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Gordon Institute of Business Science
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Drivers of Supply Chain Risk in Energy and Mining Industries in Africa.

Submitted by

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A research project submitted to the Gordon Institute of Business Science, University of Pretoria, in partial fulfilment of the requirements for the degree of Master of Business Administration.

11 November 2019

Abstract

Supply chain management has increasingly come to the forefront of firm's competitive strategy and hence it has become vital to understand supply chain risks faced in today's globalized world where supply networks have become more complex. These supply chain risks are quite evident in the extractive industries in Africa where firms inundated by unique supply chain risks which have proven to be financially, ecologically and socially damaging. Despite these risks, these firms are key to African countries as they participate in tax generation, employment opportunities and to some extent development of secondary industries. Further, the abundance of mineral resources on the continent makes this a lucrative industry for firms to operate in. Thus, to better understand what the drivers of supply chain risks in this industry were and applicable risk mitigation strategies, a quantitative research was carried out across supply chain managers working in mining and energy firms in Africa.

Data collated from 85 participants was obtained and tested for validity as well as reliability. The probability of external risks was found to be more prevalent compared to internal risks. Similarly, the impact of external supply chain risks was observed to be higher than internal risks. Through regression analysis the data pointed towards a strong relationship between probability and impact of external supply chain risks. Further, government policy changes were portrayed as the main external risk determinants seen to even affect key internal supply chain risks such as supplier failure.

The findings of this study therefore provide empirically validated evidence, of the existence and relationship between probability and impact of existence of supply chain risks in the extractive industry.

Keywords

Supply chain risks, mining companies, energy companies, extractive industry, supply chain risk management.

Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

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Evelyne Wothaya Kiambati Date

Contents

List of Tables

List of Figures

1. INTRODUCTION TO RESEARCH PROBLEM

1.1. Drivers of Supply Chain Risk

Supply chains incorporate what companies require to design, process, deliver and make the product or service available for use by consumers (Hugos, 2018). Therefore, efficient supply chains offer sustenance to firms, making management of supply chain risks one of the ways in which companies can deliver value to their customers and ensure they survive in an otherwise turbulent global economy (Christopher, 2011; Hugos, 2018). Previously, in order to be more efficient, supply chain managers focused on optimisation of costs but the industry has now had to revisit this mind-set to focus on value creation and managing the web of relationships that exist in today's global supply chains(Christopher, 2011).

These relationships and intermediaries are constantly expanding due another trend, globalisation, which makes supply chains even more vulnerable as companies expand to meet growing market needs by expanding product lines and lifecycles (Azzi, Chamoun, & Sokhn, 2019; Christopher, 2011; Hugos, 2018). Global supply chains are inter-connected through global sourcing, multiple tiers in the supply chain or even outsourcing (Van den Brink, Kleijn, Tukker, & Huisman, 2019;Kim & Davis, 2016). Increasingly, there is a demand for companies to be aware of their supply chain linkages, the risks that exist in these networks and the roles companies are required to play in creating strong and resilient supply chains to build competitive advantage and boost firm performance (Li, Ragu-Nathan, Ragu-Nathan, & Subba Rao, 2006).

Mining and energy industry supply chains have come under scrutiny given their environmental, social and economic impact in the continent. Conflict minerals have caused supply chain managers to re-think how minerals are sourced and risks associated with the minerals, given the complexity and lack of visibility of global value chains(Hofmann, Schleper, & Blome, 2018). Crude oil producers such as Nigeria and Angola have also been beleaguered by an "economic resource curse" whereby despite the wealth generated, weak institutions and poor governance have eroded the economic value extracted through corruption(Amiri, Samadian, Yahoo, & Jamali, 2019; Sauer & Seuring, 2017; Transparency International, 2019).This makes for tougher supply chain conditions for global companies who operate under strict anti-corruption laws such as US's Foreign Corrupt Practices Act (F.C.P.A), European Union's Convention against Corruption or U.K.'s Bribery Act of 2010.

Consequently, management of supply chain and specifically risks and disruptions has become an increasingly studied topic among academia and practitioners(Li et al., 2006). Hugos(2018) , Li et al., (2006) Hult, Ketchen, & Arrfelt (2007) noticed the shift wherein competition was no longer firms versus firms but rather lay between supply chains. This gives weight as to why the topic is relevant in academic and business context. This chapter will thus define the need to understand supply chain risk management in the energy and mining sectors in Africa by examining the vulnerabilities that lie in the value chains having knowing the impact these industries have.

1.2. Purpose of the Research Problem

The field of this study is operations research and supply chain management.

The purpose of this research is to analyse supply chain risk, the impact of the different risks supply chain practitioners face as well as the likelihood of the occurrence given the fact that early detection or anticipating the aftermath of a risk provides an avenue for business to react in a timely way and reduce the cost implications of risk (Bradley, 2014).

Africa heavily depends on natural resources with countries such as Democratic Republic of Congo, South Sudan and Republic of Congo having a dependency of more than 30% of their GDP in this sector (World Bank Group, 2017). Globally, Africa collectively holds more than 30% of mining reserves, 8% worth of gas deposits and 10% of crude oil reserves (World Bank Group, 2019).

Despite this vast wealth, the African Union (2009) recognised that the risk carried by these sectors eroded the benefit for locals in the long-tem. Moreover, higher rental charges in form of royalties and tax regimes, to foreign investors in the extractive industries were still not sufficient to support these countries. It was based on this paradox, that the African Mining vision was established, to ensure that local rural populace benefited from mineral wealth through economic engagement into mineral supply chains.

Further, economic activity brought on by this capital intensive industries made them more susceptible to bribery (Sauer & Seuring, 2017). Knutsen, Kotsadam, Olsen, & Wig (2017) suggested that this happened due to opacity on the revenue extractive companies generated for the local governments as well as the immovable remote location of the mining activities. The high profit margins thus attracted local security officials seeking to prey on the vulnerability of the mines safety as well as brutal

militias hoping for a windfall. Consequently, military conflicts have risen in countries such as Democratic Republic of Congo raising the need for risk management strategies (African Union, 2009; Hofmann et al., 2018).

Conflict minerals have led to social supply chain issues as upstream consumers demand more transparent supply chains and laws have even been enacted requesting companies to ascertain their products are free from conflict such as the US' Dodd-Frank Act of 2010 also known as the Conflict Minerals Rule ,which led to 95% certification of Tantalum producers (Hofmann et al., 2018; Kim & Davis, 2016; Sauer & Seuring, 2017). Tantalum, found in Democratic Republic of Congo, Rwanda, Burundi and Zimbabwe had in the past faced disruptions due to difficulties faced in its supply chain such as unsafe artisanal mining, political tensions, human rights abuse, smuggling and lack of traceability (Mancheri et al., 2018).

The Conflict Free Sourcing Program was borne out of the need to assess and verify over 25 countries that used these minerals were conflict free by looking into supplier systems and buying activities (Young, 2018). The Organisation for Economic Co-operation and Development also established a due diligent concept that starts investigations from upstream suppliers in mineral supply chains of gold, tungsten, tin and tantalum (Schütte, 2019).Further, it seems the Organisation for Economic Co-operation and Development Forum on Responsible Mineral Supply was keen on adding cobalt and mica to this category whereby restrictions for mining companies would start to apply(Young, 2018).

Even with intense government intervention in extractive industries , the black market trade still thrived and was evident when the United Arab Emirates gold imports from Africa in 2016 were valued at $15.1 billion while there were no corresponding export flows from African countries(Lewis, McNeill, & Shabalala, 2019). This could have stemmed from the high regulatory effect from governments that were perceived to be ineffective and hence negatively prompted firms to act illegally(Chung, Lo, & Li, 2016).

Besides regulatory pressure, mining and energy companies also faced stimuli such as peer pressure where leading companies were pioneering benchmarks of managing supply chains as well as being strong-armed by customers who demanded compliant suppliers (Kim & Davis, 2016).Therefore as business models changed, so did their supply chain risk profiles and the need to audit the different types of risk such as environment, demand, process, control and supply (Christopher, 2011).

Mining has come under scrutiny given the environmental and social costs to the African continent that. Hence, risk management and sustainability issues have come up such as the implementation of The Equator Principles (TEP) in the Project Finance community (Spitz & Trudinger, 2019).Due to the severe environmental impact of extractive industries, Sauer & Seuring (2017) considered sustainability an oxymoron and called for a balance by extractive industries to serve societal needs and still remain sustainable. To solve this, Mokhtar, Genovese, Brint, & Kumar(2019) suggested sustainability could be boosted by supply chain leaders through engaging downstream and upstream suppliers. This make identification of key primary and secondary suppliers in each of the supply nodes critical in managing associated risks(Wang, Li, & Anupindi, 2015).

On country level, the South African mining industry was estimated to contribute more than R300 Billion into the economy and employed almost half a million people(Goodman, Rajagopaul, & Cassim, 2019; Kotze & Rossouw, 2018).However, South Africa lagged behind other globally comparative mineral markets. The reason for this, opines Goodman et al.,(2019) was due to slow adoption of mining technology, demotivated employees who constantly protested, volatile prices, high dependency on imports and declining demand from China, amongst other concerns (Cosbey et al., 2016; Hofmann et al., 2018). With more than 50,000 jobs shed in the last decade, the South African mining industry was in dire need of making technological improvements in areas such procurement and logistics (Goodman et al., 2019).

Volatile mineral prices had also forced large South African mines to resort to mechanisation to improve productivity and reduce operational cost pressures and this has led to conflicts with unions especially for the platinum-group metals (Mnwana & Bowman, 2018).Other commodity price influencers included central banks, that consider minerals such as gold a safe heaven, and giant economies such as India and China who had a long-held an affinity for gold jewellery as a status symbol and saving mechanism(Aguilera & Radetzki, 2017). Hence the need to protect profitability has led to a technology adoption trend which was also trickling down to medium and artisanal sized miners who were now looking increasing their outputs(Pedersen et al., 2019).

Developed countries mines tended to source 58% of their operational expenditures locally due to increased supplier capabilities while lower-middle income countries, of which most African countries were, only sourced a paltry 12% locally(Cosbey et al.,

2016). The effect of sourcing globally meant added exposure to disruptions n African supply chains (Cosbey et al., 2016).

To counter the dependency on imports, that was wont to be exposed to currency fluctuations and disruptions, mining companies in South America had resorted to sourcing from high-performing local contractors. This strategy would be hard to emulate in Africa as most industries are nascent and would have been hard-pressed to provide the high quality demanded by investors (Cosbey et al., 2016; Goodman et al., 2019). Yet, however little procurement was done locally by mining companies in Africa, the shared value effect was felt in the strengthening of local manufacturers and service providers who then provided employment opportunities and re-invested locally (Cosbey et al., 2016).

There has been a drive towards lean supply chains that encourage collaborations with suppliers and customers and maintenance of low stock even when safety stocks are needed in case of disruptions(Thun & Hoenig, 2011). This is risky as disruption in one node can cause chaos in another making the root cause of supply chain risk difficult to fix according to Hendricks & Singhal (2005). Supplier choice options may not also be available as some specialised parts may only be obtainable through some suppliers and alternatives may be hard to come by(Park, Hong, & Roh, 2013).

Ironically, even in the face of risk, organisations tended to rely on archaic software instead of advanced technology that would highlight risk analytics indicators that would thwart disruptions early on (Business Continuity Institute, 2018). Chevreux, Hu, & Gandhi (2018) argued that even with significant digital investments in the supply chain, where practitioners were more knowledgeable, the world had proven unpredictable making planning and deploying risk mitigation strategies much more difficult. (Bode, Wagner, Petersen, & Ellram, 2011; Kim, Chen, & Linderman, 2015).

Apple, the first company to break the value of over a $1 trillion, had much of its success pegged on an excellent supply chain system(Davies, 2018; Lockamy, 2017). Apple's competitor, Huawei, had also faced supply chain constraints given the recent US blacklist that was reverberating across the globe, motivated by the technology race between China and the US (Mesquita, 2019; Ting-Fang & Li, 2019). Huawei's downstream effect was the cutting of orders from suppliers by almost 30% and stock-piling on key components as its own customers, wireless companies in countries such as Japan and UK, shied away from working with them due to new compliance requirements (Ting-Fang & Li, 2019).

In the long-run, there could be even tighter export controls on technology goods restricting world trade which is seemingly a new trend of de-globalisation(Witt, 2019). Reminiscent of the cold war era, this brewing China-US trade was estimated to shrink the World Gross Domestic Product (GDP) by 2.8% in 2019 further necessitating the need for resilient supply chains(Mesquita, 2019).

In light of these risks, Hendricks & Singhal (2005) urged practitioners to develop skills that heightened their supply chain responsiveness in addition to deepening their understanding of the different nodes that affected their supply chains. An example of this responsiveness was found out by Kim et al. (2015) when they saw a PC manufacturer pre-meditate supply chain disruptions from a minor Thai supplier who was later on affected by incoming floods.

However, while many companies understand the impact of risk on their supply chains, not enough act adequately enough to mitigate the risks (Thun & Hoenig, 2011). A prime example of this was when the Tohoku earthquake occurred in 2011. Toyota even with its famed Toyota Production System (TPS), took almost three months to get back to the pre-earthquake production levels as observed by Matsuo (2015). The estimated damage from the Japanese Earthquake and subsequent Tsunami was around $235 Billion, compared to the 2004 Indian Ocean Tsunami that cost $9.5 billion, making it one of the most catastrophic natural disasters(Park et al., 2013).

The earthquake disrupted supply chains globally due to Japan's position as a major component manufacturer and this was seen through the 20% hike in component prices (Matsuo, 2015). Nevertheless, Cisco, through a nimble supply chain disruption management strategy managed to evade the same climatic risk across its suppliers by act accordingly, mitigating their losses(Revilla & Sáenz, 2014). Equally, when a fire in a Philips factory in New Mexico occurred, there were two varying difference in how companies that relied on the factory for supplies reacted; Nokia was able to detect and react quickly while Ericsson failed to do so to the detriment of their position in the cell phone market leading to financial losses (Bradley, 2014).

In conclusion, Bode et al. (2011), advised that when firms were preoccupied with the importance of deeply understanding supply chain risks, they acted responsively and learnt from the past disruptions. This way, firms benefited through superior performance and competitive advantage.

1.3. Scope of the research

Risk sources and how managers mitigate them differ from business to business and geography hence, the focus on Africa and the extractive industries is due to their similarities in nature and geography. Due to the vast number of industries operating in Africa, the research was decidedly narrowed down to focus on the mining and energy firm that contribute significantly to the continent (World Bank Group, 2019).

Supply Chain managers were targeted based on their importance in providing value for their firms through sourcing of materials to enhance productivity and ultimately ensuring their extracted resources provide value to the end consumer.

In 2017, mining saw a recovery due to high prices, better cost control and increased demand leading to a 35% increase in market capitalisation of US$195.86 billion by the global top 25 firms (Ahmed, 2018). Of this group included Glencore, Vale, BHP and Anglo-American who had significant investments across the African continent. Hence supply chain managers working in these companies were targeted.

The energy industry was also targeted as the two industries bear similar supply chain risks such as regulatory and consumer disruption. Supply chain managers were targeted from top companies such as Halliburton, General Electric, Perenco, Schlumberger and Baker Hughes amongst other players.

1.4. Hypothesis

The following hypothesis was be examined in the research:

Hypothesis 1: Supply chains in Africa are highly predisposed to supply chain risks

Hypothesis 2: Complexity in supply chain is a key driver of supply chain risk

Hypothesis 3: Exogenous supply chain risks have a higher likelihood to occur than endogenous supply chain risks

Hypothesis 4: Exogenous supply chain risks have a greater impact on the supply chain than endogenous supply chain risks.

1.5. Theoretical and Business implications of the research

This research aimed to contribute to academia given the gap that existed in understanding Supply Chain risks in Africa and more specifically in the mining and energy industry domain. The research examined how supply chain managers perceived risks affecting their industries. Additionally, the research unpacked how well aware supply chain managers were, of the determinants of risks that existed in their supply chain.

A study by the Business Continuity Institute (2018) found that more than 56% of the 589 respondents surveyed encountered a supply chain disruption with 14% suffering losses of more than €1 million. Company losses due to disruption further included quality reduction, loss of trust by customers and suppliers and damaged reputation (Jacobs & Singhal, 2017).

Beyond the extractive industry, managing risks was critical as an investigation by Hendricks & Singhal (2005) on the long-term effect of supply chain disruptions in publicly traded companies uncovered a negative impact on stock price during the disruption announcement period. Furthermore, Hendricks & Singhal (2005) noted a slower recovery of the stock price with more than 30% decline in stock price over a three year period. Therefore, supply chain risk management is critical to companies' bottom-line given the financial impact caused if there are disruptions such as trade wars or global political shifts such as de-globalisation(Witt, 2019).

Knowing this impact of supply chain risks to business, the research hopes to better equip firms in understanding these risks as well as offering risk mitigation strategies. Risk mitigation strategies could include leaner supply chains, development of regulatory frameworks, and implementation of supply chain visibility tools and use of big data.

The following chapter looks into what has been academically reviewed in the sphere of supply chain risks and the firms operating in the mining and energy industries. It examines the various hypothesis that have been tested, theories and arguments that have been proposed previously.

2. LITERATURE REVIEW

2.1. Introduction

The intention of this research was to look into what drove supply chain risks in mining and energy industries and subsequently the literature review sought to provide insights and examine what academic literature existed in the domain. This chapter looks at proposed theories, arguments around the topic of supply chain risk management and trend in the extractives industries in Africa. The literature review was examined as follows.

To begin with, the author looked at the different definitions of supply chain management based on existing academic literature and leading supply chain practitioners. The aim was to provide a basis of how supply chain management evolved as a concept, the existing models and history to date.

Thereafter, the author interrogated how supply chain risks were defined and distinguished in the industry. Risks definition opened up literature on existing risk management practices and suggestions on how companies tackled exogenous or endogenous risks.

Thirdly, the mining and energy industry context was explored to better understand the ecosystem they operated in and how supply chain risk affected them. Industry practices such as conflict minerals certification, artisanal mining were reviewed to have a better understanding of the industry ecosystem.

Fourthly, the basis with which the research was developed argued through presentation of short-falls in the academic research and the need in business. Major trends such as big data analytics, consumer trends and globalisation were also deliberated. Lastly, the theoretical framework that was used to analyse this study was presented and thereafter, the summary of the chapter was followed.

2.2. Supply Chain Management

Supply chain as a discipline originated from Jay Forrestor's quest to understand demand fluctuations in supply pipelines and the connections between customers and suppliers, a phenomena he termed "the bullwhip effect" (Blanchard, 2010).The supply chain management term came about in the 1980's and had been evolving given the changes happening in business and continued interest in the topic, making it a difficult concept to definitively define(Stadtler, 2005).

Blanchard (2010) and Stadtler (2005) attributed the supply chain management concept to a Booz Allen consultant, Keith Oliver, who used the word to merge the

concepts of transportation, distribution and materials management and instead of having them as disparate functions.

Waters(2010) denoted the term supply chain management as an extension of logistics management whereby whereas logistics management only looked at the planning process and was information driven, supply chain management provided real value by focusing on linkages with suppliers upstream and final customers downstream. This ensured value maximisation by way of enhanced competitiveness.

Stadtler (2005) sought to integrate numerous definitions terming supply chain management as “the task of integrating organizational units along a SC and coordinating materials, information and financial flows in order to fulfil (ultimate) customer demands with the aim of improving competitiveness of the SC as a whole” (p.576). This was encapsulated in Figure 1 below.

Figure 1: House of Supply Chain Management (Stadtler, 2005)

Based on above definition, Supply Chain Management was considered a Complex Adaptive System (CAS) which Holland (2006) characterised using four key features; conditional action where an agent could act based on another agents signals or environmental change, parallelism where information was passed on concurrently, adaption and evolution where changes were expected to occur and lastly, modularity where agents could combine or separate different system components to achieve a desired outcome.

Choi, Dooley, & Rungtusanatham(2001) and (Hearnshaw & Wilson, 2013) further elaborated the application of CAS in supply chain by defining supply networks as

living systems that are non-linear, emerging based on changes in the system, adaptable to changes by self-organising and this evolution helps in identification of trends. What this meant to companies is that they could be faced with disruptions at any given time without even knowing about it(Zhao, Zuo, & Blackhurst, 2019). This was further endorsed by Hearnshaw & Wilson (2013) and Nair & Reed-Tsochas (2019) who argued that real-life supply chains mimicked complex network models and were key in understanding how overall firm performance could be improved. Through modelling of supply chain networks (Zhao et al., 2019) proposed two supply chain management strategies; reactive whereby results showed 50 times less impact on networks when applied and proactive strategies where companies pre-empted network effects before their tier one suppliers were hit.

Often, supply chain managers focused efforts on the physical aspect of the supply chain whereas discrete, back-end value adding activities in supply chain consisted of additional nodes that may have not been in the radar indicating how amorphous a supply chain could be (Carter, Rogers, & Choi, 2010). It was therefore apt that Borgatti & Li (2009), compared supply chain networks to ecological food networks due to the similarity in heterogeneity and the tendency to have dependence chains across supply networks especially in the advent of global interconnectedness (Kumara, Greaves, & Raghavan, 2005).

Hitt, Xu, & Carnes (2016) defined the aim of supply chain management as the creation of value for customers and optimising profitability along the supply chain through coordination of multiple a physical activities. Hugos (2018) supported this extended view of supply chain and sought to differentiate the traditional concept of logistics from the concept of supply chain management by defining logistics as the activities that occurred within the firm while supply chain focused on the whole value chain. The whole value chain consisted of companies that collaborated to provide the end product to the customer through activities such as product development, finance and marketing. In essence, supply chain management was a systems approach whose framework allowed businesses to respond effectively to conflicting priorities.

This definition was in line with Michael Porter's value chain framework where managers were advised to strategically focus on profitability and efficiency in their five primary processes-inbound logistics, operations ,outbound logistics , sales and marketing and service which also encompassed how the ecosystem of a supply chain was built (Blanchard, 2010).As such, Hugos' definition was ideal for this study

because it included a larger spectrum of the supply chain of which the research was exploring.

2.3. Supply Chain Risk

Supply chain risks were noted to have serious impact to businesses and had become worse due to trends such as globalisation, outsourcing, customer demands, lean manufacturing or supply chains and the increased linkages causing further complexity(Fan, Li, Sun, & Cheng, 2017). As such, managers were asked to counter these risks through supplier and customer integration which then offered nimbleness in a volatile world(Jajja, Chatha, & Farooq, 2018).

The definition of risks in supply chain varied from author to author with Heckmann, Comes & Nickel (2015) further finding definitions of supply chain risk vague. Therefore supply chain risk were problematic to measure, visualise, regulate, and represent unlike other fields such as finance that had data sets where risk could be measured.

Christopher (2011), defined supply chain risk as the probability of a risk multiplied by the impact. He cited the example of a tornado that was not likely to happen in the Pringles' sole North American factory but when it did, it had a huge impact on Procter and Gamble's production of its popular brand. Revilla & Sáenz (2014) defined supply chain risks or disruptions as abnormal occurrences that impact negatively the movement of materials and goods across a supply chain.

In the supply chain domain, risks were also categorised as either rising from the supply chain network (endogenous risks) or based on external risks (exogenous risks) (Faisal, 2009; Giannakis & Papadopoulos, 2016). Exogenous risks included risks such as weather, financial crisis, social instability while endogenous risks included aspects of supply capacity constraints and demand risk(Faisal, 2009).Since most exogenous risks were much more difficult to control and predict, priority was given to endogenous risks where the sphere of control was much more closer(Giannakis & Papadopoulos, 2016).

While looking at Apple's exposure to external risk, Lockamy (2017) identified several external risks which could impact other companies that source globally. These risks included, country risk which related to economic issues in the country, business climate risk which was connected to a country's political and economic volatility, logistics risk which gauged how easy it was to fulfil supply chain obligations such as warehousing and transport , commercial risk and lastly, corruption risk.

Reputational risk also come into scope leading to the development of third-party forums or initiatives that verified and certified supply chains such as Initiative for Responsible Mining Assurance (IRMA) (IRMA, 2019). The Rana disaster in Bangladesh, that saw more than a thousand people dead forced the retail industry set up similar industry initiatives to improve workers safety(Jacobs & Singhal, 2017).Some industries also set up country wide initiatives that looked at the whole value chain and product life cycle such as the Australian Steel Stewardship Forum and Aluminium Stewardship Initiative (ASI) which served a similar purpose in the aluminium industry (ASI, 2019; Steelstewardship, 2019).

With outsourcing of telecommunications and data, cyber risk also became an emerging concern to supply chain managers with the increased usage of machines (Makris, Hansen, & Khan, 2019).Snyder et al.(2016) also recommended supply chain risk management to include disruption risks such as supplier interruptions, operational risk and financial risk.

A holistic definition of supply chain risk was offered by Heckmann, Comes & Nickel (2015) “Supply chain risk is the potential loss for a supply chain in terms of its target values of efficiency and effectiveness evoked by uncertain developments of supply chain characteristics whose changes were caused by the occurrence of triggering-events.” (Heckmann, Comes, & Nickel, 2015, p. 12). A good example of this would be a critical analysis of Jeep’s upstream component supplier that revealed the sole provider of their clay castings was in financial trouble and would looking at leaving closing their factory (Christopher, 2011). The definition by Heckmann, Comes & Nickel (2015) encompassed the complexity of the different nodes affecting one’s supply chain, the impact in efficiency and value of a disruption were it to occur and hence this was the selected definition that was used for the purpose of this research.

2.4. Supply chain risk management

Thun & Hoenig (2011) defined supply chain risk management as the holistic view and control of the internal and external risks that are found in supply chain which was a move away from the traditional risk management where only internal risks were analysed. This definition was in the context of their research in the automobile industry in Germany. Tang (2006) viewed supply chain risk management as maintenance of profitability and continuity through management of supply chain partners.

Waters (2010), advised companies to be wary of reducing slack in supply chains as

supply chain risk had heightened in the advent of globalization and trends such as outsourcing(Das, 2018). Straube and Pfohl (Waters, 2010) interviewed over 1300 supply chain managers in China, US and Europe and found that companies were driven to reduce risk due to a need for process efficiency and customer centricity. Giannakis & Papadopoulos (2016) further supported this by encouraging managers to focus on their internally generated risks and applying a holistic supply chain risk management strategy before contagion formed in the external environment. Waters (2010), contended supply chains needed to be robust enough to mitigate risks through capabilities such as a supply chain continuity team that created measured responses to risks.

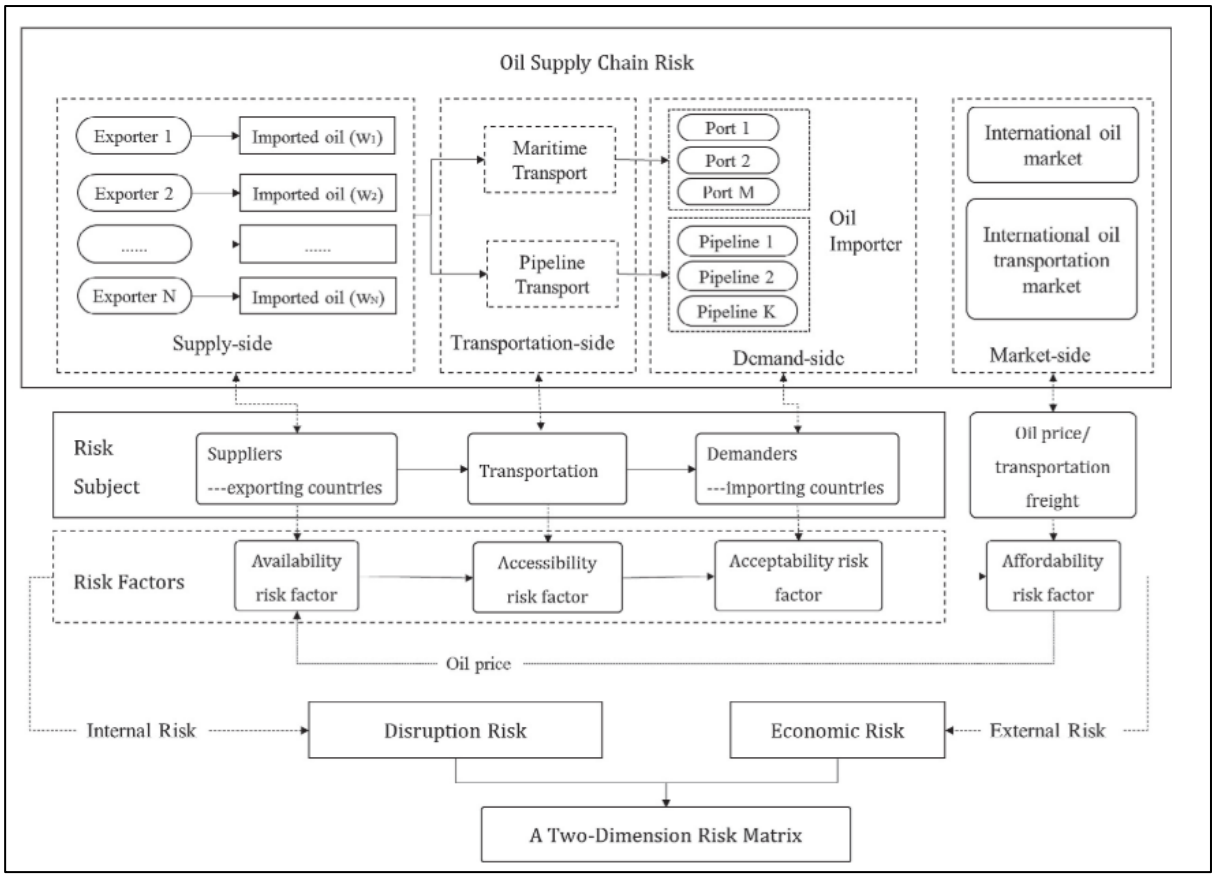
In managing catastrophic supply chain risks ,Bradley (2014) proposed the following steps; Firstly, identification which could be done by means of mapping a company's supply chain, measurement- where likelihood and impact of the risk was reviewed, prioritisation of the major risks through a scale based on frequency or impact, evaluation of the tactics, and implementation of the mitigation tactics.

Practitioners were also warned that decreasing complexity in order to reduce disruptions could have also led to further disruption and therefore should have focused on eliminating unnecessary complexities that added risk and little value to customers (Christopher, 2011). It was therefore prudent to understand how managers could alleviate these risks given the variances in mitigation choices and the potential profit harming tendencies.

Traditional supply chain risk management was found to be inadequate given the nature of unforeseen risks, hence companies were asked to be more proactive in building capacity to quickly act and communicate should these risks occur(Scholten & Schilder, 2015).Companies were also found to manage risk depending on their priorities. Xu et al.(2019) found that if a company prioritised the environment, then environmental risk would be ranked highly in their supply chain risk management framework. Fan et al.(2017) suggested managers should view supply chain risk management as part of a supply chain risk information system containing three processes-risk information sharing, risk analysis and assessment and risk sharing mechanisms.

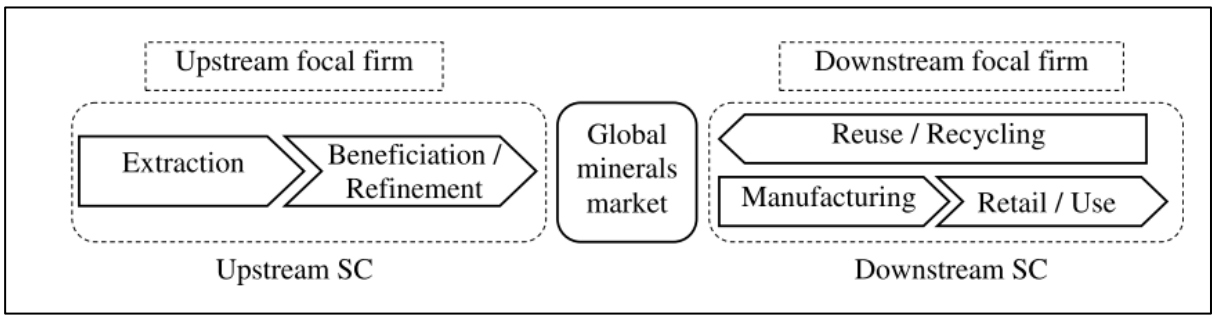
While examining China's systemic risks in the global oil Supply Chain, Sun, Liu, Chen, & Li (2017) proposed the 4A- framework highlighted below in Figure 2. This framework tackled the how accessible suppliers were, how available transport was, whether the infrastructure was up to scratch and if the economy was affordable.

Figure 2: The Framework of two-dimensional risk matrix



A generic concept of the mineral supply chain was proposed by Sauer & Seuring (2017) to provide a better understanding of the main distinguishing activities that happened in the upstream and downstream mineral supply chains.

Figure 3: Mineral Supply Chain Concept



2.5. Current Supply Chain Risk Management Practices in Mining and Energy Industries

Van den Brink et al. (2019) noted that supply chain risk management practises and policies in mining had expanded to not only cover the extractive process at the mines and had now started to probe further into the value chain with processes such as

manufacturing and processing coming under scrutiny. Despite Africa producing 80% of the globally critical element tantalum, the two main producers Rwanda and Democratic Republic of Congo rarely benefited as global prices stayed low, leaving this critical supply chain vulnerable to shocks such as civil conflicts (Mancheri et al., 2018).

While traditional supply chain risk management sought to reduce supply chain disruptions as the chief objective, in the context of mineral supply chains, supply chain managers had to include other risk identification aspects such as certification of the firm, .e.g. the Kimberly process certificate and chain of custody which examined adherence of certain standards in the entire value chain .e.g. Forest Stewardship Council (Hofmann et al., 2018). Pressure from the UN, consumers and investors was mounted on the extractive industries in Africa to source responsibly with endorsements of initiatives such as the United Nations Guiding Principles on Business and Human Rights (UNGPs) occurring in 2011(Van den Brink et al., 2019). Traceability was another risk identification measure which was observed to be inherently difficult due to how globally dispersed and multi-tiered supply chains had become. Case in point, 80% of mining companies operating in Democratic Republic of Congo were unclear about whether they had a clean bill of health in their mineral supply chain between 2014 and 2015 (Kim & Davis, 2016).This was because it took a lot of effort to scrutinise the physical movement of material in the value chain. Further, due diligence demanded partners, suppliers and customers, gather internal and external knowledge of each other's adherence to regulatory requirements (Hofmann et al., 2018).

This non-transparency aided civil conflict, abuse of human rights and smuggling by militia gangs. It is for such reasons that the US Dodd Frank Act was developed to ensure Congolese rebels were not profiting from conflict minerals; tin also known as cassiterite, tantalum also known as coltan, tungsten also known as wolframite and gold(Mancheri et al., 2018; Van den Brink et al., 2019). Together, these minerals were also known as "3TG" for their initials.

Previously, China, a big consumer of African mineral resources had not signed up to these risk identification initiatives rendering the initiatives weak. Nevertheless, as of 2016, Chinese companies had signed up for Electronics Industry Citizenship Coalition (EICC) and the Global e-Sustainability Initiative (GeSI) smelter certifications(Mancheri et al., 2018).

The other significant extractive industry in the African continent was the crude oil

industry which had seen two main patterns in the global supply chain; fluctuations in price which increased exposure for importing countries as well as distribution disruptions brought on by geopolitics such as the Iran and American trade spats(Sun et al., 2017).

Morais & Silvestre (2018) found that companies were intrinsically motivated to be sustainable in their sourcing did so mostly for financial gains and this possibly hampered their structural collaborative efforts in the management of social supply chain issues which was a major concern in extractive industries in Africa. However, some of the larger companies were found to list not only their tier one level of suppliers but further downstream suppliers in efforts to increase transparency and curb noncompliance(Van den Brink et al., 2019).

Academically, El Baz, Laguir, & Stekelorum (2019) urged for further research work in the domain of supply chain management in Africa as most of what has been covered examined issues in North America, Europe and to some extent Asia and thus limited the knowledge and phenomena in this field. The need for managers to understand how supply chain risk is managed in Africa is critical as Nnamdi & Owusu (2014) saw a lack of understanding as a barrier to entry for companies that wanted to operate in the continent. African based logistics were identified to be inefficient with delays in sourcing, excessive costs and poor coordination between suppliers and customers (El Baz et al., 2019).

In fact, the annual World Bank Logistics Performance Index (LPI) consistently ranked African countries at the bottom due to challenges such as geographical positioning, war, poor infrastructure, institutional and regulatory hindrance, low economies of scale, yet supply chain reliability was highly sought across the world (World Bank, 2018;Sodhi, Son, & Tang, 2012). Companies competing in such countries therefore suffered supply chain risk consequences due poor infrastructural support (Sreedevi & Saranga, 2017).

Moreover, Yeboah, Feng, Daniel, & Joseph(2014) emphasised the need for investors to consider logistics and infrastructure risks that inhibit African companies where economic policies coupled with weak corporate governance hampered growth. Zimbabwe, for example was highly mineral dependant yet, faced challenges in implementing sustainable supply chain management due to misalignment of policies between government and stakeholders(Muchaendepi, Mbowa, Kanyepe, & Mutingi, 2019).

Sequeira & Djankov (2014) noted corruption at African ports as a key challenge that

supply chain managers encounter while trying to import goods into the continent further heightening risk. African bureaucrats were wont to increase supply chain risk through the insistence of bribes, red tape or refusal of service to companies participating in trade as was observed in the port of Durban and Maputo. Paradoxically, the same infrastructural investments, ports, were meant to improve logistics by reducing cost and improving turnaround freight delivery time (World Bank, 2018). In light of this, Amiri et al.(2019) emphasised the criticality of strengthening institutions in curtailing corruption effects such as the Dutch disease that was afflicting countries like Nigeria and Angola.

Additionally, African countries faced extreme weather conditions such as flooding in East Africa, drought in South Africa, Cyclone Idai in Southern Africa and these natural disasters had therefore increased the appreciation of supply chain risk management in the continent. Cyclone Idai in Mozambique forced Vale, a Brazilian mining company, to halt operations as the railway line meant to transport coal was submerged (Nhamire & Sullivan, 2019). Less than a month after Cyclone Idai, Cyclone Kenneth hit Mozambique prompting Anadarko Petroleum, an energy company, to cancel flights in and out of their offshore gas project where they had invested billions of dollars (Nhamire & Sullivan, 2019).

China, was also noted for scaling down on mining consumption due to it's Made in China(MiC) economic policy where focus was on developing technologies, a move away from their initial focus on infrastructural development(Goodman et al., 2019). Incongruously, as China restricted exportation of Chinese rare earth minerals for their own technological use restricting manufacturing of products globally, they increased demand for these metals from other countries such as Japan which could serve as new markets for African minerals (Sauer & Seuring, 2017).

Extractive industries operating in Africa also had to be wary of relying on other traditional Asian markets for demand of resources due to growing tensions in the South China Sea where China was seeking to exert control through military might. The ramifications of a future conflict could cause a ripple effect in supply chains across the globe, estimated to even be larger than the Asian financial crisis as almost one third of global trade navigated through this sea (Whitager & Martinez, 2018).

Faced with high unemployment statistics, South Africa's government has been crippling mining companies through legislative efforts such as tax codes and local content requirements that forced mines to keep employees even when global markets face falling prices and demand increased productivity (Mnwana & Bowman, 2018).

Sometimes, these labour tensions between labourers, mine owners and government turned deadly as seen in Marikana in 2012 where 34 striking miners were murdered (Hammond, Cooper, & van Staden, 2017).Similar labour issues also plagued other African mines with artisanal miners in countries such as Ghana despite contribution to environmental degradation and safety concerns, were left to operate by an inefficient government unable to provide youth with jobs (Hilson, 2017).

2.6. Current Gaps in Supply Chain Risk Management in Mining and Energy industry

The essence of supply chain management according to Waters (2010) and Blanchard (2010) was to maximise profitability by ensuring the company was operating in a competitive manner through reduction of inefficiencies, faster turn-around times, fewer quality issues and maintenance of optimum inventory. Therefore if a company was not able to meet these demands, something in their supply chain needed to be fixed. There was a need for companies to first understand their capabilities and how their capabilities influenced supply chain risk before embarking on SCRM practices in order to reduce the impact of disruptive risks that were costly(Kim, Chen, & Linderman, 2015; Rajesh, 2017).

El Baz et al. (2019) accused previous research regarding supply chain topics in Africa, as shortcoming in theoretical foundation and there was a tendency to theory dress even when it was not applicable. For example, when Revilla & Sáenz (2014) studied emerging markets in South America, Africa, the Middle East, and parts of Asia and compared them to developed countries, they found the level of supply chain disruption management on an operational level to be the same across these countries. On the contrary, El Baz et al. (2019)found that unlike Asia and Latin America where supply chain had evolved to encompass strategic topics, African companies were still tackling operational and product specific issues. This therefore left room for research to be conducted in understanding cultural impact in management of supply chain risks as noted by Revilla & Sáenz (2014).

Heckmann, Comes and Nickel (2015) sought separation of supply chain risk management quantification from existing financial and insurance models as they were short-sighted since they only looked at efficiency-based objective while supply chains covered much more such as cost and waste-considering objectives. This was also noted by Giannakis & Papadopoulos (2016) as they sought evidence of “hard”, quantifiable operational and financial data to convince companies to prioritise risk. For example, some firms refused to implement reverse logistics, though beneficial,

as it was difficult to quantify the rate of return and profitability (Govindan, Soleimani, & Kannan, 2015). Ribeiro & Barbosa-Povoa (2018) saw a shortcoming in how resilience in supply chain was modelled with very few quantitative models applied in supporting supply chain decision making. Echoing Giannakis & Papadopoulos (2016), they both advocated for the need of clear quantitative models that could support managers in making efficient strategies.

Rigour particularly for African supply chains was demanded by Nnamdi & Owusu (2014) as they found limited supply chain research on the continent . Fahimnia, Tang, Davarzani, & Sarkis (2015) in a literature review on a supply chain topic also denoted the non-presence of African researchers in developing or using quantitative supply chain risk management tools.

Snyder et al. (2016) also found that most supply chain strategies looked at one direction of mitigating risk instead of a multi-pronged approach of using both proactive and reactive strategies simultaneously. Managers therefore had to think of how to develop lasting communal impact with less reliance on extraction in a fast-evolving future world. Qazi, Dickson, Quigley, & Gaudenzi (2018) proposed using Bayesian Belief Networks (BBN) and Expected Utility Theory (EUT) which uniquely integrated the risk appetite of a manager as well as the frequency and interdependence between risks.

Another hindrance in implementation of supply chain risk management noted by Hoskisson, Eden, Ming Lau, & Wright (2000) was recognizing the difficulty of applying western business strategies for emerging economies due to complexities such as negative government influence, institutional infrastructure and difficult economic environment. Risk attitude and behaviour of a manager at times determined how well they rationalised a disruption, their risk appetite or how well they could optimise capacity problems(Giannakis & Papadopoulos, 2016; Snyder et al., 2016). Changes in management could even influence the adoption of socially oriented initiatives in the supply chain(Morais & Silvestre, 2018).

The importance of culture also came into play when it comes to how managers perceived and managed risks. Bode et al. (2011) while examining how firms behave in the event of a risk, discovered that depending on the trust levels between partners, organisations processed disruptions differently. Africa for example had a high degree of close social networks that affected the efficiency of a supply chain which may not be the case in some cultures where personal relationships were not strong (El Baz et al., 2019).

The mining sector in Africa, as observed in Tanzania was viewed as patriarchal in nature with women being excluded in critical conversations such as sustainability even when they are the most affected by mining activities in the community (Lauwo, 2018).This gap has been noted by policy makers who sought to improve this imbalance by hiring women in roles previously thought of as men only (Lahiri-Dutt, 2015).

The African Mining Vision established by the African Union (2009) was looking at addressing inequalities that existed in the mining sector whereby resource rich countries were known to also bear little fruit for local populaces who battled with poverty. Nevertheless, this vision seems to have fallen short of its expectations as African countries were seen to still suffer through illegal smuggling and inconsistent application of due diligence policies (Schütte, 2019).

Yet, some natural resource-dependant countries like Norway and the United Arab Emirates, had managed to shake-off the resource curse by developing sovereign wealth funds that decreased their dependence on resource incomes, ensuring development was sustainable(Vasudeva, Nachum, & Say, 2018). With the exception of Botswana, very few African countries have been observed doing this.

Artisanal mining is another constraint that African countries such as Ghana faced. Faced with crippling unemployment and poverty, rural dwellers resorted to environmentally and unsafe mining practices which the government brutally attempted to quash (Hilson, 2017). Similarly in Tanzania, efforts to support artisanal miners through partnerships with large transnational companies such as Africa Barrick Gold and Anglo gold fell short of their objectives due to fear of reputational risk associated with artisanal mining(Pedersen et al., 2019) .

In comparison to Latin America and western countries, Revilla & Sáenz (2014) found that Africa faced the greatest difficulty in supply chain risks due to political upheavals and economic constraints. Government involvement in African extractive industries supply chain had been found weak in terms of regulatory power and supply chain design (Sauer & Seuring, 2017). This was seen in the implementation of ineffectual local content laws in countries such as Zimbabwe, Ghana, Kenya, Uganda and Mozambique where oil and gas firms were instructed to give priority to local suppliers. Keen to empower locals with newly discovered finds, the Mozambican government resorted to creating local content laws that were in the end ineffective as each either overrode the other or were too complicated to be implemented (Ovadia, 2016).

To avoid governance risks such as corruption , firms operating in the African continent

sometimes opted to pay higher transport costs which could be three times what was expected had they not been faced with a bribery claim showing the far reaching effects of corruption(Sequeira & Djankov, 2014). This was defined as the Tullock Paradox whereby the government would have been better off charging tariffs than receiving bribes as bribes were much small in value compared to legal income. Regardless, African governments had been found to weaken watch-dog institutions and had little political will to root out corruption, making it a complicated issue to resolve(Stapenhurst, Karakas, Sarigöllü, Jo, & Draman, 2017).

Since African governments relied heavily on extractive firm's contribution to the economy, a lot of them were exposed to price volatility. Therefore, extractive industries should have focused on linkages where they enabled local companies by sourcing locally or building infrastructure that could in the long-term support diversification in other industries(Sauer & Seuring, 2017). This issue was not specific to Africa as an empirical study of spill-over effects in Chile indicated a not so strong relationship between copper mining and other industries such as manufacturing(P. Ruiz, 2017). Thus, resource dependant countries have to think of ways to improve the linkages.

While technology had been proposed as a way to reduce this governance risk, a majority of government officials were deterred by the notion of declining cash payments and hence were not likely to implement technological tools that could significantly reduce supply chain risk (Sequeira & Djankov, 2014).

Technology had also been viewed as one way to improve the productivity of mining and energy companies in the continent.It was also estimated that only 1% of the data extracted from an oil rig was used and thus deployment of technology in difficult environments such as Africa, had the potential of unlocking opportunities worth $400 billion in cost savings which could be passed on to consumers (Woetzel & Nyquist, 2017). In the US, technological applications had brought cost effective ways to mine shale oil making it a viable option (Aguilera & Radetzki, 2017). It is for these reasons that mining giant, Rio Tinto, operating in Australia's remote Pilbara region, was exploring technology such as drones to improve workers safety as well as automated drills to improve utilisation and supply of minerals (Woetzel & Nyquist, 2017).

Nair & Reed-Tsochas (2019) also saw an opportunity in conducting data analysis given the ease in accessibility, however, measurement of data was also constrained by a poor grasp of the non-linear nature of supply chain systems. This gap in data analysis presented another challenge in that managers had to also source for hard

to come by skilled workers to interpret the data as well as integrate it with mining fundamentals such as capital investments, productivity gains and labour costs (Chevreux, Hu, & Gandhi, 2018; Woetzel & Nyquist, 2017).

Understanding the underlying data in the organisation was critical as opposed to looking at a snapshot. Van den Brink et al. (2019) recommended the use block chain technology in efforts to improve traceability but the extent to which this had been applied in African mines or energy companies was limited as this was still in the early days. Roßmann, Canzaniello, von der Gracht, & Hartmann (2018) noted the potential of big data analytics in handling uncertainty and improving competitive advantage with logistics practitioners already implementing or in the process of deploying analytical tools.

Wang, Gunasekaran, Ngai, & Papadopoulos (2016) further understood business analytics helped companies strategically and operationally by way of providing data on supply chain design, sourcing, inventory management, demand planning and production. The disconnect for businesses however was the limited understanding and applicability of big data analytics by supply chain managers(Roßmann et al., 2018).While there was an emerging field of supply chain, termed Supply Chain 4.0 due to its association with digitalisation, and emerging trends such as 3D printing, big data and cloud computing, companies were seen to be slow to adapt and integrate these key trends due to uncertainty.

Besides avoiding risk, Wang et al.(2016) advocated the use of big data as a strategic tool that would help managers in taking calculated risks based on trends and adapt to these trends without the need for exigency plans. Park et al.(2013) deemed supply chain design information as an important aspect of managing supply chain disruptions through its three distinctive elements. The downside of big data and the usage of supply chain analytics lay in the cost required in upgrading existing technology, variation in organisational culture or how the overall organisational strategy may have not been in line with supply chain analytics requirements (G. Wang et al., 2016).

While investigating the sustainability of buying firms beyond local geographical borders, Wilhelm, Blome, Wieck, & Xiao(2016) found that sometimes, suppliers had low supply chain sustainability capabilities leaving buyers to take on the role of enhancing the suppliers capabilities in avoidance of the penalties that may affect their stakeholders. Kim et al. (2015) advised companies to not only look at their suppliers' internal competitive advantages but also look map out their connections to examine the exposure to risk. Understanding downstream and upstream impact of suppliers

also allowed organisations to have a proactive approach in case of anomalies or emergent trends in the system (Christopher, 2011). For example Sequenzia, a tea company, engaged with suppliers in order to incentivise them to act sustainably and increase transparency in their tea supply chain (Wilhelm et al., 2016).

Additionally, global companies that are legendary for resilient supply chains such as Apple were not immune to risk. Lockamy (2017) examined their supply chain and found their primary sourcing country Taiwan, to have moderate exposure to external risks. Due to this wide spread of risk, Christopher (2011) urged companies to create a supply chain risk profile for their suppliers. Further, extractive supply chains were being scrutinized globally such as the Organisation for Economic Co-operation and Development guidance, which provided a framework for mining companies to reduce their risk through development of strong managerial systems, documentation and valuation of supply chain risk, design and implantation of risk strategies, reporting and audit of third party due diligence (Hofmann et al., 2018). In as much as transparency was key to buyers and western governments, one of the key issued faced in meeting these demands was shortage in resources(Hofmann et al., 2018).

The other reason managers did not engage in supply chain risk management was due to the cost implication. Thun & Hoenig (2011), uncovered the extent of supply chain risks and their likelihood to occur across 67 automobile companies in Germany where they found that companies with preventative supply chain risk mitigation tools were more likely to implement them as opposed to companies with reactive supply chain risk mitigation tools due to the high cost barrier of reactive mitigation tools.

Yeboah, Feng, Daniel, & Joseph (2014)while analysing the supply chain risks in agriculture also found that cost played a key role and companies were cautious in engaging in risk management without understanding where to invest. The cost of sourcing from local suppliers who were reliable but expensive, versus overseas suppliers who were cheaper but more prone to risk was another conundrum supply chain managers faced(He, Alavifard, Ivanov, & Jahani, 2018). Hence companies had to do more when it came to creating resilient supply chains by identifying and analysing risks and this could be done by ensuring the system design could absorb shocks regardless of the environment that they existed in (Thun & Hoenig, 2011).

Christopher (2011) offered a seven-step approach in managing supply chain risks. It started off with increasing awareness of the value chain, improving where gaps exist through simplification, identifying the critical nodes, managing these paths, improving their visibility, establishing a business continuity team and finally working with

suppliers and customers to implement these risk management procedures. However a great model it was in allowing companies to focus on other types of business risks and providing competitive advantage, practitioners were erstwhile concerned with sustainability of employing the seven steps (Giannakis & Papadopoulos, 2016).

Witt (2019) suggested that the world was now entering a de-globalisation era where economic openness was reducing triggered by global issues such as the 2007/2008 financial crisis and the European migrant crisis in 2015. Thus, supply chain managers had been asked to think of scenarios where global sourcing could be diminished. Witt (2019) showed a trend of countries becoming more reliant on their domestic production as opposed to sourcing from other countries hence as a measure of GDP, trade and foreign direct investment had been declining. The idea of a "Global Factory", where companies could source for goods and services in countries with lower costs thus providing a competitive advantage, was therefore diminishing.

Manufacturers with global supply chain reliance were now being forced to source responsibly by engaging in supplier development strategies and supporting multi-sector compliance programs(Sauer & Seuring, 2017). Firms that provided training and coaching to their suppliers were termed as applying transformational supply chain leadership while companies that focused on enforcing contracts with suppliers to ensure compliance would be applying transactional supply chain leadership(Mokhtar et al., 2019). The use of both types' of leadership styles enhanced supplier capabilities as suppliers are not only motivated but performance was gauged on metrics that gear them towards reducing losses to the buyer.

Organisations that strategically sourced were seen by Wang et al. (2016), as avoiding supply disruptions and protecting organisations from financial harm. Firms therefore needed to move away from the traditional classification of supplier importance based on direct impact and ranking suppliers based on where they ranked in the supply chain(Kim et al., 2015).

To protect their organisations from harm, organisations applied the chokepoint concept whereby they engaged suppliers upstream to be compliant who then put pressure on their own suppliers downstream to source conflict free(Young, 2018).Supplier engagement was also not cheap as it required financial support thus firms had to start collaborating to leverage resources such as leadership, pooled finances and expertise to sector programs such as the Conflict Free Sourcing Program. These programs allowed for engagement with downstream suppliers for audits, technical advice and establishing compliant procedures. Despite their best

efforts, it was still difficult for companies to manage the whole supply chain and they often obscure unsustainable supply chains to avoid bad publicity and reputational damage (Morais & Silvestre, 2018; Young, 2018). However difficult, Scholten & Schilder(2015) maintained that the best outcome in visibility and speed was managed through having long-term and close relationships with suppliers. In fact, customers were seen to demand companies be held accountable for second and even third tier suppliers in a bit to create sustainable supply chains(Bentahar & Benzidia, 2018).

Re-engineering of supply chain networks came to the forefront due to sustainability issues around environmental and social sustainability(Eskandarpour, Dejax, Miemczyk, & Péton, 2015). Social sustainability required companies to either have a pro-social orientation where social initiative outcomes are equally maximised for stakeholders and the company or individualistic where the company pursued its own agenda or competitive orientation where the company sought to outshine their stakeholders(Morais & Silvestre, 2018).

After the 2011 Tsunami, Park et al. (2013)observed Japanese companies relocating their manufacturing hubs, increasing their supply chain collaborations and keeping buffer stock as a way of improving their supply chain design information portability. In the era of climate change a robust and agile supply chain was need. Despite the occurrence of this natural calamity in Japan, Revilla & Sáenz (2014), noted a gap as some Asian countries were seen to give low importance to natural sources of risk despite their geographic proximity to Japan.

2.7. Theoretical Frameworks in Supply Chain Risk Management

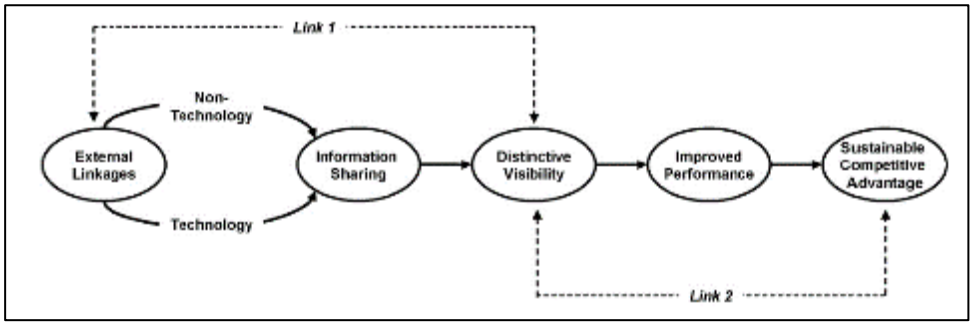
Several theories have been utilised in analysing supply chain risks such as systems theory, dynamic capabilities view ,complex adaptive systems theory and resource based view theory (Bentahar & Benzidia, 2018; Nair & Reed-Tsochas, 2019; Tukamuhabwa, Stevenson, Busby, & Zorzini, 2015).

Barney (1991)building up on the seminal article by Wernerfelt (1984) categorised company internal resources as valuable, rare, inimitable, and non-substitutable as being sources of competitive advantage and therefore it's not surprising that his resource based view theory framework was relevant in supply chain management literature. Resource based view theory became popular in supply chain management as more and more practitioners started evaluating each activity in the value chain individually and assessing their value to the firm(Hitt et al., 2016).

Hult et al. (2007) found resource based view theory useful in understanding how managers could use their resources such as information and culture, to improve supply chain performance showcasing the importance of supply chains as a competitive tool in turbulent markets. This was similar to Gunasekaran et al. (2017) proposal that managers were to focus on acquiring resources and combining them with other resources to collectively improve performance as the theory noted on their own, resources were incapable of providing an edge above competition.

By increasing visibility of these resources, through information sharing of external linkages, Barratt & Oke (2007) saw the potential of improving the supply chain performance as seen in the Figure 3 below and further advocated for the use of the resource based view in analysing supply chain risks.

Figure 3: The concept of distinctive supply chain visibility. (Barratt & Oke, 2007; Sun et al., 2017)



The use of resource based view theory in supply chain and operations research has also been criticised with Bromiley & Rau (2016) arguing the measure of rare and inimitable resources, a resource based view theory requirement, was hard to prove. Resource based view theory has also been accused of reliance on internal resources and having static assumptions, while the operational environment of most firms was observed to be dynamic in nature with external forces at play (Jajja et al., 2018). Hence, resource based view theory was expounded on by the use of the dynamic capabilities view proposed by Eisenhardt & Martin (2000)which advocated for firms usage of internal and external resources through agility and not leverage.

Based on above analysis, by Jajja et al.(2018) and Eisenhardt & Martin (2000) supply chains would then be considered quite complex with multiple agents inter-connected in a dynamic system. Thus the framework of complex adaptive system, endorsed by Choi et al. (2001) is also applicable in providing insights into supply chain networks.

Choi et al. (2001) and Holland (2006) interpreted inter-connectivity and dependency between agents, adaption to change, information sharing and modulation of components to achieve goals, as key features to complex adaptive system theory.

By considering supply chains complex systems, Surana et al. (2005) saw an opportunity for firms to utilise complex adaptive system concepts such as supply chain design, in enhancing some of their capabilities. Kim et al. (2015) similarly perceived the use of complex adaptive system in framing supply chain design and further elaborated its utility in assessing network level buyer supplier relationships.

Zhao et al. (2019) found complex adaptive system useful in mitigating supply chain risks that would otherwise be ignored due to the distances in the network yet could have had devastating impacts on the firm.

In conclusion, these three theories, Resource based view, dynamic capabilities view and complex adaptive system, were thus found to be useful to this research. However complex adaptive systems seemed to be the best fit as it best complimented the non-linear nature of supply chains. Hence it was applied to the relevant constructs.

2.8. Literature Review Conclusion

Based on the previous sections, the main foundation of literature was around supply chain risk management, the context of the extractive industries and the existence and impact of supply chain risks on this critical industries.

Supply chain risks were found to be constantly emerging as trends were often impacting the sector thus making it a topic of interest for academia. The intangible nature of some risks also made it a hard topic to be quantified even as some authors advocated for quantitative models to assist in development of risk mitigation strategies.

Supply chain risks were also dissected into internal and external risks with mitigation efforts seen differently. Some authors propagated for an extended management of external risks such as investigation of second and third tier suppliers while others proposed internal risk management tools such as big data analytics to manage external risks.

Supply chain risk management was seen to have evolved from focusing only on high level risks but was now dissecting whole value chain, in search for nodes that might affect it. This was based on observing companies that had faced financial loss due to supply chain risk management failure and was also true for companies such as Apple, whose supply chain formed part of the company's competitive advantage.

What was heavily evident was the lack of academic material on the African supply chains even though the continent contributed heavily to the extractive sector globally. An understanding of the continent supply chain networks was scant with only a few organisations such as World Bank, UN, and PWC bearing facts and figures of the on-goings in the industry even years after previous researchers lamented the poor state of research.

The African mining context had been explored by policy makers from a western perspective in order to mitigate their companies from risk exposure. While these policies to some extent did offer changes downstream, the lure of conflict minerals still existed with political upheavals occurring in places such as Democratic Republic of Congo. Labour was also a sore issue in the industry with child labour being rampant as well as unsafe working conditions in artisanal mines. Thus, long-term solutions were truly required for supply chain risks of political nature in the African continent.

Technology has been seen as an opportunity for the capital intensive mining industry to cut down on expenses through mechanisation yet, African countries perceive this as a threat to local development and unemployment. Big data is becoming critical in offering competiveness for languishing mines, yet few seem to have explored it in the continent.

Given the extended view of the supply chain, where almost all activities required in delivering a final product or service were considered, the supply chain is indeed a multifaceted system with nodes that are constantly expanding as business activities keep expanding.

3. RESEARCH HYPOTHESES

3.1. Purpose of the Research

The purpose of this research was to examine the drivers of supply chain risks in extractive industries in Africa. Despite their contribution to GDP, mining and energy companies are inundated by numerous supply chain risks yet deployment of risk mitigation strategies often rewarded companies with long-term competitive advantage.

The study was thus structured around four hypothesis. The first hypothesis tested risk awareness of managers in the Industry. What was the risk perception of Supply Chain managers? Did they consider their industry highly exposed to risk or was risk not a concern in their industry? The second hypothesis would indicate the number of risks that were considered by Supply Chain manager as being relevant and impactful to the sector.

The third hypothesis explored whether companies were more predisposed to external risks occurring compared to internal risks and lastly the last hypothesis looked at the impact of external risks compared to internal risks. Below is a summary of the objectives and outcomes expected from each of the research hypothesis.

3.2. Hypothesis 1

Hypothesis one: Supply chains in Africa are highly predisposed to supply chain risks.

Grounded on the scant African supply chain mining literature, such as Mnwana & Bowman (2018) review of mechanisation in South African mining firms, it was already expected that supply chain risks did exist in the sector. The survey instrument therefore wanted to explore to what extent these risks are considered, are they high on the supply chain manager's perspective or lower than what was deemed by the hypothesis? A high perception would provide support to the literature already reviewed. A low perception would provide new insights into how risks are perceived and whether there were competing factors. Alternatively, risk attitudes by managers could be the other reason for this occurrence as offered by Qazi et al.(2018) .

3.3. Hypothesis 2

Hypothesis two: Complexity in supply chain is a key driver of supply chain risk

The second hypothesis looked at the supply chain holistically using the number of risks outlined in the survey and their influence. This review allowed for the application of the complex adaptive system perspective where reactive and proactive risk mitigation strategies were proposed (Thun & Hoenig, 2011; Zhao et al., 2019).

3.4. Hypothesis 3

Hypothesis three: Exogenous supply chain risks have a higher likelihood to occur than endogenous supply chain risks

African supply chains have faced numerous external risks outside of firms control such as natural disasters(Nhamire & Sullivan, 2019). Additionally, weak governance frameworks such as strict local content laws and ironically weak infrastructure states were rendering the business environment difficult for companies in mining and energy (Hilson, 2017). The outcome was expected to positively rank exogenous risks highly on probability. If internal risks are found to have a higher likelihood, this could be narrowed down to what key agents in supply chain networks such as workers and suppliers. The resource based theory and dynamic capabilities view would be useful in analysing these resources.

3.5. Hypothesis 4

Hypothesis four: Exogenous supply chain risks have a greater consequence on the supply chain than endogenous supply chain risks.

The negative impact of disasters such as the cyclone Idai on the Mozambican and Zimbabwean economy was bound to be felt for a long time proving that external risks sometimes wrecked more havoc compared to internal risks(Nhamire & Sullivan, 2019; Thun & Hoenig, 2011). The impact of this hypothesis was analysed using the complex adaptive systems perspective. Other African countries that may not have experienced natural disasters might have ranked their external risks differently mapping them lower in impact compared to internal risks. This result was expected to provide a new perspective on what internal management strategies could be deployed to mitigate these internal risks.

4. PROPOSED RESEARCH METHODOLOGY AND DESIGN

4.1. Introduction

The purpose of this research was to identify the different risk agents or risk activities that supply chain deals with and the level of impact. The study hoped to uncover logistics manager's attitudes and pain points as literature in chapter 2 suggested.

4.2. Research design

A quantitative research approach was preferred to a qualitative research approach as the author wanted to have an independent perception far from feelings and opinions. Further a quantitative approach offered an opportunity to collect and analyse a large data set given the time and resource constraints of delivering the research project. The other reason is that the research strategy was better suited for the research objective, was because it would determine how different managers spanning across multiple countries perceived risk. Further, the approach was deductive as the author tried to test probabilities and impact of the different risks that that occurred in vast nodes across extractive industries supply chains.

The research found varied reason across companies or countries and thus uncovered variances in risk attitudes or appetites. Hence the explanatory purpose of adding an African perspective of supply chain phenomena was achieved (Saunders & Lewis, 2017).The research was able to juxtapose how supply chain managers operating in complex markets in Africa, adapted to risks compared to other markets since little had been conducted in the arena of supply chain risk research around African countries and its impact on businesses (El Baz et al., 2019).

Due to the time constraint in that a new questionnaire could not be designed from scratch and piloted, a pre-existing one that fit the purpose was selected. The reliability of this survey has been tested and hence reduced the time it took to develop and design a research instrument from scratch. The survey was adopted from Thun & Hoenig (2011), and buttressed the explanatory strategy of the research (Saunders & Lewis, 2017).

The following section outlined the methodology that was be used to answer the research hypothesis. It described the design, population, sample unit of analysis and the data collection process that was employed. The research was be aimed

at answering the following questions

1. The first hypothesis will be as follows: *Supply chains in Africa are highly predisposed to supply chain risks*. This hypothesis allowed for analysis of environmental awareness of African supply chain practitioners in extractive industries.
2. The second hypothesis was as follows: African *supply chains have multiple drivers of supply chain risk* where managers proposed their level of vulnerability to internal and external risks
3. The third hypothesis was as follows; *exogenous supply chain risks have a higher likelihood to occur than endogenous supply chain risks.* Under this hypothesis, the author sought to understand the probability or likelihood of external risks compared to that of internal supply chain risks.
4. The last hypothesis was as follows; *exogenous supply chain risks have a greater consequence on the supply chain than endogenous supply chain risks*. The survey instrument asked managers to measure the likelihood of a risk occurring from a scale of very high to very low.

The research time horizon was cross-sectional in nature there was an academic period constraint. The research sought to explain statistically, the weighting of different types of risks as well as the risk perception amongst extractive industry supply chain managers (Saunders & Lewis, 2017).

4.3. Population

Population of the research will be the mining and energy companies that face supply chain risks and operate in African countries. There are more than 1100 mining and energy projects in Africa, of which transnational and local companies operated in, which formed the population to be targeted(“Africa Mining IQ,” 2019).

4.4. Sampling method and size

In order to make statistical inferences of the research questions, the author selected a sample of the main energy and mining companies in Africa which at the time, stood at around more than 200 companies with over 1800 mining and energy projects(“Africa Mining IQ,” 2019; Saunders & Lewis, 2017)

As the author searched for the opinion of supply chain managers and coincidentally worked in a global supply chain services company, the author was able to reach out to internal company contacts operating in Morocco, Senegal, Angola, Mozambique, Kenya, Uganda, Tanzania, Zimbabwe, South Africa, Ghana, Ivory Coast, Madagascar, Nigeria, Gabon & Cameroon to obtain responses from mining and

energy companies operating there. The author also reached out to person contacts who worked in mining and energy companies across Africa.

4.5. Unit of analysis

The unit of analysis was the mining and energy companies that faced supply chain risks.

4.6. Measurement instrument

The measuring instrument had previously been tested in a peer reviewed journal that sought to answer similar research questions the author was keen on tackling. The Thun & Hoenig (2011) research instrument was reliable as consistent results were produced which was evident in Cronbach alpha which ranged from 0.78 and 0.68 meaning the factors were reliable (Field, 2009). The instrument was also valid given that the Eigenvalues were above 1.0 additionally, the explained variance of the factors of more than 50% attested its validity further.

Had there been no time constraint, the author would have designed a survey instrument and piloted it to test the content and construct validity (Saunders & Lewis, 2017). The instrument was slightly adapted to the African context by asking additional categorical questions such as country of the company where the manager works which allows for data segmentation into country or regional clusters. Other descriptive statistics such as the size of the firm and gender of the respondent were added to enrich the research data findings.

4.7. Data gathering process

Nemoto & Beglar (2014) offered a four-point Likert-scale as ideal in investigating opinions through creation of different categories of which people could showcase their weak or strong endorsement without losing interest or viewing the survey as a burden. Despite this endorsement of the Likert Scale, Nemoto & Beglar (2014) also advised against solely using questionnaires as a mixed data gathering methods such as additional interviews, provided a well-rounded understanding of phenomenon being studied. Unfortunately, time constraints only allowed for one source of data gathering. The author conducted a pilot distributing to a small proportion of people to gauge whether the questions are well understood and the tool was collecting data accurately (Saunders & Lewis, 2017).The survey instrument was thereafter distributed with a cover letter detailing confidentiality assurance, anonymity and the purpose of the research for respondents to be aware of the motive with an option to opt out of the survey (Saunders & Lewis, 2017).

The survey, based on the existing questionnaire used by Thun & Hoenig (2011) amongst German automakers, was developed on google survey, a free resource that allowed survey data to be collected seamlessly. As the sample size recommended for an effective survey sample was around 120 surveys, the survey was shared by the researcher electronically across the various channels to expedite the process. Since the author worked in a multinational that provided logistics services to other African based corporations, the author will approached the target audience through professional and personal networks.

Netiquette dictated that the author did not spam users but rather emailed in advance potential respondents on the upcoming survey and a courtesy email thanking them once the survey has been completed (Saunders & Lewis, 2017).The data was then be uploaded on the statistical analysis tool, Statistical Package for Social Sciences where the data was be coded appropriately.

4.8. Analysis approach

Once the data had been extracted into the SPSS, there was little need for manual intervention. Nevertheless, the author will checked for illegitimate codes, where code numbers appear in the wrong data variable as well as checking for illogical relationships(Saunders & Lewis, 2017). Cronbach alpha was used to test the reliability while factor analysis was used to test validity.

Using descriptive statistics analysis, data was presented in different types of charts showcasing the proportion of survey participants from the targeted countries, gender, the company size and the type of mineral that they worked with.

To see whether there was variance between different groups across constructs, independent samples T-Test were used to compare means across gender and company size.

The author also used Analysis of Variance (ANOVA) linear regression tests to interrogate and analyse the relationships or interdependencies between different variables (Saunders & Lewis, 2017).

To test the hypothesis, a combination of descriptive tests and mean tests were conducted for the first and second hypothesis. ANOVA and mean tests were used to test the third and fourth hypothesis.

4.9. Quality controls – including validity/ trustworthiness criteria

Time and resource constraints meant the researcher, could not practically collect data from the whole population of supply chain practitioners operating in the domain of

natural resources in Africa(Saunders & Lewis, 2017). Therefore, it was imperative that the sampling frame covered provided enough statistical inferences for the project. Factor analysis and Cronbach's alfa were be used to check the validity and reliability of the data results and were proven to be successful.

4.10. Limitations

Saunders & Lewis (2017) advised, for a survey to be an effective research instrument, the questions needed to be concise in order to capture the audience's attention which was also a drawback as the data provided by participants could be less profound had they been interviewed or observed. The research was limited to companies operating in the natural resources industries and therefore analysis and the research outcome could be externally invalid in other sectors (Onwuegbuzie & Collins, 2007; Saunders & Lewis, 2017).

Further research could possibly explore other industries where risk consequence and probability varied. The questionnaire could have been subject to individual bias in that questions were not objectively answered. The research tool also had close ended questions and therefore restricted the richness of the data provided. The factors considered may have not covered all the risks that affected practitioners hence possibly leaving out data that would have added to the supply chain literature. Risks varied from period to period and since the research was limited to a cross-sectional study, the consequence of risk ranking may have changed after the research was complete reducing the relevance of the findings.

5. RESEARCH RESULTS

5.1. Introduction

This chapter showcases the data findings from the survey, distributed via google forms to supply chain managers across Africa. It helps provide an explanation of the data and looks at the different tests to assist in answering the hypothesis. First, the chapter will provide insights on the response rate of the questionnaire and number of valid responses. Thereafter the descriptive statistics using mean scores will be presented to indicate what was contained in the survey sample. Process with which validity and reliability of the measurement tool is measured for the different constructs will then be discussed. Analysis will then explore the descriptive statistics of the various constructs as well as their relationships. Finally, the hypothesis tests will be presented to show the relationship between the different constructs.

5.2. Survey Response Rate

The survey was released over a period of five weeks between August and September through google forms.In total, there were 112 respondents in total with only 85 valid responses which was under the target value of 120 respondents. 27 responses were non-valid as 23 were not considered managers in supply chain hence were disqualified and left the survey while four chose not to participate. The target sample size was not met despite the snowballing technique of distributing more than 400 emails to mining company managers across the continent and distribution of the survey amongst African logistics professionals operating in the mining and energy industry. This result therefore indicates a response rate of roughly around 21%. The survey was designed such that once a respondant was qualified, all questions were responded to. Therefore, the completion rate was 76% with 85 valid responses.Therefore all 85 samples were taken into account when data analysis was conducted.

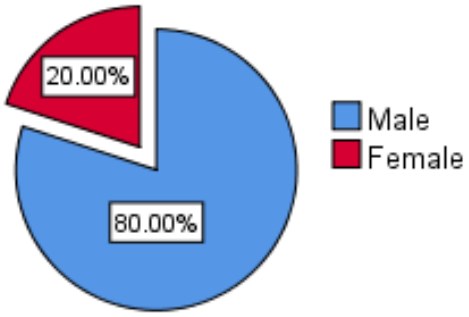
The completion rate for each Likert scale question and frequency table per question is indicated in Appendix C.

5.3. Sample Demographics

The survey targeted supply chain or procurement managers operating in the mining and energy industries and therefore one of the questions sought to disqualify anyone who was not under consideration. This was question two, *Please confirm you are a*

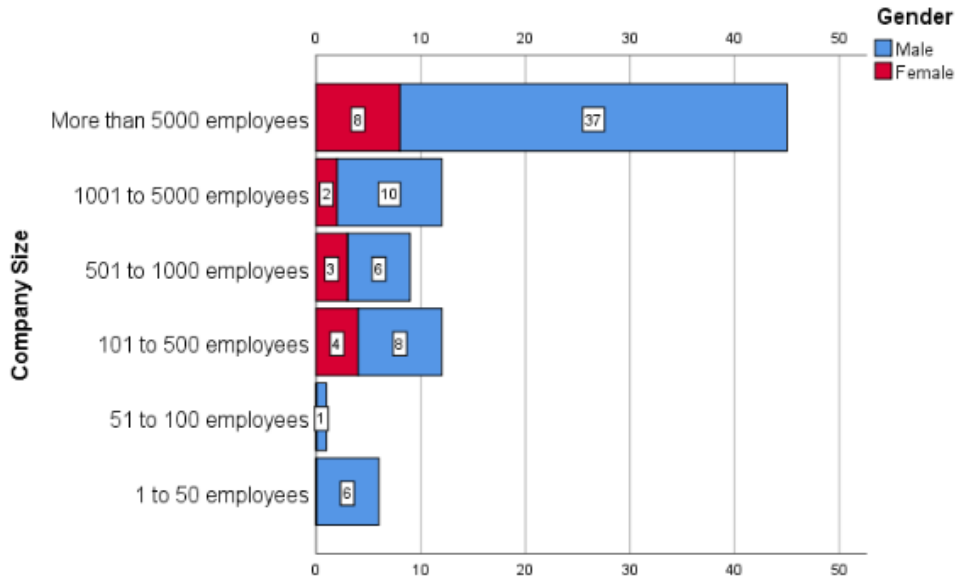
manager working in the area of Logistics and Supply Chain Management in the Mining or Energy Industry in Africa. Participants were also asked to identify their gender with a majority 68 (80%) identifying as male while 17(20%) identified as female as per Figure 4.

Figure 4: Percentage of Gender Distribution



Supply chain practitioners were also asked to describe their global company sizes from small sized starting between 1-50 employees to large companies with more than 500 employees represented. The data, highlighted in figure 5, showed most of the respondents, 45 (53%) likely worked for a global mining or energy company. It also indicated that this was likely where female managers were bound to work compared to smaller or mid-sized firms.

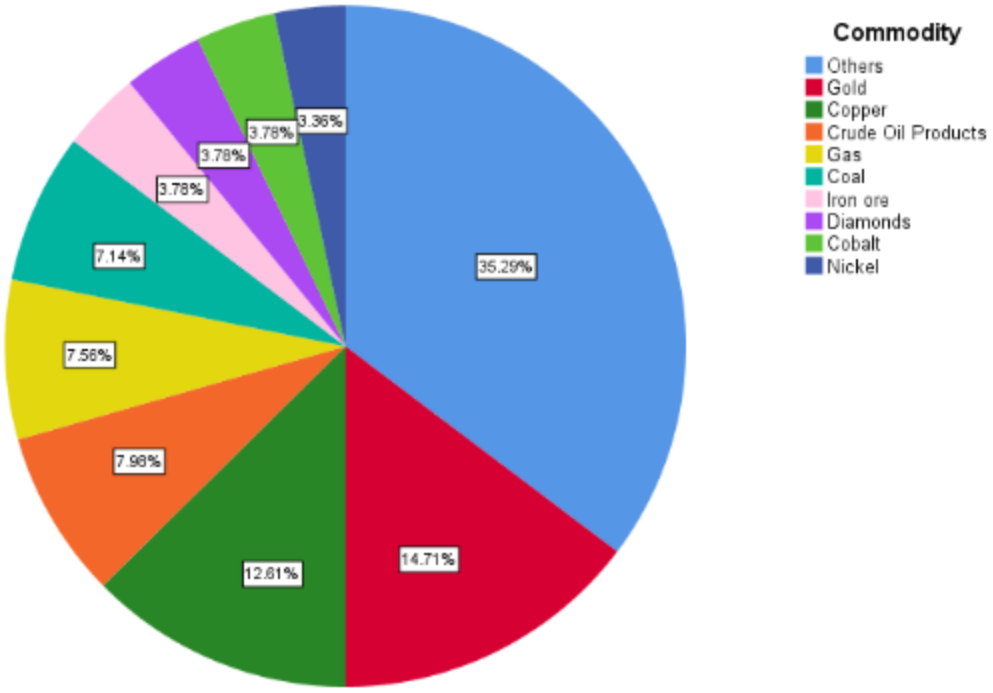
Figure 5 : Company size across the genders



Individuals partaking in the survey, were also to identify what countries they operated in across the African continent. Many of the respondents operated in South Africa (47%) while the other top three countries included Ghana (22.4%) and Mozambique (17.6%). Since the question was multiple choice, the number of responses far outweighed the number of respondents as some respondents operated in more than one country.

Additionally, respondents were asked to identify which commodity they worked with, and the highest number of responses were managers dealing with gold (14. 5%), copper (14.7%) and crude oil (12.6%). “Others” were 29 mineral commodities or types of energy that were clustered together as they represented a number less than seven. This included minerals such as manganese, tantalum, tin, titanium and many others reflected in Figure 6.

Figure 6: Percentage of Commodity



5.4. Construct Validity and reliability

Before conducting a review of the data critically and testing the hypothesis, it was important to ensure that the data met validity requirements. The selected test was factor analysis as it first allowed for reduction of the number of variables, it also looked at the relationship between the constructs and measured variables allowing for refinement of the theory in addition to providing construct validity.

5.4.1. KMO Measure of Sampling Adequacy and Bartlett's test of sphericity results

KMO and Bartlett's tests were conducted for each of the construct as indicated in Table 1 to 6. The drivers of supply chain construct had a KMO value of 0.729 , shown in table 1, which according to Field (2009) is good and thus factor analysis was appropriate. Bartlett's test of sphericity is statistically significant as $P<0.05$ indicating that correlations were large enough to create a meaningful analysis.

Table 1: Drivers of supply chain risk KMO and Bartlett's test results

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.729
Bartlett's Test of Sphericity	Approx. Chi-Square	135.498
	df	28
	Sig.	.000

Consequence of endogenous risks as well as the probability of endogenous and exogenous risks have a KMO value of 0.788 and Bartlett's test of sphericity was less than 0.05, thus statistically significant. Thus, KMO is acceptable and factor analysis is appropriate.

Table 2: Consequence of endogenous supply chain risks KMO and Bartlett's test results

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.788
Bartlett's Test of Sphericity	Approx. Chi-Square	417.925
	df	28
	Sig.	.000

Consequence of exogenous risks obtained a KMO value which is higher than the 0.5 limit at 0.777 hence sampling is adequate. Bartlett's test of sphericity is statistically significant at 0.000 significance.

Table 3: Consequence of exogenous supply chain risks KMO and Bartlett's test results

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.777
Bartlett's Test of Sphericity	Approx. Chi-Square	271.632
	df	36
	Sig.	.000

At a KMO value of 0.793, sampling adequacy for the construct on probability of endogenous supply chain risks is met. Bartlett's test of sphericity is also statistically significant as P<0.05.

Table 4: Probability of endogenous supply chain risks KMO and Bartlett's test results

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.793
Bartlett's Test of Sphericity	Approx. Chi-Square	292.259
	df	28
	Sig.	.000

Probability of exogenous risks has the highest KMO value of 0.807 which according to Field (2009) was great indicator of sampling adequacy and factor analysis is appropriate. Bartlett's test of sphericity for all constructs are statistically significant as P<0.05 indicates that Principal Component Analysis (PCA) is suitable.

Table 5: Probability of exogenous supply chain risks KMO and Bartlett's test results

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.807
Bartlett's Test of Sphericity	Approx. Chi-Square	262.192
	df	45
	Sig.	.000

The drivers of supply chain risk construct correlation matrix was examined and found that all variables except one had a correlation less than 0.3. This variable, changes in government policy, had the highest correlation with changes in consumer taste at .253. However, the communalities extraction value of 0.614 indicates a strong aggregate influence over all the other factors (Field, 2009). This high value shows that changes in government policy, is reflected in the measuring instrument. The construct validity can also be considered met due to the total variance explained results which show that two variables were already accounting for 52% of the Eigen values.

Table 6 : Drivers of supply chain risks correlation matrix

Correlation Matrix

		To what extent does Globalisation of the supply chain contribute to an increase in Supply Chain Risk	To what extent does Changes in Government Policies contribute to an increase in Supply Chain Risk	To what extent does Technology Change contribute to an increase in Supply Chain Risk	To what extent does Focus on sustainability contribute to an increase in Supply Chain Risk	To what extent does Reduction of suppliers contribute to an increase in Supply Chain Risk	To what extent does Changes in consumer taste contribute to an increase in Supply Chain Risk	To what extent does Centralised production contribute to an increase in Supply Chain Risk	To what extent does Focus on efficiency contribute to an increase in Supply Chain Risk
Correlation	To what extent does Globalisation of the supply chain contribute to an increase in Supply Chain Risk	1.000	-.104	.337	.374	.222	.160	.355	.253
	To what extent does Changes in Government Policies contribute to an increase in Supply Chain Risk	-.104	1.000	.143	.017	.179	.253	.191	.066
	To what extent does Technology Change contribute to an increase in Supply Chain Risk	.337	.143	1.000	.436	.206	.239	.387	.342
	To what extent does Focus on sustainability contribute to an increase in Supply Chain Risk	.374	.017	.436	1.000	.282	-.003	.364	.543
	To what extent does Reduction of suppliers contribute to an increase in Supply Chain Risk	.222	.179	.206	.282	1.000	.282	.215	.328
	To what extent does Changes in consumer taste contribute to an increase in Supply Chain Risk	.160	.253	.239	-.003	.282	1.000	.306	.250
	To what extent does Centralised production contribute to an increase in Supply Chain Risk	.355	.191	.387	.364	.215	.306	1.000	.431
	To what extent does Focus on efficiency contribute to an increase in Supply Chain Risk	.253	.066	.342	.543	.328	.250	.431	1.000

Table 7: Drivers of supply chain risks Eigen values

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.888	36.102	36.102	2.888	36.102	36.102	2.597	32.459	32.459
2	1.296	16.201	52.304	1.296	16.201	52.304	1.588	19.844	52.304
3	.858	10.728	63.032						
4	.835	10.442	73.473						
5	.693	8.658	82.132						
6	.611	7.631	89.763						
7	.473	5.907	95.670						
8	.346	4.330	100.000						

Extraction Method: Principal Component Analysis.

The probability of endogenous supply chain risks construct showed strong correlation amongst the different variables hence none of the probabilities were irrelevant. Communalities values were also above 0.3. Total Variance Explained further cemented the construct validity with only 2 of the variables providing 65% of Eigen value variance.

Table 8: Probability of endogenous supply chain risks correlation matrix

Correlation Matrix

		Probability of Supplier Failure	Probability of Supplier Quality Problems	Probability of Workers' Strike	Probability of Accident .e.g. Fire	Probability of Machine Breakdowns	Probability of Cyber Attacks	Probability of IT system Failure	Probability of Technological change
Correlation	Probability of Supplier Failure	1.000	.719	.279	.540	.484	.290	.318	.115
	Probability of Supplier Quality Problems	.719	1.000	.409	.596	.609	.270	.375	.253
	Probability of Workers' Strike	.279	.409	1.000	.478	.311	.308	.431	.191
	Probability of Accident .e. g. Fire	.540	.596	.478	1.000	.631	.408	.455	.210
	Probability of Machine Breakdowns	.484	.609	.311	.631	1.000	.262	.350	.270
	Probability of Cyber Attacks	.290	.270	.308	.408	.262	1.000	.721	.435
	Probability of IT system Failure	.318	.375	.431	.455	.350	.721	1.000	.504
	Probability of Technological change	.115	.253	.191	.210	.270	.435	.504	1.000

Table 9: Probability of endogenous risks Eigen values

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.863	48.287	48.287	3.863	48.287	48.287	2.986	37.327	37.327
2	1.379	17.237	65.524	1.379	17.237	65.524	2.256	28.197	65.524
3	.779	9.741	75.265						
4	.641	8.016	83.281						
5	.535	6.689	89.970						
6	.318	3.972	93.942						
7	.255	3.192	97.133						
8	.229	2.867	100.000						

Extraction Method: Principal Component Analysis.

The correlation matrix for the construct on probability of exogenous supply chain risks had all variables with a correlation of more than 0.3. The communalities extraction values also superseded the 0.3 indicating a strong aggregate influence of all variables. Further three out of the ten variables were able to account for 63% of Eigen values variance meeting construct validity.

Table 10: Probability of exogenous supply chain risks correlation matrix

Correlation Matrix

		Probability of Change in commodity prices	Probability of Change in customer demand	Probability of Increasing raw material prices	Probability of Terrorist Attack	Probability of Global Trade Wars .e.g China and US	Probability of Natural Disaster e.g. Cyclone, Drought	Probability of Change in Government Policy	Probability of Poor Transport Infrastructure	Probability of Import or Export restrictions	Probability of Increasing customs duty
Correlation	Probability of Change in commodity prices	1.000	.286	.363	.170	.222	.088	.300	.299	.363	.240
	Probability of Change in customer demand	.286	1.000	.223	.345	.304	.319	.226	.118	.293	.181
	Probability of Increasing raw material prices	.363	.223	1.000	.200	.231	.241	.271	.351	.263	.408
	Probability of Terrorist Attack	.170	.345	.200	1.000	.497	.591	.270	.207	.408	.249
	Probability of Global Trade Wars .e.g China and US	.222	.304	.231	.497	1.000	.516	.326	.259	.340	.366
	Probability of Natural Disaster e.g. Cyclone, Drought	.088	.319	.241	.591	.516	1.000	.339	.266	.295	.302
	Probability of Change in Government Policy	.300	.226	.271	.270	.326	.339	1.000	.496	.453	.473
	Probability of Poor Transport Infrastructure	.299	.118	.351	.207	.259	.266	.496	1.000	.576	.523
	Probability of Import or Export restrictions	.363	.293	.263	.408	.340	.295	.453	.576	1.000	.617
	Probability of Increasing customs duty	.240	.181	.408	.249	.366	.302	.473	.523	.617	1.000

Table 11: Probability of exogenous risks Eigen values

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.989	39.890	39.890	3.989	39.890	39.890	2.613	26.128	26.128
2	1.391	13.915	53.805	1.391	13.915	53.805	2.251	22.505	48.634
3	1.006	10.057	63.862	1.006	10.057	63.862	1.523	15.228	63.862
4	.761	7.614	71.476						
5	.631	6.309	77.785						
6	.606	6.059	83.844						
7	.544	5.443	89.287						
8	.443	4.431	93.718						
9	.369	3.693	97.410						
10	.259	2.590	100.000						

Extraction Method: Principal Component Analysis.

The construct on consequence of endogenous supply chain risk correlation matrix indicates all variables have a correlation above 0.3 which means no variable was deleted as they were relevant to the construct. Communalities also showed a string aggregate influence of all variables as they are values greater than 0.3 with the weakest factor being Probability of workers strikes at 0.369. The total variance explained table shows that out of the eight selected variables only two were able to account for more than 71% of the Eigen values meaning the construct validity was met.

Table 12: Consequence of endogenous supply chain risks correlation matrix

Correlation Matrix

		Consequence of Change in commodity prices	Consequence of Change in customer demand	Consequence of Increasing raw material prices	Consequence of Terrorist Attack	Consequence of Global Trade Wars .e.g China and US	Consequence of Natural Disaster e.g. Cyclone, Drought	Consequence of Change in Government Policy	Consequence of Poor Transport Infrastructure	Consequence of Import or Export restrictions	Consequence of Increasing customs duty
Correlation	Consequence of Change in commodity prices	1.000	.417	.491	.249	.265	.234	.360	.316	.263	.406
	Consequence of Change in customer demand	.417	1.000	.303	.386	.355	.290	.268	.310	.389	.243
	Consequence of Increasing raw material prices	.491	.303	1.000	.250	.319	.281	.225	.308	.290	.356
	Consequence of Terrorist Attack	.249	.386	.250	1.000	.440	.686	.184	.333	.376	.250
	Consequence of Global Trade Wars .e.g China and US	.265	.355	.319	.440	1.000	.500	.291	.202	.417	.344
	Consequence of Natural Disaster e.g. Cyclone, Drought	.234	.290	.281	.686	.500	1.000	.178	.212	.305	.198
	Consequence of Change in Government Policy	.360	.268	.225	.184	.291	.178	1.000	.522	.498	.642
	Consequence of Poor Transport Infrastructure	.316	.310	.308	.333	.202	.212	.522	1.000	.664	.581
	Consequence of Import or Export restrictions	.263	.389	.290	.376	.417	.305	.498	.664	1.000	.673
	Consequence of Increasing customs duty	.406	.243	.356	.250	.344	.198	.642	.581	.673	1.000

Correlation Matrix

		Consequence of Supplier Failure	Consequence of Supplier Quality Problems	Consequence of Workers' Strike	Consequence of Accident .e.g. Fire	Consequence of Machine Breakdowns	Consequence of Cyber Attacks	Consequence of IT system Failure	Consequence of Technological change
Correlation	Consequence of Supplier Failure	1.000	.826	.438	.506	.515	.453	.509	.266
	Consequence of Supplier Quality Problems	.826	1.000	.447	.399	.483	.426	.415	.264
	Consequence of Workers' Strike	.438	.447	1.000	.645	.540	.556	.556	.399
	Consequence of Accident .e.g. Fire	.506	.399	.645	1.000	.661	.480	.521	.397
	Consequence of Machine Breakdowns	.515	.483	.540	.661	1.000	.493	.495	.377
	Consequence of Cyber Attacks	.453	.426	.556	.480	.493	1.000	.817	.548
	Consequence of IT system Failure	.509	.415	.556	.521	.495	.817	1.000	.690
	Consequence of Technological change	.266	.264	.399	.397	.377	.548	.690	1.000

Table 13: Consequence of endogenous risks Eigen values

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.552	56.901	56.901	4.552	56.901	56.901	2.969	37.106	37.106
2	1.141	14.264	71.166	1.141	14.264	71.166	2.725	34.059	71.166
3	.791	9.887	81.053						
4	.483	6.038	87.091						
5	.413	5.160	92.250						
6	.322	4.029	96.280						
7	.182	2.271	98.550						
8	.116	1.450	100.000						

Extraction Method: Principal Component Analysis.

The communalities extraction for the construct on consequence of exogenous supply chain risks were greater than 0.3 thus all variables were showing influence. The correlation matrix indicated all variables had at least one correlation above 0.3 meeting the relevance of the construct. Additionally, 3 out of the eight variables were able to account for 67% of Eigen values variance meeting construct validity.

Table 14: Consequence of exogenous supply chain risks correlation matrix

Table 15: Consequence of exogenous risks Eigen values

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.249	42.492	42.492	4.249	42.492	42.492	2.759	27.592	27.592
2	1.496	14.957	57.449	1.496	14.957	57.449	2.250	22.496	50.088
3	1.048	10.483	67.932	1.048	10.483	67.932	1.784	17.844	67.932
4	.726	7.257	75.189						
5	.660	6.596	81.785						
6	.581	5.810	87.595						
7	.399	3.992	91.587						
8	.336	3.364	94.951						
9	.289	2.888	97.840						
10	.216	2.160	100.000						

Extraction Method: Principal Component Analysis.

5.5. Instrument reliability results

Cronbach's alpha was used to detect the reliability and consistency of the questionnaire which was Likert scale based. It was also used to assist in analysing how well the construct questions linked together. All the construct had a Cronbach's alpha greater than 0.65 which is generally accepted(Field, 2009)

5.5.1. Drivers of supply chain construct reliability

The drivers of supply chain risk construct had a Cronbach's alpha of 0.736 and deleting any one of the variables did not significantly improve it and hence all variables were considered.

Table 16: Drivers of supply chain construct Cronbach's alpha results

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.736	.729	8

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
To what extent does Globalisation of the supply chain contribute to an increase in Supply Chain Risk	19.94	17.246	.388	.265	.718
To what extent does Changes in Government Policies contribute to an increase in Supply Chain Risk	19.04	19.892	.166	.145	.751
To what extent does Technology Change contribute to an increase in Supply Chain Risk	19.65	16.326	.507	.299	.693
To what extent does Focus on sustainability contribute to an increase in Supply Chain Risk	19.76	17.015	.507	.454	.695
To what extent does Reduction of suppliers contribute to an increase in Supply Chain Risk	19.79	17.145	.406	.199	.714
To what extent does Changes in consumer taste contribute to an increase in Supply Chain Risk	19.87	17.947	.347	.254	.725
To what extent does Centralised production contribute to an increase in Supply Chain Risk	20.04	16.368	.553	.335	.685
To what extent does Focus on efficiency contribute to an increase in Supply Chain Risk	19.87	15.685	.544	.406	.684

5.5.2. Probability of endogenous supply chain risks construct reliability

The probability of endogenous supply chain risks had a Cronbach's alpha of 0.842 with most variables showing decline in the alpha if removed. Hence none, of the variables were deleted.

Table 17: Probability of endogenous supply chain risks construct Cronbach's alpha results

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.842	.843	8

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Probability of Supplier Failure	17.51	18.920	.555	.557	.826
Probability of Supplier Quality Problems	17.53	18.300	.667	.646	.813
Probability of Workers' Strike	17.72	18.800	.489	.313	.835
Probability of Accident .e.g. Fire	17.95	17.617	.691	.569	.808
Probability of Machine Breakdowns	17.69	19.048	.596	.496	.822
Probability of Cyber Attacks	18.19	18.821	.561	.548	.825
Probability of IT system Failure	18.11	17.286	.657	.618	.813
Probability of Technological change	17.94	20.175	.397	.308	.844

5.5.3. Probability of exogenous supply chain risks construct reliability

The probability of exogenous supply chain risks had a Cronbach's alpha of 0.826 which was the highest without deletion of any other variable proving the construct was reliable.

Table 18: Probability of exogenous supply chain risks construct Cronbach's alpha results

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.826	.829	10

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Probability of Change in commodity prices	25.09	27.396	.389	.271	.823
Probability of Change in customer demand	25.52	27.253	.404	.226	.821
Probability of Increasing raw material prices	25.31	27.477	.434	.286	.818
Probability of Terrorist Attack	25.79	24.193	.528	.464	.812
Probability of Global Trade Wars .e.g China and US	25.33	25.747	.554	.379	.806
Probability of Natural Disaster e.g. Cyclone, Drought	25.72	25.372	.538	.462	.808
Probability of Change in Government Policy	24.95	26.664	.550	.363	.808
Probability of Poor Transport Infrastructure	25.00	26.452	.532	.456	.809
Probability of Import or Export restrictions	25.19	24.869	.642	.567	.797
Probability of Increasing customs duty	25.16	25.711	.584	.513	.804

5.5.4. Consequence of exogenous supply chain risks construct reliability

The consequence of exogenous supply chain risk had a Cronbach's alpha of 0.845 with no significant improvement were an item to be deleted.

Table 19: Consequence of exogenous supply chain risks construct Cronbach's alpha results

Reliability Statistics

Cronbach's Alpha	N of Items
.845	10

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Consequence of Change in commodity prices	25.92	27.005	.498	.393	.834
Consequence of Change in customer demand	26.20	26.590	.502	.336	.834
Consequence of Increasing raw material prices	26.21	27.074	.471	.320	.837
Consequence of Terrorist Attack	26.45	24.917	.551	.540	.831
Consequence of Global Trade Wars .e.g China and US	26.32	26.076	.541	.394	.831
Consequence of Natural Disaster e.g. Cyclone, Drought	26.56	25.892	.508	.530	.834
Consequence of Change in Government Policy	25.80	27.424	.524	.473	.833
Consequence of Poor Transport Infrastructure	25.99	26.226	.577	.540	.828
Consequence of Import or Export restrictions	26.11	25.334	.662	.633	.819
Consequence of Increasing customs duty	26.08	25.910	.614	.626	.824

5.5.5. Consequence of endogenous supply chain risks construct reliability

The consequence of endogenous supply chain risk had the highest Cronbach's alpha of all constructs at 0.891 further cementing the reliability of the measurement tool.

Table 20: Consequence of Endogenous Supply Chain Risks Construct Cronbach's Alpha Results

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.891	.891	8

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Consequence of Supplier Failure	18.58	22.795	.656	.751	.879
Consequence of Supplier Quality Problems	18.64	23.615	.607	.716	.883
Consequence of Workers' Strike	18.66	22.918	.677	.526	.877
Consequence of Accident .e.g. Fire	18.87	22.471	.680	.592	.876
Consequence of Machine Breakdowns	18.82	23.004	.672	.517	.877
Consequence of Cyber Attacks	19.18	22.052	.721	.693	.872
Consequence of IT system Failure	19.18	21.480	.770	.785	.867
Consequence of Technological change	19.04	23.892	.549	.505	.888

5.6. Descriptive statistics for observable variables and constructs

The following sub-section will look at the descriptive statistics of the different constructs. A mean score was used to explain the construct. Since all the 85 responses were valid, all the responses were included in the account.

5.6.1. Perception of Risk

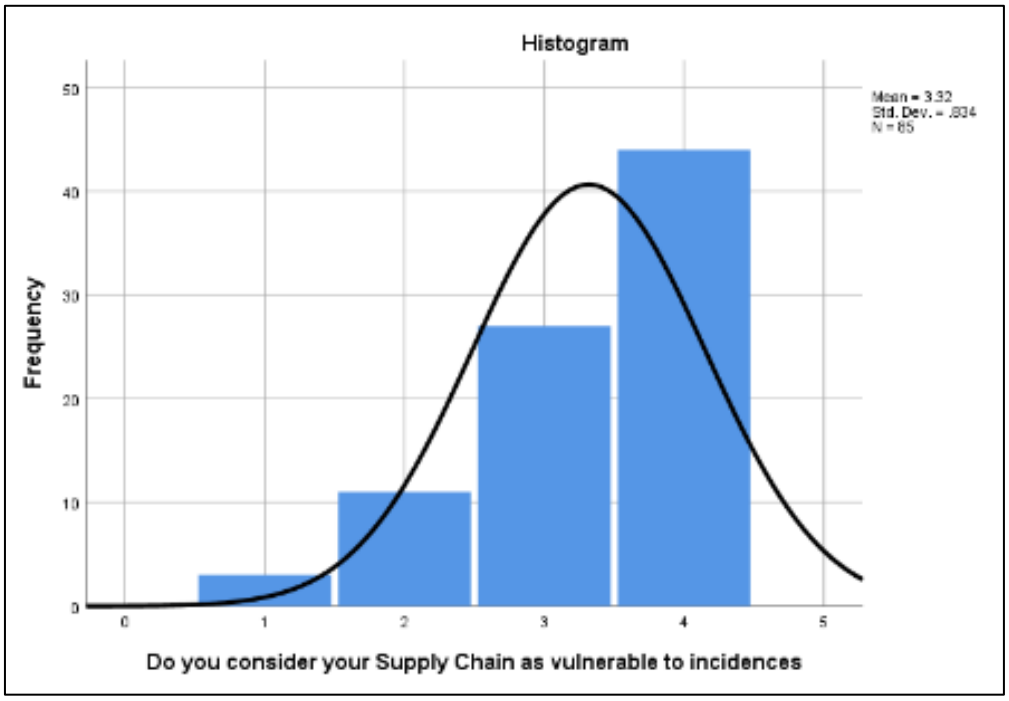
This construct measures the perception of supply chain risks among supply chain managers and this generated a mean score of 3.32 with a standard deviation of 0.834 as shown on Table 21. A 4-point Likert scale ranging from 1 “do not agree” to 4 “Do Agree absolutely”. This indicates that most managers regard their supply chains to be susceptible to Supply Chain risks with only 3% of the participants disagreeing that they were vulnerable which is shown on Figure 7.

Table 21: Supply chain vulnerability descriptive statistics

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Do you consider your Supply Chain as vulnerable to incidences	85	1	4	3.32	.834
Valid N (listwise)	85				

Figure 7: Supply chain vulnerability histogram



5.6.2. Drivers of Supply Chain Risks

Based on Table 22, the highest driver of supply chain risks according to the respondents based on the highest mean of 3.53 is Government policies with more than 67% of the managers selecting option 4 “Do absolutely Agree”, followed by Technological change with a mean of 2.92. The overall construct mean of 2.82, as shown on Figure 8, indicated most of these variables are drivers to supply

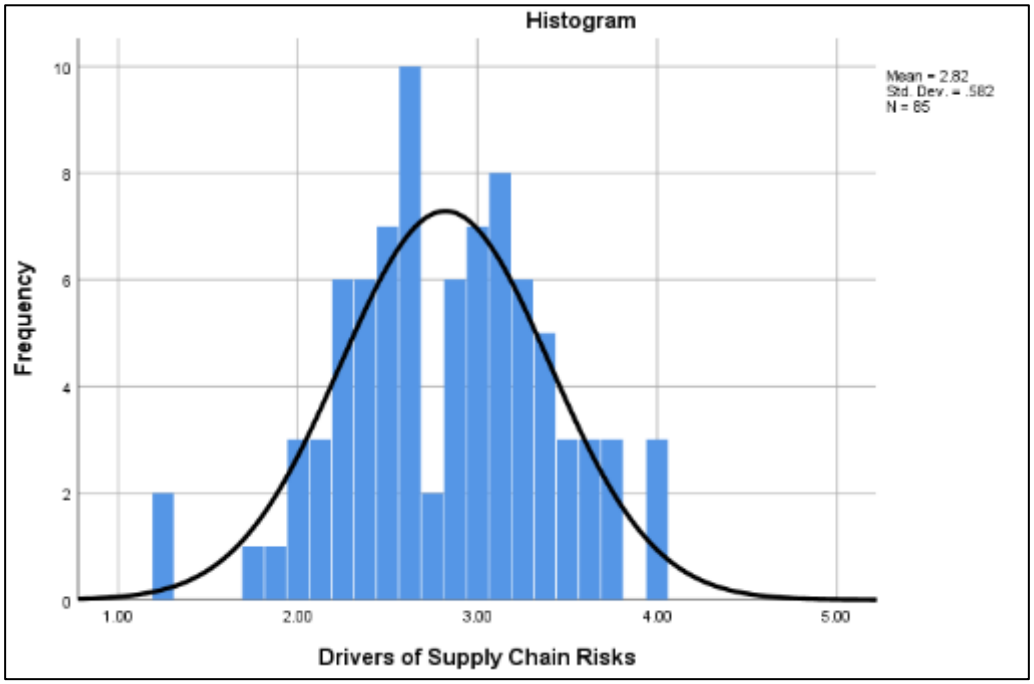
chain risks. The SD at .582 shows the data was more concentrated to the mean with few outliers.

Table 22 : Drivers of supply chain risks descriptive statistics

Statistics

	N		Mean	Std. Deviation
	Valid	Missing		
To what extent does Globalisation of the supply chain contribute to an increase in Supply Chain Risk	85	0	2.62	1.035
To what extent does Changes in Government Policies contribute to an increase in Supply Chain Risk	85	0	3.53	.781
To what extent does Technology Change contribute to an increase in Supply Chain Risk	85	0	2.92	1.038
To what extent does Focus on sustainability contribute to an increase in Supply Chain Risk	85	0	2.80	.910
To what extent does Reduction of suppliers contribute to an increase in Supply Chain Risk	85	0	2.78	1.028
To what extent does Changes in consumer taste contribute to an increase in Supply Chain Risk	85	0	2.69	.951
To what extent does Centralised production contribute to an increase in Supply Chain Risk	85	0	2.53	.971
To what extent does Focus on efficiency contribute to an increase in Supply Chain Risk	85	0	2.69	1.102

Figure 8 : Drivers of supply chain risk histogram



5.6.3. Probability of Exogenous Risks

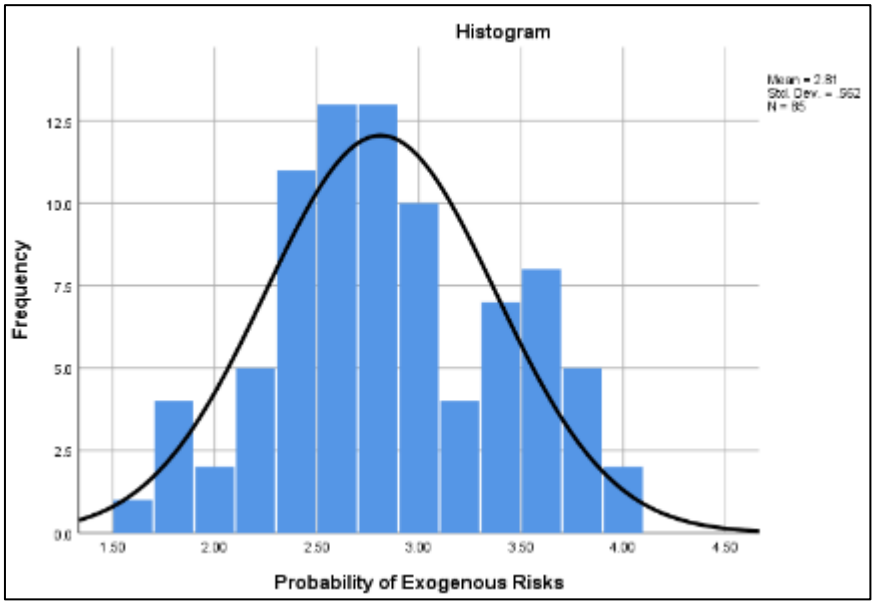
Ten questions regarding probability external risks were represented in the survey. The occurrence of exogenous risks was highly likely based on the survey results that generated a collective mean of 2.81 with a high concentration as evidenced in Figure 9 (M=2.81, SD=0.562). The highest exogenous risk based on the questionnaire, was the probability of change in government policy with a mean of 3.16 as per Table 23. With at least 82% of managers citing it a 3 “High“ and 4 “Very high” on the Likert scale, this risk is shown to be significant.

Table 23: Probability of exogenous risks descriptive statistics

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Probability of Change in commodity prices	85	1	4	3.02	.859
Probability of Change in customer demand	85	1	4	2.60	.862
Probability of Increasing raw material prices	85	1	4	2.81	.779
Probability of Terrorist Attack	85	1	4	2.33	1.169
Probability of Global Trade Wars .e.g China and US	85	1	4	2.79	.901
Probability of Natural Disaster e.g. Cyclone, Drought	85	1	4	2.40	.978
Probability of Change in Government Policy	85	1	4	3.16	.769
Probability of Poor Transport Infrastructure	85	1	4	3.12	.822
Probability of Import or Export restrictions	85	1	4	2.93	.923
Probability of Increasing customs duty	85	1	4	2.95	.872
Valid N (listwise)	85				

Figure 9: Probability of exogenous supply chain risks histogram



5.6.4. Probability of Endogenous Risks

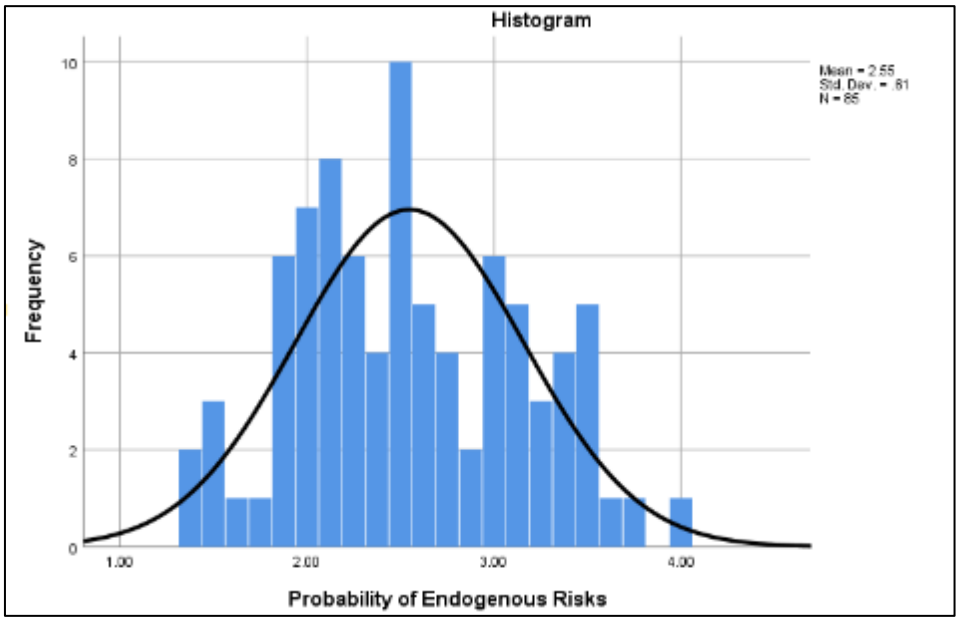
The likelihood of internal risks occurring seemed lower than external risks with the highest mean of 2.87 as indicated in Table 24. The questions measured were eight in total with the highest mean emanating from probability of supplier failure with more than 75% of the respondents ranking it 3 ”High “ and 4 “Very high”. On average internal probabilities of risk were ranked at 2.55 as shown on Figure 10. The data was also more concentrated towards the mean with an SD value of .61

Table 24: Probability of endogenous supply chain risks descriptive statistics

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Probability of Supplier Failure	85	1	4	2.87	.856
Probability of Supplier Quality Problems	85	1	4	2.85	.838
Probability of Workers' Strike	85	1	4	2.66	.958
Probability of Accident .e.g. Fire	85	1	4	2.42	.918
Probability of Machine Breakdowns	85	1	4	2.68	.790
Probability of Cyber Attacks	85	1	4	2.19	.866
Probability of IT system Failure	85	1	4	2.27	1.005
Probability of Technological change	85	1	4	2.44	.823
Valid N (listwise)	85				

Figure 10: Probability of endogenous supply chain risks histogram



5.6.5. Consequence of Exogenous Risks

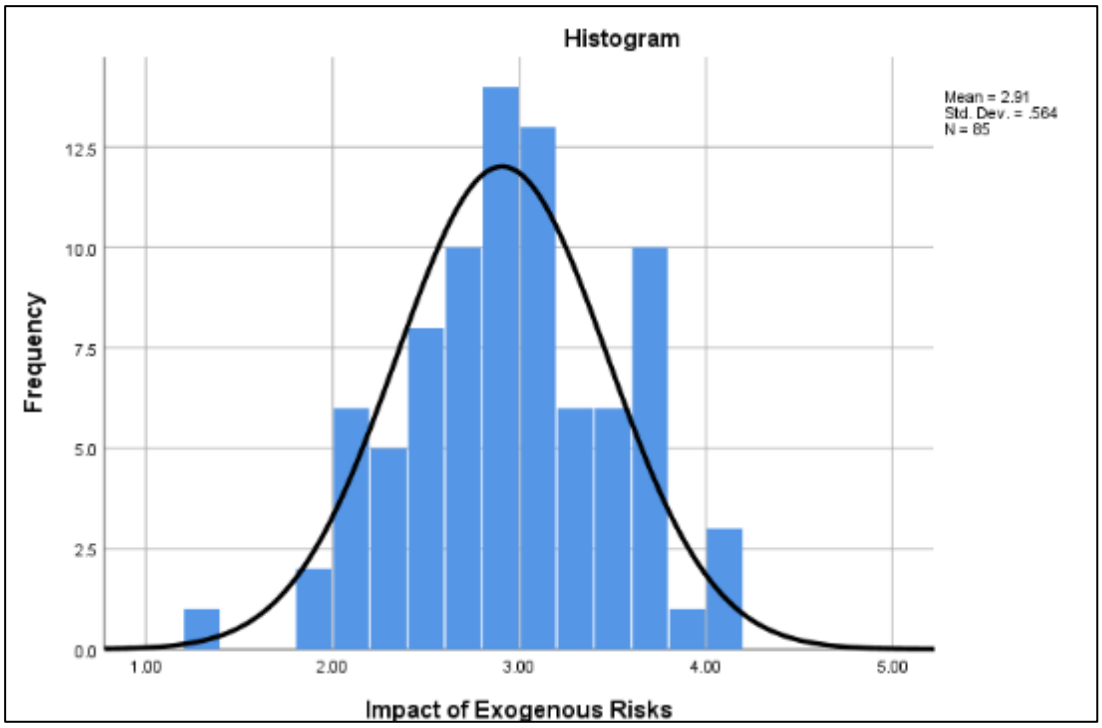
Of the 10 questions around the consequence of external risks, the highest consequence denoted was changes in government policy with a mean of 3.27 as observed in Table 25. Around 87% managers ranked it highly in terms of consequence on their supply chain. As per Figure 11, the standard deviation was 0.564 and hence the data was concentrated around the mean.

Table 25: Consequence of exogenous risks descriptive statistics

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Consequence of Change in commodity prices	85	1	4	3.15	.809
Consequence of Change in customer demand	85	1	4	2.87	.870
Consequence of Increasing raw material prices	85	1	4	2.86	.833
Consequence of Terrorist Attack	85	1	4	2.62	1.058
Consequence of Global Trade Wars .e.g China and US	85	1	4	2.75	.898
Consequence of Natural Disaster e.g. Cyclone, Drought	85	1	4	2.51	.971
Consequence of Change in Government Policy	85	1	4	3.27	.714
Consequence of Poor Transport Infrastructure	85	1	4	3.08	.834
Consequence of Import or Export restrictions	85	1	4	2.96	.865
Consequence of Increasing customs duty	85	1	4	2.99	.838
Valid N (listwise)	85				

Figure 11: Consequence of exogenous supply chain risks histogram



5.6.6. Consequence of Endogenous Risks

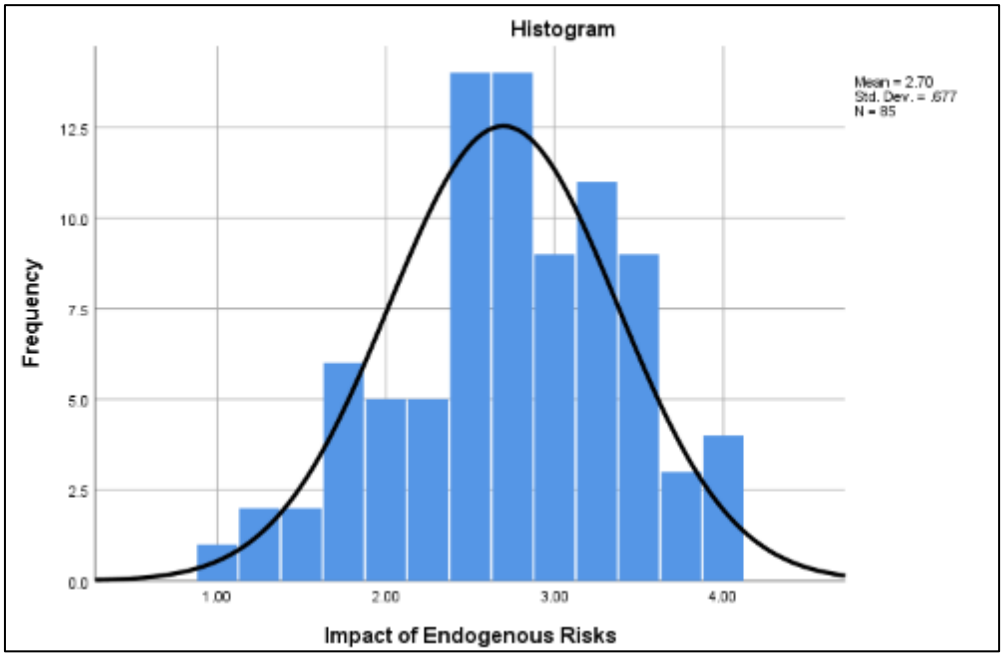
There were 8 questions around the consequence of endogenous risks with results on Figure 9 indicating a higher than average belief in the consequence of internal supply chain risk ((M=2.70, SD=0.677). The highest concern was observed on consequence of supplier failure with a mean of 2.99, shown in Table 26, and more than 72% of the managers ranking this risk it between 3 “High “ and 4 “Very High”. This internal concern was closely followed by Supplier Quality problems which had a high consequence with a mean of 2.93.

Table 26 : Consequence of endogenous supply chain risks descriptive statistics

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Consequence of Supplier Failure	85	1	4	2.99	.906
Consequence of Supplier Quality Problems	85	1	4	2.93	.842
Consequence of Workers' Strike	85	1	4	2.91	.868
Consequence of Accident .e.g. Fire	85	1	4	2.69	.926
Consequence of Machine Breakdowns	85	1	4	2.74	.861
Consequence of Cyber Attacks	85	1	4	2.39	.940
Consequence of IT system Failure	85	1	4	2.39	.965
Consequence of Technological change	85	1	4	2.53	.867
Valid N (listwise)	85				

Figure 12: Consequence of endogenous supply chain risks histogram



5.6.7. Comparing Means across Sub-Groups

The means per construct were compared across demographics to understand whether survey results were different depending on the demographic analysed.

5.6.7.1. Comparing Ranking by gender

An independent samples T-Test was carried out to establish the level of significance between the different constructs across the two genders. Where managers perception of risk was tested, see Table 27, the means of both genders were close at 3.34 for males and 3.24 for females. In Table 28, Levene's Test for Equality of Variances shows a significance value of 0.874 compared to the significance level of $p<0.05$. Therefore, there is equal variance between female

and male perception of supply chain risks which is further supported by the closeness in standard deviation of 0.831 and 0.840 respectively. The two distributions are therefore not significantly different.

Table 27: Gender group descriptive statistics

Group Statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Do you consider your Supply Chain as vulnerable to incidences	Male	68	3.34	.840	.102
	Female	17	3.24	.831	.202
Probability of Exogenous Risks	Male	68	2.7691	.55564	.06738
	Female	17	2.9824	.57362	.13912
Probability of Endogenous Risks	Male	68	2.5239	.61966	.07515
	Female	17	2.6397	.57602	.13971
Impact of Exogenous Risks	Male	68	2.8588	.56151	.06809
	Female	17	3.1000	.55000	.13339
Impact of Endogenous Risks	Male	68	2.6489	.70653	.08568
	Female	17	2.8824	.51628	.12522
Drivers of Supply Chain Risks	Male	68	2.8107	.58888	.07141
	Female	17	2.8603	.56748	.13763

Table 28: Gender group independent samples test

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Do you consider your Supply Chain as vulnerable to incidences	Equal variances assumed	.025	.874	.453	83	.652	.103	.227	-.349	.555
	Equal variances not assumed			.456	24.812	.653	.103	.226	-.362	.568
Probability of Exogenous of Risks	Equal variances assumed	.241	.625	-1.406	83	.163	-.21324	.152	-.51480	.08833
	Equal variances not assumed			-1.379	24.070	.180	-.21324	.155	-.53223	.10576
Probability of Endogenous of Risks	Equal variances assumed	.112	.739	-.698	83	.487	-.11581	.166	-.44561	.21399
	Equal variances not assumed			-.730	26.076	.472	-.11581	.159	-.44184	.21022
Impact of Exogenous of Risks	Equal variances assumed	.009	.923	-1.590	83	.116	-.24118	.152	-.54283	.06048
	Equal variances not assumed			-1.610	25.019	.120	-.24118	.150	-.54962	.06727
Impact of Endogenous Risks	Equal variances assumed	1.46	.230	-1.277	83	.205	-.23346	.183	-.59699	.13008
	Equal variances not assumed			-1.539	32.774	.133	-.23346	.152	-.54222	.07531
Drivers of Supply Chain Risks	Equal variances assumed	.017	.896	-.313	83	.755	-.04963	.159	-.36504	.26578
	Equal variances not assumed			-.320	25.336	.752	-.04963	.155	-.36877	.26950

Further, the T-test for Equality Measures also shows a significance value of 0.652 which is greater than the level of significance p<0.05 further proving there is no significance difference. At a 95% confidence interval of the difference, the data seems to indicate sometimes the males may score lower than women or sometimes higher than females and further reiterating no significance difference between the two genders. Similarly, for the other constructs, indicated in Table 18 are lower levels of significance with p>0.05 hence no significant difference between the genders is shown for all the constructs.

5.6.8. Comparing Ranking by company Size

Using ANOVA (F-test), a comparison between the different industry sizes was conducted across the different constructs. As displayed in Table 29, at a significance level of P<0.05, none of the grouped variables are significantly different with significance levels showing more than 0.05. The breakdown was as follows; Consideration of vulnerability to incidences in supply chain *F* (1, 83)=0.205, *p*=n.s , probability of exogenous risks *F* (1, 83)=1.978, *p*=n.s, probability of endogenous risks *F* (1, 83)=0.488, *p*=n.s , consequence of exogenous risks *F* (1, 83)=2.529, *p*=n.s , consequence of endogenous risks *F* (1, 83)=1.631, *p*=n.s and drivers of supply chain risks *F* (1, 83)=0.098, *p*=n.s.

Table 29: Company size ANOVA test

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Do you consider your Supply Chain as vulnerable to incidences	Between Groups	.144	1	.144	.205	.652
	Within Groups	58.279	83	.702		
	Total	58.424	84			
Probability of Exogenous Risks	Between Groups	.618	1	.618	1.978	.163
	Within Groups	25.950	83	.313		
	Total	26.568	84			
Probability of Endogenous Risks	Between Groups	.182	1	.182	.488	.487
	Within Groups	31.036	83	.374		
	Total	31.218	84			
Impact of Exogenous Risks	Between Groups	.791	1	.791	2.529	.116
	Within Groups	25.965	83	.313		
	Total	26.756	84			
Impact of Endogenous Risks	Between Groups	.741	1	.741	1.631	.205
	Within Groups	37.710	83	.454		
	Total	38.451	84			
Drivers of Supply Chain Risks	Between Groups	.034	1	.034	.098	.755
	Within Groups	28.387	83	.342		
	Total	28.420	84			

5.7. Relationship between Consequence and Probability of Supply Chain Risks

Linear regression analysis was used to examine the relationship between consequence and probability of the two different risks. Regression analysis was performed at a significance level of $p<0.05$.

The first relationship to be reviewed was between consequence and probability of exogenous risks and whether probability of risk could predict the consequence of the risk. The output on Table 30 indicates that an R value of 0.798 showing positive prediction. The regression value was F (1, 83) =145.406, $p<0.05$) and an R^2 of 0.637. This adjusted R^2 shows probability of exogenous risks positively predict the consequence of exogenous risks by 63.7%. The significance level of the regression coefficient was also at a p-value of less than 0.005 meaning it was statistically significant. Figure 13 visually shows the relationship of the two variables with a fitted LOESS curve.

Table 30: Linear regression analysis exogenous risks

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.798[a]	.637	.632	.34226

a. Predictors: (Constant), Probability_Exogenous_Risks

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17.033	1	17.033	145.406	.000[b]
	Residual	9.723	83	.117		
	Total	26.756	84			

a. Dependent Variable: Impact_Exogenous_Risks

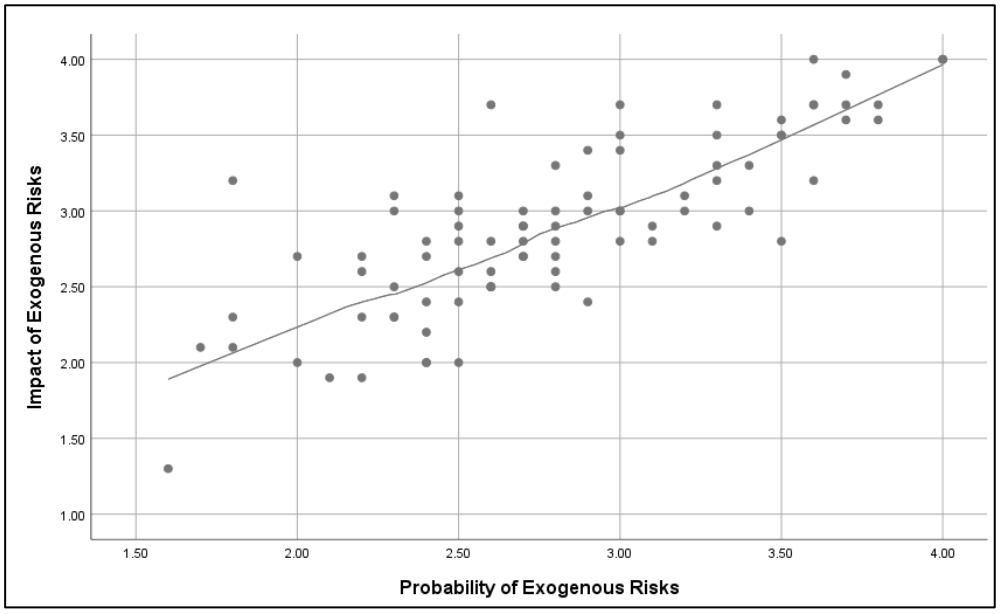
b. Predictors: (Constant), Probability_Exogenous_Risks

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.656	.190		3.445	.001
	Probability_Exogenous_Risks	.801	.066	.798	12.058	.000

a. Dependent Variable: Impact_Exogenous_Risks

Figure 13: Relationship between consequence and probability of exogenous risk graph



The second relationship examined the consequence and probability of endogenous risks. The output on Table 31 indicates that an R value of 0.703 indicating the probability of an internal risk can positively predict the consequence internal risk. The regression value was F (1, 83) =81.123, p<0.05) and an R^2 of 0.494. The regression coefficient was at p-value of less than 0.005 thus showing a high significance level. Figure 14 visually shows the relationship with a fitted LOESS curve.

Table 31: Linear regression analysis endogenous risks

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.703[a]	.494	.488	.48403

a. Predictors: (Constant), Probability_Endogenous_Risks

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	19.006	1	19.006	81.123	.000[b]
	Residual	19.446	83	.234		
	Total	38.451	84			

a. Dependent Variable: Impact_Endogenous_Risks

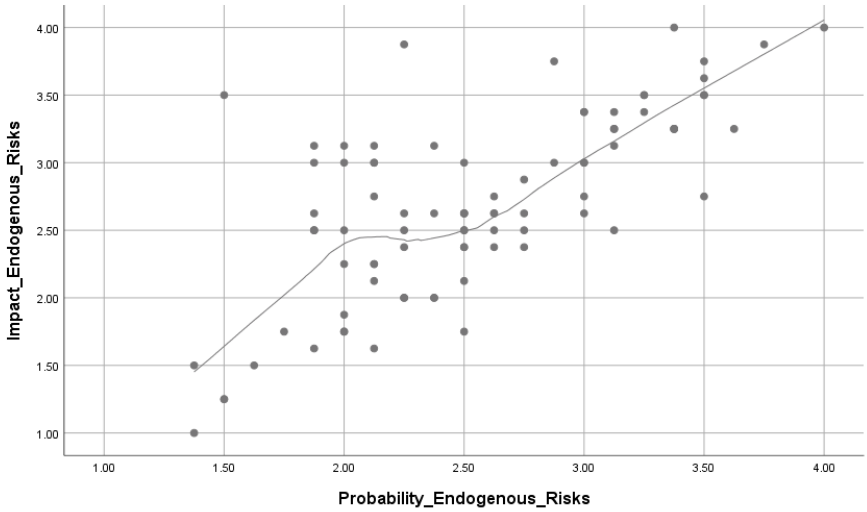
b. Predictors: (Constant), Probability_Endogenous_Risks

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.708	.227		3.122	.002
	Probability_Endogenous_Risks	.780	.087	.703	9.007	.000

a. Dependent Variable: Impact_Endogenous_Risks

Figure 14: Relationship between Consequence and Probability of Endogenous risk



In comparing the relationship between exogenous and endogenous risk, we can conclude that exogenous risks have a higher consequence given the higher R of 0.798 compared to the endogenous R of 0.703. Even though both coefficient betas were positive, the coefficient beta of exogenous risks is higher at 0.801 compared to the endogenous coefficient beta of 0.780 showing for every 1-unit increase in probability of exogenous risks, the consequence increases by 80% compared to the 78% increase of endogenous risks.

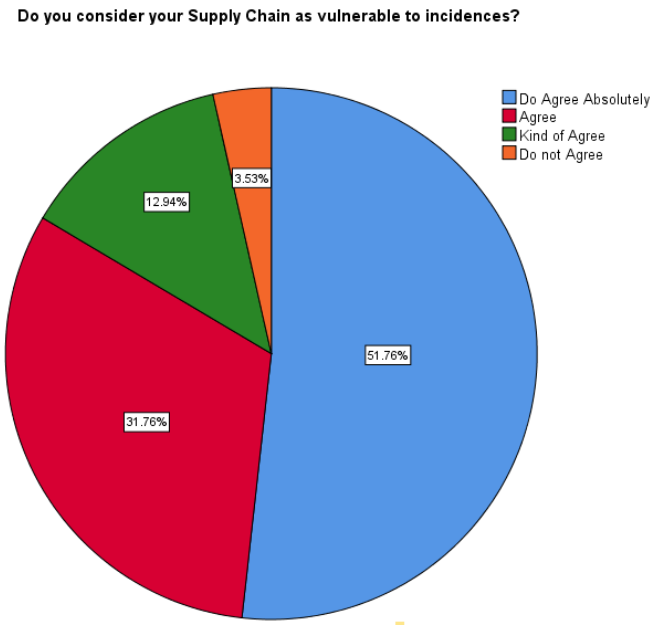
5.8. Results for hypothesis tests

To test the four hypotheses, a combination of descriptive statistics, mean and ANOVA tests were performed. The following section details the hypothesis of each research question followed by tabulation of the data obtained from SPSS. Thereafter, an interpretation of the results is offered to provide a better understanding of the data.

The first hypothesis looked at whether supply chains in Africa are highly predisposed to supply chain risks. This hypothesis tests the environmental awareness of the supply chain manager's practitioners in the continent. Based on the results shown in figure 15, more than 51.76% of the respondents considered themselves highly susceptible to risks by selecting 4 "Do agree Absolutely" with an additional 31% agreeing that indeed, their supply chains were vulnerable, hence hypothesis H1 cannot be rejected.

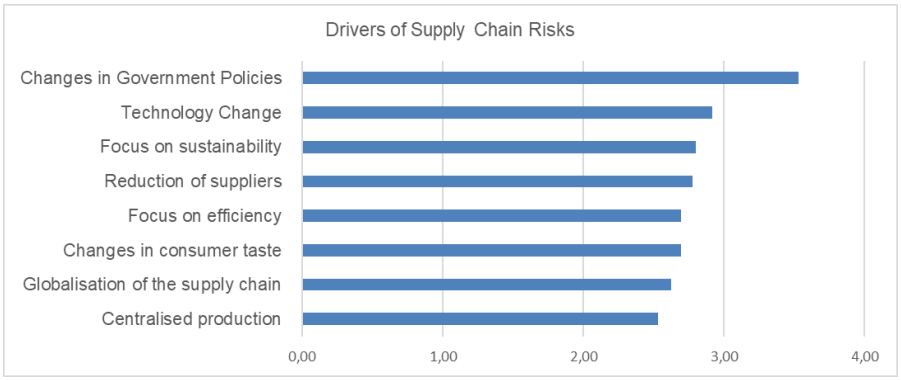
Further supporting this hypothesis is Table 21 (M=3.32, SD=0.834) and figure 7 showing there was not only a high concentration at the mean but also, supply chain managers agreed that they faced supply chains risks.

Figure 15: First hypothesis results



The second hypothesis examined whether African Supply chains had multiple drivers of supply chain risk. On average as per Figure 8, the mean of all drivers of supply chain risks is 2.82 showing significance exposure of African supply chains to risk. The highest mean value of drivers of supply chain risk, shown below on figure 16, indicated the highest concern is on changes in government policy followed by Technology change. Therefore, H2 cannot be rejected as there is evidence showing different drivers of risk which is also visually represented in Figure 15.

Figure 16: Drivers of supply chain risks mean ranking



The third hypothesis was, exogenous supply chain risks have a higher likelihood of occurrence than endogenous supply chain risks. The mean of probability of exogenous supply chain risk was 2.81 while endogenous supply chain risks indicated a mean of 2.55, generally indicating that external risks probability is perceived to be highly probable compared to internal risks. Further, an ANOVA test between the two, see Table 32, showed a high significance level ($p<0.05$) indicating that the hypothesis 3 could not be rejected.

Table 32: Exogenous supply chain risks likelihood ANOVA test

ANOVA

Probability_Endogenous_Risks

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	18.126	22	.824	3.902	.000
Within Groups	13.092	62	.211		
Total	31.218	84			

The fourth hypothesis was as follows; exogenous supply chain risks have a greater consequence on the supply chain than endogenous supply chain risks. To start off, the consequence of exogenous risk mean indicated in Figure 11, at 2.91, is higher than the mean of endogenous risks in Figure 12, at 2.7. An ANOVA test further reveals a high significance level where $p<0.05$, see Table 25, indicates hypothesis 4 cannot be rejected.

Table 33: Exogenous supply chain risks consequence ANOVA test

ANOVA

Impact_Endogenous_Risks

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	23.168	21	1.103	4.548	.000
Within Groups	15.283	63	.243		
Total	38.451	84			

5.9. Conclusion

Based on the survey instrument and subsequent data analysis, we can conclude the chapter as follows. First, results indicate presence of multiple supply chain risks in the industry with the strongest concern indicated on changes in government policies.

There is a positive relationship between the probability of risk and subsequent impact on supply chains more so with exogenous risks. Additionally, results show that external risks have a stronger relationship in probability and consequence in the supply chain compared to internal risks.

Chapter 6 will further expound on the findings from this chapter.

6. DISCUSSION OF THE RESULTS

6.1. Introduction

As described in section 4.7, the data gathering process managed to garner a response rate of 21% from email and distributions amongst supply chain colleagues working in the field of energy and mining. Based on the sample size of 85 respondents, it is an indication that more time would have been required to reach the ideal target of 120 respondents. Nevertheless, the sample size was adequate to allow for analysis as per KMO measure of sampling adequacy indication. Further, the completion rate was 76% with 27 participants dropping off as they either didn't qualify as supply managers or exited the survey. Nevertheless, 85 participants completed the survey questions 100%, hence there was no need to invalidate any of their acquired data. Tests for validity indicated that each of the construct was measured accordingly to its associated construct. Reliability was also measured to see if the research instrument was sufficient in data collection and this was positively verified.

This chapter will seek to address the findings in chapter 5 and seek to assimilate the results with the literature review in the previous chapters. There will be a review of whether the data confounds, agrees or adds to the body of literature of the research work. It is also critical to note that the review will be pertain to this existing sample size.

First, the chapter will look at the demographics provided in the sample size in order to provide a better understanding of who participated, their company background and the commodity that they dealt with. Thereafter, a review of the construct on perception of risks among managers will be inferenced based on the descriptive statistics. The other constructs; probability of exogenous risks, probability of endogenous risk, consequence of exogenous risks and consequence of endogenous risks will be discussed based on the data findings. The means comparison and relationship between probability and consequence of supply chain risks will be examined next.

The results of each of the hypothesis will thereafter be scrutinised starting off with the first hypothesis, *supply chains in Africa are highly predisposed to supply chain risks* which sought to access the awareness of supply chain risks amongst managers. Hypothesis two will follow to understand what the main drivers of supply chain risk are, if managers do perceive their supply chains to be undergoing risks. The third

hypothesis will look at the findings on whether indeed external supply chain risks are more likely to occur compared to internal risks. The last finding to be discussed will be based on hypothesis 4 which addresses the consequence of external supply chain risks compared to internal supply chain risk.

This chapter will be concluded with the main findings and supporting literature and whether indeed the research objectives are established.

6.2. Sample Demographics

The respondents of the survey were all supply chain managers working in a mining or energy company in Africa. A majority of the respondents, 80%, confirmed that they were men with only 20% representing women. This was akin to Lauwo's (2018) findings where women were not highly represented in the mining sector as it was predominantly thought of as a male dominated field due to the traditional perception that it required physical strength and was a risky domain to operate in. It could also be the manifestation of educational culture where women are discouraged to study fields related to mining and energy.

We can however see the female representations much higher in companies that have more than 5000 employees who are likely to be transnational companies operating on a global scale. This is in line with the trend observed by Lahiri-Dutt (2015) and Knutsen et al. (2017)where global companies, keen to grow emerging markets and furnish labour gaps, were known to hire women at higher rate than previous as the industry focused on specialised skills and less on brute.

The data indicated a 53% of the sample selected were seen to work in the companies with more than 5000 employees globally, showing the presence of transnational companies who formed part of the targeted samples(Stapenhurst et al., 2017). As observed by Lauwo (2018) , transnational companies, such as Anglo Gold and Barrick Gold were part of the mining conundrum in Tanzania where ecological and social impact of their mining activities seemingly outweighed the benefits they purported to bring to the countries they invested in. This was similarly observed by Mnwana & Bowman (2018) where despite mineral wealth in a rural area in Limpopo province, poverty and unemployment reigned.

The respondents were predominantly from South Africa, as this is where the researcher was based. Additionally, this affirmed the importance of mining in contribution to the South African economy as indicated by Goodman et al.(2019). The

country ranked second in terms of respondents was Ghana which had long relied on mining and recently came across significant oil and gas findings (Hilson, 2017). Mozambique, ranked third in terms of respondents, was estimated to have 100 trillion cubic feet of natural gas and thus a noteworthy country in the gas industry in Africa (Ovadia, 2016).

The main commodity with which the respondents dealt with was gold, followed by copper and crude oil products. This is in line with previous research where gold had received wide attention as a main economic contributor to the South African and Ghanaian economy as well as one the minerals with which supply chain risk is heightened as one of the designated conflict minerals(Hilson, 2017; Kim & Davis, 2016; Schütte, 2019). Additionally, the presence of numerous minerals in the continent was evident proving indeed that Africa was resource endowed(World Bank Group, 2019).

6.3. Probability of Supply Chain Risk

On average, the results showcased a high probability of external supply chain risk occurrence with 82% of the managers agreeing and also based on the mean of 2.81. This was also evident in the Thun & Hoenig (2011) research. Changes in government policy emanated as a highly probable occurrence which was a trend observed by several authors(Hofmann et al., 2018; Lauwo, 2018; Schütte, 2019; Sequeira, 2016; Stapenhurst et al., 2017).

Supply chain managers would have been exposed to the local content policies wave happening in Africa where governments were constantly reviewing the applicable mineral laws and rights to suit the political climate of the day. Indeed, Ovadia (2016) found that while oil companies were generally in support of local content laws, their major concern was how they could take back their technology once their business was complete, indicating the ineffectiveness of local content laws in trying to establish local industries(Sauer & Seuring, 2017).

In examining internal supply chain risks, the biggest deterrent was the probability of a supplier failing followed by supplier quality issues which explains the critical dyadic nature of supply chain phenomenon where a buying firm relies on another party to meet their supply requirements. This was explored by Hofmann et al. (2018) and Wang et al.(2015) who advocated for better management of suppliers and strong trust relationship through information sharing, to improve firm performance.

Moreover, Christopher (2011) backed the creation of risk profiles for each supplier. Other scholars were seen to demand companies map critical nodes for second and even third tier suppliers (Bentahar & Benzidia, 2018; Eskandarpour et al., 2015; Hendricks & Singhal, 2005; Zhao et al., 2019). Failure in supplier-buyer relationship is consistent with the literature findings whereby suppliers were found to be origins of risk such as was the case when mining companies were pressured into asking their suppliers to adhere to better sourcing practices as they faced consumer and governmental backlash (Jajja et al., 2018; Y. H. Kim & Davis, 2016).

The other scenario the data would reflect is leadership strategies when it comes to supplier management. It would seem that supply managers would not have performance management metrics such as audit, reward and punishment schemes in place for their suppliers and hence their suppliers would not be motivated to perform. For companies that would use transactional leadership strategies, suppliers were likely to improve on their performance as advocated for by Mokhtar et al. (2019). Other proposals in managing suppliers was the use of Bayesian Belief Networks that were known to support issues around selection assessment and ranking(Qazi et al., 2018).

Supplier quality issues were also likely to occur in the era of local content policies that imposed extractive companies liaise with local companies for their procurement spend. Given that most African countries struggled with weak supplier capabilities and infrastructural support, it was likely that the calibre of suppliers available were of low industry standards despite being the insistence to utilise them. This ties back to why several scholars complained about inefficiencies in African based logistics and proposed foreign direct investment as a positive influence in improving supplier performance(El Baz et al., 2019; Y. H. Kim & Davis, 2016; Nnamdi & Owusu, 2014; Yeboah et al., 2014).

6.4. Consequence of supply chain risk

Given the uncontrollable nature of external risks, it would be expected that supply chain managers would deem the consequence of external risks highly, at a mean of 2.91. The biggest impact of supply chain risk was considered to be change in government policy followed by change in commodity prices and poor transport infrastructure.

The importance of government in extractive supply chains is a recurring theme given how much influence governments wield in the private sectors in Africa, especially the financially lucrative extractive sector. Government policy has had negative influence on extractive companies such as corruption, bribery, local content laws, equity laws and taxation. Take bribery and corruption, while almost all African countries have anti-bribery laws, they are rarely enforceable with Transparency International ranking a majority African countries at the bottom of the corruption index. Indeed, firms had had to re-route their shipments, avoid mining investments in corrupt areas all due to laxity in bribery policies across the continent (Knutsen et al., 2017; Sequeira, 2016; Sequeira & Djankov, 2014).

Extractive industries are often challenged by fluctuations in commodity prices brought on by globalisation, slowed economic growth, war and other influences which often heighten supply chain risk. Staying competitive in the face of these challenge is one of the key drivers of mechanisation amongst firms. By mechanising, firms improve productivity and safeguard themselves when prices crash reducing reliance on boom periods when prices are high. While mechanisation improvements are lauded, they can also be detrimental to extractive industry which saw the price of oil dropping to unsustainable levels once shale oil producers had garnered the right technology to extract oil and ended up glutting the market (Aguilera & Radetzki, 2017).

The influence of commodity prices on supply chain risks was evident by Goodman et al. (2019) who found volatility in mineral commodity prices as one of the key concerns for investors in South African mines. In fact they found South Africa had the highest price volatility amongst other key mining markets worldwide. Commodity prices of products such as gold are also influenced by complex factors such as political considerations by a central bank or jewellery pursuits by China and India.

With regards to internal risks, the supply chain risk with the highest consequence was found to be the supplier failure and supplier quality issues which is similar to the probability ranking of endogenous risk. Based on the literature review, the financial implication of supplier failure has been observed to be disastrous to buyers making it a priority concern. Companies such as Ericson saw their market share in the cell-phone industry drop when one of their key component supplier failed while their competitor barely suffered due to great understanding of their supplier risks(Bradley, 2014). Hence supplier mitigation strategies were encouraged by Kim et al. (2015) to avoid losses despite how deep the supplier lies in the supply chain.

Supplier quality is indeed an issue on the continent with shortages experienced by firms operating. First, suppliers are likely to be expensive given the number of few providers available and secondly, when firms choose to source overseas, their costs increase due to the cost of doing business in African countries(He et al., 2018). Cosbey (2016) observed this phenomena of conflicted shared value where while mining firms were willing to support local suppliers, they found it difficult to find suppliers who could meet their quality demands which led to higher costs as they had to source outside.

The prevalence of corruption in the African mining companies can also be expensive as Foreign Corrupt Practices Act (F.C.P.A), European Union's Convention against Corruption and U.K.'s Bribery Act of 2010 are known to mete out heavy fines to companies that are culpable even when the involvement was by a third-party supplier. As it is, it was already difficult for companies to have visibility of their supply chains due to poor quality suppliers and hence such loopholes can leave firms exposed(Giannakis & Papadopoulos, 2016).

Even though suppliers in far flung places can be a source of worry, sometimes the financial consequences are not as high as expected. Retailers associated with Rana Plaza in Bangladesh expected reputational risk to cost them through bad press releases and nose-dives in their stock price. Despite the furore over the unfortunate event, the post disruption effect was much better than expected with Jacobs & Singhal (2017) observing a short-lived negative effect to the stock price. Further, retailers were not held responsible and clothing exports from Bangladesh actually increased the next year.

6.5. Comparing Means across Sub-Groups

6.5.1. Comparing Ranking by gender

The independent samples t-test indicated that there was no statistical significance in how females and males viewed the different constructs as the significance levels were all above the significance level of $p<0.05$.Hence no analysis was inferenced. A larger sample would have been ideal to compare means.

6.5.2. Comparing Ranking by company Size

Similar to the comparison of gender means, there was no difference between company sizes across the different constructs thus no analysis was discussed.

6.6. Relationship between Probability and Consequence of Supply Chain Risks

The linear regression analysis results showed a positive relationship between the probability of external risks and their impact due to the R^2 value of 0.637 which shows

that probability of external risks factor can predict the consequence of external risks by 63.7%.The examined relationship between consequence and probability of endogenous risks also yielded positive results. With an R^2 value of 0.494 the predictability of impact of internal risks was at 49.4%. Indeed the probability and impact of supply chain risks were related as Christopher (2011) termed supply chain risk as the probability of a risk multiplied by the impact which lends to the above results.

External risks were found to be slightly more predictable than internal risks which goes against the grain of the literature offered. External risks such as business environment risk, infrastructural risk, bribery risk were found to be more complicated with Lockamy (2017) identifying hard to predict and control.

The measurement of supply chain risk has proved to be difficult given the lack of quantitative measurement models such as the ones that exist in finance and thus while this positive correlation exists in both external and internal risks, the extent to which these findings are accurate is not known. Ribeiro & Barbosa-Povoa (2018) highlighted this gap in measuring supply chain resilience and were in favour of robust quantitative models that would support supply chain managers in quantifying risk.

6.7. Results for the hypothesis tests

6.7.1. Perception of Risk

Hypothesis one: Supply chains in Africa are highly predisposed to Supply chain risks

The data indicated on 5.6.1 confirms that managers indeed saw their supply chains as vulnerable to risk factors with a mean of 3.32 which is similar to the findings by Thun & Hoenig (2011).

One of the main reasons respondents would cite concerns in their supply chains would be due to the lack of implementation of supply chain risk management tools despite awareness of risk as presented in the literature. One risk management tool specific to the sector, is the concept of due diligence with practices and laws such as the Dodd-Frank Act, Conflict Free Sourcing Program and the OECD guidance in existence, but at a nascent stage of implementation globally(Hofmann et al., 2018). A belief in vulnerability could also be brought on by the weakness of supply chain risk management tools. One such tool would be technology where Chevreux, Hu, & Gandhi(2018) found that despite the advancements in technology, the unpredictability of the world made it tough for supply chain managers to accurately predict and plan for risks hence were likely to face severe impacts their value chains.

Another reason would be that despite awareness of the risks and attempts to mitigate them, managers were battling with external risks which were much harder to predict and control and therefore leaving them more exposed. This was true in the case of African supply chains where government interference and climate change were such disruptions. In these instances, Giannakis & Papadopoulos (2016) advised managers to focuse on internal risk management and hence lessening the impact of the external risks were they to happen.

By way of contrast, an analysis was done into the small minority of supply chain managers who “Kind of Agree” and “Do not agree”. Low awareness of risk could be brought on by factors such as culture as well as the risk attitude of the manager. Bradley (2014) saw that risk management was handled differently by managers based on their own understanding and perception. It was therefore likely that these managers would have partaken in risk management strategies that they would have considered sufficient enough to offer security in the event of a disruption leaving them with little exposure.

The more globalised a company the more exposed to risk the company would be especially with endogenous risks. This small majority could therefore be representative of smaller companies that perceived their risk exposure to be minimal due to low awareness of supply chain risk management. This lack of awareness was addressed by Hendricks & Singhal (2005) who implored practitioners to deepen their understanding of their supplier networks. Further Zhao et al. (2019) found proof that the more proactive supply chain managers were the less likely the impact of a disruption .

Managers who had a high perception of risk were likely to have investigated their supply chain networks and observed them. Precautious managers under this category would have encountered supply chain risks that would have cost them enough to be aware of their probability and impact to their firms establishing risk management strategies. Similarly, Qazi et al.(2018) noted that supply chain practitioners found risk measurement tools to be cumbersome and would only use them once the impact of the risks was enough to prompt the implementation of this tools.

6.7.2. Drivers of Supply Chain Risk

Second Hypothesis: African supply chains have multiple drivers of supply chain risk

Overall, all the presented drivers of supply chain risks were deemed to be high with a mean of 2.82 which infers the complexity that is today's supply chains. The highest trend was however noted on changes in government policy and technological change unlike the findings of Thun & Hoenig (2011) where globalisation was deemed the highest driver of risk followed by the need to offer product variants. This difference could be due to the difference in surveyed industries, Thun & Hoenig (2011) explored the automotive industry while this study explored the mining and energy industry. Another distinguishing factor would be the location of the survey, this research looked African countries while Thun & Hoenig based their research in Germany.

This hypothesis can be better summarised by terming the supply chain a complex adaptive system wherein three focuses lie, the internal capabilities of an extractive industry, the ecosystem in which the firm operates and co-evolution which is the environment partially created by the firm through reactions and partially created by external factors (Choi et al., 2001).

Complexity in ever expanding global supply chains was also noted by Nair & Reed-Tsochas (2019) who compared supply chains to complex network models which intertwined and required expertise to decipher and mitigate risks. This complex environment requires adaptation which was endorsed by Zhao et al. (2019) by propagating the use of reactive and proactive supply chain risk management strategies.

Ironically, while governments were usually the biggest benefactors of mineral wealth through application of royalties and tax regimes to transnational mining companies, they were also seemingly the highest contributors of risk. Dependence on natural resources was found to weaken governance structures. This caused firms to avoid areas where corruption was high when deciding to invest in mines as government officials increased bribery payments in areas where mines were located(Knutsen et al., 2017). Other concerns raised was the poor enforcement of employment laws such as the employment of child labour in mines was seen as one of the most unrelenting social risks in global supply chains(Giannakis & Papadopoulos, 2016; Kim & Davis, 2016). Countries such as Zimbabwe, which were seen in the sample presented, also faced regulatory framework issues and inconsistency between what stakeholders

such as transnational mining companies, wanted compared to what the government expected according to research conducted by Muchaendepi et al. (2019).

Government policies in the extractive industry in Africa tended to be complex due to numerous factors and this would rightly affect supply chain managers. First, the institutional framework in most African countries was weak which was consistent with the theoretical prediction of the literature offered by Sequeira & Djankov (2014) whereby bureaucracy plagued African supply chains exposing firms to risks such as bribery and corruption. Indeed Knutsen et al. (2017) found to be a strong correlation between natural resource findings in a country and corruption. Moreover, regulatory effects of due diligence activities in conflict minerals had also brought about commodity price volatility which could be strong indicator why supply chain managers flagged this as a concern. Mancheri et al.(2018)

The emergence of local content laws was another inference provided by the data. This was seen in countries such as Ghana, Kenya and Uganda where extractive companies were instructed to prioritise local suppliers when it came to their supplier utilisation. Keen to empower locals with newly discovered resource finds, the Mozambican government similarly resorted to creating local content laws that were in the end ineffective as they overrode each other or were too complicated to be implemented (Ovadia, 2016).

For supply chain managers whose concern was primarily on their buying country's governments, concerns could emanate from countries such as China where the government, bent on industrialisation, was keen on securing key mineral supply chains(Sauer & Seuring, 2017). In western countries, government policies that came into effect were laws such as the US' Dodd-Frank Act and the OECD guidance which were keen to improve transparency in conflict mineral supply chains(Kim & Davis, 2016; Schütte, 2019; Young, 2018).

Ineffectiveness in government policies could also be another reason why supply chain managers would cite this as a worry. Mining companies in South Africa keen on improving productivity, which would improve their competitiveness in the global market, had seen their mechanisation efforts thwarted by a government worried about high unemployment. This self-defeating purpose was documented by Mnwana & Bowman (2018) who further observed deterioration of mining firms relations with

government as they were indentured with tax codes and equity ownership requirements.

Technological changes were considered as the next highest risk based on a mean of 2.92 which is supported by several body of literature. Supply chain managers are likely to encounter technological changes in different nodes. Mechanisation is one aspect of technology that mining companies are keen on exploring in order to improve productivity in the face of declining commodity prices. The expected trickle-down effect to the local populace is however disputed with local communities being worse off through company lay-offs as was the case in South Africa (Mnwana & Bowman, 2018; Pedersen et al., 2019).

Supply chain practitioners would also view technological change as a risk due to the continuous advancements made in technology such as Artificial Intelligence, Internet of Things, online tracking and so much more(Roßmann et al., 2018). Despite the awareness of this tools, most companies were yet to implement technological changes due to prohibitions such as high cost or lack of visibility on the return on investment of these tools as observed by the Business Continuity Institute (2018) and (Makris et al., 2019).

Although the benefits of technology such as speed in decision making process were eminent, technological trends in supply chain were also in the formative stages and constantly changed as data sets increased, hence the hesitance to implement technological systems that would drive down this risk (Roßmann et al., 2018). Despite this fear, major freight firms were making digital investments to improve their operational capabilities (Chevreux et al., 2018; Kim et al., 2015).

The direct relation of minerals to technological consumer goods such as mobile phones and laptops would be the other reason managers raised concern on technological changes. Critical components of consumer electronics required the input of the “3TG”s and an increased appetite for consumer goods buoyed by rising consumer purchasing power, had seen the rise of conflict in eastern and central Africa thereby increasing risk (Hofmann et al., 2018).

It was apt to apply the complex adaptive systems view to this hypotheses as government policies were seen to encompass many activities in the extractive industry supply chain and the reaction amongst firms differed. Additionally, the influence of technology and other drivers of risk carried a higher than average

weighting of risk further supporting this complex adaptive systems interpretation in that there were multiple non-linear agents causing multiple reactions in a supply chain.

6.8. Probability of Supply Chain risks

Third Hypothesis: exogenous supply chain risks have a higher likelihood of occurrence than endogenous supply chain risks

A test of this hypothesis indicated that it could not be rejected as the means for exogenous risks were significantly higher than the means for endogenous risks which were 2.81 and 2.55 respectively. Additionally the ANOVA tests indicated the significance levels between the two types of risks was large enough to warrant a distinction between the two types of risks. This was in line with the Thun & Hoenig (2011) findings where external risks had higher average scores compared to internal risks probability.

Supply chain practitioners would deem the likelihood of exogenous risks higher than endogenous risks due to the complexity surrounding these types of risks. Previously termed, acts of God, such as tornadoes and hurricanes have now become common place in the face of climate change. This result is therefore an interpretation of the incidences such as Cyclone Idai whose occurrence was closely followed by Cyclone Kenneth that impacted extractive communities in Mozambique and Zimbabwe (Nhamire & Sullivan, 2019). Due to increased exposure to weather elements, Park et al. (2013) observed Japanese companies shifting their bases to mitigate the risk acknowledging the probability of external risks which was in line with proposals by Giannakis & Papadopoulos (2016) to act on natural disasters through control and flexibility responses.

Moreover, a key reason probability of external risks would outweigh internal risks would be the influence of globalisation. Laws such similar to the Dodd-Frank act and the OECD guidance have brought mining supply chains under scrutiny from Western governments which matters, as most transnational companies operating in Africa are headquartered in countries such as Canada, USA, and Australia. Hence these companies are bound by their mother country laws despite the overseas occurrence of risk. Further these laws seemed to be increasing their reach by covering more minerals beyond the “3TG” and asking for further transparency within supply chains (Hofmann et al., 2018; Young, 2018)

Uncertainty is also a given in most African countries with long-standing issues such as multiple civil wars in Democratic Republic of Congo which were observed to have a correlation with mining activities(Amiri et al., 2019; Knutsen et al., 2017). Therefore it becomes normal to expect external risks to occur as there have been patterns in the past. For example, it not unlikely that a war risk would occur in resource-rich Mozambique which has in the past been under decades of civil war (Sequeira & Djankov, 2014).

Generally speaking, El Baz et al. (2019) found that African countries were susceptible to multiple peculiarities such as lack of foreign currency and skilled labour, issues other countries were not likely to face. El Baz et al. (2019) further argued that while African companies grappled with operational issues due to the tough ecosystem they operated in, supply chains in other emerging economies had progressed to tackle strategic concerns.

6.9. Impact of supply chain risks

Fourth Hypothesis: supply chain risks have a greater consequence on the supply chain than Endogenous supply chain risks

The fourth hypothesis was also not rejected as it resulted in a higher means of the consequence of external risks compared to internal risks. This was unlike Thun & Hoenig (2011) findings where internal risks had higher average scores compared to external risks impact. The results also point back to the discussion on section 6.6 where the probability of external risks could positively predict the consequence of external risks by 63.7%.

Based on financial cost, external risks have been found to outweigh internal risks due to the degree with which firms can control them. The Japanese Tsunami of 2011 was said to have cost billions of dollars in losses to firms due to the reliability of Japan as a component producer(Matsuo, 2015). Although some firms such as Cisco were able to mitigate risk by diversifying their supplier locations in other countries, other companies saw an increase of component costs showing the devastating effect of the Tsunami (Revilla & Sáenz, 2014).

It is problematic for supply chain managers to control risks that they are not aware of and this ignorance of the unknown is what Hendricks & Singhal (2005) say causes external risks impact to be much more augmented. Zimbabwe's business climate risks is such one example; the country has faced hyperinflation effects since the late 2000s, suffered through a dictator, indigenisation laws, cyclones and so much more.

This makes it hard for managers to plan as they go through crisis after crisis making for unsustainable supply chains. Hence, Muchaendepi et al. (2019) recommended for cohesion between government and mining stakeholders to bolster institutional frameworks.

Skills development was also an issue on the continent and this demographic challenge costs extractive companies dearly. Due to the highly specialised skills required, extractive companies found themselves importing labour which required expatriate packages to attract talent due to the difficult terrain in which mines operate. Lauwo (2018) thus propagates for skills development especially for women who are even further marginalised in the patriarchal mining sector in Tanzania.

Enlightened consumers were demanding transparency in extractive supply chains through social protests. Similarly, due diligence activities were also demanded by government and enforced by law when previously they did not exist. Adherence to these requirements meant increased costs as resources were required to obtain certification and improvement of traceability capabilities (Hofmann et al., 2018; Kim & Davis, 2016; Schütte, 2019).

The environment with which extractive firms in Africa operates in is also plagued with infrastructural problems that are not of their making. Roads, Airports and shipping infrastructure conditions are often so poor that operational costs skyrocket compared to developed countries. Some of the causes of poor infrastructure include past civil strife and incompetent governance. The World Bank (2019) actually documents the difficulty of operating logistics in the continent ranking African countries on the Logistics performance index. Additionally, Knutsen et al. (2017) found infrastructure accessibility as one of the decision criterion when it came to extractive firms investment decisions.

6.10. Summarised findings

In conclusion, supply chain managers in the extractive industry are wary of the risks posed in their supply networks. Further the researcher notes the risks most supply chain managers are worried about are external risks. We also see a strong relationship between the probability and the consequence of an external supply chain risk with a positive correlation on how probabilities can predict the impact. Thus the research purpose of analysing the occurrence of supply chain risks and its impact was therefore met.

7. CONCLUSION

7.1. Recap of the Research Objectives

Given the importance of supply chain management to business, the author was interested in gaining insights into the supply chain risk arena, an interesting phenomena which has been documented by various scholars such as Waters (2011), Hugos (2018), Tang(2006), Bradley (2014), Faisal (2009), Matsuo (2015), Thun & Hoenig (2011), Jajja et al.(2018) and Zhao et al.(2019), Today's world is dynamic in nature and the topic of supply chain is ever evolving to keep up with exogenous and endogenous risks that occur along supply chain nodes. Supply chain managers who recognise these risks and mitigate them provide opportunities for their firms to outdo the competition. The alternative, failure to mitigate risks can be damaging from a financial and reputational perspective. Hence, the role of a supply manager is precarious in that they always have to think of the future and plan for risk planning scenarios and mitigation strategies, even when the probability is not quantifiable or the return on investment is not clear.

This research was also inspired by the need to investigate one of the author's company strategy of gaining market share in the mining and energy industry in Africa. Hence, the author specifically explored supply chain risk management topics discussed by researchers such as El Baz et al. (2019) , Sauer & Seuring (2017), Cosbey et al., (2016), Hofmann et al. (2018), Aguilera & Radetzki (2017), Pedersen et al., (2019), Sun et al. (2017), Mancheri et al. (2018), Van den Brink et al. (2019) and Nnamdi & Owusu (2014). Compared to developed countries, the African continent is plagued by an insurmountable number of supply chain risks which require institutional intervention and long-term solutions. Indeed, the role of governance, policy and regulatory frameworks has been a common concern in most mining reliant countries. Nevertheless, the opportunities available in the mining and energy industry make it lucrative for firms to operate necessitating the need to develop risk management strategies specific to the continent. This contrast therefore offered the author an opportunity to test whether indeed the risks in the industry were unfounded as documented by global institutions such as the Transparency International (2019) and World Bank Group (2018).

Once these risks were proven, the author wanted to look at the main determinants or the risks given the complexity of mineral and energy supply chains even outside of Africa. The literature pointed towards weak regulatory concerns, presence of global

mining companies in Africa, emergence of supply chain 4.0 strategies, supplier problems, operational inefficiencies, consumer and sustainability concerns Further, these two industries were renowned for being male dominated and hence under this objective the author wanted to see the relationship between how female managers perceived their drivers of supply chain risk compared to men (Lauwo, 2018). Further, the size of the company and their drivers of risk could possibly offer some differentiating perspectives on whether risks ailed companies differently. For example, the author noted the reaction of different companies when faced with similar risks, such as the Nokia and Ericsson case where Nokia was able to thwart the disruption while Ericsson had a delayed reaction and suffered as a consequence(Bradley, 2014).

The impact and probability of risk was the next level of investigation was the author was made aware of the distinguishing characteristics between the two. Some risks such as a cyclones in Mozambique were quite rare but the impact to extractive industries was financially damaging. This was supported by Hendricks & Singhal (2005) who found that disrupted companies often paid the price through decline in stock price. The author thus needed to explore this as the extractive industry was worth billions and a majority of the companies had presence in stock exchanges worldwide. With this in mind, the author narrowed down on this topic in order to understand the perception of supply chain risks given the importance of mitigating them as well as investigating the probability and impact of supply chain risks which has been observed by Thun & Hoenig (2011) and Giannakis & Papadopoulos (2016). Following this review, the author narrowed down on four hypothesis which were also documented in section 1.4.

- Hypothesis 1: Supply chains in Africa are highly predisposed to supply chain risks.
- Hypothesis 2: Complexity in supply chain is a key driver of supply chain risk
- Hypothesis 3: Exogenous supply chain risks have a higher likelihood to occur than endogenous supply chain risks
- Hypothesis 4: Exogenous supply chain risks have a greater consequence on the supply chain than endogenous supply chain risks.

By meeting the research purpose, the author hoped to bring back those insights into her company, a global supply chain provider of logistics. These insights would also benefit the academic world, governments, governmental institutions as well as companies operating around there industries as documented in section 1.5.

This chapter aims to showcase the inter-connected findings of the research and how relevant stakeholders can benefit from using this information. Further this chapter explains how these findings can be adapted in academia, management, government and in other areas related to supply chain management. This chapter will also highlight what the limitations of the research were. Finally, the researcher will make recommendations for future research opportunities.

7.2. Principal Findings

The empirical analysis shows that indeed supply chains in the extractive industry in the continent are vulnerable to disruptions which was also noted by the Thun & Hoenig (2011) whose instrument was adapted to advance this research. One key cause of vulnerability was the non-usage of risk mitigation tools despite the existence and knowledge of these tools some of which were highlighted by Fahimnia et al. (2015). Other indications of high risk prevalence was the dictation of international laws in relation to extraction activities in the continent which were widely documented by Hofmann et al (2018), Kim & Davis (2016), Schütte (2019) and Young (2018) The Dodd-Frank Act, the OECD guidance were developed due to visibility and traceability concerns specific to supply chains in Africa where resource booms had brought on civil wars and human rights abuse such as child labour. Moreover, the drivers of supply chain findings point towards complexity such as technological changes hence these vulnerability was set to occur.

While there were few managers who did not perceive their supply networks as susceptible to risk, the author attributes this risk attitude to cultural norms. Information sharing between different agents in the network was common in African culture and this would have given the manager the confidence that they were less vulnerable as they were more aware of what was happening in the different nodes (El Baz et al., 2019).

Additionally, the data findings indicated no significant difference between how female and male supply chain managers perceived risks which was anticipated given the penchant for male dominance in the extractive industry(Lahiri-Dutt, 2015; Lauwo, 2018). What was also observed on a minuscular level was that larger firms were more likely to have female managers compared to small sized firms with less than 100 employees. For a company size perspective, there was also no significant difference between how different sized companies perceived their supply chain risks.

Complexity was the main theme found across this research with multiple supply chain risks overlaying onto each other across supply chain networks. The author found a majority of the supply chain managers worried about risks in their supply chain, with most of the worry pegged on external supply chain risks. Using the complex adaptive system framework, the author saw different the decision making agents, the firms, and other agents such as the government , and suppliers affecting the internal mechanisms and external environments of the firms causing them to respond which validated what was proposed by Choi et al. (2001) and Nair & Reed-Tsochas (2019). These scholars noted that supply networks were dynamic such that with small effects causing big disruptions, some disruptions were not even predictable and even when risks occurred, the reaction in the system would appear different than what had been predicted. This pointed towards a dynamic capabilities view where firms applied agility in light of turbulent times.

Thun & Hoenig (2011) had found the key driver of supply chain risks in the German automotive industry to be globalisation and the author expected similar findings in the data results. Surprisingly, a majority of the supply chain managers in Africa were more worried about governments in the countries they operated in, other countries governments that dictated that transparency and generally the influence of government policy. This was noted as a distinguishing factor compared to previous data findings by Thun & Hoenig (2011) as globalisation was ranked the second last concern which surprised the author given the globalised nature of mining and energy supply chains. This could present a gap in understanding the influence of globalisation in the extractive industry which has been vastly documented by scholars such as Mnwana & Bowman (2018) and Nnamdi & Owusu (2014).

Technology changes have been rampant in the supply chain domain and thus this trend was anticipated as a driver of risk. With the advent of mechanisation, tension has risen between workers who are set to lose their jobs and firm who want to increase productivity and remain competitive in the global mining sectors. This tension has been further exacerbated by unemployment concerns which makes redundancy a tall order for governments who resist this strategy Mnwana & Bowman (2018). These tensions have in the past turned deadly such as the 2012 Marikana which brought the mine down to its knees due to workers strikes and deaths(Hammond et al., 2017).

Findings on the relationship between probability and impact of supply chain risks revealed the nature with which risks are connected. In fact Christopher (2011) posed

this as the definition of supply chain risk; impact multiplied by the probability. While the Likert-scale offered some perspectives, a more quantitative model of measurement would have provided insights into the two relationships.

The data showed external risks compared to internal risks to be considered more probable compared to internal risks, which pointed to a different reality in comparison to the survey results by Thun & Hoenig (2011). Lockamy (2017) showed that while external risks were worrying, little could be done and hence supply chain managers were thus expected to be focused on endogenous risks which they had control over and could leverage to cushion external risks. This was therefore surprising that external risks were considered highly probable. By gauging the impact of external supply chain risks to be higher than that of internal risks was telling of how much suffering extractive supply chains had endured from external factors as realised by Knutsen et al. (2017), Muchaendepi et al. (2019), Ovadia (2016), and Stapenhurst et al. (2017).

Nevertheless, endogenous risks, such as supplier failure and supplier quality also seemed to be influenced by exogenous risks such as government influence over the choice of suppliers firms could use through legal mechanisms such as local content policies(Ovadia, 2016).

7.3. Recommendations and Implications

This research had set out to provide insights into an important business function, supply chain, in one of the most lucrative yet turbulent industries in the continent. By understanding the existing supply chain risks, the research hoped to motivate managers to harness their supply chain capabilities in mitigating these risks Giannakis & Papadopoulos (2016).

Given the existing literature leaned on western firm's research, the initial empirical analysis pointed towards internal risks as the most likely and impactful to Supply chain networks but this research found this to not be the case. Therefore, this research adds to the academic literature of supply chain management in Africa where a contrast from developed countries exists as pointed out by El Baz et al. (2019).

Moreover, it assists organisations in the domain in having a better grasp of the risks that exist in their supply chain. A surprising outcome was the strong influential role of governments. The author hoped to showcase the negative and positive influence of government policies in a sector where if the right policies are implemented and executed, the higher the benefits surmounted in taxes or royalties.

7.3.1. For academics

This study added to the African supply chain management body of literature and specifically to risks pertaining to the extractive industry. Based on the author's experience during the literature review process, few high impact academic journals had supply chain topics authored by African scholars. Therefore the literature assessed offered a western leaning bias whose perception differed slightly from an African reality (El Baz et al., 2019). This study therefore lent an African voice and encouraged the development of further research into African oriented supply chains.

Academically, models of quantitative supply chain risks had been documented as solutions to supply chain risk mitigations yet, African firms seemingly did not apply them, leaving them exposed to unavoidable risks .This therefore provided an opportunity for academia to add these quantification models as part of their business school curriculum. By empowering future business leaders on the continent to model risk and act effectively, risks would become less detrimental to firm performance(Fahimnia et al., 2015).

The probability and impact of external supply chain risks revealed the opposite of what other empirical evidence pointed at, showing how different mineral and energy supply chains differed from the findings of Thun & Hoenig (2011). This offered research opportunities for future scholars to look into the supply chain models that could assist in measuring and mitigating risks specifically for African supply chains.

Further, Heckmann, Comes & Nickel (2015) had complained the definition of risk varied amongst scholars and hence in this context academia can develop a suitable definition of supply chain risks in the African context.

Supply chain risks were also observed to be dynamic in nature, necessitating an application of multiple frameworks in the course of this research. In the future, academia could look into creating a unified framework allowing for firms to interpret supply chain risks and management easily.

7.3.2. For organisations

As evidenced in the data, organisations should examine why their risks are high and investigate applicable risk mitigation tools. Given the global nature of mining firms in the continent, the availability of risk mitigation tools is possible and hence what would be required is the adaptation to the African continent(Fahimnia & Jabbarzadeh, 2016; He et al., 2018; Heckmann et al., 2015).

Organisations will also need to continuously train managers on supply chain risk management given the dynamic tendency of supply chain risks. Awareness is critical to managing risks and hence firms whose managers rank low in awareness can cause monumental losses to companies as was noted by Bradley (2014) in Ericsson, or rather save the firm from harm as was the case of Cisco (Revilla & Sáenz, 2014).

In order not to lose focus on their core activities, organisations can also employ suppliers who provide visibility and advice on risk exposure so as to minimise their upstream risks. Quality suppliers who are global in nature, do have local presence in the continent and hence selection of these types of suppliers ensures minimal exposure limiting supplier failure(Nnamdi & Owusu, 2014; Song, Ming, & Liu, 2017).

Where local content policies exist, limiting the number of quality suppliers available to be used, firms have to improve the capabilities of these suppliers to mitigate their risks(Brusset & Teller, 2017; Rajesh & Ravi, 2015).One way to do this would be application of transactional and transformational strategies where suppliers are obligated to stick to key performance indicators but are also enabled where they fall short in capabilities due to external restrictions or capabilities (Mokhtar et al., 2019).

Integration with competent suppliers was been found by Jajja et al.(2018) to positively influence reduction of supply chain risk and increase the dexterity of companies. This therefore offers opportunities for 3rd party logistics suppliers such as the author's own employer, to alleviating extractive companies from external risks such as technological issues and government policy. This could be done through provision of visibility tools, offering expertise on government policies such as customs tax and sharing risk information. By outsourcing these functions, it allows extractive companies to focus their capital on building their core competencies improving their competitive advantage.

The opacity that prompted the development of the due diligence policies such as Frank-Dodd Act were indicators of lack of trust within extractive supply chains. Extractive firms should therefore build up internal visibility tools that allow for trust levels to be increased in the era of consumer activism and government clamp downs(Hofmann et al., 2018;Kim & Davis, 2016).

In the face of supply chain risk such as sustainability concerns, organisations in Australia created sector specific forums such as the Australian Steel Stewardship Forum and Aluminium Stewardship Initiative to allow for interactions and

development of cohesive supply chain risk strategies. Likewise, African mining organisations can work towards establishing collaborations such as these that could also be used to collectively bargain with governments who are seen as strong agents of supply chain risk(ASI, 2019; Steel Stewardship, 2019).

Despite evidence of prevailing governance issues, organisations should look at ways of engaging governments in executing well-crafted policies that would strengthen institutions (Sequeira & Djankov, 2014; Transparency International, 2019; World Bank Group, 2018). Further, providing evidence of how weak regulatory frameworks inflict the government pockets through reduced taxes and royalties, could motivate governments to effect changes(Hofmann et al., 2018; Muchaendepi et al., 2019; Ovadia, 2016).

7.3.3. For governments

There is a recurring worry around governments proving their role as positive and negative agents in the extractive industry supply chain. Positive in that legal acts such as Dodd-Frank act have brought on visibility to an industry that has meted out a lot of misery to those who participated in the upstream supply chains such as children and women(Mancheri et al., 2018; Young, 2018). Thus the positive influence of government is important in accelerating the development of this industry and continuity of such initiatives benefits the local populace in resource reliant African countries. Ironically, the governments that push these efforts are not African ones, but rather western governments. This therefore necessitates the need for African governments to spearhead such initiatives as they are set to benefit through reduction of country risk which is then set to attract additional foreign direct investments and uplift the plight of workers in these industries(Knutsen et al., 2017).

Policies such as the African Union's mining vision have long been in existence as guidance for countries to enable the trickle-down wealth effect of resources to local mining communities. Yet ten years later, this policy seems to be poorly executed given the extractive hazards seen by numerous scholars(Mnwana & Bowman, 2018; Muchaendepi et al., 2019; Ovadia, 2016). Therefore, it becomes critical for governments to recognise the importance of executing well –thought out policies intended to benefit mining communities as poor execution leads to civil unrest, unemployment, inflation amongst other risks , further repelling investors.

The system issue of corruption has also been proven to be expensive in the long-run as explained by the Tullock-Paradox (Sequeira & Djankov, 2014). By tackling corruption, governments provide a safer economic environment which is attractive to investors, unlike the current scenario where investors go out of their way to avoid countries with higher corruption indices (Knutsen et al., 2017).

Reliance on the extractive industries is also becoming unsustainable in the advent of volatile commodity prices creating a need to focus on growing other sectors. As such African governments need to look at exemplary models in Norway and Chile(Ruiz, 2017; Vasudeva et al., 2018; Wagner, 2018). The Norwegian and the Chilean government founded “Rainy Day” funds to provide cover as they were vulnerable to crude oil prices and copper price fluctuations and wanted to avoid being at the mercy of volatile markets.

Similarly, African governments can focus on saving the colossal funds that come in during resource booms and invest them in other markets where the exposure is less through sovereign funds. In Norway’s case, the benefits of these funds have supported social programs which largely benefit locals improving their living standards. Closer to home, Botswana has enacted similar social strategies with the partially government owned Debswana Diamond company.

7.4. Limitations and Suggestions for future research

One of the limitations of using questionnaires for research, as observed by Saunders & Lewis (2017) , which was also highlighted in chapter four, was the need to provide brief questions in order not to lose the audience’s attention. This was possibly detrimental to the data provided as it only gave the author a glimpse of what the participant was thinking. An interview in contrast would have allowed the author to provide deeper insights to their answers.

The role of government policy was a key concern yet the literature pointed towards different types of governmental influences. In this case, further probing an interviewee would have allowed the author to pin point to specific government policies. Future research can explore qualitative research methodologies such as in-depth interviews to supplement these quantitative findings making for richer work.

Given the dynamism offered by supply chain risks, this research is only focused on a certain period of time and thus findings may change if conducted over a different period. Researchers interested in the topic can therefore build up on this work to observe trends and whether there is any change over a time difference. Further, the

drivers of risks did not cover all the types or risks that affect practitioners hence allows for further research to be conducted on other types of risks building the body of literature around supply chain risks in Africa.

The research is also focused on the natural resources industries making it somewhat irrelevant to other industries that do not face the same risks (Onwuegbuzie & Collins, 2007; Saunders & Lewis, 2017). Further research can therefore explore other industries where risk consequence and probability may vary.

The questionnaire may have been subjected to survey fatigue leading to a smaller response rate compared to the target. While reliable and valid, the data feel short as it provided few insights into the demographics such as a better female representation and company size spread.

This was evident in the T-tests where the constructs were analysed to see if there were differentiators across genders and no significance was relayed despite the literature pointing towards different perspectives of risk in gender. Additionally, Independent t-tests also showed no distinguishing evidence between how small and large companies perceived risks, the probabilities as well as the impact. Thus, a larger sample size would have provided strong arguments on the influence of company size.

There was also fewer sample responses of resource reliant and risk heavy countries such as Angola and Nigeria, which could have provided richer insights into the industry. A future recommendation to counter this would be to open the survey for a longer period which was not possible given the time limit of this cross-sectional study.

The presence of global companies was evident in the findings yet, artisanal mining was prevalent in the continent, providing as much as 20% of the global gold production. Despite this, little inference of artisanal mining companies was made from the data. This opens up avenues for future research delving further into this sub-sector that is plagued by supply chain sustainability risks such as the use of mercury and human rights issues such as use of child labor.

Empirically the probability of risk seems to indicate a positive prediction of impact as evidenced in the linear regression analysis. However, the nature of risks did not allow for this to be held constant and hence practitioners should be wary of using this measure as a predictor.

7.5. Concluding remarks

Supply chain risks are an interesting phenomena to be studied given the importance in today's globalised supply chains. The need to understand what these risk are, is the first juncture in supply chain risk management which the findings were able to arrive at. The data from this research points towards a strong relationship between probability and impact of external supply chain risks. Government policy changes are portrayed as the main risk determinants. Further the influence of government is seen to inhibit supplier choices thus elevating supplier failure as the key concern in internal risks. The research objective was achieved based on all these findings.

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APPENDICES

Appendix A: Research Instrument–Survey Instrument

Preamble

I am currently a student at the University of Pretoria's Gordon Institute of Business Science and completing my research in partial fulfilment of the degree of Masters in Business Administration (MBA). I am conducting research on the Drivers of Supply Chain Risk in Mining and Energy Industries in Africa. The aim of the study is to understand the supply chain risks and vulnerabilities faced by Logistics and Supply Chain Managers in Energy and Mining.

Your participation is voluntary, and you can withdraw at any time without penalty. Your participation is anonymous and only aggregated data will be reported. No personal identifying information will be collected or stored.

By selecting the "I agree and wish to participate" option below and by completing the survey, you indicate that you voluntarily participate in this research. If you have any concerns with the research, please contact the research supervisor or me through the details provided below.

The questionnaire will take you no more than 15 minutes to complete. At the end of the questionnaire, a link will be provided for you to forward the questionnaire to known acquaintances in the area of Logistics and Supply Chain Management in the Energy and Mining Industry.

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Phone: 072 240 9840

1. Do you wish to continue? *
   - I agree and wish to participate
   - I do not consent and would like to exit
2. Do you work in the mining or energy industry in Africa?

Please confirm you work in the area of Logistics and Supply Chain Management in the Mining or Energy Industry in Africa *

- Yes, I work in the area of Logistics and Supply Chain in the Mining or Energy Industry in Africa
- No, I do not work in the area of Logistics and Supply Chain in the Mining or Energy Industry in Africa

3. In which African country do you operate in? *
   - Drop Down Menu of all 54 African Countries
4. What is the size of your company globally?
   - 1- 50 employees
   - 51 – 100 employees
   - 101 – 500 employees
   - 501 – 1000 employees
   - 1001 – 5000 employees
   - More than 5000 employees
5. What commodity do you predominantly deal in?
   - Chromium
   - Coal
   - Cobalt
   - Copper
   - Crude Oil
   - Diamonds
   - Gas
   - Gold
   - Ilmenite
   - Iron ore
   - Manganese
   - Palladium
   - Platinum
   - rare earth deposits
   - Rutile
   - Tantalum
   - Tin
   - Tungsten
   - Uranium

- Vanadium
- Vermiculite
- Zirconium

6. In general, do you consider your Supply Chain as vulnerable to incidences? *

	1	2	3	4	
Do not agree	◯	◯	◯	◯	Do Agree absolutely

7. In your opinion, to which extent do the following trends contribute to an increase in Supply Chain Risk?
   - **Globalisation of the supply chain**

	1	2	3	4	
Do not agree	◯	◯	◯	◯	Do Agree absolutely

   - **Changes in Government Policies**

	1	2	3	4	
Do not agree	◯	◯	◯	◯	Do Agree absolutely

   - **Technology Change**

	1	2	3	4	
Do not agree	◯	◯	◯	◯	Do Agree absolutely

   - **Focus on Sustainability**

	1	2	3	4	
Do not agree	◯	◯	◯	◯	Do Agree absolutely

   - **Reduction of suppliers**

	1	2	3	4	
Do not agree	◯	◯	◯	◯	Do Agree absolutely

- **Changes in consumer taste**

1 2 3 4

Do not agree ○ ○ ○ ○ Do Agree absolutely

- **Centralised production**

1 2 3 4

Do not agree ○ ○ ○ ○ Do Agree absolutely

- **Focus on efficiency**

1 2 3 4

Do not agree ○ ○ ○ ○ Do Agree absolutely

8. How do you estimate the probability of the following Supply Chain Risks in your company? *

	Very Low		High	Very High
1. Change in Government Policy	○	○	○	○
2. Poor Transport Infrastructure				
3. Change in commodity prices				
4. Supplier Failure				
5. Supplier Quality Problems				
6. Terrorist Attack				
7. Global Trade Wars .e.g China and US				
8. Workers' Strike				
9. Cyber Attacks				
10. IT system Failure				
11. Technological change				
12. Accident .e.g. Fire				

13.	Natural Disaster e.g. Cyclone, Drought
14.	Machine Breakdowns
15.	Import or Export restrictions
16.	Increasing customs duty
17.	Change in customer demand
18.	Increasing raw material prices

9. How do you estimate the Consequence of the following Supply Chain Risks in your company?

	Very Low		High	Very High
1.	Change in Government Policy			
2.	Poor Transport Infrastructure			
3.	Change in commodity prices			
4.	Supplier Failure			
5.	Supplier Quality Problems			
6.	Terrorist Attack			
7.	Global Trade Wars .e.g China and US			
8.	Workers' Strike			
9.	Cyber Attacks			
10.	IT system Failure			
11.	Technological change			
12.	Accident .e.g. Fire			
13.	Natural Disaster e.g. Cyclone, Drought			
14.	Machine Breakdowns			
15.	Import or Export restrictions			
16.	Increasing customs duty			
17.	Change in customer demand			
18.	Increasing raw material prices			

Thank you for completing the Survey.
Please feel free to copy and send this link :https://forms.gle/gtjG7F2rPXbNJEDTA to your supply chain acquaintances in the mining and energy sectors in Africa.
Thank you for your time.

Appendix B: Frequency Table

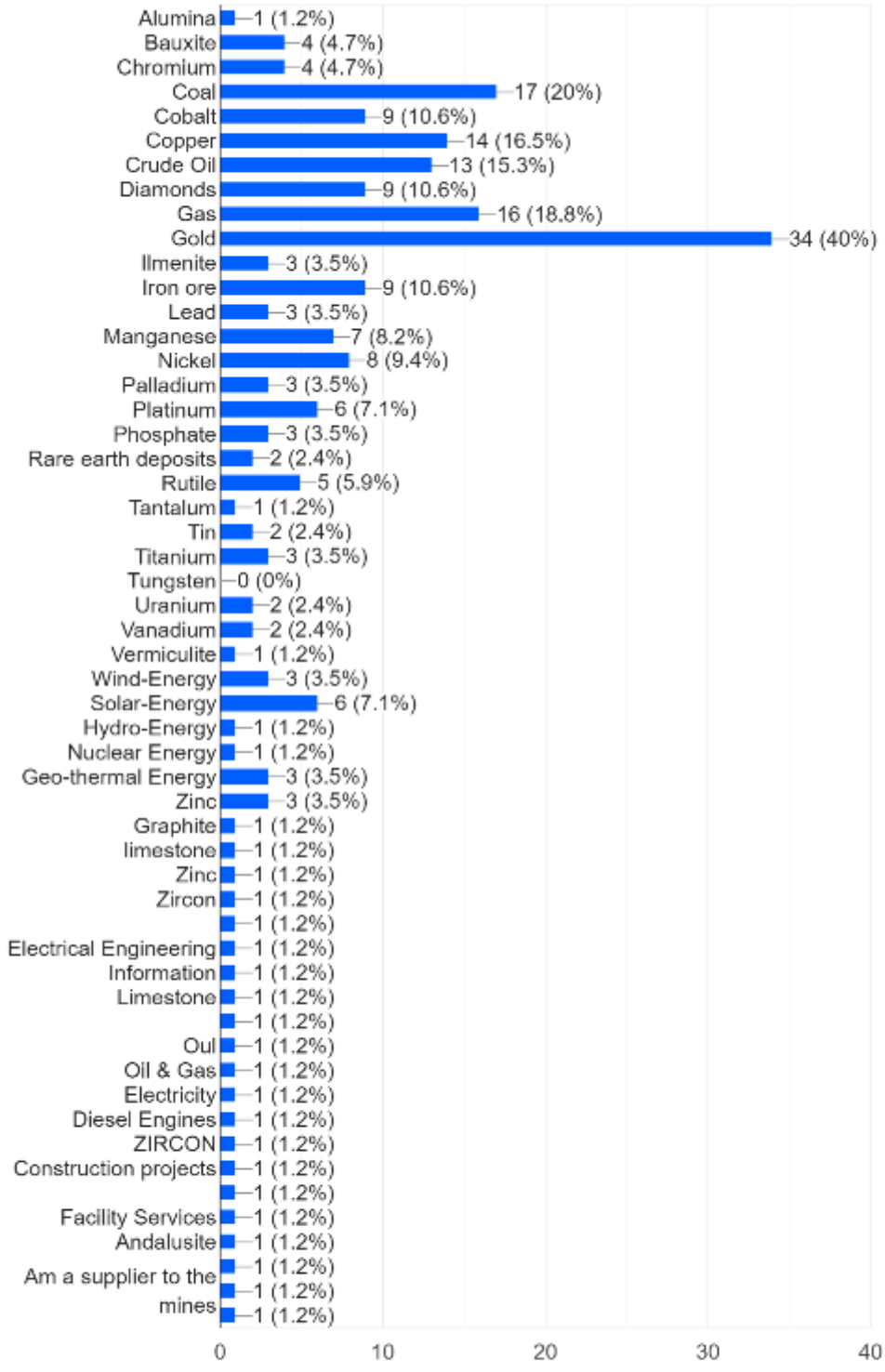
Statistics

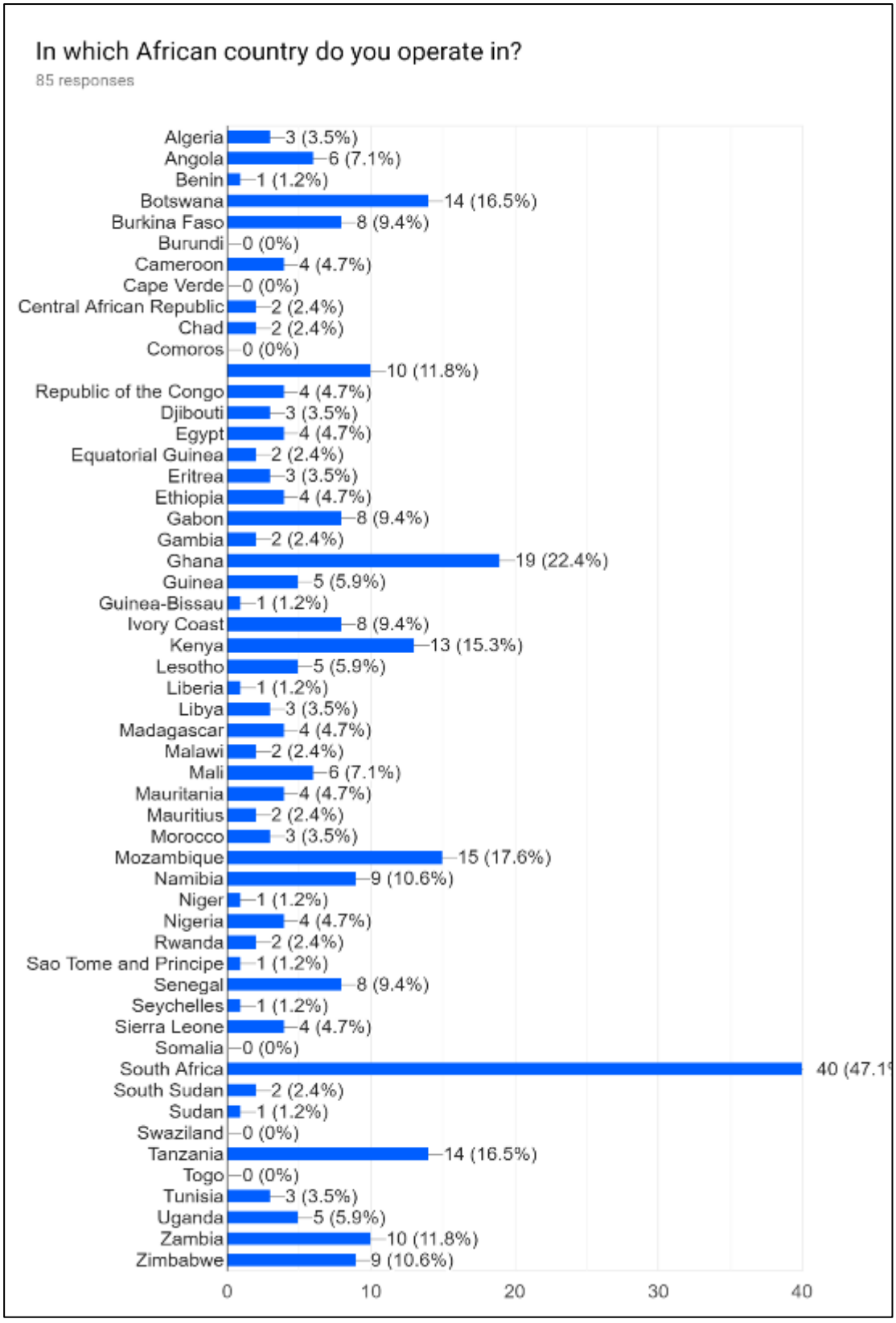
Participant ID

N	Valid	85
	Missing	0

What commodity do you deal in?

85 responses




In which African country do you operate in?
85 responses
Algeria 3 (3.5%)
Angola 6 (7.1%)
Benin 1 (1.2%)
Botswana 14 (16.5%)
Burkina Faso 8 (9.4%)
Burundi 0 (0%)
Cameroon 4 (4.7%)
Cape Verde 0 (0%)
Central African Republic 2 (2.4%)
Chad 2 (2.4%)
Comoros 0 (0%)
10 (11.8%)
Republic of the Congo 4 (4.7%)
Djibouti 3 (3.5%)
Egypt 4 (4.7%)
Equatorial Guinea 2 (2.4%)
Eritrea 3 (3.5%)
Ethiopia 4 (4.7%)
Gabon 8 (9.4%)
Gambia 2 (2.4%)
Ghana 19 (22.4%)
Guinea 5 (5.9%)
Guinea-Bissau 1 (1.2%)
Ivory Coast 8 (9.4%)
Kenya 13 (15.3%)
Lesotho 5 (5.9%)
Liberia 1 (1.2%)
Libya 3 (3.5%)
Madagascar 4 (4.7%)
Malawi 2 (2.4%)
Mali 6 (7.1%)
Mauritania 4 (4.7%)
Mauritius 2 (2.4%)
Morocco 3 (3.5%)
Mozambique 15 (17.6%)
Namibia 9 (10.6%)
Niger 1 (1.2%)
Nigeria 4 (4.7%)
Rwanda 2 (2.4%)
Sao Tome and Principe 1 (1.2%)
Senegal 8 (9.4%)
Seychelles 1 (1.2%)
Sierra Leone 4 (4.7%)
Somalia 0 (0%)
South Africa
40 (47.1
South Sudan 2 (2.4%)
Sudan 1 (1.2%)
Swaziland 0 (0%)
Tanzania 14 (16.5%)
Togo 0 (0%)
Tunisia 3 (3.5%)
Uganda 5 (5.9%)
Zambia 10 (11.8%)
Zimbabwe 9 (10.6%)
0
10
20
30
40

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	68	80.0	80.0	80.0
	Female	17	20.0	20.0	100.0
	Total	85	100.0	100.0	

Do you consider your Supply Chain as vulnerable to incidences

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Do not Agree	3	3.5	3.5	3.5
	Kind of Agree	11	12.9	12.9	16.5
	Agree	27	31.8	31.8	48.2
	Do Agree Absolutely	44	51.8	51.8	100.0
	Total	85	100.0	100.0	

To what extent does Globalisation of the supply chain contribute to an increase in Supply Chain Risk

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Do not Agree	14	16.5	16.5	16.5
	Kind of Agree	25	29.4	29.4	45.9
	Agree	25	29.4	29.4	75.3
	Do Agree Absolutely	21	24.7	24.7	100.0
	Total	85	100.0	100.0	

To what extent does Technology Change contribute to an increase in Supply Chain Risk

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Do not Agree	10	11.8	11.8	11.8
	Kind of Agree	19	22.4	22.4	34.1
	Agree	24	28.2	28.2	62.4
	Do Agree Absolutely	32	37.6	37.6	100.0
	Total	85	100.0	100.0	

To what extent does Changes in Government Policies contribute to an increase in Supply Chain Risk

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Do not Agree	3	3.5	3.5	3.5
	Kind of Agree	6	7.1	7.1	10.6
	Agree	19	22.4	22.4	32.9
	Do Agree Absolutely	57	67.1	67.1	100.0
	Total	85	100.0	100.0	

To what extent does Focus on sustainability contribute to an increase in Supply Chain Risk

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Do not Agree	7	8.2	8.2	8.2
	Kind of Agree	24	28.2	28.2	36.5
	Agree	33	38.8	38.8	75.3
	Do Agree Absolutely	21	24.7	24.7	100.0
	Total	85	100.0	100.0	

To what extent does Reduction of suppliers contribute to an increase in Supply Chain Risk

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Do not Agree	10	11.8	11.8	11.8
	Kind of Agree	26	30.6	30.6	42.4
	Agree	22	25.9	25.9	68.2
	Do Agree Absolutely	27	31.8	31.8	100.0
	Total	85	100.0	100.0	

To what extent does Changes in consumer taste contribute to an increase in Supply Chain Risk

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Do not Agree	10	11.8	11.8	11.8
	Kind of Agree	25	29.4	29.4	41.2
	Agree	31	36.5	36.5	77.6
	Do Agree Absolutely	19	22.4	22.4	100.0
	Total	85	100.0	100.0	

To what extent does Centralised production contribute to an increase in Supply Chain Risk

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Do not Agree	13	15.3	15.3	15.3
	Kind of Agree	30	35.3	35.3	50.6
	Agree	26	30.6	30.6	81.2
	Do Agree Absolutely	16	18.8	18.8	100.0
	Total	85	100.0	100.0	

To what extent does Focus on efficiency contribute to an increase in Supply Chain Risk

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Do not Agree	16	18.8	18.8	18.8
	Kind of Agree	20	23.5	23.5	42.4
	Agree	23	27.1	27.1	69.4
	Do Agree Absolutely	26	30.6	30.6	100.0
	Total	85	100.0	100.0	

Probability of Change in commodity prices

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	5	5.9	5.9	5.9
	Low	15	17.6	17.6	23.5
	High	38	44.7	44.7	68.2
	Very High	27	31.8	31.8	100.0
	Total	85	100.0	100.0	

Probability of Change in customer demand

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	10	11.8	11.8	11.8
	Low	25	29.4	29.4	41.2
	High	39	45.9	45.9	87.1
	Very High	11	12.9	12.9	100.0
	Total	85	100.0	100.0	

Probability of Increasing raw material prices

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	4	4.7	4.7	4.7
	Low	23	27.1	27.1	31.8
	High	43	50.6	50.6	82.4
	Very High	15	17.6	17.6	100.0
	Total	85	100.0	100.0	

Probability of Terrorist Attack

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	28	32.9	32.9	32.9
	Low	21	24.7	24.7	57.6
	High	16	18.8	18.8	76.5
	Very High	20	23.5	23.5	100.0
	Total	85	100.0	100.0	

Probability of Global Trade Wars .e.g China and US

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	7	8.2	8.2	8.2
	Low	24	28.2	28.2	36.5
	High	34	40.0	40.0	76.5
	Very High	20	23.5	23.5	100.0
	Total	85	100.0	100.0	

Probability of Natural Disaster e.g. Cyclone, Drought

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	15	17.6	17.6	17.6
	Low	36	42.4	42.4	60.0
	High	19	22.4	22.4	82.4
	Very High	15	17.6	17.6	100.0
	Total	85	100.0	100.0	

Probability of Change in Government Policy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	2	2.4	2.4	2.4
	Low	13	15.3	15.3	17.6
	High	39	45.9	45.9	63.5
	Very High	31	36.5	36.5	100.0
	Total	85	100.0	100.0	

Probability of Poor Transport Infrastructure

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	3	3.5	3.5	3.5
	Low	15	17.6	17.6	21.2
	High	36	42.4	42.4	63.5
	Very High	31	36.5	36.5	100.0
	Total	85	100.0	100.0	

Probability of Supplier Failure

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	4	4.7	4.7	4.7
	Low	25	29.4	29.4	34.1
	High	34	40.0	40.0	74.1
	Very High	22	25.9	25.9	100.0
	Total	85	100.0	100.0	

Probability of Supplier Quality Problems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	5	5.9	5.9	5.9
	Low	22	25.9	25.9	31.8
	High	39	45.9	45.9	77.6
	Very High	19	22.4	22.4	100.0
	Total	85	100.0	100.0	

Probability of Workers' Strike

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	11	12.9	12.9	12.9
	Low	25	29.4	29.4	42.4
	High	31	36.5	36.5	78.8
	Very High	18	21.2	21.2	100.0
	Total	85	100.0	100.0	

Probability of Accident .e.g. Fire

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	10	11.8	11.8	11.8
	Low	44	51.8	51.8	63.5
	High	16	18.8	18.8	82.4
	Very High	15	17.6	17.6	100.0
	Total	85	100.0	100.0	

Probability of Machine Breakdowns

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	5	5.9	5.9	5.9
	Low	29	34.1	34.1	40.0
	High	39	45.9	45.9	85.9
	Very High	12	14.1	14.1	100.0
	Total	85	100.0	100.0	

Probability of Import or Export restrictions

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	5	5.9	5.9	5.9
	Low	24	28.2	28.2	34.1
	High	28	32.9	32.9	67.1
	Very High	28	32.9	32.9	100.0
	Total	85	100.0	100.0	

Probability of Increasing customs duty

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	2	2.4	2.4	2.4
	Low	28	32.9	32.9	35.3
	High	27	31.8	31.8	67.1
	Very High	28	32.9	32.9	100.0
	Total	85	100.0	100.0	

Probability of Cyber Attacks

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	19	22.4	22.4	22.4
	Low	37	43.5	43.5	65.9
	High	23	27.1	27.1	92.9
	Very High	6	7.1	7.1	100.0
	Total	85	100.0	100.0	

Probability of IT system Failure

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	21	24.7	24.7	24.7
	Low	33	38.8	38.8	63.5
	High	18	21.2	21.2	84.7
	Very High	13	15.3	15.3	100.0
	Total	85	100.0	100.0	

Probability of Technological change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	10	11.8	11.8	11.8
	Low	36	42.4	42.4	54.1
	High	31	36.5	36.5	90.6
	Very High	8	9.4	9.4	100.0
	Total	85	100.0	100.0	

Consequence of Change in commodity prices

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	4	4.7	4.7	4.7
	Low	10	11.8	11.8	16.5
	High	40	47.1	47.1	63.5
	Very High	31	36.5	36.5	100.0
	Total	85	100.0	100.0	

Consequence of Change in customer demand

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	8	9.4	9.4	9.4
	Low	14	16.5	16.5	25.9
	High	44	51.8	51.8	77.6
	Very High	19	22.4	22.4	100.0
	Total	85	100.0	100.0	

Consequence of Increasing raw material prices

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	7	8.2	8.2	8.2
	Low	15	17.6	17.6	25.9
	High	46	54.1	54.1	80.0
	Very High	17	20.0	20.0	100.0
	Total	85	100.0	100.0	

Consequence of Terrorist Attack

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	15	17.6	17.6	17.6
	Low	24	28.2	28.2	45.9
	High	24	28.2	28.2	74.1
	Very High	22	25.9	25.9	100.0
	Total	85	100.0	100.0	

Consequence of Global Trade Wars .e.g China and US

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	8	9.4	9.4	9.4
	Low	23	27.1	27.1	36.5
	High	36	42.4	42.4	78.8
	Very High	18	21.2	21.2	100.0
	Total	85	100.0	100.0	

Consequence of Natural Disaster e.g. Cyclone, Drought

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	13	15.3	15.3	15.3
	Low	32	37.6	37.6	52.9
	High	24	28.2	28.2	81.2
	Very High	16	18.8	18.8	100.0
	Total	85	100.0	100.0	

Consequence of Change in Government Policy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	1	1.2	1.2	1.2
	Low	10	11.8	11.8	12.9
	High	39	45.9	45.9	58.8
	Very High	35	41.2	41.2	100.0
	Total	85	100.0	100.0	

Consequence of Poor Transport Infrastructure

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	4	4.7	4.7	4.7
	Low	14	16.5	16.5	21.2
	High	38	44.7	44.7	65.9
	Very High	29	34.1	34.1	100.0
	Total	85	100.0	100.0	

Consequence of Supplier Failure

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	6	7.1	7.1	7.1
	Low	17	20.0	20.0	27.1
	High	34	40.0	40.0	67.1
	Very High	28	32.9	32.9	100.0
	Total	85	100.0	100.0	

Consequence of Supplier Quality Problems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	5	5.9	5.9	5.9
	Low	18	21.2	21.2	27.1
	High	40	47.1	47.1	74.1
	Very High	22	25.9	25.9	100.0
	Total	85	100.0	100.0	

Consequence of Workers' Strike

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	6	7.1	7.1	7.1
	Low	18	21.2	21.2	28.2
	High	39	45.9	45.9	74.1
	Very High	22	25.9	25.9	100.0
	Total	85	100.0	100.0	

Consequence of Accident .e.g. Fire

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	8	9.4	9.4	9.4
	Low	29	34.1	34.1	43.5
	High	29	34.1	34.1	77.6
	Very High	19	22.4	22.4	100.0
	Total	85	100.0	100.0	

Consequence of Machine Breakdowns

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	7	8.2	8.2	8.2
	Low	24	28.2	28.2	36.5
	High	38	44.7	44.7	81.2
	Very High	16	18.8	18.8	100.0
	Total	85	100.0	100.0	

Consequence of Import or Export restrictions

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	5	5.9	5.9	5.9
	Low	18	21.2	21.2	27.1
	High	37	43.5	43.5	70.6
	Very High	25	29.4	29.4	100.0
	Total	85	100.0	100.0	

Consequence of Increasing customs duty

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	2	2.4	2.4	2.4
	Low	24	28.2	28.2	30.6
	High	32	37.6	37.6	68.2
	Very High	27	31.8	31.8	100.0
	Total	85	100.0	100.0	

Consequence of Cyber Attacks

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	18	21.2	21.2	21.2
	Low	25	29.4	29.4	50.6
	High	33	38.8	38.8	89.4
	Very High	9	10.6	10.6	100.0
	Total	85	100.0	100.0	

Consequence of IT system Failure

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	17	20.0	20.0	20.0
	Low	30	35.3	35.3	55.3
	High	26	30.6	30.6	85.9
	Very High	12	14.1	14.1	100.0
	Total	85	100.0	100.0	

Consequence of Technological change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Low	9	10.6	10.6	10.6
	Low	34	40.0	40.0	50.6
	High	30	35.3	35.3	85.9
	Very High	12	14.1	14.1	100.0
	Total	85	100.0	100.0	

Appendix C: Ethical Clearance

Gordon Institute of Business Science
University of Pretoria

20 August 2019

Kiambati Evelyne

Dear Evelyne

Please be advised that your application for Ethical Clearance has been approved.

You are therefore allowed to continue collecting your data.

Please note that approval is granted based on the methodology and research instruments provided in the application. If there is any deviation change or addition to the research method or tools, a supplementary application for approval must be obtained

We wish you everything of the best for the rest of the project.

Kind Regards

GIBS MBA Research Ethical Clearance Committee