2015:6), this is by far the largest and most dynamic area of supply chain disruptions. In this growing arena, the major threats include natural disasters, climate, natural resources, terrorism, social media, capital availability, banking and global finance, transportation and global trade, political volatility, regulations and customs requirements, country rules and legislation, currency exchange rate fluctuations etc.

The four spheres proposed by Schlegel is by no means a comprehensive and all inclusive view on risk sources that can result in supply chain disruption. With the growing importance of relationship management in the supply chain environment it is necessary to empirically test the impact of relationship management as risk source that could cause supply chain disruption.

Various researcher and academia emphasised the importance of relationship management in their research (Avery *et al*., 2014:36; Foerstl *et al*., 2010:119; Miocevic & Crnjak-Karanovic, 2011:115). Time and again relationship management is stressed as either important or as having an impact on the organisation and the extended enterprise. The concept of Supply Chain Relationship Management (SCRM) is well researched but not as an antecedent to supply chain disruption and thus leads to the question if a breakdown in the relationship with either the supplier or the internal client can lead to supply chain disruption in the mining industry?

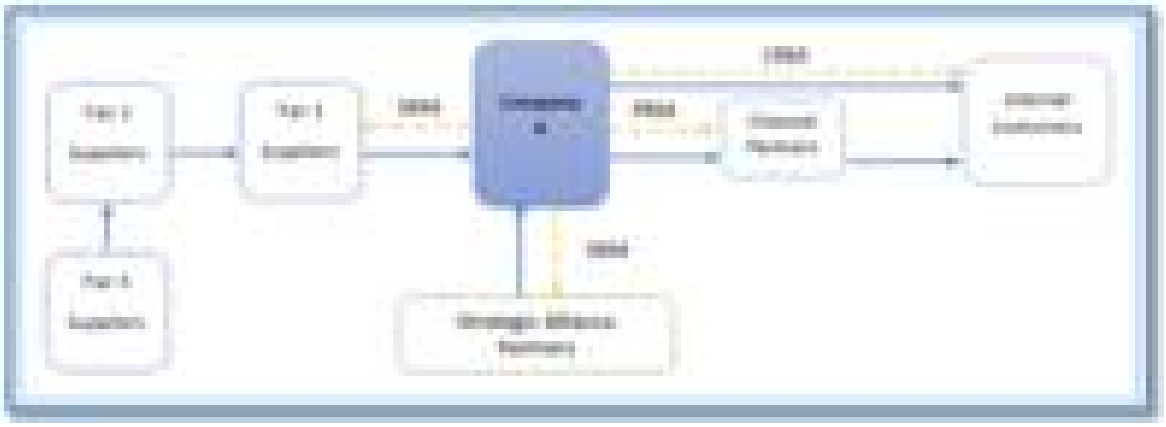
Value creation in the relationship age is centred in knowledge exchange and real-time connectivity between an organisation and the extended enterprise, thus its customers, suppliers and business partners (Chan, 2008:55; Christopher, 2016:156). According to

Christopher (2016:156), the supply chain is becoming a league of organisations that have mutual goals and bring specific strengths to the value creation and value delivery system.

The evolution of the supply chain over the last few years caused increased complexity and fragility. This is due to the increase of dependencies between supply chain entities (suppliers, partners, customers); changes occurring more frequently within the extended supply chain network, the increased number of entities within the supply chain and the fact that relationships between supply chain entities have become less transparent (PWC, 2013a:5). It is important for an organisation to control these relationships to ensure that it does not negatively influence the various entities within the extended enterprise as many of the disruptions are supply / supplier related (PWC, 2013b:31). This could be achieved through an enterprise relations management strategy to address the various aspects, create visibility and manage the relationships within the environment to ensure optimal value creation, prevent disruption and disconnection between the supply chain network entities.

There are two facets to the relationship management strategy namely the strategy for downstream relationships and the upstream relationship network as illustrated in Figure 2-11 below.

Figure 2-11: Supply chain relationship management



Source: Adapted from Chan (2008:56)

The downstream relationship management includes Customer Relationship Management (CRM) and Partner Relationship Management (PRM), whereas the upstream relationship management is supported by Supplier Relationship Management (SRM). In Figure 2-11

the end customers are represented by internal customers, channel partners such as distributors, retailers, dealerships and independent agents while value added resellers (VARs) are represented by channel partners, but will not form part of the research as the research will focus on the internal customers and not the external customer segment of the industry. The multi-tier suppliers of raw materials and parts are represented by Tier 3 Suppliers and other suppliers of products and services such as third-party logistics providers (3PLs), technology providers and contract manufacturers are represented by Strategic Alliance Partners. The solid arrows indicate the flow in the supply chain and the dotted arrows indicate the flow of relationship management.

Changes of the economy and the evolution of value creation models are both concomitant with the development from production-based to service-based and from service-based to relationship-based business environments (Chan, 2008:63). In modern business practices business performance is measured by a company's relationships with its extended enterprise. Organisations are now starting to realise that they have become more reliant on suppliers in terms of security of supply, corporate social responsibility, innovative power and ongoing cost containment (PWC, 2013b:6). The management of relationships from end-to-end is essential in today's extended supply chain (Christopher, 2016:236). If the relationship is not managed and taken care of it could lead to a breakdown in trust and commitment between the supply network entities and this could lead to disruption in the supply chain.

Procurement is not only a significant expense in any company that can affect the bottom line of the organisation, but it also influences multiple supplier relationships on a daily basis. The management of relationships with suppliers is thus critical for the organisation as supplier performance can affect the performance of the entire value chain. Companies must collaborate and integrate with suppliers to remain competitive and to ensure procurement excellence (PWC, 2013b:7). Effective supplier management can reduce procurement costs, improve product quality and ensure on-time delivery (Chan, 2008:53). The key to success is the way in which the network of associations and suppliers are fused together in partnerships to achieve mutually beneficial goals and reduce risk (Christopher, 2016:240).

To illustrate the importance of relationship management within the supply chain, PWC identified seven factors that enable stronger capabilities in both supply chain management and risk management (PWC, 2013a:10); refer Table 2-4 below. All seven of these enablers must be developed, implemented and controlled with collaboration of the suppliers and internal customers to optimise supply chain management and risk management:

Table 2-4: Enablers for supply chain management & risk management

ENABLER	DESCRIPTION	PARTNERS
Risk governance	The presence of appropriate risk management structures, processes and culture	Supply chain Internal customers Suppliers
Flexibility and redundancy in product, network and process architectures	Having the right levels of flexibility and redundancy across the value chain to be able to absorb disruptions and adapt to change	Supply chain Internal customers Suppliers
Alignment between partners in the supply chain	Strategic alignment on key value dimensions, identification of emerging patterns and advancement towards higher value propositions	Supply chain Internal customers Suppliers
Upstream and downstream supply chain integration	Information sharing, visibility and collaboration with upstream and downstream supply chain partners	Supply chain Internal customers Suppliers
Alignment and integration between internal business functions	Alignment and integration of activities between company value chain functions on a strategic, tactical and operational level	Supply chain Internal customers
Complexity management / rationalisation	Ability to standardise and simplify networks and processes, interfaces, product architectures and product portfolios and operating models	Supply chain Internal customers Suppliers
Data, models and analytics	Development and use of intelligence and analytical capabilities to support supply chain and risk management functions	Supply chain Internal customers Suppliers

Source: Adopted from PWC (2013a:10)

Alignment between partners in the supply chain is considered the most important factor in enabling risk reduction (PWC, 2013a:10). Building a strong relationship between the company and their suppliers ensures that over the life span of the relationship, the

efficiency and services will be superior to those where relationships are not managed. Relationship management is thus critical to ensure competitive advantage for the organisation, but also a key aspect in reducing the risk the company is exposed to from the extended enterprise. SRM gives the company access to the unique knowledge, resources, capabilities, talent and ideas of the supplier. In a mature SRM relationship it also provides full visibility on relevant risks within the network and allow for mitigation approaches to be developed in collaboration with the suppliers (PWC, 2013b:10). The concept of SRM as a possible source supply chain disruption will be included in the proposed framework and tested empirically.

When assessing supply chain disruption it is necessary to assess the sources of risk that could result in disruption should it materialise, but it is equally important to assess the impact and likelihood of supply chain disruption which is occurring. It might be a case that a risk source is highly likely to occur, but with a very limited impact on the supply chain and although management should be aware of the risk it will not receive the same level of attention as a risk that is highly likely to occur with a major impact on supply chain disruption.

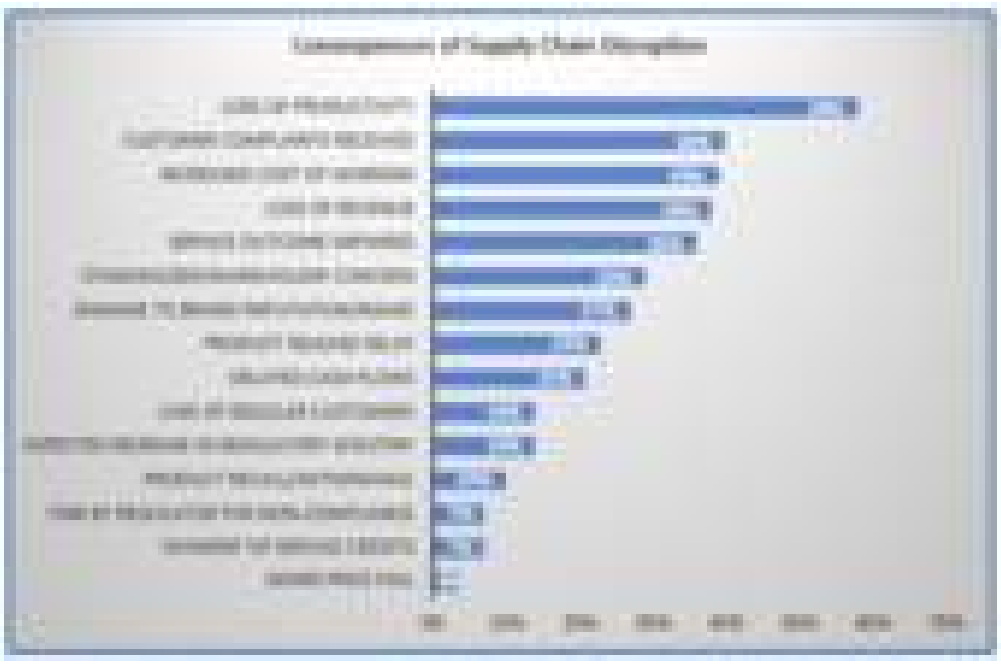
2.7 IMPACT AND LIKELIHOOD OF SUPPLY CHAIN DISRUPTION

Shareholder value is driven through supply chain excellence because it controls the pulse of the organisation – the fundamental flow of all material and information from suppliers through the company to its customers (Slone *et al*., 2010:5). Supply chain disruptions and other risk related issues are considered the most pressing concerns facing organisations competing in the global marketplace. Interruptions in the supply of vital parts or commodities can impact production and affect a business' overall operations. The consequences of this can include loss of customers, tarnished brand and reputation and an overall fall in revenues and share price, all of which can affect market share if not resolved quickly and efficiently. Hendricks and Singhal (2008:780) emphasised the relevance of supply chain disruptions by empirically showing that these events have a significant negative impact on shareholder value and on operating performance i.e. sales, operating income and return on assets. Their research showed that on average, disruptions are associated with a nearly 11% decrease in stock prices – refer to Graphs

2-2 and 2-3 below as illustration of the impact in the South African mining industry. They also found that, depending on the model used, the average destruction in shareholder value ranges from $129 million to $145 million per disruption (Hendricks & Singhal, 2008:783).

The consequences of supply chain disruption on the organisation are illustrated in Figure 2-12 below. The graph and subsequent discussion illustrate the far-reaching effect of supply chain disruption on the organisation.

Figure 2-12: Consequences of supply chain disruption

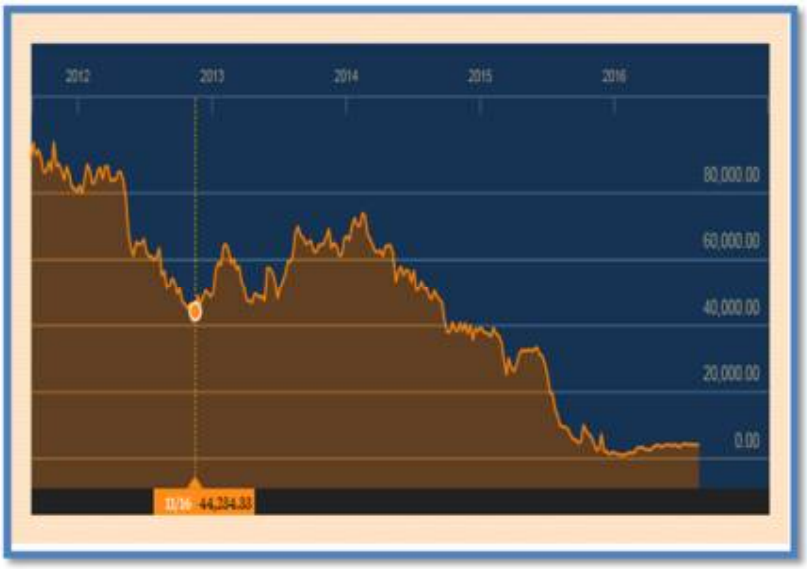


Source: Business Continuity Institute (2015:12)

Shareholder value: On average companies that publicly disclosed a supply chain disruption reported between 11% and 25% reduction in share price value and it took on average two years for the share price to recover. Companies with extended disruptions never recover (Hendricks & Singhal, 2008:783; Schlegel, 2015:8).

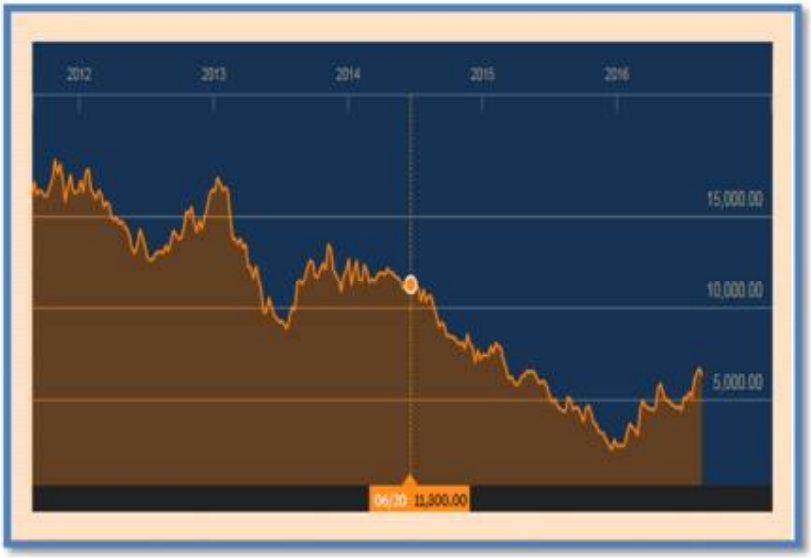
The negative impact of disruption on the share price is clearly illustrated in the graphs below indicating the devastating impact the prolong strike in 2014 in the platinum industry had on both Lonmin and Impala Platinum's share prices.

Graph 2-1: Impact of platinum strike on Lonmin's share price



Source: Bloomberg (2016a)

Graph 2-2: Impact of platinum strike on Impala Platinum's share price



Source: Bloomberg (2016b)

Revenue: In terms of the impact on revenue, 38% of companies reported "loss of revenue" as a consequence of supply chain disruptions (Business Continuity Institute, 2015:17).

Costs: On average 11% increase in costs were reported for a publicly reported supply chain incident. 39% of companies reported increased cost of working as a consequence of supply chain disruption. (Business Continuity Institute, 2015:12; Hendricks & Singhal, 2005:6)

Profit: Supply chain disruption has a substantial negative impact on profitability. Hendricks and Singhal (2005:6) concluded from their research that after adjusting for industry and economy effects, the average effect of disruptions in the year leading to the disruption equates to:

- 107% decrease in operating income
- 114% decrease in return of sales
- 93% decrease in return on assets
- 7% lower sales growth
- 11% increase in cost
- 14% growth in inventories

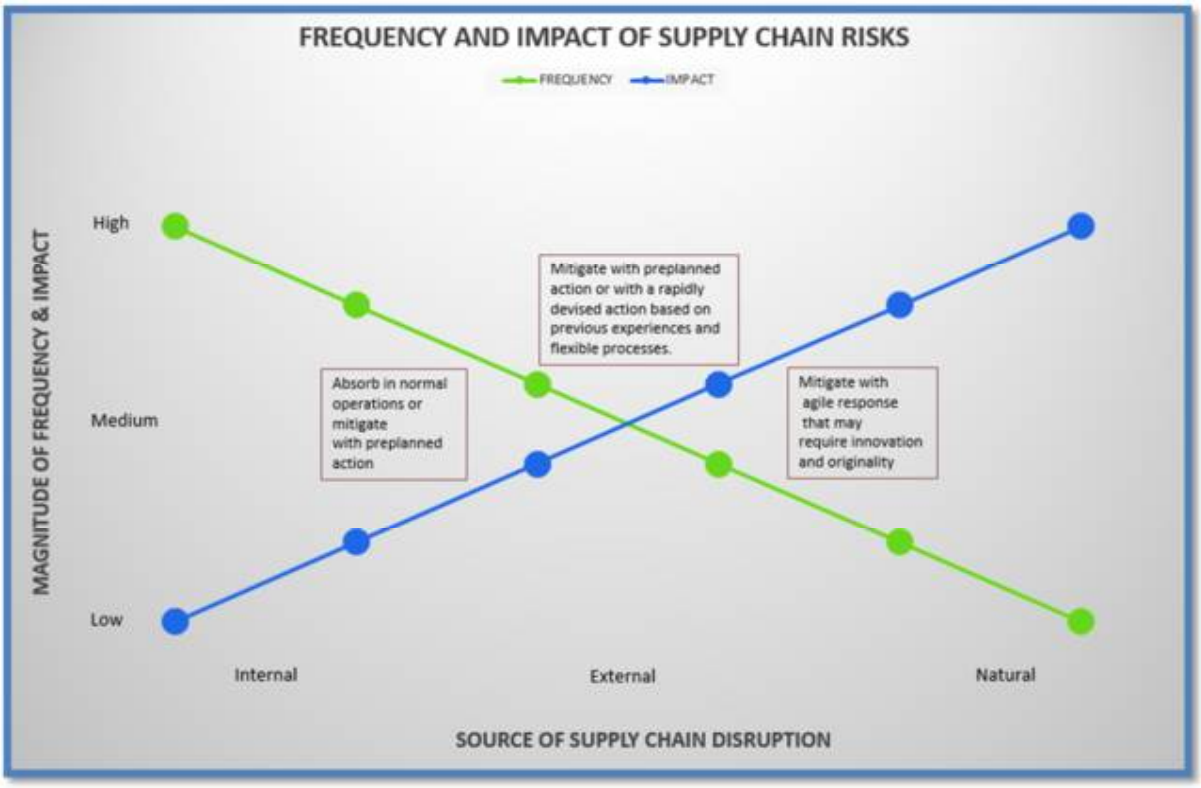
Brand: a total of 27% of the companies reported that their brand and reputation was damaged after a supply chain disruption. 40% of companies reported that they received customer complaints as a result of disruptions and 36% reported that their service outcome was impaired (Business Continuity Institute, 2015:12).

Incidents: a total of 74% of companies suffered at least 1 supply chain disruption during a 12-month period. A total of 35% of organisations indicated that they do not record, measure and report performance-affecting supply chain disruptions. This could indicate that the incidents suffered during a 12-month period might be higher than the reported 74%. 50% of the disruptions reported originated below the tier 1 (direct) suppliers. 21% originated from the organisations supplier's supplier (tier 2) and 8% much lower down in the supply chain (tier 3 & tier 4). This is a clear indication of the risk associated with the full upstream supply chain and the importance of visibility and good relationships with these suppliers (Business Continuity Institute, 2015:8).

Schlegel and Trent (2012:44) also confirm the impact of disruption with operating income reducing with 107%, return on sales down by 114%, return of assets reduced by 93%, sales growth 6.92% lower, a growth in cost of 10.66%, growth in inventories of 13.88% and over 10% reduction in shareholder value.

The above is a clear warning that supply chain disruption can and will have a major impact on any business. The impact do not only impede the supply chain environment, but research has provided evidence that it has a serious impact on shareholder value, revenue growth, costs, profits as well as the customers and thus the sustainable livelihood of the organisation. With this in mind the question arises about the probability of a supply chain disruption. Schlegel (2015:8) explains the frequency and impact of supply chain risk in Figure 2-13.

Figure 2-13: Frequency and impact of supply chain risks



Source: Schlegel (2015:8)

The above figure outlines the relationship of the frequency and impact of supply chain risk. The “Y” axis profiles the magnitude and frequency of risk events. This ranges from

low to high and is depicted by the green line. The "X" axis, represented by the blue line, depicts the source of risk events. Taking a view from left to right the first disruption source emanates from within a company's own supply chain. This typically contains all the processes, tools and techniques at the company's disposal and is normally identified as "chronic risks." These are problems and events that happen quite frequently – every day – and have a very limited impact on the company. Companies tend to develop workaround strategies to handle these risk events. The next level in the graph represents disruptions caused from outside the company. These external disruptions originate from suppliers, customers, manufacturers, third party logistics (3PLs) and other external sources. These disruptions don't manifest as often as chronic risks. However, they tend to have a larger impact on the company. Finally there are the natural risks, including hazard risks and man-made risk events. This typically includes risks such as plant fires, explosions, floods and many more. The frequency of these events is much lower, but they tend to have a major impact on the company. According to Summers (2012:5), a "Black Swan" event is a rarity with extreme impact and with retrospective predictability. It includes events such as the Chernobyl nuclear disaster in 1986, the World Trade Centre terrorist attack in 2011 and the Texas City oil refinery explosion in 2005 (Summers, 2012:9).

A supply chain disruption framework to identify risk sources that could result in disruption should it materialise as well as assessing the likelihood and impact of supply chain disruption are required. The aim of the research is to suggest such a framework that management can use to identify risk sources that could result in disruption and reduce the risk and impact of disruption.

The four spheres of supply chain risk as proposed by Schlegel (2015:6) will be used as the foundation for the proposed framework, but were augmented to include five spheres. The fifth sphere added to the framework includes relationship management that focuses on relationship management with the external supplier and the internal customer.

The proposed framework as derived from the literature study will consist of spheres relevant to the supply chain and each sphere has risk sources associated with it that can cause disruption should it materialise.

Figure 2-14: Proposed five sphere supply chain disruption framework

Source: Adapted from Schlegel (2015:6)

The proposed five spheres of supply chain risk as derived from the literature that can cause disruption if it materialise include:

Sphere 1: Supply

The sphere contains upstream disruptions caused by failure of the supply base to deliver on time, sole sourcing strategies, labour issues, financial issues, compliance issues, product or services quality problems, transport network failure, product recall, imported products, pricing instability, product shortages, product counterfeiting, supplier failures and product sabotage (Schlegel, 2015:6):.

Sphere 2: Internal demand

These are downstream disruptions caused by problems within the internal customer demand location. This includes internal distribution problems, budget constraints, demand error, demand volatility, system risks, incorrect specifications, drawings and

standards, communication failures, poor planning and execution, labour issues and product failures (Schlegel, 2015:6).

Sphere 3: Process

This sphere originates from within a company and its own internal organisational environment. This includes system anomalies, inventory shortages, quality problems, capacity constraints, equipment failure, industrial action, quality issues, compliance issues, intellectual property violations, energy scarcity, health and safety incidents, cost cutting, outsourcer failure, accounts payable processing delays, supply chain security, supply chain visibility, business strategy, lack of SC agility, SC complexity and change in leadership (Schlegel, 2015:6).

Sphere 4: Relationship management

As a new addition to the supply chain disruption context, this sphere focuses on the impact of relationships on the supply, demand and process spheres. This includes the impact of information sharing, trust between the extended entities, mutual problem solving, risk sharing, supplier loyalty, relationship commitment and relationship management with both the external suppliers and the internal customers (Chan, 2008:55; Christopher, 2016:156).

Sphere 5: Environmental landscape

The environmental landscape sphere embraces the supply, internal demand, process and relationship management spheres and forms the basis for any organisation to conduct their business in a sustainable and competitive way. A company cannot conduct their business in isolation, divorced from the external environmental landscape that impacts the business environment and political landscape. This is a critical sphere of the proposed framework that includes major threats like: natural disasters, adverse weather conditions, conflict minerals, custom rules and regulations, import duties, unethical conduct, exchange rate volatility, political upheaval, cyber-attacks, data breaches, unplanned IT and telecommunication outages, fraud, corruption, bribery, global logistics, terrorism,

negative media coverage, BEE compliance loss of SC talent and skills, rapidly changing technologies etc. (Schlegel, 2015:6):.

Although the focus of the research will be on the five spheres of risk sources that can cause supply chain disruption, the framework make provision for the assessment of the impact and likelihood of any of the sources within a sphere. Once the risk source is identified as a source of disruption it is assessed based on the likelihood of causing disruption, ranging from low likelihood to high likelihood of causing disruption. Similarly the impact is assessed based on low, medium or high impact. This will assist managers to focus their attention and resources on risk sources of disruption that is likely to occur with a medium to high impact. It will allow them to design preventative action plans as well as implement immediate action should the disruption occur. The framework provides managers with an overall view on the organisation's risk profile, enabling them to mitigate, terminate, tolerate or treat the identified risk. The framework will be tested in the mining industry to determine its relevance for the industry.

2.8 CONCLUSION

The growing importance of an agile supply chain on a global scale cannot be overemphasised. Increasingly, businesses need to strengthen their scenario and emergency planning capacity to analyse complex and often uncertain interdependencies if they are to build resilience to risks. Likewise, industries also need to understand the global risks of doing business. The gold mining industry in South Africa has not been excluded from the prerequisite of an agile supply chain with the capability of identifying risk sources from a supply, demand, process and environmental landscape perspective that can result in disruption should it materialise. To the contrary the more volatile and complex the landscape within the industry becomes, the more important and critical the need for a framework to identify supply chain disruption risk sources. This will allow companies to identify, implement and mitigate risks through a recognised supply chain risk management process. Companies need to reinforce their resilience to ensure continued operation and survival in the face of risks. The clear need for a supply chain disruption framework becomes evident.

As supply chains have become more interconnected and global, their vulnerability has increased substantially. There are also more potential points of failure and less margin of error for absorbing delays and disruptions. Supply chain risk exposure is increasing and so too is the frequency of problems. A 2011 survey by the Business Continuity Institute found that 85% of companies with global supply chains had experienced at least one supply chain disruption in the previous 12 months (Deloitte Consulting, 2013:4).

With the rapidly changing supply chain environment and the volatile gold mining industry in South Africa it is in the best interest of business managers to find new ways to identify and address supply chain disruption risk sources in order to mitigate and remove the risks that face their companies and industry. The proposed five sphere framework will enable managers to identify risk sources based on supply, internal demand, process, relationship management and the environmental landscape. The risk sources have the potential to cause disruption of the supply chain should it materialise and thus the concept of risk and disruption cannot be looked at in isolation. It will also empower supply chain managers to meet the challenges and risk within the supply chain as well as reduce the impact on business operations.

2.9 CHAPTER SUMMARY

In this chapter various concepts relating to supply chain disruption were deliberated. Firstly, supply chain nomenclature were defined including terminology like supply chain management (SCM), supply chain risk (SCR), supply chain disruption (SCD) and supply chain risk sources (SCRS). Secondly, the current situation within the supply chain disruption construct, with specific focus on drivers of supply chain disruption and sources of supply chain complexity were discussed. Thirdly, a closer inspection of supply chain agility and the dimensions of agility were deliberated. Fourthly, a view was taken on the supply chain and mining industry risk sources that impact on supply chain disruption. Fifthly, the supply chain risk sources that can cause disruption, should it materialise, were assessed. Sixthly, the impact and likelihood of supply chain disruption were investigated with focus on shareholder value, revenue, costs, profit, brand, incidents and the frequency of disruptions.

The final aspect was the proposal of a five sphere supply chain disruption framework including risk sources based on supply, internal demand, process, relationship management and the environmental landscape. The framework also allows for the assessment of the impact and likelihood of supply chain disruption aspects. The proposed framework should enable business managers to control and mitigate supply chain disruption.

CHAPTER 3: RESEARCH METHODOLOGY AND FINDINGS

3.1 INTRODUCTION

The literature review in Chapter 2 of this study provided an overview of supply chain disruption concepts as well as the supply chain disruption context that exist within the gold mining industry in South Africa. Specific attention was given to supply chain nomenclature, disruption constructs, risk sources that can cause disruption should it materialise and the impact and likelihood of supply chain disruption within the mining industry. Numerous sources indicated the rapidly changing supply chain environment with growing network complexity and dependencies between supply chain entities, while the speed of change has accelerated the level of transparency and visibility in the extended supply chain network has decreased, thus dramatically enhancing the risk of supply chain disruption.

The focus of Chapter 2 was on the research methodology followed to assist in meeting the research objectives as laid out in Chapter 1. The investigation procedures, data analysis as well as the results are described in this chapter. All statistical analysis was done by the Statistical Consultation Services at the North-West University of the Potchefstroom campus, using the software package, SPSS Inc. (2016), IBM SPSS Statistics Version 23, release 23.0.0.

3.2 PROCEDURE AND SCOPE OF THE QUANTITATIVE RESEARCH

The empirical study focused on various departments in the gold mines within the mining industry in the North West Province of South Africa. After determining the demographic profile of the respondents, the study attempted to establish whether respondents have an understanding and basic overview of the supply chain disruption context within their company with specific reference to reporting of the source, impact and type of supply chain disruptions experienced. The empirical study attempted to determine the risk sources that, should it materialise, would result in supply chain disruption. This was done based on five supply chain disruption spheres namely supply side, internal demand side, process side, relationship management side, environmental and landscape side with

specific risk sources within each sphere with the applicable and relevant risk sources identified through the literature review.

3.3 PROCEDURE AND SCOPE OF THE QUALITATIVE RESEARCH

The author conducted unstructured interviews (refer Annexure D) with selected subject matter experts within the gold mining industry in order to clarify and identify important variables within the supply chain disruption environment. The decision points included:

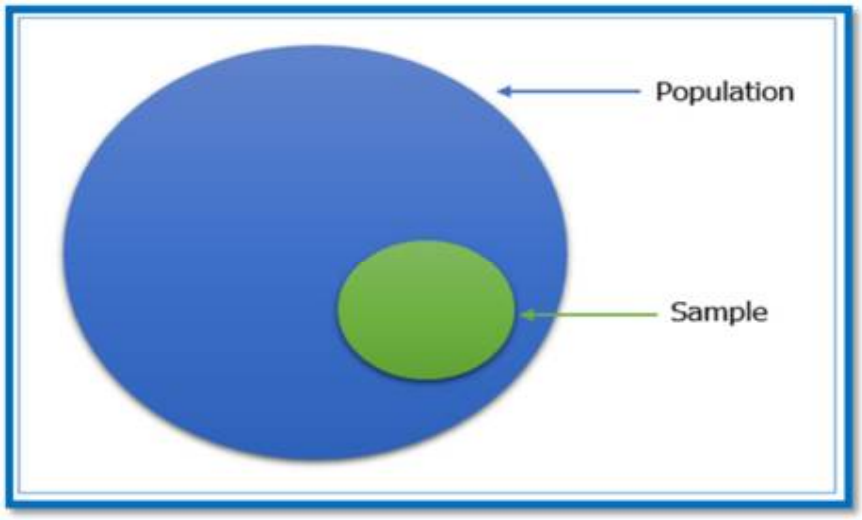
- Causes of SCD (Figure 1-2)
- Key concerns identified in 2013 (Figure 1-3)
- Mining Risks and relevance to the gold mining industry (Figure 2-7)
- World Economic Forum risk categories and applicability in the gold mining industry (Figure 2-8)
- Five spheres and risk sources relevant to gold mining industry (Annexure C)

The information collected from the unstructured interviews and the literature review were used to construct the questionnaire for the quantitative research and to test the relevance of information obtained in the literature study.

3.4 SAMPLE GROUP AND SIZE

The populations of a research study is the total group of potential participants (individuals, groups, organisations, human products) in a research study to whom a researcher would want to generalise the results of an empirical study as illustrated in Figure 3-1 below (Welman *et al*., 2005:55).

Figure 3-1: Research population and sample



Source: McLeod (2014)

For the purpose of this study the population was employees with a Patterson job grade (as discussed in Chapter 1) of C - lower and above working within the gold mining industry. The identified participants all work within the supply chain or have a direct association with the supply chain, either in the capacity as an internal client or a support function to the supply chain.

The calculation of a sample size is important to ensure scientific and statistically significant results during the quantitative research process; however, it would have been cumbersome, costly and not feasible to get all staff members of all gold mines within the North West Province of South Africa to participate in the study. A probability sample was not necessary as the author wished to perform exploratory research to achieve the objectives in sub-section 1.6 of Chapter 1 above. It was assumed that the targeted employees, being in the supply chain or directly associated with the supply chain would have been knowledgeable about supply chain disruption within their various departments. The author thus decided to take a non-probability convenience sample from the study population. A convenience sample refers to data collection from members of the study population conveniently available to participate in the study and was chosen by the author as the best way to collect the data quickly and efficiently due to very little variation in the study population (Sekaran & Bougie, 2009:276; Welman *et al.*, 2005:69).

Self-selecting sampling was also used in the study, because the need for respondents was expressed in an e-mail invitation sent to the study population as described above (see Annexure A). Individuals then had to express their desire to take part in the study and the data was subsequently collected from those who responded to the invitations. This sampling method was chosen to ensure voluntary representation from the gold mining industry in the North West Province of South Africa (Levine *et al*., 2014:256; Sekaran & Bougie, 2009:272; Welman *et al*., 2005:69).

Equation 3-1: the sample size equation below represents the equation generally used to calculate a sample size required to be representative of the population in a research study when random sampling was used. Since the author used a non-probability convenience sample in this study, the sample size equation is thus not relevant as some members of the study population had no chance of being selected (Welman *et al*., 2005:67).

Equation 3-1: Sample size

$$n = \frac{Z^2\pi(1-\pi)}{e^2}$$

Where:

n = the sample size required for the given parameters

Z = the number of standard deviations for the given accuracy

π = the proportion of sample of interest (a value of 0.5 maximises the sample size, therefore minimising the error)

e = the error allowable, for instance, 10% (Levine *et al*., 2014:317)

All the participants were asked to complete one questionnaire and the questionnaire was subsequently sent out to 215 potential respondents. A total of 150 questionnaires were returned of which 123 were used to base the analyses on. Twenty seven questionnaires were discarded due to the respondents having technical difficulties in answering the survey and not completing all the questions. Subsequently a total response rate of 70% and an active response rate of 57% were achieved on the questionnaires. It will, however

be established that the sample used in this study was representative of the population due to the demographic profile of the sample and thus acceptable.

Non-responses were expected and could have been due to:

- the inability of the author to locate the respondents due to incorrect e-mail addresses;
- the inability of respondents to respond due to being excessively busy and not having the time to respond due to their job positions and responsibilities or being absent from work and unreachable via e-mail,
- respondents located but unable to make contact and
- refusal of respondents to answer without reasons (Welman *et al*., 2005:73).

3.5 SURVEY INSTRUMENT

Two schools of thought exist for the capturing of research information, namely quantitative and qualitative approaches. The quantitative approach is an objective approach that seeks precise measurement and analysis of the core concept (Welman *et al*., 2005:8). It is also less time consuming. The qualitative research approach is a descriptive form of research and is subjective in the sense that the researcher interprets the data such as the answers to open-ended questions. The purpose of both quantitative and qualitative research is to attempt to understand the participant's point of view. Quantitative researchers do it by controlling the situation and using remote, empirical and inferential methods. Qualitative researchers use unstructured interviewing and a detailed observation process to gain better information about the participant's views (Welman *et al*., 2005:9).

The author chose a quantitative as well as a limited qualitative approach. Both approaches were followed to meet the research objective as set out in Chapter 1. The qualitative approach was used to augment and confirm the constructs used in the quantitative research process and clarify information from the literature review. Due to the nature of the responsibilities and accountabilities of the target group of respondents

within their organisation, the author anticipated that their time would be limited to respond to the study and decided that the quantitative approach would be the most appropriate method to obtain the maximum number of results in the available timeframe. A limited qualitative approach was also followed by conducting unstructured interviews with subject matter experts to obtain and clarify information relevant to supply chain disruption within the gold mining industry. A qualitative approach was also used to assess feedback received from the respondents of the questionnaire in terms of the questions where respondents were requested to provide other risk sources that can cause supply chain disruption should it occur.

The survey instrument used was a questionnaire because it was an inexpensive instrument that was easy to administer and quick to deliver and the respondents could answer at their convenience. Ethical clearance was obtained from the Ethics Committee in the North-West University Research Support office. The questionnaire was developed using *SurveyMonkey* to ensure ease of use and anonymity. *SurveyMonkey* is an online survey development cloud-based software service company (*SurveyMonkey*, 2016). Prior approval from management was obtained to distribute the questionnaire within the participating organisations (refer Annexure B). The survey was then distributed by the author through electronic distribution by sending an e-mail which included a link to the web address of the relevant web form. A letter including the ethical clearance and code with an explanation of the purpose of the study was also attached (refer Annexure A). Sixteen days were allowed to complete the form. A reminder was sent to the participants after a week as well as the day before the official submission date of the questionnaire.

The questionnaire was constructed by the author and was based on the literature study conducted and reported on in Chapter 2. The input of subject matter experts was obtained during the development of the questionnaire to ensure that the relevant constructs were included in the questionnaire. A focus group was established to review the draft questionnaire. The purpose of the focus group was to ensure that the questionnaire is consistent, logical and user friendly. The focus group consisted of 4 people with collective supply chain experience in excess of 100 years as well as a person with more than 30 years' business experience, but no supply chain experience (refer Annexure C). This was done to ensure that the terminology used in the questionnaire

makes sense to a non-supply chain individual. The questionnaire was updated with the input of the focus group and then sent to the Statistical Consultation Services at the North-West University of the Potchefstroom campus to obtain their expert input on the format and layout of the questionnaire. Their feedback and suggestions were incorporated into the questionnaire and finally the questionnaire was send to a professional language editor to validate spelling and grammar.

The questionnaire consisted of 95 questions that were divided in 8 sections. The first section contained 8 questions relating to the biographical data of the respondents. The second section incorporated 5 questions establishing an overview of supply chain disruption within the organisation; respondents had to select the option best suited to their organisation. The third section related to supply side disruption with 14 selection type questions with the answering of the questions in the form of a 4-point Likert scale with a scale from Strongly disagree (1) to Strongly agree (4). A 4-point scale was used with the objective to eliminate a neutral response from participants. The structure of the questions was of such a nature that if the participant did not agree with the statement he had the option to disagree or strongly disagree and vice versa, making the neutral option immaterial. Provision was made for respondents to add any other supply side disruption that they are aware of through the options of typing the supply side disruption sources (refer 3.10.1). The fourth section related to internal demand side disruption with 12 selection type questions with the answering of the questions in the form of a 4-point Likert scale with a scale from Strongly disagree (1) to Strongly agree (4). Provision was made for respondents to add any other internal demand side disruption that they are aware of through the options of typing the internal demand side disruption sources (refer 3.10.2). The fifth section related to process side disruption with 19 selection type questions with the answering of the questions in the form of a 4-point Likert scale with a scale from Strongly disagree (1) to Strongly agree (4). Provision was made for respondents to add any other process side disruptions that they are aware of through the options of typing the process side disruption sources (refer 3.10.3). The sixth section related to relationship management side disruption with 8 selection type questions with the answering of the questions in the form of a 4-point Likert scale with a scale from Strongly disagree (1) to Strongly agree (4). Provision was made for respondents to add

any other relationship management side disruption that they are aware of through the options of typing the relationship management side disruption sources (refer 3.10.4). The seventh section related to environmental side disruption with 11 selection type questions with the answering of the questions in the form of a 4-point Likert scale with a scale from Strongly disagree (1) to Strongly agree (4). Provision was made for respondents to add any other environmental side disruption that they are aware of through the options of typing the environmental side disruption sources (refer 3.10.5). The final section related to landscape side disruption with 18 selection type questions with the answering of the questions in the form of a 4-point Likert scale with a scale from Strongly disagree (1) to Strongly agree (4). Provision was made for respondents to add any other landscape side disruption that they are aware of through the options of typing the landscape side disruption sources (refer 3.10.6).

The questionnaire consisted of three parts, namely questions to determine the demographic profile of the respondents, the overview of supply chain disruption context within the organisation as well as the 5 spheres of supply chain disruption with the various risk sources per specific sphere. The questionnaire is included in Annexure A.

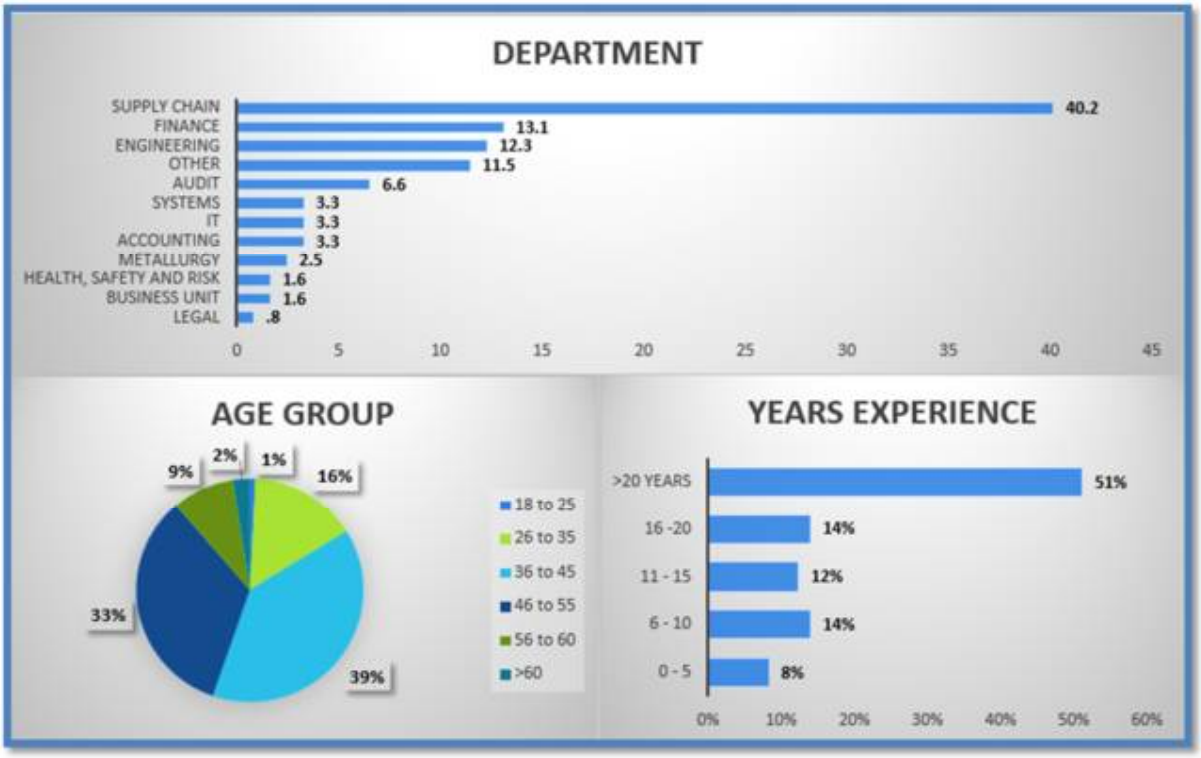
An explorative preliminary investigation was done before distributing the survey (Annexure C). Staff members in the supply chain department at an international gold mining company who are MCIPS certified and involved in supply chain operations, were involved. After some amendments were made, the survey was distributed to the potential participants.

3.6 DEMOGRAPHICAL PROFILE OF RESPONDENTS

Of the 123 respondents that completed the survey, 40.2% (49) were from supply chain departments. Only 22.4% (26) of the respondents were not in managerial positions and this could be contributed to the fact that some managers decided to forward the questionnaire to other staff members within their departments alternatively. In assessing the feedback received, the questionnaire did not specify “junior management” as an option and hence respondents selected “other” as an option as it did not cater for their exact requirements. In terms of the demographics the respondents were mainly in

managerial positions (77.6%), 81.3% (100) of them were between 36 and 60 years old and 68.3% (84) were male.

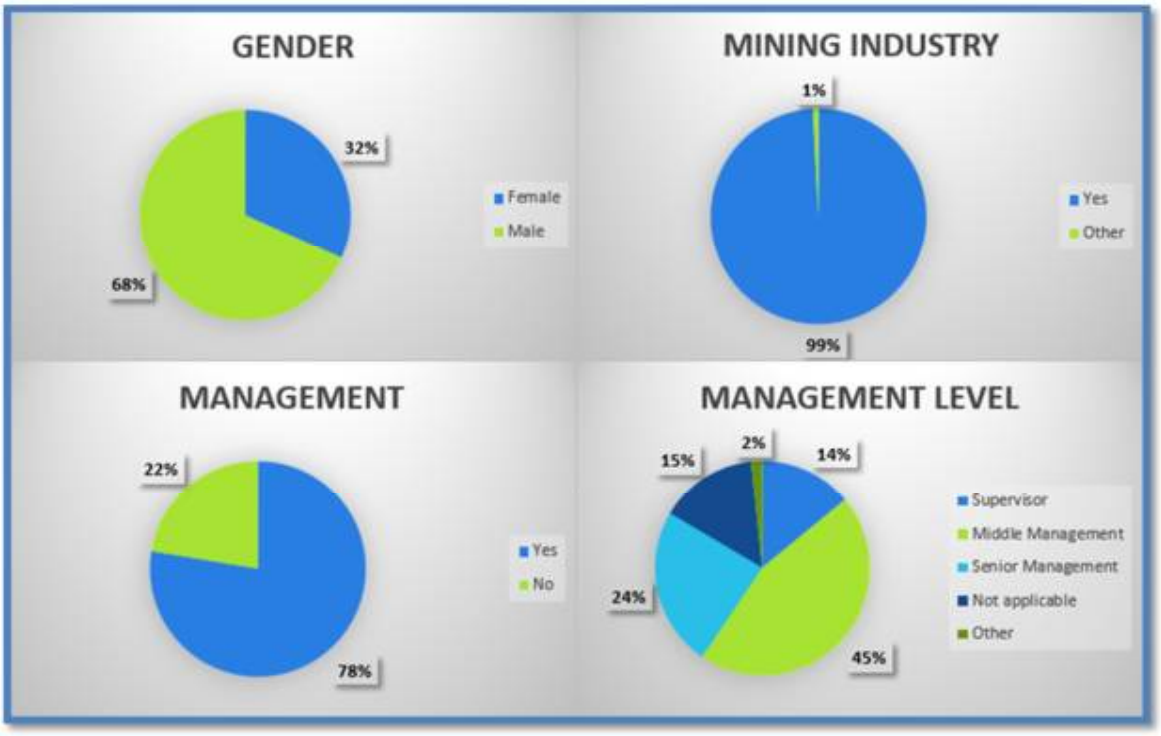
Figure 3-2: Demographical profile based on department, age and experience



It can therefore be concluded that the demographic profile of the sample used in this study was representative of the population due to the corresponding demographic profiles as the majority of management in the mining industry in South Africa at the time when the study was conducted, was male and between the ages of 36 and 60 (Buthelezi, 2013; PWC, 2015c:11; Dlamini, 2016). The mining industry has, since its inception, been an almost exclusively male industry and hence the old adage that mining is the oldest “Boys” club in the world is still very relevant today (PWC, 2015c:28).

It is important to note that the questionnaire was distributed exclusively to individuals working in the gold mining industry in the North West Province of South Africa. The target population for this research study was individuals working within the gold mining industry in the North West Province due to their accessibility, the cost aspect and the timeframe for the completion of the survey.

Figure 3-3: Demographical profiles based on gender, industry and management



In analysing the responses on the question relating to the mining industry, 1% of the participants indicated that they work in other industries, but on further investigation of their feedback it was evident that they are employed within the gold mining industry and hence their responses were included in the assessment. One of the recommendations in Chapter 4 for further research studies is to extend the research to other mining industries.

3.7 EMPIRICAL STUDY: RESULTS

The frequency analysis, descriptive statistics, reliability, T-Test and internal consistency of the selected constructs as well as correlations between constructs and selected questions were tested using the SPSS software package and will be discussed below:

3.7.1 T-Test analysis on biographical and SC disruption overview statistics

The biographical data as well as the supply chain overview data used to assess the context within the industry were assessed to establish if there is a practical significant

difference between the mean as well as the effect size of particular aspects such as gender, management, supply chain versus other departments view, entities reporting disruption versus not reporting entities and the predominant source of disruption within the external inbound SC incidents.

3.7.1.1 Biographical data T-Test

As indicated in the biographical data assessment the mining industry is still very male dominated. As a result of the male dominance within the industry the T-Test was used to determine if there is a practical significant difference between the male and female opinions within the industry. Table 3-1 clearly indicates that there is no significant difference between how males and females perceive the possible supply chain disruption risk factors within the mining industry. In assessing the mean, showing a very similar trend toward agreeing and the effect size, everything $\approx 0.2,$ (almost equal to 0.2) indicating no practical significant difference between genders. The only factor that shows a tendency towards a medium (≈ 0.5) practically visible difference is factor ES with an effect size of ≈ 0.31, but this is not an indication of a large (≈ 0.8) practically significant difference. It is important to note that the p-values are reported for completeness sake only, but won't be interpreted, since a convenience sample instead of a random sample was used.

Table 3-1: Gender T-Test analysis

F#	Description	n	Mean	Std Dev	Sig. (2-tailed) p-value	Effect size
SS	1 Female	39	2.87	0.36	0.307	0.18
	2 Male	84	2.80	0.40		
ID	1 Female	38	2.98	0.38	0.757	0.05
	2 Male	84	2.96	0.44		
PS	1 Female	38	2.85	0.34	0.481	0.12
	2 Male	83	2.80	0.40		
RM	1 Female	37	2.85	0.44	0.854	0.03
	2 Male	79	2.83	0.52		
ES	1 Female	36	2.68	0.55	0.123	0.31
	2 Male	78	2.50	0.53		
LS	1 Female	36	2.78	0.45	0.822	0.04
	2 Male	78	2.76	0.50		

A similar trend as with gender is noticeable with regards to management versus non-management. Table 3-2 points out that there is no significant difference between how management and non-management perceive the possible supply chain disruption risk factors within the mining industry. The mean shows a very similar trend towards agreeing and even strongly agree in some instances. The effect size (small - ≈ 0.2) indicates no practical significant difference between management and non-management. Both the RM (0.29) and ES (0.33) factors indicate a tendency towards a medium (≈ 0,5) practically visible difference, but this is not an indication of a large (≈ 0.8) practically significant difference.

This finding is noteworthy if taken into account that the mining industry in South Africa is still very male dominated as mentioned before. Despite the dominance of the male gender within the industry the perception of the genders are the same with regards to SCD within the gold mining industry. The majority of respondents were on management level (78%) indicating that management level employees have a similar view on SCD that

they share with non-management level employees resulting in no practical significant difference between management and non-management levels. This might be an indication of ***"groupthink"*** *(refer to the Bay of Pigs case study) especially if the years of experience is taken into account, 77% of respondents had 11 years or more experience within the industry. This might limit the identification, innovation and mitigating strategies relating to SCD and is not the optimal situation to address the problem in a supply chain environment that is becoming more complex and important within the organisation. Groupthink could result in rationalising away serious problems and danger signs.*

Table 3-2: Management T-Test analysis

F#	Description	n	Mean	Std Dev	Sig. (2-tailed) p-value	Effect size
SS	1 Management	90	2.82	0.37	0.730	0.08
	2 Non-Management	26	2.85	0.43		
ID	1 Management	90	2.97	0.43	0.697	0.09
	2 Non-Management	25	3.01	0.41		
PS	1 Management	90	2.81	0.38	0.292	0.24
	2 Non-Management	24	2.90	0.36		
RM	1 Management	87	2.87	0.51	0.178	0.29
	2 Non-Management	22	2.72	0.43		
ES	1 Management	86	2.53	0.51	0.176	0.33
	2 Non-Management	21	2.73	0.63		
LS	1 Management	86	2.78	0.48	0.958	0.01
	2 Non-Management	21	2.77	0.52		

Similar to both gender and management the assessment of supply chain versus other departments show no significant difference. The other departments were grouped together into other to conduct the analysis. In Table 3-3 below the mean also shows a very similar trend towards agreeing and strongly agree in some instances. The effect size (small - ≈ 0.2) indicates no practical significant difference between the supply chain view and other departments that participated in the survey. In this instance the ES (0.29) and

LS (0.28) factors indicate a tendency towards a medium (≈ 0,5) practically visible difference, but as in the above instances it is not an indication of a large (≈ 0.8) practically significant difference. *The finding is notable if taken into account that the supply chain function works with SCD on a direct basis and other departments might have an indirect interaction with the concept. This could be explained in that the other departments are negatively affected by the occurrence of SCD in that the products and / or services they require are not available due to the disruption. They will in this instance liaise with the supply chain function to mitigate the impact and resolve the problem as soon as possible to ensure that they receive the product or service, thus providing them insight into SCD*.

Table 3-3: Supply chain versus other departments' T-Test analysis

F#	Description	n	Mean	Std Dev	Sig. (2-tailed) p-value	Effect size
SS	1 Supply chain	49	2.86	0.34	0.317	0.16
	2 Other	74	2.80	0.42		
ID	1 Supply chain	48	3.02	0.43	0.321	0.18
	2 Other	74	2.94	0.42		
PS	1 Supply chain	48	2.85	0.34	0.434	0.13
	2 Other	73	2.80	0.41		
RM	1 Supply chain	43	2.83	0.52	0.901	0.02
	2 Other	73	2.84	0.48		
ES	1 Supply chain	43	2.66	0.56	0.131	0.29
	2 Other	71	2.50	0.52		
LS	1 Supply chain	43	2.86	0.51	0.144	0.28
	2 Other	71	2.72	0.46		

3.7.1.2 Supply chain disruption overview T-Test

Table 3-4 indicates that there is no significant difference between entities reporting supply chain disruptions and those not reporting it. The mean shows a very similar trend toward agreeing and in some instances strongly agree. The effect size (small - ≈ 0.2)

indicates no practical significant difference between participants. The ID factor (0.38) indicates a tendency towards a medium (≈ 0,5) practically visible difference, but as in the above instances it is not an indication of a large (≈ 0.8) practically significant difference. *This is important and the correlation could be due to the fact that although some respondents do not report SCD they are not excluded from the impact and effect of SCD within their organisation and function. As stated in Chapter 2, the supply chain has an impact and influence on the wider organisation and the full supply chain network (downstream internal customers and upstream suppliers), thus it is understandable that there will be a strong grasp and knowledge of SCD. The affected functions will liaise with the supply chain function to mitigate the impact and resolve the problem as soon as possible to ensure that they receive the product or service, thus providing them insight into SCD.*

Table 3-4: Report SC disruption T-Test analysis

F#	Description	n	Mean	Std Dev	Sig. (2-tailed) p-value	Effect size
SS	1 Report	84	2.84	0.38	0.572	0.11
	2 Not Report	38	2.79	0.42		
ID	1 Report	83	3.02	0.41	0.052	0.38
	2 Not Report	38	2.85	0.44		
PS	1 Report	82	2.81	0.39	0.857	0.03
	2 Not Report	38	2.82	0.37		
RM	1 Report	81	2.82	0.48	0.633	0.09
	2 Not Report	35	2.87	0.54		
ES	1 Report	80	2.56	0.55	0.915	0.02
	2 Not Report	34	2.55	0.53		
LS	1 Report	80	2.77	0.48	0.909	0.02
	2 Not Report	34	2.76	0.50		

The same trend is noted in Table 3-5 below with regards to entities analysing the source of SC disruption versus those not analysing the source of disruption; there is no significant

difference. The mean shows a trend towards agreeing and the effect size (small - ≈ 0.2) indicates no practical significant difference between participants. The ES (0.32) and LS (0.29) factors indicate a tendency towards a medium (≈ 0,5) practically visible difference, but is not an indication of a large (≈ 0.8) practically significant difference. *This again confirms the impact of the supply chain function on other functions with a similar view as the impact and liaison with the supply chain. It provides various stakeholders with good insight and knowledge on SCD as the supply chain function will provide feedback to the affected function with regards to the source of the disruption and the action plan to mitigate and resolve the problem.*

Table 3-5: Analyse source of SC disruption T-Test analysis

F#	Description	n	Mean	Std Dev	Sig. (2-tailed) p-value	Effect size
SS	1 Analyse source	74	2.84	0.40	0.647	0.09
	2 Do not analyse	42	2.80	0.38		
ID	1 Analyse source	73	2.99	0.43	0.620	0.09
	2 Do not analyse	42	2.95	0.42		
PS	1 Analyse source	73	2.80	0.40	0.276	0.19
	2 Do not analyse	41	2.87	0.34		
RM	1 Analyse source	71	2.82	0.49	0.500	0.13
	2 Do not analyse	39	2.88	0.53		
ES	1 Analyse source	70	2.49	0.57	0.081	0.32
	2 Do not analyse	38	2.68	0.48		
LS	1 Analyse source	70	2.73	0.49	0.138	0.29
	2 Do not analyse	38	2.87	0.46		

In all the various T-Test analysis conducted above it is evident that there is no significant difference between the various concepts with only a medium tendency in specific instances as indicated. *The finding is significant and confirms the importance of supply chain within the wider organisation. As illustrated in Figure 1-4 in Chapter 1 the supply chain function has a major impact on various business aspects within the organisation*

including sales revenue, cost, working capital and physical capital thus a direct influence on the economic profit through the net income and assets of the organisation and ultimately an impact on shareholder value:

- ***Sales revenue** depends on the supply chain delivering product availability.*
- ***Cost** – 60% - 70% of cost is controlled by the extended supply chain.*
- ***Working capital** – inventory is managed by the supply chain.*
- ***Physical capital** – supply chain determines the utilisation of factories, warehouses and space in retail stores.*

This illustrates the fact that other functions within the organisation, internal clients and external suppliers are dependent on the supply chain in order to conduct their business and any factor impacting the supply chain will eventually impact their business, driving them to understand and liaise with the supply chain to prevent any negative impact on their business. Thus SCD could wreak havoc on the organisation's time-to-market, revenue forecast and market share assumptions (Dittmann, 2014:4, Hendricks & Singhal, 2008:783). The size of the supply chain network has increased, dependencies between entities and functions have evolved and as a result the supply chain has become central to the effectiveness of the organisation. The supply chain function is responsible for managing the upstream and downstream entities, the co-ordination and collaboration with channel partners, internal customers and suppliers. Based on this the relationship between the supply chain and other functions within the business have become more dynamic and the other functions and management recognising the importance of having a close working relationship with the supply chain function. This has resulted in knowledge and information share between the entities and this could contribute as to why the research could not find a significant difference between the various concepts. This could also be an indication that groupthink is prevalent within the industry.

Note: p-values are reported for completeness sake, but won't be interpreted, since a convenience sample instead of a random sample was used.

3.7.2 Frequency analysis and descriptive statistics

3.7.2.1 An overview of the supply chain disruption context

The second section of the questionnaire explored the overview of supply chain disruption context within the mining industry focussing on the reporting of affected performance, SCD incidents experienced, the origin of SCD, the predominant source of disruption and finally the type of disruptions experienced.

Table 3-6 below illustrates that the majority (52.5% or 64) of respondents indicated that, although their company report performance that is affected by SCD, it is not aggregated and only occur within certain departments or functions.

Table 3-6: Reporting performance affected by SCD (Q B1)

B1: Do you report performance affected by supply chain disruptions i.e. where unplanned costs have been incurred or loss of productivity or revenue was experienced?	Frequency	Valid Percent (%)
Yes – this is coordinated and reported across the whole company	20	16.4
Yes – within certain departments, functions but NOT aggregated	64	52.5
No	38	31.1
Total	122	100.0
Missing	1	
Total	123	

A further 31.1% (38) indicated that they don't report on affected performance at all. With only 16.4% (20) indicating that performance affected by SCD is reported in a coordinated approach, it hints towards a lack of a holistic approach towards SCD within the gold mining industry. This is well below the 26.5% of organisations reporting in a coordinated and aggregated basis enterprise wide found by the Business Continuity Institute survey (2015:4). This might impede the company's visibility and a pro-active approach in mitigating risk.

With regards to the questions as to how many SCD incidents the company experienced in the past 12 months Table 3-7 shows that 44.7% (55) of the respondents did not know

how many incidents the organisation experienced, 4.1% (5) indicated that they experienced no incidents with 21.1% (26) indicating that they experienced between 1 and 5 incidents and 13.8% (17) indicated that they experienced more than 50 incidents. This supports the research and again illustrates the devastating effect that SCD can have on an organisation. *As illustrated in Chapter 2, SCD has a negative impact on shareholder value and only one incident can cause major damage to the reputation or impede on the competitive advantage of the organisation. The potential danger posed by the high number of disruptions clearly indicates the need for a robust SCDF to identify, monitor, control and mitigate SCD within the organisation.*

Table 3-7: Number of SCD incidents within the organisation (Q B2)

B2: How many SC incidents did your company experienced in the past 12 months that caused a disruption	Frequency	Valid Percent (%)
None	5	4.1
1 – 5	26	21.1
6 – 10	10	8.1
11 – 20	5	4.1
21 – 50	5	4.1
>50	17	13.8
I don't know	55	44.7
Total	123	100.0

In terms of the disruptions experienced by organisations in the past 12 months, Table 3-8 indicates that 48.0% (59) of the respondents responded that they don't know the proportion that originated in the external inbound (via suppliers) supply chain. A total of 20.3% (25) indicated that less than 10% originates in the external inbound supply chain and only 0.8% (1) indicated that more than 90% originates in the external inbound supply chain.

This seems to support the finding that respondents in the mining industry are not clear on the number of incidents and the proportion that originates from the external inbound

supply chain. *The Business Continuity Institute (2015:9) in their survey found a very similar trend with the highest number of respondents also indicating that they don't know the proportion that originated in the external inbound supply chain.*

Table 3-8: Proportion of SCD originating in the external inbound SC (Q B3)

B3: Looking back at the disruptions experienced by your company in the past 12 months, what proportion can be calculated which originated in your external inbound (via suppliers) supply chain? Choose an option that fits best.	Frequency	Valid Percent (%)
<10%	25	20.3
11-25%	14	11.4
26-50%	8	6.5
51-75%	13	10.6
76-90%	3	2.4
>90%	1	0.8
I don't know the proportion	59	48.0
Total	123	100.0

Table 3-9 indicates that the predominant source of disruptions across all events according to the respondents reside (44.8% or 52) with the immediate supplier (Tier 1). Further to this 36.2% (42) reported that they do not analyse the full supply chain to identify the original source of the disruption. The minority indicated that the predominant source resides within the Tier 2 supplier (14.7% or 17) or even further down the Tier 3 or Tier 4 suppliers (4.3% or 5). *The research conducted by the Business Continuity Institute (2015:09) found a similar trend with the highest percentage of incidents within Tier 1 (86.6%) followed by Tier 2 (39.6%) and Tier 3 and lower (11.5%).*

Table 3-9: The predominant sources of SCD (Q B4)

B4: Considering the external inbound SC incidents you are aware of in the last 12 months, what was the predominant source of disruption across all events?	Frequency	Valid Percent (%)
With the immediate supplier (TIER 1)	52	44.8
With the supplier's supplier (TIER 2)	17	14.7
Much lower down the SC (i.e. TIER 3, TIER 4, etc.)	5	4.3
We do NOT analyse the full SC to identify the original source of the disruption	42	36.2
Total	116	100.0
Missing	7	
Total	123	

Illustrated in Table 3-10 the majority of respondents indicated that they have experienced physical disruption (73.9% or 85) as opposed to non-physical disruption (2.6% or 3) with 23.5% (27) indicating that they have experienced both physical and non-physical disruptions.

Table 3-10: The types of disruption experienced (Q B5)

B5: What has been your experience of physical and non-physical disruption in your SC? We have experienced…..	Frequency	Valid Percent (%)
Physical disruption (e.g. product recall or delivery failure)	85	73.9
Non-physical disruption (e.g. cyber-attack or data breach)	3	2.6
Both physical & non-physical disruption	27	23.5
Total	115	100.0
Missing	8	
Total	123	

The above analysis indicates that although SCD exists within the mining industry the approach in terms of the reporting of, visibility, knowledge, predominant sources, number

of incidents and the proportion of the incidents is not aggregated, well communicated or controlled within the organisations. This supports the primary objective of the research to establish a SCDF for the gold mining industry that can be adopted by business managers as a managerial tool to identify supply chain disruption risk sources. This will enable them to address and minimise the gaps in terms of reporting, visibility, communication and control.

3.7.2.2 Supply chain risk sources

Tables 3-12 to 3-17 display frequencies and descriptive statistics for the supply chain risk sources per factor to be included in the SCDF for the gold mining industry. Missing values were treated as missing and subsequently omitted in the calculations of the means and standard deviations. With regards to all missing data in the discussions below, it did not influence the various factors and was thus discarded from the analysis without any influence on the factors. Statistics are based on all cases with valid data. Questions SS15, ID13, PS20, RMS 9, ES12 and LS19 were recorded with the last option in the selection interpreted as missing and subsequently omitted in the calculations of the means and standard deviations.

The mean is the most common measure of central tendency and the standard deviation measures the "average" scatter around the mean (Levin *et al*., 2014:142).

Table 3-11 below reflects the factors to be discussed in this section.

Table 3-11: Factor Names

Factor Number	Factor Name	Table Number
Factor 1	Supply side disruption	Table 3-12
Factor 2	Internal demand side disruption	Table 3-13
Factor 3	Process side disruption	Table 3-14
Factor 4	Relationship management side disruption	Table 3-15
Factor 5	Environmental side disruption	Table 3-16
Factor 6	Landscape side disruption	Table 3-17

The supply side disruption factor showed in Table 3-12 below includes the following risk sources identified through the literature review and the unstructured interviews with supply chain subject matter experts: sole sourcing (SS1); labour issues (SS2); financial issues e.g. cash flow constraints (SS3); compliance issues e.g. legal, governance (SS4); product or services quality problems (SS5); delivery problems e.g. late delivery (SS6); transport network failure (SS7); product recall (SS8); imported products (SS9); pricing instability (SS10); product shortages e.g. parts or equipment (SS11); product counterfeiting (SS12); supplier failures (SS13) and product sabotage (SS14). The means for these questions ranged between 2.28 and 3.29 with standard deviations of between 0.61 and 0.80. The mean indicates a tendency towards agree and strongly agree with product sabotage indicating a tendency towards disagree (2.28) and delivery problems (3.29) with a tendency to strongly agree.

Table 3-12: Factor 1 - Supply side disruption – Frequencies and descriptive analysis

Question	n	% SD	% D	% A	% SA	Mean	Std Dev
Supply side disruption: The potential of a major SC disruption is high due to the following:							
SS1 Sole Sourcing	123	3.3	20.3	55.3	21.1	2.94	0.74
SS2 Labour issues	123	4.1	18.7	48.8	28.5	3.02	0.80
SS3 Financial issues	123	5.7	25.2	58.2	10.6	2.74	0.72
SS4 Compliance issues	123	3.3	18.7	61.8	16.3	2.91	0.69
SS5 Quality issues	123	0.8	22.0	56.1	21.1	2.98	0.68
SS6 Delivery problems	123	0	8.9	52.8	38.2	3.29	0.62
SS7 Transport network failure	123	2.4	35.0	45.5	17.1	2.77	0.76
SS8 Product recall	123	4.1	48.0	42.3	5.7	2.50	0.67
SS9 Imported products	123	4.1	31.7	48.8	15.4	2.76	0.76
SS10 Pricing instability	123	1.6	31.7	47.2	19.5	2.85	0.75
SS11 Product shortages	123	2.4	15.4	65.0	17.1	2.97	0.65
SS12 Product counterfeiting	123	6.5	50.4	32.5	10.6	2.47	0.77
SS13 Supplier failures	123	0.8	13.8	65.0	20.3	3.05	0.61
SS14 Product sabotage	123	11.4	53.7	30.1	4.9	2.28	0.73

Legend: SD – Strongly Disagree; D – Disagree; A – Agree; SA – Strongly Agree

Table 3-13 below encapsulates the second factor namely internal demand side disruption with risk sources including internal distribution problems (ID1); budget constraints (ID2); demand error (ID3); demand volatility (ID4); system risks (ID5); incorrect specifications

(ID6); incorrect drawings (ID7); incorrect standards (ID8); lack of communication (ID9); poor planning and execution (ID10); labour issues (ID11) and product failures (ID12). The means for the questions in this construct ranged between 2.73 and 3.43 with standard deviations of between 0.58 and 0.74. The mean indicates a strong tendency towards agree and in many instances towards strongly agree. Incorrect specifications (3.20), incorrect drawings (3.01), incorrect standards (3.01), lack of communication (3.39) and poor planning and execution (3.43) shows a tendency towards strongly agree. It must be noted that the sample size (n) is 122 as one of the respondents did not complete this section of the questionnaire. The reasons for non-completion was discussed earlier in this chapter and as mentioned it did not have a significant influence on the analysis and was thus discarded.

Table 3-13: Factor 2 - Internal demand side disruption – Frequencies and descriptive analysis

Question	n	% SD	% D	% A	% SA	Mean	Std Dev
Internal demand side disruption: The potential of a major SC disruption is high due to the following:							
ID1 Internal distribution	122	2.5	29.5	56.6	11.5	2.77	0.68
ID2 Budget constraints	122	1.6	27.9	53.3	17.2	2.86	0.71
ID3 Demand error	122	1.6	36.9	48.4	13.1	2.73	0.71
ID4 Demand volatility	122	1.6	28.7	58.2	11.5	2.80	0.66
ID5 System risks	122	0	35.2	56.6	8.2	2.73	0.60
ID6 Incorrect specifications	122	1.6	13.9	46.7	37.7	3.20	0.74
ID7 Incorrect drawings	122	1.6	21.3	51.6	25.4	3.01	0.73
ID8 Incorrect standards	122	1.6	20.5	53.3	24.6	3.01	0.72
ID9 Lack of communication	122	0	4.9	50.8	44.3	3.39	0.58
ID10 Planning, execution	122	0	5.7	45.9	48.4	3.43	0.60
ID11 Labour issues	122	2.5	23.8	52.5	21.3	2.93	0.74
ID12 Product failures	122	1.6	30.3	58.2	9.8	2.76	0.64

Legend: SD – Strongly Disagree; D – Disagree; A – Agree; SA – Strongly Agree

The third factor relates to process side disruptions with the following risk sources identified: system anomalies (PS1); inventory control i.e. shortages, JIT (just in time) (PS2); capacity constraints (PS3); equipment failure (PS4); industrial action i.e. strikes (PS5); quality issues (PS6); compliance issues e.g. SOX compliance (PS7); intellectual property violations (PS8); energy scarcity i.e. loss of supply or rapid price increase (PS9);

health and safety incidents (PS10); cost cutting (PS11); outsourcer failure (PS12); accounts payable processing (PS13); supply chain security (PS14); supply chain visibility (PS15); business strategy e.g. outsourcing (PS16); lack of SC agility e.g. alertness, accessibility, decisiveness, swiftness, flexibility (PS17); supply chain complexity (PS18) and change in leadership e.g. management changes (PS19). Means for these questions ranged between 2.41 and 3.07 with standard deviations of between 0.59 and 0.80. Intellectual property violations (2.41) show a tendency towards disagree while lack of SC agility (3.07) and supply chain complexity (3.00) reveal an inclination towards strongly agree. The sample size (n) is 121 as two of the respondents did not complete this section of the questionnaire. It can be discarded as it had no significant influence on the outcome of the analysis.

Table 3-14: Factor 3 - Process side disruption – Frequencies and descriptive analysis

Question	n	% SD	% D	% A	% SA	Mean	Std Dev
Process side disruption: The potential of a major SC disruption is high due to the following:							
PS1 System anomalies	121	0.8	36.4	53.7	9.1	2.71	0.64
PS2 Inventory control	121	1.7	26.4	57.9	14.0	2.84	0.67
PS3 Capacity constraints	121	1.7	31.4	57.9	9.1	2.74	0.64
PS4 Equipment failure	121	1.7	24.0	61.2	13.2	2.86	0.65
PS5 Industrial action	121	5.0	17.4	52.1	25.6	2.98	0.80
PS6 Quality issues	121	3.3	24.0	57.9	14.9	2.84	0.71
PS7 Compliance issues	121	6.6	46.3	35.5	11.6	2.52	0.79
PS8 Intellectual property	121	5.8	52.9	35.5	5.8	2.41	0.69
PS9 Energy scarcity	121	0.8	30.6	48.8	19.8	2.88	0.73
PS10 Health & Safety	121	0.8	28.1	57.0	14.0	2.84	0.66
PS11 Cost cutting	121	0.8	19.0	62.8	17.4	2.97	0.63
PS12 Outsourcer failure	121	0	22.3	64.5	13.2	2.91	0.59
PS13 AP processing	121	3.3	32.2	48.8	15.7	2.77	0.75
PS14 Supply chain security	121	0.8	42.1	51.2	5.8	2.62	0.61
PS15 Supply chain visibility	121	0	40.5	46.3	13.2	2.73	0.68
PS16 Business strategy	121	1.7	25.6	58.7	14.0	2.85	0.67
PS17 Lack of SC agility	121	0	17.4	58.7	24.0	3.07	0.64
PS18 SC complexity	121	1.7	19.8	55.4	23.1	3.00	0.71
PS19 Change in leadership	121	2.5	24.8	46.3	26.4	2.97	0.76

Legend: SD – Strongly Disagree; D – Disagree; A – Agree; SA – Strongly Agree

Relationship management side disruption denotes the fourth factor. The factor approach relationship management from two sides, namely the relationship with external suppliers as well as the relationship with internal customers. The following risk sources were identified: trust of the strategic supplier (RMS1); information sharing with strategic suppliers (RMS2); relationship commitment with strategic suppliers (RMS3); supplier relationship management (RMS4); trust of the internal customer (RMS5); information sharing with internal customers (RMS6); relationship commitment with internal customers (RMS7) and internal customer relationship management (RMS8). The means for these questions ranged between 2.67 and 2.97 with standard deviations of between 0.60 and 0.71. Both relationship commitment with the internal customers (2.96) and internal customer relationship management (2.97) shows a tendency towards strongly agree. The sample size (n) is 116 as seven of the respondents did not complete this section of the questionnaire and can be discarded as it had no significant influence on the outcome of the analysis.

Table 3-15: Factor 4 - Relationship management side disruption – Frequencies and descriptive analysis

Question	N	% SD	% D	% A	% SA	Mean	Std Dev
Relationship management side disruption: The potential of a major SC disruption is high due to the lack off:							
RMS1 Trust strategic supplier	116	1.7	36.2	55.2	6.9	2.67	0.63
RMS2 Information sharing Supplier	116	1.7	35.3	54.3	8.6	2.70	0.65
RMS3 Relationship commitment Supplier	116	0.9	30.2	56.0	12.9	2.81	0.66
RMS4 Supplier Relationship Management	116	0.9	31.0	50.0	18.1	2.85	0.71
RMS5 Trust internal customer	116	0	27.6	61.2	11.2	2.84	0.60
RMS6 Information sharing Customer	116	0	25.0	60.3	14.7	2.90	0.62
RMS7 Relationship commitment Customer	116	0.9	19.8	62.1	17.2	2.96	0.64
RMS8 Internal customer relationship	116	1.7	19.8	58.6	19.8	2.97	0.68

Legend: SD – Strongly Disagree; D – Disagree; A – Agree; SA – Strongly Agree

Table 3-16 denotes the fifth factor namely environmental side disruption that includes the following risk sources: natural disasters e.g. earthquakes, tsunamis (ES1); adverse weather (ES2); conflict minerals e.g. illegal miners (ES3); customs rules and regulations (ES4); import duties (ES5); unethical conduct e.g. child labour (ES6); exchange rate volatility (ES7); commodity price volatility (ES8); terrorist attacks (ES9); environmental incidents e.g. pollution, waste management (ES10) and lack of alertness to environmental changes (ES11). The means for these questions ranged between 2.25 and 2.99 with standard deviations of between 0.65 and 0.88. This is the factor with the strongest tendency towards disagree, with natural disasters (2.39), adverse weather (2.26), unethical conduct (2.34) and terrorist attacks (2.25) leaning towards disagree with the rest of the questions revealing a tendency towards agree. The sample size (n) is 114 as nine of the respondents did not complete this section of the questionnaire. It can be discarded as it had no significant influence on the outcome of the analysis.

Table 3-16: Factor 5 - Environmental side disruption – Frequencies and descriptive analysis

Question	n	% SD	% D	% A	% SA	Mean	Std Dev
Environmental side disruption: The potential of a major SC disruption is high due to the following:							
ES1 Natural disasters	114	14.0	45.6	28.1	12.3	2.39	0.88
ES2 Adverse weather	114	11.4	54.4	30.7	3.5	2.26	0.71
ES3 Conflict minerals	114	6.1	42.1	34.2	17.5	2.63	0.84
ES4 Customs rules & regulations	114	3.5	33.3	55.3	7.9	2.68	0.67
ES5 Import duties	114	2.6	43.0	48.2	6.1	2.58	0.65
ES6 Unethical conduct	114	14.0	46.5	30.7	8.8	2.34	0.83
ES7 Exchange rate volatility	114	7.0	28.1	41.2	23.7	2.82	0.88
ES8 Commodity price volatility	114	2.6	20.2	52.6	24.6	2.99	0.75
ES9 Terrorist attacks	114	17.5	48.2	26.3	7.9	2.25	0.84
ES10 Environmental incidents	114	4.4	40.4	44.7	10.5	2.61	0.74
ES11 Lack of alertness	114	2.6	43.9	43.9	9.6	2.61	0.70

Legend: SD – Strongly Disagree; D – Disagree; A – Agree; SA – Strongly Agree

The final factor, namely landscape side disruption with risk sources identified as: political upheaval e.g. civil unrest, conflict (LS1); cyber-attacks (LS2); data breach (LS3); unplanned IT outages (LS4); unplanned telecommunication outages (LS5); fraud (LS6);

corruption (LS7); bribery (LS8); global logistics (LS9); nationalisation (LS10); availability of natural resources (LS11); laws and regulatory issues (LS12); BEE compliance (LS13); loss of SC talent and skills (LS14); human illness i.e. TB or HIV Aids (LS15); negative media coverage e.g. Twitter, Facebook, Newspapers, Radio, TV etc. (LS16); failure of critical infrastructure (LS17) and rapidly changing technologies (LS18). Means for these questions ranged between 2.49 and 3.24 with standard deviations of between 0.66 and 0.82. The factors show an overall tendency towards agree with BEE compliance (3.18) and loss of SC talent and skills (3.24) presenting a tendency towards strongly agree. The sample size (n) is 114 as nine of the respondents did not complete this section of the questionnaire and can be discarded as it had no significant influence on the outcome of the analysis.

Table 3-17: Factor 6 - Landscape side disruption – Frequencies and descriptive analysis

Question	N	% SD	% D	% A	% SA	Mean	Std Dev
Landscape side disruption: The potential of a major SC disruption is high due to the following:							
LS1 Civil unrest, conflict	114	7.0	33.3	48.2	11.4	2.64	0.78
LS2 Cyber-attacks	114	6.1	41.2	45.6	7.0	2.54	0.72
LS3 Data breach	114	6.1	43.0	46.5	4.4	2.49	0.68
LS4 Unplanned IT outages	114	5.3	40.4	41.2	13.2	2.62	0.78
LS5 Unplanned Telecoms	114	4.4	40.4	39.5	15.8	2.67	0.80
LS6 Fraud	114	3.5	22.8	55.3	18.4	2.89	0.74
LS7 Corruption	114	3.5	22.8	50.0	23.7	2.94	0.78
LS8 Bribery	114	3.5	22.8	50.9	22.8	2.93	0.77
LS9 Global logistics	114	1.8	34.2	51.8	12.3	2.75	0.69
LS10 Nationalisation	114	3.5	41.2	38.6	16.7	2.68	0.79
LS11 Availability resources	114	1.8	36.0	51.8	10.5	2.71	0.68
LS12 Laws & Regulatory	114	0.9	26.3	57.9	14.9	2.87	0.66
LS13 BEE compliance	114	1.8	20.2	36.0	42.1	3.18	0.82
LS14 Loss of SC talent	114	0	14.9	46.5	38.6	3.24	0.70
LS15 Human illness	114	2.6	50.9	36.8	9.6	2.54	0.71
LS16 Negative media cover	114	5.3	44.7	38.6	11.4	2.56	0.77
LS17 Infrastructure failure	114	0.9	25.4	57.9	15.8	2.89	0.66
LS18 Changing technology	114	0.9	38.6	47.4	13.2	2.73	0.70

Legend: SD – Strongly Disagree; D – Disagree; A – Agree; SA – Strongly Agree

Both the environmental and landscape side disruption factors form part of the fifth sphere of the proposed SCDF. Although they form part of a single sphere each factor has its own

unique risk sources that had to be tested independently to determine if the source should be part of the factor that can cause supply chain disruption.

3.8 RELIABILITY AND INTERNAL CONSISTENCY

Cronbach's alpha is a measure of reliability and internal consistency and indicates whether items and subsets of items in the measuring instrument are highly correlated. Cronbach's alpha ($\propto$) is therefore a coefficient of reliability of items in a survey instrument and has to do with the quality of the measurement (UCLA, 2016:1). If, for instance, an instrument such as a questionnaire produces different scores every time it is used under the same conditions, it will have low reliability. A value of $\propto > 0.7$ is considered to be acceptable and a value of $\propto$ 0.8 is considered to be good and is often used as evidence of an underlying or latent construct (Field, 2007:666; Sekaran & Bougie, 2009:325).

Table 3-18 summarises the Cronbach's alpha obtained per individual factor. It is evident from the table that all six factors has a $\propto > 0.8$ and is thus considered good and should thus be a construct for the supply chain disruption framework.

Table 3-18: Cronbach's alpha values per factor

C#	Construct	Questions	Cronbach's alpha	Mean	Std Dev.
SS	Supply side	SS1 – SS14	0.819	2.82	0.39
ID	Internal demand side	ID1 – ID12	0.858	2.97	0.42
PS	Process side	PS1 – PS19	0.873	2.82	0.38
RM	Relationship management side	RM1 – RM8	0.898	2.84	0.50
ES	Environmental side	ES1 – ES11	0.895	2.56	0.54
LS	Landscape side	LS1 – LS18	0.923	2.77	0.48

The mean for the various constructs ranges from 2.56 to 2.97, indicating a tendency towards agree. The standard deviation range is between 0.38 and 0.54. Based on this the constructs can be included in the SCDF with confidence.

3.9 CORRELATIONS

Spearman's rho (ρ) correlation, also called Spearman's rank correlation coefficient, is a nonparametric equivalent of the Pearson correlation and a procedure that measures the linear correlation between two variables. A negative correlation between two constructs

implies that as the one construct increases, the other one decreases (Welman *et al*., 2005:229).

The correlation was determined between the various factors: supply side (SS), internal demand side (ID), process side (PS), relationship management side (RM), environmental side (ED) and landscape side (LS). Similarly the correlations between the factors and age (A2), experience (A7), disruptions experienced (B2) and origin of disruption (B3) in the external inbound (via suppliers) supply chain was calculated. As mentioned before the p-values are reported for completeness sake, but won't be interpreted, since a convenience sample instead of a random sample was used.

Table 3-19: Factor correlation

	Spearman's rho	SS	ID	PS	RM	ES	LS
SS	Correlation Coefficient	1.000					
	Sig. (2-tailed)						
	N	123					
ID	Correlation Coefficient	0.695**	1.000				
	Sig. (2-tailed)	0.000					
	N	122	122				
PS	Correlation Coefficient	0.679**	0.613**	1.000			
	Sig. (2-tailed)	0.000	0.000				
	N	121	121	121			
RM	Correlation Coefficient	0.408**	0.477**	0.613**	1.000		
	Sig. (2-tailed)	0.000	0.000	0.000			
	N	116	116	116	116		
ES	Correlation Coefficient	0.576**	0.510**	0.529**	0.363**	1.000	
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		
	N	114	114	114	114	114	
LS	Correlation Coefficient	0.531**	0.521**	0.631**	0.490**	0.719**	1.000
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	
	N	114	114	114	114	114	114

**** Correlation is significant at the 0.01 level (2-tailed)**

Table 3-19 depicts the correlation between the various factors and it is evident that there is a large (~ 0.5) (approximately 0.5), positive practical significant relationship between all the factors. The correlation between RM and SS (0.408**) has a medium (~ 0.3) to large correlation as well as the correlation between ES and RM (0.363**). This is significant in terms of the relationship these factors have on each other and their inclusion in the SCDF. As the one construct increases the other construct will increase due to the positive correlation between the factors.

Table 3-20 indicates the correlation analysis between the various factors and both age (A2) and experience (A7). From the data it is clear that there is a small (~ 0.1) thus no practical significant relationship. A negative, no practical significant or small correlation exist between SS and age (-.063), SS and experience (-.060), ID and age (-.113), ID and experience (-.141); PS and experience (-.032), ES and age (-.043) and ES and experience (-.129). Neither age nor experience has a correlation with the respondents' opinions on the various supply chain disruption factors. This correlates with the findings in the T-test analysis earlier in this chapter. *The fundamental importance of the supply chain to the wider organisation ensures that irrespective of age or experience of the respondents they have a similar view on the various constructs. Again this might indicate that groupthink is prevalent within the relevant organisations. Groupthink is a phenomenon when a group of people get together and* start to think collectively with one mind. *The group is more concerned with maintaining unity than with objectively evaluating their situation, alternatives and options. The group, as a whole, tends to take irrational actions or overestimate their positions or moral rightness. Groupthink tends to occur in isolated groups, especially in groups with no clear rules for decision making and in groups where all of the people involved have similar backgrounds. It is destructive to effective thinking.*

Examples of group think includes a group of employees at a company with a product or process that is becoming outdated who are unwilling to consider new alternatives to advance in the industry. The employees may collectively live in a world where they can't understand why their product is not selling and may refuse to acknowledge the economic reality that they cannot survive without advancing. Another examples as previously referred to is the Bay of Pigs invasion. An invasion was planned by the Eisenhower administration, but accepted by the Kennedy administration without question when they

took over. The administration ignored question and accepted stereotypes about the Cubans without questioning whether the Central Intelligence Agency information made sense.

Table 3-20: Age and experience correlation

C#	Spearman's rho	A2	A7
SS	Correlation Coefficient	-0.063	-0.060
	Sig. (2-tailed)	0.490	0.513
ID	Correlation Coefficient	-0.113	-0.141
	Sig. (2-tailed)	0.216	0.126
PS	Correlation Coefficient	0.007	-0.032
	Sig. (2-tailed)	0.943	0.725
RM	Correlation Coefficient	0.108	0.123
	Sig. (2-tailed)	0.251	0.189
ES	Correlation Coefficient	-0.043	-0.129
	Sig. (2-tailed)	0.647	0.174
LS	Correlation Coefficient	0.019	0.035
	Sig. (2-tailed)	0.842	0.109

The correlations between disruption experienced (B2) and the origin of disruptions (B3) also show a small (~ 0.1) no practical significant relationship with the various factors. The only exception is the correlation with relationship management (RM). Both the correlations between RM and disruptions experienced (B2) and RM and the origin of disruptions (B3) have a medium (~ 0.3), practical significant relationship. The disruptions experienced as well as the origin of the disruptions thus have a medium impact on how respondents perceive the relationship management factor. A negative no practical significant or small correlation exists between ID and B2 (-0.002), ES and B2 (-0.140), ES and B3 (-0.124) and IS and B2 (-0.092).

Table 3-21: Disruptions experienced and origin of disruption correlation

C#	Spearman's rho	B2	B3
SS	Correlation Coefficient	0.078	0.119
	Sig. (2-tailed)	0.528	0.349
ID	Correlation Coefficient	-0.002	0.028
	Sig. (2-tailed)	0.989	0.825
PS	Correlation Coefficient	0.079	0.164
	Sig. (2-tailed)	0.523	0.196
RM	Correlation Coefficient	0.318**	0.352**
	Sig. (2-tailed)	0.009	0.005
ES	Correlation Coefficient	-0.140	-0.124
	Sig. (2-tailed)	0.270	0.341
LS	Correlation Coefficient	-0.092	0.084
	Sig. (2-tailed)	0.472	0.519

3.10 QUALITATIVE ANALYSIS

The open–ended questions analysed qualitatively were based on:

1. Supply side SC disruption sources.
2. Internal demand side SC disruption sources.
3. Process side SC disruption sources.
4. Relationship management side SC disruption sources.
5. Environmental side SC disruption sources.
6. Landscape side SC disruption sources.

3.10.1 Question SS 15:

Other supply side SC disruption sources you are aware of (please specify).

The respondents identified the following supply side SC disruption sources:

- Trans-boundary suppliers (global suppliers).
- Demand planning.
- Overdue quotations.
- Not having the proper checks and balances in place.
- Buyer experience (technical knowledge).
- Safety related issues.
- Community instability.

At this stage not enough information is available to rank the above SC disruption sources. It is recommended that future research should include and rank the sourced based on the information obtained.

The other risk sources identified by the participants can be included in the current factor providing it is assessed from a supply side perspective. The community instability would however be more appropriate under the landscape side factor. Demand planning relates closely with demand error (ID3) and volatility (ID4), but it can impact the supply chain from a supply side as well making it relevant within the supply and internal demand sides. Safety related issues are addressed under health and safety incidents (PS10) under the internal demand side factor.

3.10.2 Question ID 13:

Other internal demand side SC disruption sources you are aware of (please specify)

The respondents identified the following internal demand side SC disruption sources:

- Incomplete annexures to guide buyers.
- Continuous whistle blowing among suppliers / competitors.
- Silo mentality across functions.
- Not understanding the supply chain complexities.

Incomplete annexures refers to specifications (ID6), drawings (ID7) and standards (ID8) and are thus addressed in the questionnaire. Continuous whistle blowing relates to the suppliers, internal customers as well as the supply chain function, making this a risk source well suited to the landscape side disruption factor. Supply chain complexity (PS18) is addressed under process side disruption factors and thus already part of the questionnaire and assessment.

3.10.3 Question PS 20:

Other process side SC disruption sources you are aware of (please specify)

The respondents identified the following process side SC disruption sources:

- Process deviation allows for manipulation / favouritism.
- Poor communication and acknowledgement of the strategic role that the supply chain plays within an organisation.

End users attempt to circumvent the formal supply chain process and procedures lead to process deviations that can create risk such as breach of contract, patent infringements, non-compliance to legislation and internal policy and procedures, duplications, fraud, theft, sub-standard product or services acquisitions, no quality control and reputational damage to the organisation. Lack of communication (ID9) is addressed as part of the internal demand side factor.

3.10.4 Question RM 9:

Other relationship management side SC disruption sources you are aware of (please specify)

The respondents identified the following relationship management side SC disruption sources:

- Different imperative and expectations from supply chain depending on the function / business unit concerned.

The suggested concept can also align with supply chain security (PS14), supply chain visibility (PS15), lack of SC agility (PS17) and supply chain complexity (PS18) under the process side disruption factor.

3.10.5 Question ES 12:

Other environmental side SC disruption sources you are aware of (please specify)

The following environmental side SC disruption sources were identified:

- Reliance on customer communication to make the supply chain aware of:
    - Environmental considerations.
    - Legislative changes.
    - Environmental laws.

This can be addressed within the relationship management side disruption factor under information sharing with internal customers (RM6). It is not so much reliance on customers as it depends on information sharing between the various subject matter experts to ensure the relevant and up to date information is communicated and shared with stakeholders affected by the information.

3.10.6 Question LS 19:

Other landscape side SC disruption sources you are aware of (please specify)

The respondents identified the following landscape side SC disruption sources:

- Changing generational make-up of the workforce.

- Entrepreneurial flair of the youth.

The above suggested risk sources should form part a future research to determine if respondents perceive them as sources that could disrupt the supply chain should it materialise. With the current landscape of *#Fees must fall*, the impact of generational make-up and the demands from the youth cannot be underestimated as having no impact or threat in future.

Recommendations regarding these questions have been made in Chapter 4.

3.11 CONCLUSION

In this chapter the results of the empirical research study were presented and analysed. The explanation of the results started with the discussion on the demographic profiles of the respondents. These findings indicated that most of the respondents were from supply chain departments and in managerial positions and most of them were males between the ages of 36 and 60 years with work experience in excess of 20 years. Although the mining industry is still very much male dominant the research found that there is no significant difference in how gender views the factors. Similarly the research found that management as well as supply chain versus other departments see no significant difference in how they view the factors. Age and experience also had a small, no practical significant relationship on respondents' view of disruption confirming the significance of the supply chain function as important to various functions, management, non-management, age groups and experience. It confirms the findings in the literature that the supply chain has an influence on the upstream and downstream entities within the organisation and risks within the supply chain should be managed and controlled to mitigate risk sources that could result in supply chain disruption, negatively impacting the shareholder value of the organisation.

Secondly, it was found that although supply chain disruption do occur within the gold mining industry in the North West Province of South Africa the majority do not report the occurrence in an aggregated way, but rather within specific functions. With the result a large percentage of respondents don't know the number of incidents or the proportion originating in the external inbound supply chain. The majority reported that they

experience physical disruption as opposed to non-physical or a combination of the two. Reporting on disruption as well as analysing the source of disruption made no difference in how respondents viewed the factors.

Thirdly, the results indicated that all the risk sources identified per factor must form part of the factors as most sources had a mean leaning towards agree and in some instances strongly agree with a large, practical significant relationship between factors. Fourthly, it was found that all factors are considered good ($\propto > 0.8$) and should thus be a construct of the proposed supply chain disruption framework. Fifthly, the research indicated that organisations that experienced disruption and analysed the origin of disruption had a small, no practical significant relationship with how respondents perceive SC disruption.

Findings resulting from the qualitative research indicated that the majority of the other risk sources that participants identified already form part of the questionnaire, it might just be under a different factor. With regards to newly proposed sources it forms part of the recommendations in Chapter 4 to make these sources part of future research but also to include them in the proposed SCDF to allow discussion by the relevant management teams. Should they be of the opinion that these sources can cause a supply chain disruption within their organisation should it materialise, they can include it in the framework.

3.12 CHAPTER SUMMARY

This chapter focused on the research methodology and findings of the empirical study. The procedures and scope of the quantitative as well as qualitative research done in this study as well as the sample size and survey instrument (a questionnaire), were discussed. The demographical profile of the respondents was then analysed.

The T-test, frequency analysis, descriptive statistics, reliability and the internal consistency as well as correlations between selected constructs and questions were tested using the SPSS software package. A supply chain disruption overview context in the gold mining industry in the North West Province of South Africa was reported on and the reliability and internal consistency of the constructs reported on were analysed. The

last section of the quantitative analysis was the discussion on correlations between specific constructs.

Lastly, the open-ended questions that were analysed as part of the qualitative research, were reported on.

CHAPTER 4 CONCLUSIONS AND RECOMMENDATIONS

4.1 INTRODUCTION

The primary objective for this study was to establish a supply chain disruption framework (SCDF) for the gold mining industry that can be adopted by business managers as a managerial tool to identify supply chain disruption risk sources. The secondary objectives to be realised to achieve the primary objectives were firstly to determine how supply chain disruption is conceptualised in the literature and secondly to outline consistent nomenclature as basis for the literature review and research study. Thirdly it was necessary to determine the critical supply chain disruption risk sources that are required to establish a supply chain disruption management business framework in the gold mining industry and fourthly to establish which of these disruption risk sources should be included in the proposed new framework. It was also necessary to determine the relevance of the risk sources identified as supply chain disruption risk sources in the gold mining supply chain environment and to establish the correlations between the identified supply chain disruption risk sources. The last secondary objective was to identify recommendations that can be made for future research and practices.

The literature review in Chapter 2 firstly covered supply chain nomenclature defining terminology including supply chain management (SCM), supply chain risk (SCR), supply chain disruption (SCD) and supply chain risk sources (SCRS). Secondly, the current situation within the supply chain disruption construct, with specific focus on drivers of supply chain disruption and sources of supply chain complexity were discussed. Thirdly, a closer inspection of supply chain agility and the dimensions of agility were deliberated. Fourthly, a view was taken on the supply chain and mining industry risk sources that impact on supply chain disruption. Fifthly, the supply chain risk sources that can cause disruption should it materialise were assessed. Sixthly, the impact and likelihood of supply chain disruption were investigated with focus on shareholder value, revenue, costs, profit, brand, incidents and the frequency of disruptions.

The final aspect was the proposal of a five sphere supply chain disruption framework including risk sources based on supply, internal demand, process, relationship

management and the environmental landscape. The framework also allows for the assessment of the impact and likelihood of supply chain disruption aspects. The findings regarding the empirical study as described in Chapter 3 were done in relation to the literature studied in Chapter 2.

In Chapter 1 section 1.8 it was stated that Chapter 4 would be devoted to drawing conclusions from the literature review as discussed in Chapter 2 and the empirical study as reported on in Chapter 3. Subsequent recommendations will be put forward for the establishment of a supply chain disruption framework in the gold mining industry in the North West Province of South Africa.

4.2 CONCLUSIONS REGARDING A SUPPLY CHAIN DISRUPTION FRAMEWORK FOR THE GOLD MINING INDUSTRY AS MANAGEMENT TOOL TO IDENTIFY SUPPLY CHAIN DISRUPTION RISK SOURCES

Supply chain as a profession, like many other professions, has its own unique nomenclature that excludes and in many instances confuses non-supply chain individuals from understanding and meaningfully participating in discussions relating to the subject matter. Due to this and taking into account the major impact the supply chain has on the shareholder value of the organisation as illustrated in Figure 1-4, the departing point was to provide and outline nomenclature for the research study. This included supply chain management (SCM), supply chain risk (SCR), supply chain disruption (SCD) and supply chain risk sources (SCRS), thus realising the second secondary objective, but also the first secondary objective. The first secondary objective as discussed in sub-section 1.6.2.1 was realised as a result of the literature study indicating that supply chain disruption is a real and relevant threat to any organisation. Supply chain disruption was defined and some of the more prevalent drivers of supply chain disruption like increased complexity, publication of disruptive events, the impact on performance and executive responsibility and accountability were probed to conceptualise supply chain disruption.

With regards to sub-sections 1.6.2.3 (third secondary objective) and 1.6.2.4 (fourth secondary objective) the various risk sources were identified through the literature review and unstructured interviews with supply chain subject matter experts within the mining industry. This resulted in the identification of 5 spheres, namely supply side, internal

demand side, process side, relationship management side, environmental and landscape side disruption spheres. Within each sphere the literature review and empirical study outlined risk sources as supply chain disruption risk sources in the gold mining supply chain environment. The research revealed that should any of these risk sources materialise it can result in supply chain disruptions with a major impact not only on the shareholder value of the organisation, but reputational damage that the organisation can ill afford in the competitive business environment faced by organisations worldwide.

The empirical study revealed a strong correlation between the identified supply chain disruption risk sources in each sphere confirming each sphere as a construct to be included in the proposed framework and realising the sixth secondary objective.

The last secondary objective is addressed and realised in section 4.3 of this chapter in making recommendations for future research and practices and will be elaborated on below.

The results of this research paper confirm the literature and research conducted by other authors and researchers in previous studies in that the risk sources identified and tested in this study can cause supply chain disruption should they manifest (Schlegel and Trent, 2012:44; Summers, 2012:9; Schlegel, 2015:6; Business Continuity Institute, 2015:8).

4.2.1 Comments

The empirical research indicated that supply chain disruption is indeed happening within the mining industry in the North West Province in South Africa with 74% reporting physical disruptions, 3% non-physical disruptions and 23% both physical and non-physical disruptions occurring within their organisation. A concerning factor revealed by the study is that only 16% reported that performance are affected by SCD in a coordinated approach and across the whole company. The majority (53%) indicated that although they report on disruption, it is within a certain department and not aggregated with 31% indicating that they do not report on SCD at all. The above findings, combined with the fact that 45% of the respondents don't know the number of SCD incidents that occurred within their organisation, 48% don't know the proportion of SCD that originates within the external inbound supply chain and 36% reported that their organisations do

not analyse the full supply chain to identify the original source of disruption, indicates that supply chain disruption is not optimally managed and controlled within the industry. This endorses the need for a SCDF to provide visibility, control, proper communication and actions plans to address and mitigate risk sources on a company-wide platform.

4.3 RECOMMENDATIONS REGARDING SUPPLY CHAIN DISRUPTION FRAMEWORK WITHIN THE MINING INDUSTRY

The ultimate objective of any supply chain management framework should be to support the company's vision and strategic objectives driving competitive advantage for the organisation. This can be achieved by risk reduction strategies to ensure that the risks that the organisation is exposed to in the supply chain are identified and managed to acceptable levels. Supply chain management needs to implement risk reduction strategies and risk management processes that entail identification, planning, arranging and controlling of activities and resources to minimise the impact of all risks to levels that can be tolerated by both internal and external shareholders and stakeholders.

To be able to put risk reduction strategies in place and implement a SCDF, everybody within the organisation should understand where the supply chain function fits into the business, what the purpose of the supply chain function is, what strategies and processes they must follow to align with the company's vision and strategic objectives, what the internal and external risk sources are that can have an influence on not only the supply chain function, but the upstream and downstream supply network including the organisation. It is also critical to know what the things are that can go wrong and what risk reduction strategies must be in place to proactively eliminate, mitigate or manage these risk sources.

The recommendation therefore is to combine the proposed SCDF into the overall group risk management process of the organisation. This must cover risk understanding and the impact of supply side, internal demand side, process side, relationship management side, environmental and landscape side risk sources, how to re-engineer business processes, the implementation of a proper risk management framework, including the proposed SCDF. The objective of the SCDF is to provide assurance to the Board and management that key supply chain risk sources within the SC are identified and that

adequate and effective controls are in place to manage those risks. The SCDF identifies key strategic focus spheres within the supply chain environment and linked to this the organisation must develop key performance indicators for performance to be measured against.

To be able to function effectively amidst the rapidly changing supply chain environment requires balancing multiple aspects simultaneously to ensure an optimal supply chain management process. As mentioned before, the unpredictability and volatility in the supply chain leads to increased risk, which may result in disruption of the supply chain. These disruptions may be unexpected and rare, but they must be identified, understood, mitigated and managed. For any organisation it is important to have a framework in place that can identify, prevent and / or mitigate a risk source before it actually transpires.

The aim of the SCDF is to identify and manage the risk to acceptable levels the organisation is exposed to in the supply chain by means of risk reduction strategies. Due to the crucial role and impact of supply chain initiatives on an organisation it is critical that a combined programme and project approach are followed with a cross-functional team methodology. This must include an understanding of the potential benefits, business case, vision, top-down management support, internal ownership, accountability and responsibility, training, communication to and from external and internal stakeholders and a formal change management programme.

The literature review and empirical research indicated that the five spheres can cause supply chain disruption if the risk sources associated with each sphere materialise Schlegel (2015:6):

- Supply side
- Internal demand side
- Process side
- Relationship management side
- Environmental and landscape side

The research confirm the findings in previous research and the literature conducted by other authors. These are the risk sources and disruption spheres that must be identified and understood by the extended supply chain network to be able to design strategies that will pro-actively help to mitigate the risk sources. With uncertainty and volatility being inevitable the proposed strategy to use is:

- ongoing **identification** of supply chain risk sources unique to the organisation, industry and external environment and landscape;
- through a cross-functional team approach, assess the identified risk sources in terms of the **likelihood** of occurring (low, medium, high) and the **impact** should it materialise (low, medium, high). Workshop the relevant risk sources and create a common understanding of the risks.
- **Policies** and **procedures** are created to summarise the key decisions and processes developed through the cross-functional team approach.
- **Implement** the agreed actions, risk treatment plans as well as any other additional aspects agreed on.
- **Manage** and **reduce** the supply chain risks identified by implementing:
    - a formal supplier risk management programme,
    - increasing demand planning and accuracy,
    - a continuous process improvement programme,
    - a relationship management programme and
    - an environmental and landscape monitoring programme.
- **Manage** and **enhance** supply chain agility by means of the following:
    - Alertness: quickly detect changes, opportunities and threats (Gligor, 2013:24).
    - Accessibility: access relevant data (Gligor, 2013:27).

- Decisiveness: make decisions decisively based on the available information (Gligor, 2013:29).
- Swiftness: implement decisions quickly (Gligor, 2013:24).
- Flexibility: modify tactics and operations to the magnitude required (Gligor, 2013:33).

❖ Allocate the risks to **risk owners** to monitor and report on the status of defined actions and the development of the risk sources.

Risk profiles and sources change over time and with the fast changing environment within the supply chain environment risk treatment plans, controls, objectives and regulatory requirements that were once effective can become irrelevant very quickly. The following monitoring mechanisms should be implemented:

❖ Monitor implemented risk treatment plans.

The monitoring process must be embedded within the normal day-to-day monitoring processes already in place within the organisation and should be a standard agenda point in departmental meetings. Progress should be evaluated on an ongoing basis by the organisation's internal audit department.

❖ Ongoing effectiveness of risk treatment plans.

Evaluate the effective operation of risk treatment plans on an ongoing basis per functional area. This will include management reviews and self-assessments.

❖ Identify and assess new emerging risks.

Regular review of risk sources and profiles are required to ensure it remains relevant to the functional area, organisation, industry and external environment and landscape. The review frequency will be agreed upon among the cross-functional teams.

Therefore, deliberate actions must be taken to put a SCDF in place with the organisation's integrated risk management process to ensure that all the risk sources that the supply

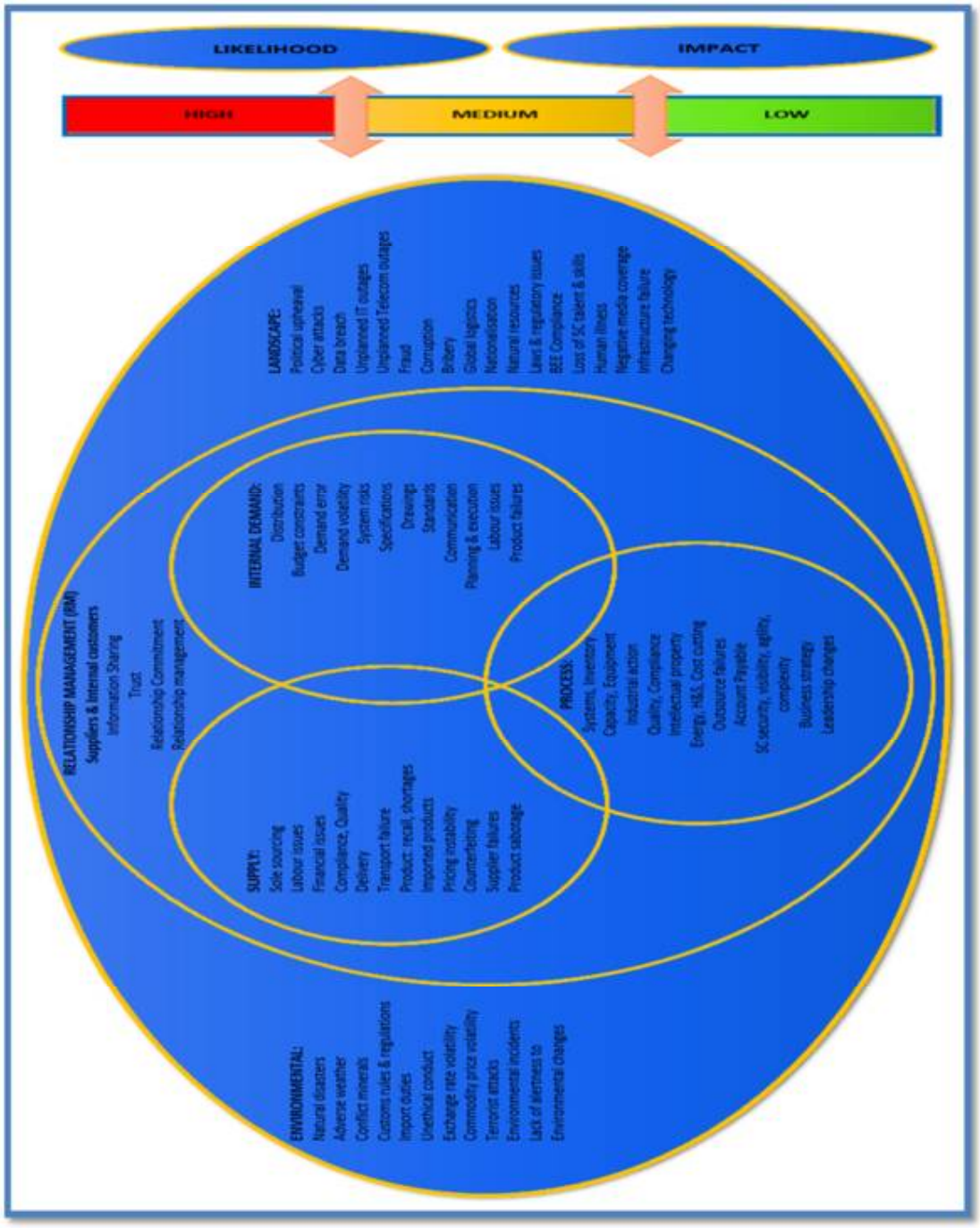
chain is exposed to are proactively identified, managed and reviewed on a continuous basis.

Based on the inadequate **reporting** and **communication** of SCD within the gold mining industry it is important to design and implement disruption and risk reporting and communication on an aggregated basis throughout the organisation. The essence of disruption and risk reporting and communication is to ensure that the right people are aware of relevant risks and possible disruptions at the right time. This ensures that the correct actions and mitigations are timeously implemented. A reporting framework must be developed by the cross-functional team, taking into account existing management processes and legal and regulatory requirements. Developing standard templates will enable an effective and efficient risk reporting process. A formal communication framework must be linked to the reporting framework to ensure aggregated company-wide communication. The communication framework should also include the external stakeholders like suppliers and partners that can be negatively affected by a possible supply chain disruption.

Figure 4-1 below illustrates the SCDF that was proposed through the literature review and empirically tested through the research study. The SCDF must be read and implemented in conjunction with the recommendations made in the above section. It is important to note that the SCDF cannot be assessed and implemented in isolation of the above recommended process. Risk management is a process for managing the risks an organisation faces; it is not a standalone function (KPMG, 2008:2). It is an integrated system that combines the management of strategic objectives to risks and controls in order to improve organisational performance, increase transparency, provide early warning systems and improve business sustainability. This system should be integrated down to individual functions such as the supply chain to ensure consistency and standardisation. The framework is based on a framework proposed by Schlegel (2015:6). The author included a fifth sphere namely relationship management side disruptions and the empirical study confirmed this as a construct of the proposed framework. The respondents also indicated other possible risk sources (refer Chapter 3) during the survey that should be incorporated in the discussions of the cross-functional teams to determine if these risk sources are relevant and applicable to the specific organisation. If the cross-

functional team is in agreement the other risk sources should be incorporated in the SCDF for the organisation.

Figure 4-1: Proposed supply chain disruption framework (SCDF)



The proposed framework consist of five spheres derived from the literature and empirical research with risk sources relevant to each sphere as illustrated below. The proposed

framework provides a SCDF for the gold mining industry that can be adopted by business managers as a managerial tool to identify supply chain disruption risk sources.

Sphere 1: Supply side disruption

The risk sources relevant to the supply side disruption sphere:

- Sole sourcing
- Labour issues
- Financial issues e.g. cash flow constraints
- Compliance issues e.g. legal, governance
- Product or services quality problems
- Delivery problems e.g. late delivery
- Transport network failure
- Product recall
- Imported products
- Pricing instability
- Product shortages e.g. parts or equipment
- Product counterfeiting
- Supplier failures
- Product sabotage

Sphere 2: Internal demand side disruption

Risk sources relevant to the internal demand side disruption sphere include:

- Internal distribution problems

- Budget constraints
- Demand error
- Demand volatility
- System risks
- Incorrect specifications
- Incorrect drawings
- Incorrect standards
- Lack of communication
- Poor planning and execution
- Labour issues
- Product failures

Sphere 3: Process side disruption

The risk sources relevant to the process side disruption sphere include:

- System anomalies
- Inventory control i.e. shortages, JIT (just in time)
- Capacity constraints
- Equipment failure
- Industrial action i.e. strikes
- Quality issues
- Compliance issues e.g. SOX compliance
- Intellectual property violations

- Energy scarcity i.e. loss of supply or rapid price increase
- Health and safety incidents
- Cost cutting
- Outsourcer failure
- Accounts payable processing
- Supply chain security
- Supply chain visibility
- Business strategy e.g. outsourcing
- Lack of SC agility e.g. alertness, accessibility, decisiveness, swiftness, flexibility
- Supply chain complexity
- Change in leadership (management changes)

Sphere 4: Relationship management side disruptions

The risk sources relating to relationship management are both from a supplier and internal customer perspective and consist of:

- Trust of the strategic supplier
- Information sharing with strategic suppliers
- Relationship commitment with strategic suppliers
- Supplier relationship management
- Trust of the internal customer
- Information sharing with internal customers
- Relationship commitment with internal customers

- Internal customer relationship management

Sphere 5: Environmental and landscape side disruptions

The **environmental** side disruption risk sources comprise:

- Natural disasters e.g. earthquakes, tsunamis
- Adverse weather
- Conflict minerals e.g. illegal miners
- Customs rules and regulations
- Import duties
- Unethical conduct e.g. child labour
- Exchange rate volatility
- Commodity price volatility
- Terrorist attacks
- Environmental incidents e.g. pollution, waste management
- Lack of alertness to environmental changes

The **landscape** side disruption risk sources consist of:

- Political upheaval e.g. civil unrest, conflict
- Cyber attacks
- Data breach
- Unplanned IT outages
- Unplanned telecommunication outages

- Fraud
- Corruption
- Bribery
- Global logistics
- Nationalisation
- Availability of natural resources
- Laws and regulatory issues
- BEE compliance
- Loss of SC talent and skills
- Human illness i.e. TB or HIV Aids
- Negative media coverage e.g. Twitter, Facebook, Newspapers, Radio, TV etc.
- Failure of critical infrastructure
- Rapidly changing technologies

The current framework provides a basic structure for identifying risk sources that can cause disruption and supply chain managers should include and / or exclude any of the risk sources relevant to their organisation, industry and their internal and external environment and landscape. The framework will enable managers to identify risk sources applicable to their organisation and complete risk assessments and design pro-active strategies to treat, minimise, tolerate or terminate the applicable risk source.

4.4 LIMITATIONS AND IMPLICATIONS FOR FURTHER RESEARCH

When making recommendations and conclusions in empirical research, the limitations and implications for further research must be identified and considered. Although supply chain experts and internal customers of the supply chain department within the gold

mining industry in the North West Province in South Africa participated in this study, the findings reported cannot be generalised to the mining industry in general in South Africa, due to the use of a non-probability convenience sample.

A couple of managerial implications can be inferred from the study. The findings support the inclusion of risk sources in supply chain design. As shown, there are several supply chain design variables like complexity, globalisation and agility that augment a firm's exposure to risk. The supply chain business model and design must be concluded by taking cognisance of the risk sources identified through the research into account in order to prevent or limit supply chain disruption. The proposed framework may also inform organisational policy. Improved decision making may be informed by implementing policies and procedures that facilitate and provide guidelines for mitigation and control of risk sources that can cause disruption.

Despite these limitations, the study has added to the empirical body of supply chain research in the gold mining industry in the North West Province in South African and based on the rapidly changing environment marked by constant change and increasing complexity, thus exposing the organisation to ever increasing risk sources, the findings of this study present numerous challenges for further research.

4.5 RECOMMENDED FURTHER STUDIES

This mini-dissertation is concluded by the identification of future research opportunities. Since not much research has been done with regards to supply chain disruption in South Africa, many opportunities for further research exist. The comparison between supply chain disruption in the mining industry and other industries such as the manufacturing industry could be researched. A comparison with other mining industries like coal, platinum, iron and diamond mining could be researched and an overall disruption framework for the South African mining industry could add value to the research.

Another approach for the research is to conduct research based on the downstream external inbound supply chain. This will provide an insight from the external supplier's perspective and might identify further risk sources that can result in disruption. This will incorporate a view from not only a gold mining perspective, as a large number of the

suppliers in the gold mining industry also provide products and services to other mining companies and non-mining related industries.

A deeper knowledge of how supply chain characteristics increase or decrease the possibility of disruption and consequently affect supply chain risk exposure would give managers important information concerning their decision on supply chain design.

A longitudinal approach to the research will provide insight and understanding as to how supply chain exposure to risk sources and possible disruption develop and changes over a period of time allowing managers to design and implement more robust risk treatment plans. It will also assist with the identification and assessment of emerging risk sources creating an early warning system to deal with future risks.

4.6 CONCLUSION

The aim of this study was to establish a supply chain disruption framework for the gold mining industry that can be adopted by business managers as a managerial tool to identify supply chain disruption risk sources.

An extensive literature review was conducted to determine how supply chain disruption is conceptualised in the literature. Through the literature review consistent nomenclature was outlined as basis for the literature review and research study. Critical supply chain disruption risk sources were identified as basis for the supply chain disruption management business framework in the gold mining industry. The findings of the survey conducted confirmed the disruption risk sources to be included in the proposed framework as well as the relevance of the risk sources within the gold mining supply chain environment. Correlations between the identified supply chain disruption risk sources were confirmed with the survey and identified as constructs of the SCDF.

Recommendations towards the identification of risk sources for the SCDF and the incorporation of the framework into the overall risk framework of the organisation with focus on identification, likelihood, impact, policy and procedures, implementation, management, control, reporting and communication of the framework were put forward

and it can further be concluded that the research objectives as set out in section 1.6 were satisfactorily met.

4.7 CHAPTER SUMMARY

In this chapter, the findings of the literature review as well as the survey used in the empirical research were summarised and conclusions and recommendations were made towards the establishment of a supply chain disruption framework for the gold mining industry in the North West Province in South Africa.

Recommendations for the implementation of the SCDF as part of the overall risk framework of the organisation were made. Specific focus was given to the identification of risk sources that, should it materialise, could result in supply chain disruption, the likelihood and impact of occurrence, the establishment of guiding policy and procedures, implementation, management, control, reporting and communication of the framework within the organisation.

The limitations and implications for further research were discussed and suggestions were made towards further studies.

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ANNEXURES A

- **SURVEYMONKEY QUESTIONNAIRE**

Supply Chain Disruption

Dear Participant

The aim of this study is to assess the sources of supply chain (SC) disruption in the mining industry in order to develop a supply chain disruption framework. This study forms part of a mini dissertation to be submitted in partial fulfilment of the requirements for the degree Master in Business Administration at the Potchefstroom campus of the North-West University. It is an internationally accredited degree that requires adherence to strict ethical standards as a prerequisite to conduct this research. Participation in the study is voluntary at all times. All responses will be treated as strictly confidential and will be used for academic purposes only. Your inputs are anonymous, it is not possible to trace any inputs back to a particular respondent. The results of the study will be made available to you on request.

Your participation in this study will help to assess the sources of supply chain disruption in the mining industry. It will take no more than approximately 15 minutes to complete the questionnaire. Your input is of great value to this research and I appreciate your help in providing this information. If you have any queries regarding this study you are welcome to contact Louise Greyling, by using the following email address: lgreyling@anglogoldashanti.com

Ethical clearance has been obtained: EMSPBS16/02/16-01/23

Will you please be so kind as to complete the questionnaire on or before 16 September 2016?

NEXT

Supply Chain Disruption

Biographical Data

General Instructions:

Please answer all questions by selecting the relevant option per question.

A1. What is your gender?

1. Female
2. Male

A2. What is your age?

1. 18 to 25
2. 26 to 35
3. 36 to 45
4. 46 to 55
5. 56 to 60
6. >60

A3. Are you working in the mining industry?

1. Yes
2. No
3. Other (please specify)

A4. Are you in management?

1. Yes
2. No

A5. Level of management?

1. Supervisor
2. Middle Management
3. Senior Management

PREV NEXT

4 Director
5 Not applicable
6 Other (please specify)

A6. What department do you work in?

1 Accounting
2 Audit
3 Business unit
4 Engineering
5 Finance
6 Health, safety and risk
7 IT
8 Legal
9 Metallurgy
10 Supply chain
11 Systems
Other (please specify)
12

A7. How many years' experience do you have in the mining industry?

1 0 - 5
2 6 - 10
3 11 - 15
4 16 - 20
5 >20 years

A8. Approximately how many employees work at your company?

1 0 - 250
2 251 - 1 000
3 1 001 - 5 000
4 5 001 - 10 000
5 >10 000

PREV NEXT

Supply Chain Disruption

Supply Chain Disruption Overview

B1. Do you report performance affected by supply chain (SC) disruptions i.e. where unplanned cost have been incurred or loss of productivity or revenue was experienced?

1. Yes - this is coordinated and reported across the whole company
2. Yes - within certain departments, functions but **NOT** aggregated
3. No

B2. How many SC incidents did your company experienced in the past 12 months that caused a disruption?

1. None
2. 1 - 5
3. 6 - 10
4. 11 - 20
5. 21 - 50
6. >50
7. I don't know

B3. Looking back at the disruptions experienced by your company in the past 12 months, what proportion can be calculated which originated in your external inbound (via suppliers) supply chain? Choose an option that fits best.

1. <10%
2. 11 - 25%
3. 26 - 50%
4. 51 - 75%
5. 76 - 90%
6. >90%
7. I don't know the proportion

B4. Considering the external inbound SC incidents you are aware of in the last 12 months, what was the predominant source of disruption across all events?

1. With the immediate supplier (TIER 1)
2. With the supplier's supplier (TIER 2)
3. Much lower down the SC (i.e. TIER 3, TIER 4, etc.)
4. We do **NOT** analyse the full SC to identify the original source of the disruption

B5. What has been your experience of physical and non-physical disruption in your SC? We have experienced....

1. Physical disruption (e.g. product recall or delivery failure)
2. Non-physical disruption (e.g. cyber attack or data breach)
3. Both physical & non-physical disruption

Supply Chain Disruption

Supply Side Disruption (SS)

Please answer ALL the questions by selecting the option you agree with most.

THE POTENTIAL OF A MAJOR SC DISRUPTION IS HIGH DUE TO THE FOLLOWING:

SS1. Sole Sourcing

Strongly Disagree (1) Disagree (2) Agree (3) Strongly Agree (4)

SS2. Labour issues

Strongly Disagree (1) Disagree (2) Agree (3) Strongly Agree (4)

SS3. Financial issues e.g. cash flow constraints

Strongly Disagree (1) Disagree (2) Agree (3) Strongly Agree (4)

SS4. Compliance issues e.g. legal, governance

Strongly Disagree (1) Disagree (2) Agree (3) Strongly Agree (4)

SS5. Product or services quality problems

Strongly Disagree (1) Disagree (2) Agree (3) Strongly Agree (4)

SS6. Delivery problems e.g. late delivery

Strongly Disagree (1) Disagree (2) Agree (3) Strongly Agree (4)

SS7. Transport network failure

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

SS8. Product recall

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

SS9. Imported products

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

SS10. Pricing instability

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

SS11. Product shortages e.g. parts or equipment

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

SS12. Product counterfeiting

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

SS13. Supplier failures

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

SS14. Product sabotage

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

SS15. **Other** Supply Side SC disruption sources you are aware of (please specify)

1	2	3	4

Supply Chain Disruption

Internal Demand Side Disruption

Please answer ALL the questions by selecting the option you agree with most.

THE POTENTIAL OF A MAJOR SC DISRUPTION IS HIGH DUE TO THE FOLLOWING:

ID1. Internal distribution problems

Strongly Disagree | Disagree | Agree | Strongly Agree

1 2 3 4

ID2. Budget constraints

Strongly Disagree | Disagree | Agree | Strongly Agree

1 2 3 4

ID3. Demand error

Strongly Disagree | Disagree | Agree | Strongly Agree

1 2 3 4

ID4. Demand volatility

Strongly Disagree | Disagree | Agree | Strongly Agree

1 2 3 4

ID5. System risks

Strongly Disagree | Disagree | Agree | Strongly Agree

1 2 3 4

ID6. Incorrect specifications

Strongly Disagree | Disagree | Agree | Strongly Agree

1 2 3 4

ID7. Incorrect drawings

Strongly Disagree | Disagree | Agree | Strongly Agree

1 2 3 4

PREV | NEXT

ID8. Incorrect standards

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

ID9. Lack of communication

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

ID10. Poor planning and execution

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

ID11. Labour issues

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

ID12. Product failures

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

ID13 **Other** internal demand side SC disruption sources you are aware of (please specify)

1	2	3	4

PREV | NEXT

Supply Chain Disruption

Process Side Disruption

Please answer ALL the questions by selecting the option you agree with most.

THE POTENTIAL OF A MAJOR SC DISRUPTION IS HIGH DUE TO THE FOLLOWING:

PS1. System anomalies

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

PS2. Inventory control i.e. shortages, JIT (just in time)

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

PS3. Capacity constraints

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

PS4. Equipment failure

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

PS5. Industrial action i.e. strikes

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

PS6. Quality issues

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

PREV | NEXT

PS7. Compliance issues e.g. SOX compliance

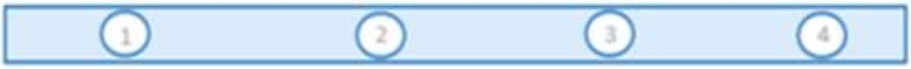
Strongly Disagree | Disagree | Agree | Strongly Agree

PS8. Intellectual property violations

Strongly Disagree | Disagree | Agree | Strongly Agree

PS9. Energy scarcity i.e. loss of supply or rapid price increase

Strongly Disagree | Disagree | Agree | Strongly Agree



PS10. Health and safety incidents

Strongly Disagree | Disagree | Agree | Strongly Agree

PS11. Cost cutting

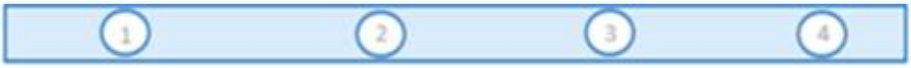
Strongly Disagree | Disagree | Agree | Strongly Agree

PS12. Outsourcer failure

Strongly Disagree | Disagree | Agree | Strongly Agree

PS13. Accounts payable processing

Strongly Disagree | Disagree | Agree | Strongly Agree



PS14. Supply chain security

Strongly Disagree | Disagree | Agree | Strongly Agree

PS15. Supply chain visibility

Strongly Disagree Disagree Agree Strongly Agree

1 2 3 4

PS16. Business strategy e.g. outsourcing

Strongly Disagree Disagree Agree Strongly Agree

1 2 3 4

PS17. Lack of SC agility e.g. alertness, accessibility, decisiveness, swiftness, flexibility

Strongly Disagree Disagree Agree Strongly Agree

1 2 3 4

PS18. Supply chain complexity

Strongly Disagree Disagree Agree Strongly Agree

1 2 3 4

PS19. Change in leadership (management changes)

Strongly Disagree Disagree Agree Strongly Agree

1 2 3 4

PS20 **Other** process side SC disruption sources you are aware of (please specify)

1 2 3 4

PREV NEXT

Supply Chain Disruption

Relationship Management Side Disruption

Please answer ALL the questions by selecting the option you agree with most.

THE POTENTIAL OF A MAJOR SC DISRUPTION IS HIGH DUE TO THE LACK OF:

RMS1. Trust of the strategic supplier

Strongly Disagree (1) Disagree (2) Agree (3) Strongly Agree (4)

RMS2. Information sharing with strategic suppliers

Strongly Disagree (1) Disagree (2) Agree (3) Strongly Agree (4)

RMS3. Relationship commitment with strategic suppliers

Strongly Disagree (1) Disagree (2) Agree (3) Strongly Agree (4)

RMS4. Supplier relationship management

Strongly Disagree (1) Disagree (2) Agree (3) Strongly Agree (4)

RMS5. Trust of the internal customer

Strongly Disagree (1) Disagree (2) Agree (3) Strongly Agree (4)

RMS6. Information sharing with internal customers

Strongly Disagree (1) Disagree (2) Agree (3) Strongly Agree (4)

RMS7. Relationship commitment with internal customers

Strongly Disagree (1) Disagree (2) Agree (3) Strongly Agree (4)

PREV NEXT

RMS8. Internal customer relationship management

Strongly Disagree | Disagree | Agree | Strongly Agree

RMS9. **Other** relationship management side SC disruption sources you are aware of (please specify)

Supply Chain Disruption

Environmental Side Disruption

Please answer ALL the questions by selecting the option you agree with most

THE POTENTIAL OF A MAJOR SC DISRUPTION IS HIGH DUE TO THE FOLLOWING:

ES1. Natural disasters e.g. earthquakes, tsunamis

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

ES2. Adverse weather

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

ES3. Conflict minerals e.g. illegal miners

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

ES4. Customs rules and regulations

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

ES5. Import duties

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

ES6. Unethical conduct e.g. child labour

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

ES7. Exchange rate volatility

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

PREV | NEXT

ES8. Commodity price volatility

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

ES9. Terrorist attacks

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

ES10. Environmental incidents e.g. pollution, waste management

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

ES11. Lack of alertness to environmental changes

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

ES12. **Other** environmental side SC disruption sources you are aware of (please specify)

1	2	3	4

PREV | NEXT

Supply Chain Disruption

Landscape Side Disruption

Please answer ALL the questions by selecting the option you agree with most.

THE POTENTIAL OF A MAJOR SC DISRUPTION IS HIGH DUE TO THE FOLLOWING:

LS1. Political upheaval e.g. civil unrest, conflict

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

LS2. Cyber attacks

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

LS3. Data breach

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

LS4. Unplanned IT outages

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

LS5. Unplanned telecommunication outages

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

LS6. Fraud

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

LS7. Corruption

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

PREV | NEXT

LS8. Bribery

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

LS9. Global logistics

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

LS10. Nationalisation

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

LS11. Availability of natural resources

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

LS12. Laws and regulatory issues

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

LS13. BEE compliance

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

LS14. Loss of SC talent and skills

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

LS15. Human illness i.e. TB or HIV Aids

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

LS16. Negative media coverage e.g. Twitter, Facebook, Newspapers, Radio, TV etc.

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

LS17. Failure of critical infrastructure

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

LS18. Rapidly changing technologies

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

LS19. **Other** landscape side SC disruption sources you are aware of (please specify)

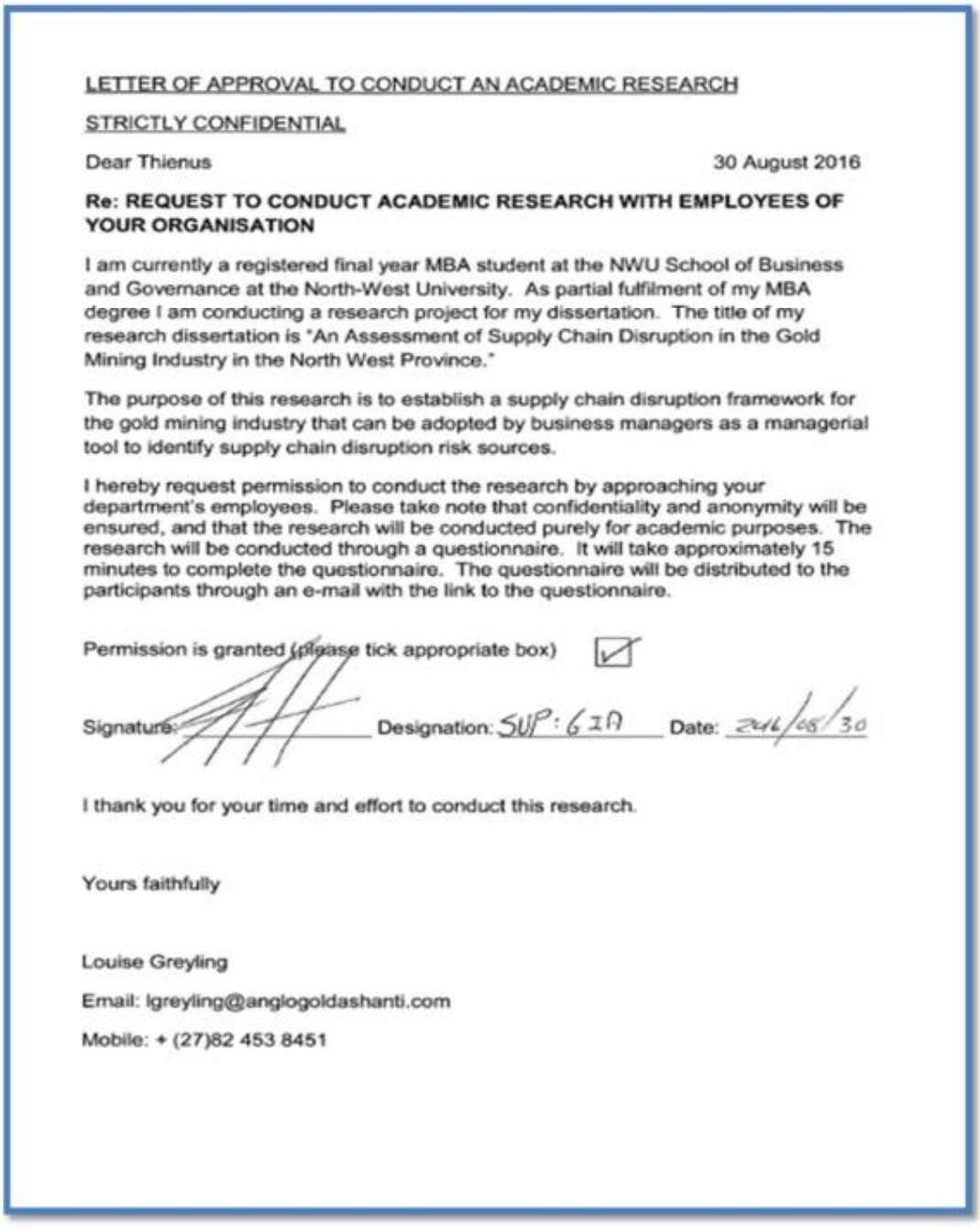
1	2	3	4

Thank you for your participation

PREV DONE

ANNEXURE B

- **LETTER OF APPROVAL TO CONDUCT ACADEMIC RESEARCH**



LETTER OF APPROVAL TO CONDUCT AN ACADEMIC RESEARCH

STRICTLY CONFIDENTIAL

Dear Thienus 30 August 2016

Re: REQUEST TO CONDUCT ACADEMIC RESEARCH WITH EMPLOYEES OF YOUR ORGANISATION

I am currently a registered final year MBA student at the NWU School of Business and Governance at the North-West University. As partial fulfilment of my MBA degree I am conducting a research project for my dissertation. The title of my research dissertation is "An Assessment of Supply Chain Disruption in the Gold Mining Industry in the North West Province."

The purpose of this research is to establish a supply chain disruption framework for the gold mining industry that can be adopted by business managers as a managerial tool to identify supply chain disruption risk sources.

I hereby request permission to conduct the research by approaching your department's employees. Please take note that confidentiality and anonymity will be ensured, and that the research will be conducted purely for academic purposes. The research will be conducted through a questionnaire. It will take approximately 15 minutes to complete the questionnaire. The questionnaire will be distributed to the participants through an e-mail with the link to the questionnaire.

Permission is granted (please tick appropriate box) ☑

Signature: _____ Designation: SUP: GIA Date: 2016/08/30

I thank you for your time and effort to conduct this research.

Yours faithfully

Louise Greyling

Email: lgreyling@anglogoldashanti.com

Mobile: + (27)82 453 8451

ANNEXURE C

QUESTIONNAIRE DEVELOPMENT – FOCUS GROUP

An assessment of supply chain disruption in the gold mining industry in the North West Province

Dear Participant

The aim of this study is to assess the sources of supply chain (SC) disruption in the mining industry in order to develop a supply chain disruption framework. This study forms part of a mini-dissertation to be submitted in partial fulfilment of the requirements for the degree Master in Business Administration at the Potchefstroom campus of the North-West University. It is an internationally accredited degree that requires adherence to strict ethical standards as a prerequisite to conduct this research. Participation in the study is voluntary at all times. All responses will be treated as strictly confidential and will be used for academic purposes only. Your inputs are anonymous; it is not possible to trace any inputs back to a particular respondent. The results of the study will be made available to you on request.

Your participation in this study will help to assess the sources of supply chain disruption in the mining industry. It will take not more than approximately 15 minutes to complete the questionnaire. Your input is of great value to this research and I appreciate your help in providing this information. If you have any queries regarding this study you are welcome to contact Louise Greyling, by using the following email address: lgreyling@anglogoldashanti.com

Ethical clearance has been obtained: EMSPBS16/02/16-01/23

Will you please be so kind as to complete and return the questionnaire on/before the 12nd of September 2016?

GENERAL INSTRUCTIONS

1. Please answer **all** questions by selecting ONE option per question.
2. There are no right or wrong answers,

SECTION A:

Please mark the applicable block with a cross (X)

A1. Indicate your gender:

1) Male	2) Female

A2. State your age category?

1) 18-25	2) 26-35	3) 36-45	4) 46-55	5) 56-60	6) >60

A3. Are you in management?

1) Yes	2) No

A4. Level of management?

1) Supervisor	2) Middle Management	3) Senior Management	3) Director	5) Other	6) Not applicable

If you chose “other” please specify

_____

A5. Select the department you are working in

1)	Supply Chain
2)	IT
3)	Systems
4)	Audit
5)	Health, Safety & Risk
6)	Finance
7)	Business Unit
8)	Other

If you chose “other” please specify

_____

A6. How many years’ experience do you have in the mining industry?

1) 0-5	2) 6-10	3) 11-15	4) 16-20	5) >20 years

A7. Approximately how many employees work at your organisation?

1) 0-250	2) 251 – 1 000	3) 1 001 – 5 000	4) 5 001 – 10 000	5) >10 000

A8. Are you working in the mining industry?

1)	Yes	2)	No

If no please specify the industry you are working in:

_____

Turn to the next page please

SECTION B:

B1. Do you report performance affected by supply chain disruptions i.e. where unplanned cost has been incurred or loss of productivity or revenue experienced?

1) YES, this is coordinated & reported across the whole organisation	2) YES, within certain departments / functions, but NOT aggregated	3) NO

B2. How many supply chain incidents did your organisation experienced in the past 12 months that caused a disruption?

1) None	2) 1-5	3) 6-10	4) 11-20	5) 21-50	6) >50	7) I don't' know

B3. Looking back at the disruptions experienced by your organisation in the past 12 months, what proportion would you calculate originated in your external inbound (via suppliers) supply chain? Choose the single option that best fits

1) < 10%	2) 11-25%	3) 26-50%	4) 51-75%	5) 76-90%	6) > 90%	7) I don't' know the proportion

B4. Considering the external inbound supply chain incidents you are aware of in the last 12 months, what was the predominant source of disruption across all events?

1) With the immediate supplier (TIER 1)	2) With the supplier's supplier (TIER 2)	3) Much lower down the supply chain (i.e. TIER 3, TIER 4, etc.)	4) We do NOT analyse the full supply chain to identify original source of the disruption

B5. What has been your experience of physical and non-physical disruption in your supply chain? We have experienced…

1) Physical disruption (e.g. product recall)	2) Non-physical disruption (e.g. cyber-attack or data breach)	3) Both physical & non-physical disruption

Turn to the next page please

SECTION C:

SUPPLY SIDE (SS) Upstream disruptions caused by failure of the supply base to deliver on time, deliver quality, sustain financial integrity and maintain compliance and supply chain agility and resilience etc.	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
The potential of a major supply chain (SC) disruption due to the following is high:				
SS1) Sole sourcing	1	2	3	4
SS2) Labour issues	1	2	3	4
SS3) Financial issues (e.g. insolvency)	1	2	3	4
SS4) Compliance issues (e.g. legal, governance)	1	2	3	4
SS5) Product or service quality problems	1	2	3	4
SS6) Delivery problems (e.g. late, Just-in-Time)	1	2	3	4
SS7) Transport network failure	1	2	3	4
SS8) Product recall	1	2	3	4
SS9) Imported products	1	2	3	4
SS10) Pricing instability	1	2	3	4
SS11) Product shortages (e.g. parts, equipment)	1	2	3	4

SS12) Product counterfeiting	1	2	3	4
SS13) Supplier failures	1	2	3	4
SS14) Product sabotage	1	2	3	4

SS15) If you know of any other Supply Side SC disruptions please specify them below:

_____

INTERNAL DEMAND SIDE (IDS) Downstream disruptions caused by problems in the distribution flows, product failures, budget constraints, warehouse and distribution centre issues, demand volatility, transportation lead times, incorrect specifications and standards, communication failures and poor planning etc.	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
The potential of a major SC disruption due to the following is high:				
IDS1) Internal distribution problems	1	2	3	4
IDS2) Budget constraints	1	2	3	4
IDS3) Demand error	1	2	3	4
ISS4) Demand volatility	1	2	3	4
IDS5) System risks	1	2	3	4
IDS6) Incorrect specifications	1	2	3	4
IDS7) Incorrect drawings	1	2	3	4
IDS8) Incorrect standards	1	2	3	4
IDS9) Lack of communication	1	2	3	4
IDS10) Poor planning and execution	1	2	3	4
IDS11) Labour issues	1	2	3	4
IDS12) Product failures	1	2	3	4

IDS13) If you know of any other Internal Demand Side SC disruptions please specify them below:

PROCESS SIDE (PS) The risk sources originate from within a company and its own four walls. This include time delays, system anomalies, inventory shortages, quality problems, capacity shortages, equipment issues, accounts payable processing, intellectual property management, supply chain security and supply chain visibility, health and safety compliance and business strategy etc.	Strongly Disagree	Disagree	Agree	Strongly Agree
The potential of a major SC disruption due to the following is high:				
PS1) System anomalies	1	2	3	4
PS2) Inventory control (i.e. shortages, JIT)	1	2	3	4
PS3) Capacity constraints	1	2	3	4
PS4) Equipment failure	1	2	3	4
PS5) Industrial action (i.e. strike action)	1	2	3	4
PS6) Quality issues	1	2	3	4
PS7) Compliance issues (e.g. SOX)	1	2	3	4
PS8) Intellectual property violations	1	2	3	4
PS9) Energy scarcity (i.e. loss of supply or rapid price increase)	1	2	3	4
PS10) Health and Safety incidents	1	2	3	4
PS11) Cost cutting	1	2	3	4
PS12) Outsourcer failure	1	2	3	4
PS13) Accounts payable processing	1	2	3	4
PS14) Supply chain security	1	2	3	4
PS15) Supply chain visibility	1	2	3	4

PS16) Business strategy (e.g. outsourcing)	1	2	3	4
PS17) Lack of SC agility (e.g. alertness, accessibility, decisiveness, swiftness, flexibility	1	2	3	4
PS18) Supply chain complexity	1	2	3	4
PS19) Change in leadership (management change)	1	2	3	4

PS20) If you know of any other Process Side SC disruptions please specify them below:

_____

RELATIONSHIP MANAGEMENT SIDE (RMS) These risk sources focus on the impact of relationships on the supply, demand and process spheres. This include the impact of information sharing, trust between the extended entities, mutual problem solving, risk sharing, supplier loyalty and relationship commitment etc.	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
The potential of a major SC disruption is high due to lack of:				
RMS1) Trust of the strategic supplier	1	2	3	4
RMS2) Information sharing with strategic suppliers	1	2	3	4
RMS3) Relationship commitment with strategic suppliers	1	2	3	4
RMS4) Supplier relationship management	1	2	3	4
RMS5) Trust of the internal customer	1	2	3	4
RMS6) Information sharing with internal customer	1	2	3	4
RMS7) Relationship commitment with internal customer	1	2	3	4
RMS8) Internal customer relationship management	1	2	3	4

RMS9) If you know of any other Relationship Management Side SC disruptions please specify them below:

_____

ENVIRONMENTAL SIDE (ES) In this growing arena, the major threats include natural disasters, climate, etc.	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
The potential of a major SC disruption due to the following is high:				
ES1) Natural disasters (e.g. earthquake, tsunami)	1	2	3	4
ES2) Adverse weather	1	2	3	4
ES3) Conflict minerals (e.g. zamma-zammas)	1	2	3	4
ES4) Custom rules	1	2	3	4
ES5) Import duties	1	2	3	4
ES6) Unethical conduct (e.g. child labour)	1	2	3	4
ES7) Exchange rate volatility	1	2	3	4
ES8) Commodity prices volatility	1	2	3	4
ES9) Terrorist attacks	1	2	3	4
ES10) Environmental incident (e.g. pollution, waste management)	1	2	3	4
ES11) Lack of alertness to environmental changes	1	2	3	4

ES12) If you know of any other Environmental Side SC disruptions please specify them below:

_____

LANDSCAPE (L) In this growing arena, the major threats include political upheaval, cyber-attacks and data breaches etc.	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
The potential of a major SC disruption due to the following is high:				
L1) Political upheaval (civil unrest, conflict)	1	2	3	4

L2) Cyber-attack	1	2	3	4
L3) Data breach	1	2	3	4
L4) Unplanned IT outage	1	2	3	4
L5) Unplanned telecommunication outage	1	2	3	4
L6) Fraud	1	2	3	4
L7) Corruption	1	2	3	4
L8) Bribery	1	2	3	4
L9) Global logistics	1	2	3	4
L10) Nationalisation	1	2	3	4
L11) Availability of natural resources	1	2	3	4
L12) Laws and regulatory issues	1	2	3	4
L13) BEE Compliance	1	2	3	4
L14) Loss talent and skills	1	2	3	4
L15) Human illness (i.e. TB or HIV Aids)	1	2	3	4
L16) Negative social media and external media discussions (i.e. Twitter, Facebook, Newspapers, Radio, TV etc.)	1	2	3	4
L17) Failure of critical infrastructure	1	2	3	4
L18) Fast-changing technologies	1	2	3	4

L19) If you know of any other Landscape SC disruptions please specify them below:

_____

Thank you for your participation

ANNEXURE D

QUALITATIVE RESEARCH – UNSTRUCTURED INTERVIEWS

Discuss relevance and context of Top 10 causes of SCD 2014 within gold mining – Figure 1-2 Chapter 1:

- Unplanned IT & Telecoms Outage
- Adverse weather
- Outsources service failure
- Loss of talent/skills
- Transport network disruptions
- New laws and regulations
- Cyber attack
- Data breach
- Industrial disputes
- Exchange rate volatility

Discuss key concerns identified in 2013 - still relevant in gold mining industry in 2016 – Figure 1-3 Chapter 1:

- Change in demand market structure
- Change in competitive dynamics or customer preferences
- Supplier execution failure or unavailability
- Change in supply market structure
- Downstream channel partner execution failure or unavailability

Discuss Mining Risks (Figure 2-7) and determine if this is relevant in gold mining industry

- Labour relations
- Achievable business plans or budgets
- Volatile commodity prices and foreign exchange fluctuations
- High input costs

- Reliance on third party infrastructure
- Regulatory, political and legal environment
- Employee safety and health
- Human resource skills and capacity
- Liquidity
- Compliance with environmental standards

World Economic Forum categories of global risk Figure 2-8, Chapter 2:

Are these categories of global risk applicable to gold mining industry?

WORLD ECONOMIC FORUM RISK CATEGORIES	GOLD MINING INDUSTRY
Economical	
Environmental	
Geopolitical	
Social	
Technological:	

Discuss the 5 sphere and all relevant risk sources Figure 2-12, Chapter 2:

Sphere 1: Supply side disruption – risk sources

Sphere 2: Internal demand side disruption – risk sources

Sphere 3: Process side disruption – risk sources

Sphere 4: Relationship management side disruptions – risk sources

Sphere 5: Environmental and landscape side disruptions