Supply chain risks in a bulk import supply chain of commodity chemicals

by

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SUPPLY CHAIN RISKS IN A BULK IMPORT SUPPLY CHAIN OF COMMODITY CHEMICALS

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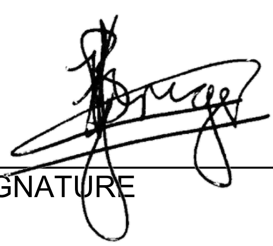

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EXECUTIVE SUMMARY

In modern day supply chains, it has become important for all role players to not only be aware of the risks associated with import supply chains in general, but more also specifically in the commodity trade. Due to the nature and small margins in the commodity trade industry it is crucial for the relevant role players to not only take note of these risks, but to also develop strategies and techniques to mitigate and /or reduce these risks when possible. In the ever-changing world where demand fluctuates, and the only constant is change, it requires a supply chain that can adapt to external forces with techniques and strategies that are suitable at that time. In order to understand risks and how to manage them better, this dissertation will focus on the key risks involved in the bulk import supply chain of soda ash, which is used in the manufacturing of many products, including well-known consumer products.

The study investigated various risks, supply chain risk management, and strategies to manage these risks in a proactive and reactive way through collaboration, agility, robustness, stability and flexibility. This study also tries to indicate the role and importance of collaboration, integration and supply chain resilience. A quantitative research design was used to gather the data, which included a questionnaire with close-ended questions with scales from which respondents had to select the options with which they mostly agreed. The major risks identified in the study are pandemics (COVID-19), port delays, logistics outsourcing, labour strikes and infrastructure deterioration. The top five risk mitigation strategies employed are flexible transport, collaboration with suppliers/customers, resilient supply chain, works toward integration with suppliers/customers and robust supply chain.

Keywords: Supply chain, Risk, Risk management, Supply chain risk management, Quantitative research, Bulk soda ash, Soda ash import, Collaboration, Agility, Robustness, Stability, Flexibility, Integration, Resilience, Risk mitigation strategy

BEKNOPTE OORSIG

In hedendaagse voorsieningskettings het dit belangrik geword vir alle rolspelers om nie net bewus te wees van die risiko's wat oor die algemeen met invoervoorsieningskettings gepaardgaan nie, maar ook spesifiek in die kommoditeitshandel. Vanweë die aard van dié bedryf en die klein marges in kommoditeitshandel, is dit noodsaaklik dat die relevante rolspelers van hierdie risiko's moet kennis dra, en strategieë en tegnieke moet ontwikkel om die risiko's te temper en/of te verminder waar moontlik. In die voortdurend veranderende wêreld waar aanvraag wissel en waar verandering die enigste konstante is, moet 'n voorsieningsketting in staat wees om by eksterne kragte te kan aanpas – met tegnieke en strategieë wat op daardie tydstip geskik is. Om risiko's te verstaan en beter te kan bestuur, sal hierdie verhandeling fokus op die sleutelrisiko's wat ter sake is in die grootmaat-invoervoorsieningsketting van soda-as, wat gebruik word in die vervaardiging van vele produkte, waaronder bekende verbruikersprodukte.

Die studie het ondersoek ingestel na verskillende risiko's, voorsieningskettingrisikobestuur, en strategieë om hierdie risiko's proaktief en reaktief te bestuur, deur samewerking, lenigheid, robuustheid, stabiliteit en soepelheid. Daar is ook gepoog om die rol en belangrikheid van samewerking, integrering en voorsieningskettingveerkrag aan te dui. 'n Kwantitatiewe navorsingsontwerp is gebruik om die data in te samel, insluitende 'n vraelys met geslote vrae en skale waar respondente dié opsies moes kies waarmee hulle die meeste saamstem. Die vernaamste risiko's wat in hierdie studie geïdentifiseer is, is pandemies (soos COVID-19), oponthoude by hawens, logistieke uitkontraktering, werkstakings, en vervalle infrastruktuur. Die topvyf-risikotemperingstrategieë wat ingespan word is buigsaamheid ten opsigte van vervoer, samewerking met verskaffers en/of klante, veerkragtige voorsieningsketting, gerigtheid op integrering met verskaffers en/of klante, en 'n kragtige voorsieningsketting.

Sleutelwoorde: Voorsieningsketting, Risiko, Risikobestuur, Voorsieningskettingrisikobestuur, Kwantitatiewe navorsing, Grootmaat-soda-as, Soda-as-invoere, Samewerking, Lenigheid, Robuustheid, Stabiliteit, Buigsaamheid, Integrasie, Veerkrag, Risikotemperingstrategie

ISIFINYEZO ESIPHEZULU

Uchungechunge lokuhlinzeka ezinsuku zanamuhla, sekubalulekile kubo bonke ababambiqhaza ukuthi bangagcini nje ngokuqaphela ubungozi obuhambisana okulethwa kochungechunge lokuhlinzeka kwempahla kwamanye amazwe ngokujwayelekile, kodwa futhi, ikakhulukazi, ekuhwebeni kwempahla. Ngenxa yesimo kanye nemikhawulo emincane embonini yohwebo lwempahla, kubalulekile ukuthi ababambiqhaza abathintekayo bangagcini nje ngokuqaphela lezi zingozi, kodwa futhi bakhe amasu nezindlela zokunciphisa kanye/noma zokwehlisa lezi zingozi uma kungenzeka. Emhlabeni oguquguqukayo lapho isidingo sishintshashintsha, futhi okuwukuphela kwenguquko engaguquki, kudinga uchungechunge lokuhlinzeka olungakwazi ukuzivumelanisa namandla angaphandle ngamasu nezindlela ezifanele ngaleso sikhathi. Ukuze kuqondwe ubungozi kanye nendlela yokuphatha kangcono, le ncwadi izogxila ezingozini ezibalulekile ezikhona ochungechungeni lokuhlinzekwa kwenqwaba yesoda kwamanye amazwe, olusetshenziswa ekukhiqizeni imikhiqizo eminingi, kuhlanganisa nemikhiqizo yabathengi eyaziwayo.

Ucwaningo luphenye ubungozi obuhlukahlukene, ukuphathwa kwengcuphe yochungechunge lokuhlinzeka, kanye namasu okulawula lobu bungozi ngendlela esheshayo nesebenzayo ngokusebenzisana, ukushesha, ukuqina, ukuzinza nokuvumelana nezimo. Lolu cwaningo luphinde luzame ukukhombisa indima kanye nokubaluleka kokubambisana, ukuhlanganiswa kanye nokuqina kochungechunge lokuhlinzeka. Kusetshenziswe idizayini yocwaningo lokulinganisa ukuze kuqoqwe idatha, ehlanganisa nohlu lwemibuzo olunemibuzo evalekile enezilinganiso lapho abaphendulayo bekufanele bakhethe khona abavumelana ngazo kakhulu. Izingozi ezinkulu eziphawulwe ocwaningweni yizifo eziyiphandemikhi (ezifana ne-COVID-19), ukubambezeleka kwechweba, ukukhishwa kwemisebenzi yezokuthutha, iziteleka zabasebenzi kanye nokuwohloka kwengqalasizinda. Amasu amahlanu aphezulu okunciphisa ubungozi asetshenziswayo kwezokuthutha ezivumelana nezimo, ukusebenzisana nabahlinzeki kanye/noma amakhasimende, uchungechunge lokuhlinzeka kwempahla eqinile, lusebenzela ukuhlanganiswa nabahlinzeki kanye/noma amakhasimende, kanye nochungechunge oluqinile lokuhlinzeka ngezinto.

Amagama abalulekile: Uchungechunge lokuhlinzeka, Ubungozi, Ukuphathwa kobungozi, Ubungozi bochungechunge lokuhlinzeka, Ucwaningo lwezibalo, Bulk ingwaba yesoda, ukungeniswa kwengwaba yesoda, Ukusebenzisana, Ukushesha, Ukuqina, Ukuzinza, Ukuvumelana nezimo, Ukuhlanganisa, Ukuqina, Isu lokunciphisa ubungozi

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LIST OF ABBREVIATIONS

Abbreviation	Description
3PL	Third party logistics providers
4PL	Fourth party logistics providers
AC	Accept the risk
AHP	Analytic hierarchy process
AV	Avoid the risk
BCP	Business continuity plans
BSR	Buyer-supplier relationship
CRM	Customer relationship management
CS	Customer services
CSM	Customer service management
CV	Criterion variable
DM	Demand management
DRR	Disaster risk reduction
DV	Dependent variable
E2E	End-to-end
EA	Effect analysis
EFA	Explorative factor analysis
ERP	Enterprise resource planning
EV	Extraneous variable
FMCG	Fast-moving consumer goods
GDP	Gross Domestic Product
IG	Ignore the risk
IT	Information technology (IT),
IV	Independent variable
IVV	Intervening variable
JIT	Just-In-Time
KMO	Kaiser-Meyer Olkin Measure
Me	Mean
MFM	Manufacturing flow management
MRP	Material requirements planning
MRPII	Manufacturing resource planning
MRQ	Main research question
MV	Moderating variable
MVP	Minimum viable product
Na_2CO_3	Sodium Carbonate
NDP	National Development Plan
NPA	National Ports Authority
OEM	Original Equipment Manufacturer
OF	Order fulfilment
PC	Personal computer
PDC	Product development and commercialisation
PSCD	Port-related supply chain disruptions
RE	Reduce the risk
RFID	Radio-frequency identification
RM	Returns management
ROI	Return on investment
RV	Result variable

S&OP	Sales and operations planning
SAPO	South African Port Operations
SC	Supply chain
SCM	Supply chain management
SCOR	Supply chain operations reference
SCR	Supply chain risk
SCRAM	Supply chain resilience assessment and management
SCRES	Supply chain resilience
SCRM	Supply chain risk management
SDG	Sustainable development goals
SRM	Supplier relationship management
SRQ	Secondary research question
TQM	Total quality management
TR	Transfer the risk
USA	United States of America
VMI	Vendor managed inventory

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CHAPTER 1: INTRODUCTION AND BACKGROUND TO THE STUDY

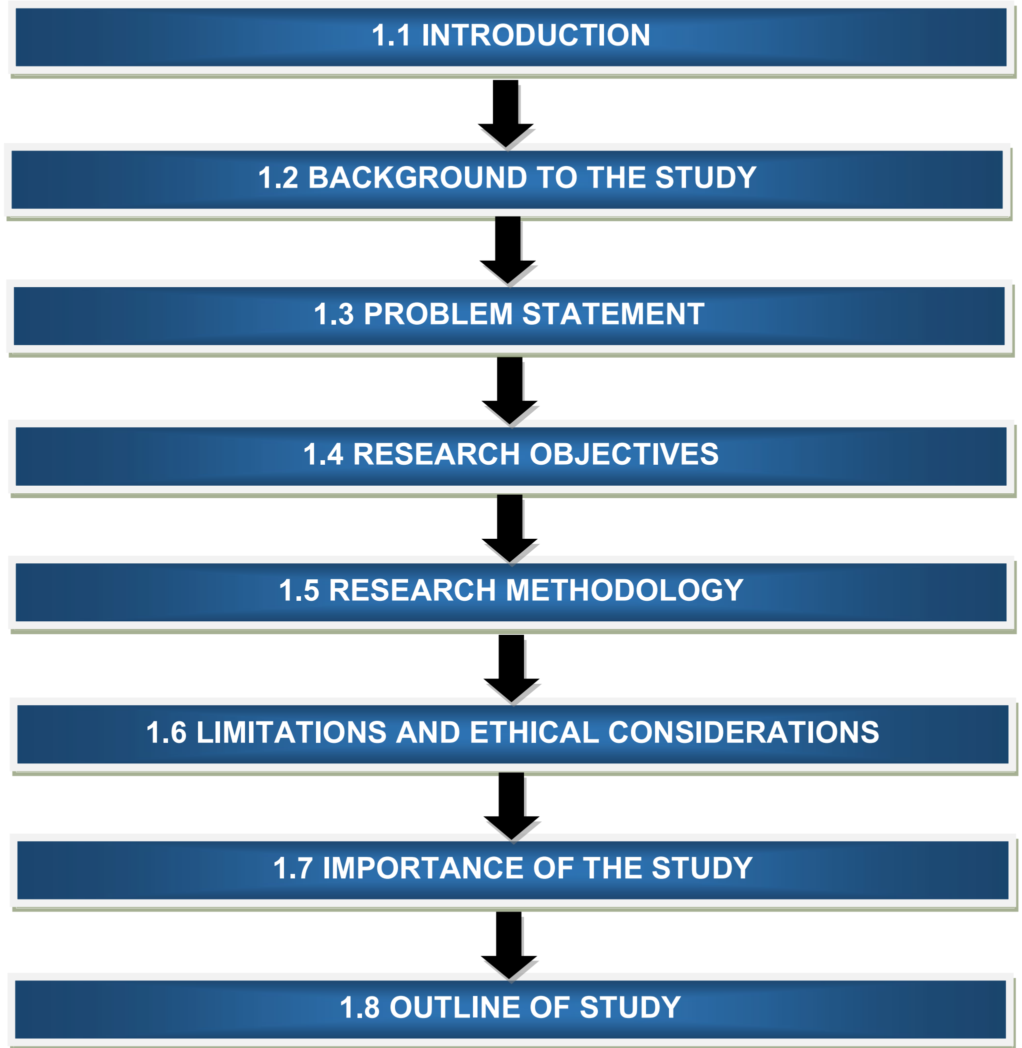

Figure 1.1: Flow diagram of Chapter 1.

Source: Compiled by researcher

1.1 Introduction

Over the years supply chain risks have increasingly attracted academic and corporate interest, mainly due to organisations having to operate in a turbulent business environment (Bak, 2018:2). Organisations are forced to deal with several uncontrollable risks, originating from fast technological progresses, unstable customer behaviour, changing business models, and intensified regulatory pressure (Slagmulder & Devoldere, 2018:733). More often, risks are characterised by high rapidity, complication, uncertainty and volatility (Munyanyi & Chimwai, 2019:54).

A supply chain, as defined by Tazehzadeh (2014:2), is a “network of parties, or organizations connected to each other, through linkages of upstream and downstream, and are involved in various activities, producing services and products and delivering them to the ultimate customers.” The ultimate purpose of a supply chain is to create value by empowering compatibility between internal and external processes and reducing overall cost in the supply chain (Feng, He, Zhu & Amin, 2017:3). Meanwhile global supply chains, where organisations continuously try to expand their boundaries by seeking inexpensive manufacturing sites, need to be well informed about possible risks that can disrupt the supply chain. Organisations need to consider possible risk management strategies to mitigate these risks, which could lead to disruptions if not managed (Tazehzadeh, 2014:2; Shahbaz, Rasi & Ahmad, 2019:202). A supply chain disruption is an unplanned and / or unanticipated event that ends up disrupting the normal flow of goods and materials within the supply chain network. Risk management, therefore, is concerned with the strategies involved to manage potential risks, in order to reduce their occurrence probability and impact before they become disruptions. Risk management broadly involves the identification, analyses and response to risks, in an organization (Shahbaz, Rasi & Ahmad, 2019:203).

There are innumerable risks in supply chains, of which some will be discussed later. One significant risk, as listed by the sustainable development goals (SDG) and the National Development Plan (NDP 2030), is transportation risks. A well-functioning transportation system and infrastructure is crucial to ensure the growth and development of a country, like South Africa (Chakwizira, 2019:2). To achieve this, South Africa has established a disaster risk reduction (DRR) plan. Disaster risk reduction can be defined as: “The systematic development and application of policies, strategies and practices to minimise vulnerabilities and disaster risks throughout a society, to avoid (prevent) or to limit (mitigate and prepare) adverse impacts of hazards, within the broader context of sustainable development” (UNISDR, 2009). An efficient transportation network is heavily dependent on investment and quality infrastructure to promote and enhance GDP growth and development. South Africa, however, has missed the opportunity for decades to invest in almost all areas of transport, including roads, rail, and seaports (Chakwizira, 2019:3). This inaction or lack of investment in transportation infrastructure could lead to a catastrophic disruption in the future if this risk is not managed. Lack of investment could lead to deteriorating infrastructure, which will influence the supply chain by reducing, slowing or completely stopping the flow of goods, also so in the bulk commodities industry being investigated in this research.

It is against this backdrop and introduction that this research focused on supply chain risks in the bulk import supply chain of commodity chemicals.

1.2 Background to the Study

According to Kırılmaz and Erol (2017:1), global chains are a big provider of the so-called "competitive advantage". This competitive advantage is mainly obtained by accessing low-cost labour together with a combination of the following factors: low-cost raw materials, extended financing terms, larger and more diversified markets, and additional incentives offered by the exporting countries to attract foreign capital (Manuj & Mentzer, 2008:192; Awad, 2010:1). Global supply chains have brought about increased international trade. The reliance on suppliers, which are sometimes geographically separated from the buyers, has increased. This geographical separation has opened the door to increased risks, which if left unmanaged, will turn into supply chain disruptions. Global supply chains are vulnerable to risks and disruptions, as was evident during recent crises like earthquakes, volcanic eruptions, hurricanes, and sabotage experienced in various parts of the world (Bak, 2018:2). In studies done by McKinsey (2010:26) as well as Butner (2010:23) it was found that only 69 percent of organisations have supply chain risk management (SCRM) monitoring programs in place, despite supply chain risk (SCR) being listed as one of the biggest challenges for executives in these studies. These studies clearly indicate that although risks in the supply chain (SC) are acknowledged by executives, a considerable portion of organisations have not acted, and are therefore exposed to these SC risks and disruptions.

Supply chain risk (SCR) is associated with vulnerability, disruption, uncertainty, and to a certain extent, supply chain security (Bak, 2018:2). Due to the complexities experienced in the supply chain environment, especially during activities such as exports and imports, as a result of the number of supply chain stakeholders, these supply chains tend to inherently experience more vulnerabilities and uncertainty. Both vulnerability and uncertainty increase risk in the supply chain. Supply chains can never be 100 percent free from risks, but if a clear understanding surrounding the dynamics are known and identified, it will go a long way to mitigating these risks. Before the risks can be mitigated one needs to complete a risk assessment to identify the risks. Risk assessment is a crucial part of the SCRM process, which will be discussed later in Chapter 3.

1.2.1 Focus of the study

This study investigated supply chain risks in an import supply chain of bulk commodity chemicals. The *first aspect* of this research, *risks* of import supply chains, is in stark contrast to the numerous benefits associated with global supply chains. Manuj and Mentzer (2008:199) mentioned the risks involved in global supply chains, and the remedial strategies for these risks. There is ample evidence of previous research on the associated risks and uncertainties of *global supply chains*, but little research can be found that combines the bulk import risks related to the South African environment.

In their research, Manuj and Mentzer (2008:197) and Shahbaz *et al.* (2019:205), makes mention of four broad categories of risks relevant to this research study, although various other categorisations exist, that will be discussed later (Christopher & Peck, 2004:2; Urciuoli & Hintsa, 2018:196; Ganguly & Kumar, 2019:4). According to Manuj and Mentzer (2008:197), supply chain risks are categorised into four main groups: supply, demand, operational, and security. *Supply risks* can be defined as the unplanned negative events that occur during the inbound supply chain, which has a negative impact on the quantity and quality of customer service. *Demand risks*, similarly, to supply risk, are those negative events that occur during the outbound supply chain leading to reduced overall customer experience. *Operational risk* concerns itself with the adverse events that occur within a firm that affects the production of goods and/or services, ultimately leading to reduced customer service. *Security risks,* environmental risks and corporate risks are those risks associated with the adverse events that threaten human resources, information systems, and operations integrity, which could lead to freight breaches, forcefully stolen data, crime, sabotage and environmental disasters (Manuj & Mentzer, 2008:198). All previously discussed risks i.e., supply, demand, operational, and security risks were explored in this research amongst others.

As previously indicated, there are many risks involved in international supply chains. Various researchers and authors indicate the following events as risks in the international supply chain: currency changes, in-transit time variability, absolute forecasts fluctuations, poor quality, bad safety records, unforeseen business disruption, inventory ownership, culture differences, supplier/customer dependency and opportunism, oil price fluctuation, and risk events affecting suppliers and customers (Zsidisin & Ellram, 2003:16; Chopra & Sodhi, 2004:55; Spekman & Davis, 2004:415; Manuj & Mentzer, 2008;199; Xie, Anumba, Lee, Tummala & Schoenherr, 2011:477; Bak, 2018:3; Urciuoli & Hintsa, 2018:203; Ganguly & Kumar, 2019:4).

This study focused specifically on *supply chain risk management*. Supply chain risk management (SCRM) is a relatively new field of research and originated from the mixture of supply chain management research and risk management research (Tazehzadeh 2014:2; Shahbaz *et al.,* 2019:203). Supply chain management, in a broad sense, focuses on the relationships between all stakeholders in the chain, while risk management focuses on the identification and evaluation of risks and their consequential effects and losses. The area between risk management and supply chain management is known as supply chain risk management, as can be seen in figure 1.2 below (Shahbaz, Bin & Rehman, 2017:9234; Shahbaz *et al.*, 2019:203).

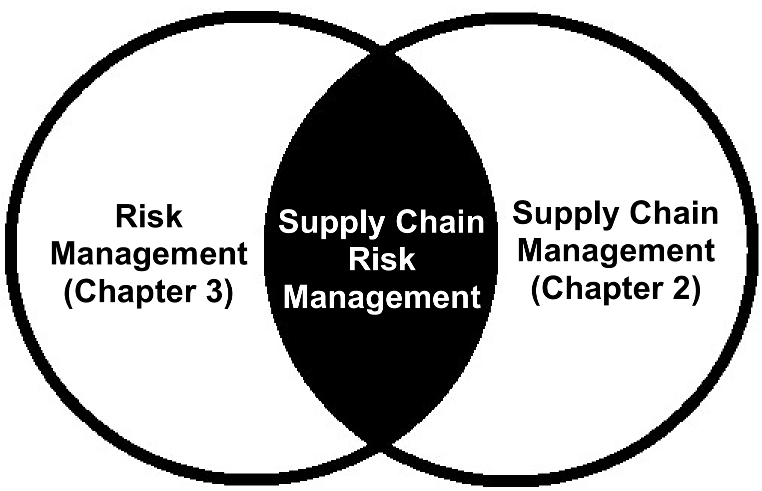

Figure 1.2: Supply chain risk management.

Source: Adopted from Shahbaz, Rasi and Ahmad (2019:203)

Besides risks and supply chain risk management, this research study focused on the *bulk commodity operations* in an import supply chain. This study focused specifically on the *bulk commodity import* of Sodium Carbonate (Na_2CO_3), or better known as *soda ash.* Soda ash is a commodity commonly used in a wide variety of applications in various industries. Some of the major consumers of soda ash include glass manufacturers, detergent manufacturers and chemicals distributors (Marcu, Stoefs, Belis & Tuokko, 2015:1). In the glass sector, soda ash is mainly used for temperature control, whereby it reduces the melting temperature of the glass, thereby reducing the energy consumption with up to 10%, while decreasing the emissions. In the glass sector, soda ash makes up 20% of the volume of glass products and contributes 13% of the glass production costs (Marcu *et al.*, 2015:1). In the detergent sector, soda ash is used in washing powders and soaps, and is also used as a water softener and remover of grease. Further possible uses in the chemical industry include the production of sodium bicarbonate, also known as baking powder (Marcu *et al.,* 2015:2).

Hugo and Badenhorst-Weiss (2011:76) make it clear that the movement of materials through the supply chain is the core of any supply chain. This movement of materials creates the competitive advantage by providing customer service that exceeds that of its competitors (Naude, 2013:409). Often, manufacturers of soda ash are geographically removed from their primary buying markets. This means that soda ash is manufactured in areas such as Turkey, and buyers from regions such as Africa and South-East Asia need to *import* the soda ash.

Another focus of this research study was the *unique operating conditions* of Africa and South Africa. Normally, bulk commodities would be transported over long distances by railway line, but this is not the case in South Africa, as bulk tankers (road transport) are used, which is expensive (Kotikash, 2012:26). Soda ash is imported from India and Turkey, and is, for the most part, shipped to SA by maritime transport. Port congestion at South African ports contribute significantly to the complexities and risks associated with bulk operations (Tunali & Ertunc, 2017:70). Port congestion leads to ship demurrages, which ultimately affects the price of the commodity negatively (Kotikash, 2012:27). The port risks investigated in this study include all the seaports in South Africa (Dyer, 2014:8). South Africa's busiest seaports, besides congestion, present various risks which must be overcome if a supply chain is to provide the competitive advantage that is required to offer excellent customer service. It is common knowledge that South African seaports suffer as a result of issues such as, inferior infrastructure, very little port investments, older and outdated technologies and machinery, port space constraints, variable and high port costs, and skills shortages (Gumede & Chasomeris, 2012:34; Chasomeris, 2015:2).

In addition to the above specific focus areas, this study also focused on specific *risk impacts*. Different risks have low or high impacts on the supply chain. 'Low-impact risks' of supply chains include supply risks, demand risks, operations risks and security risks (Manuj & Mentzer, 2008:193), while 'high-impact or rare-but-severe impact risks', also known as catastrophic risks, including acts of God, civil unrest, economic disruptions and terrorist attacks (Tang & Tomlin, 2009:156). From a different perspective, the impact of "normal" low-impact risks is also described as "delays", while the impact of "abnormal" high-impact risks is described as "disruptions" (Wagner & Bode, 2006:302; Gaonkar & Viswanadham, 2007:266; Olson & Wu, 2010:15; Sodhi & Tang, 2012:23; Truong Quang & Hara, 2018:1370). This research study focused on both low-impact and high-impact risks. Further to this, the research focused on the risks of *bulk commodity* chemicals imported specifically at the ports of South Africa (Dyer, 2014:1).

In Figure 1.3 below, the bulk supply chain is illustrated, from point of origin to destination, which consists of various stakeholders. These stakeholders include suppliers, land transportation at origin side, ports at origin side, ocean transport (maritime), ports at destination side, land transport at destination side and customers. Each of these stakeholders has various other stakeholders as supporting functions in the supply chain. Suppliers have manufacturing plants, transport, and warehousing facilities to support the export of their goods, while land transportation has various modes of transport, including road and train cartage. These transportation services are mostly conducted by 3PLs (third party logistics providers). Ports, on the other hand, include activities and authorities like stevedores, customs agents, clearing and forwarding agents, port transportation and warehousing (Foolchand, 2006:2; Botha, 2016:42; Tunali & Ertunc, 2017:70).

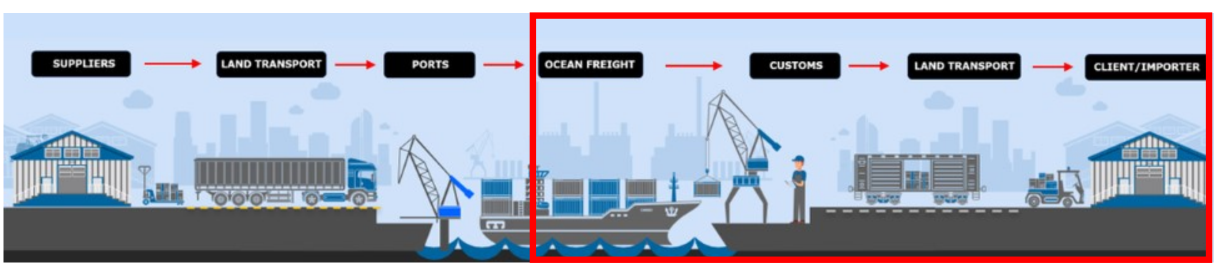

Figure 1.3: Supply chain stakeholders in bulk operations.

Source: www.jlktrade.com

This research mainly focused on the *import section* (i.e. South African side) of the supply chain. This means all stakeholders, from ocean freight to end customers (as can be seen in the red highlighted square in figure 1.2), were considered in this research. This includes ocean freight stakeholders, ports stakeholders and customs, clearing and forwarding stakeholders, land transportation stakeholders, importers and customers.

1.3 Problem Statement

Research done by Fan and Stevenson (2018:6) indicated a growth in annual publications and research done on Supply Chain Risk Management (SCRM) since 2000. It is clear from this research that SCRM is an area of importance, with a lot more attention due to the volatility, constant change and associated risks faced in supply chains worldwide.

It is clear from the preceding discussion that the bulk import and export supply chains have inherent risks, such as, inefficiencies, delays and infrastructure challenges. Previous research had been conducted on the bulk commodity *exports* in South Africa, such as bulk coal export in which the associated risks became clear (Foolchand, 2006:2; Ganesan, Rosentrater & Muthukumarappan, 2008:426; Viljoen, 2012:19; Botha, 2016:34). Little to no research could be found on bulk import, particularly the bulk import of soda ash and its associated supply chain risks in the South African context. Soda ash is an important source of, or input to economic activities in South Africa and it makes sense to investigate supply inefficiencies or risks that may cause a ripple effect throughout supply chains that use soda ash.

As indicated above, ample research has been done on supply chain risk management, and some research was done in general bulk supply chain operations in various geographical areas like Nigeria, Tanzania and Kenya (Kadigi, Mwathe, Dutton, Kashaigili & Kilima, 2014:37; Gidado, 2015:161). No research could be found that combined all the focus areas indicated in the previous paragraphs into one research study.

The problem statement of this study could thus be formulated in the following **main research question (MRQ)**:

MRQ*: What are the risks experienced by a bulk soda ash import supply chain and how are these risks managed?*

The **secondary research questions (SRQ)** can be formulated as follows:

***SRQ1**: What are the bulk supply chain and bulk soda ash import supply chain operating conditions in South Africa?*

***SRQ2**: What are the risk mitigation strategies in the bulk import supply chain of soda ash?*

***SRQ3**: What is the relationship between the different risk factors and the mitigation strategies in the soda ash industry?*

1.4 Research Objectives

1.4.1 Primary research objective

The primary research objective is to identify and describe the supply chain risks in a bulk soda ash powder import supply chain and to determine how these risks are managed.

1.4.2 Secondary research objectives

The secondary research objectives are as follows:

- **a)** To explore and describe bulk supply chains and bulk commodity operations and operating conditions in South Africa, by means of a literature study.
- **b)** To explore and describe risks, risk management and mitigation strategies in commodity supply chains, by means of a literature study.
- **c)** To identify and explore the supply chain risks in the soda ash supply chain in South Africa, by means of an empirical (survey) study.
- **d)** To identify and describe the risk management and mitigating practices used in a bulk soda ash import supply chain, by means of an empirical (survey) study.
- **e)** To determine the relationships between the different risk factors and mitigation strategies with the aid of inferential statistics.

1.5 Research Methodology

The research design can be regarded as the outline or blueprint for solving and answering the research problem and objectives. In order to answer the research questions, the study consisted of two phases; namely, 1) the literature study; and 2) empirical research.

1.5.1 Phase I: Literature study

The first phase of this research consisted of a comprehensive review of the relevant body of literature pertaining to this research study. The sources used in the literature review consisted mainly of secondary data in textbooks and accredited journals found in research databases such as ScienceDirect and Google Scholar. The findings of these literature studies are discussed and highlighted in Chapter 2 and Chapter 3 dealing with supply chain and risk management concepts respectively.

1.5.2 Phase II: Empirical research

Phase two of the study consisted of the empirical study. In order to address the objectives of this research a quantitative research approach was selected and followed. According to Da Mota Pedrosa, Näslund and Jasmand (2012:276) research in the field of supply chain and logistics traditionally favoured quantitative research. In line with this trend in logistics research, a quantitative research study was conducted. After the completion of the literature study, the researcher formulated questions relevant to the research topic in order to support the empirical study. A questionnaire was developed for distribution to the sample population by means of a web survey and e-mail. The target population consisted of the different stakeholders (organisations) in a soda ash import supply chain, including chemical distributors, stevedores, port operators and logistics companies. The study firstly aimed to explore the risks of bulk import supply chains, and secondly to describe these risks and mitigating strategies using descriptive and inferential statistics. This technique was chosen by the researcher because questionnaires can be self-administered and respondents from a wide geographical area can participate in the research (Van Zyl *et al*., 2014:148). Further, during 2020 when the COVID-19 pandemic arrived, it made sense to have the respondents conduct self-administered questionnaires online due to lockdown regulations and to avoid risk of spreading infections. The research methodology will be discussed in detail in Chapter 4.

1.6 Limitations and Ethical Considerations

1.6.1 Limitations of the study

Since the research was quantitative in nature, and nonprobability sampling was used, the study has inherent *limitations*. The findings, conclusions, and remedies of this study cannot be generalised to all bulk commodity chemical import supply chains, but rather to the specific bulk soda ash powder imports in South Africa. Another limitation is the narrow scope of investigation. This study did not investigate the risks of the entire supply chain, from mining the raw soda ash until final consumption. Risks in the other parts of the total supply chain before importation to South Africa were omitted; however, they do have an impact on the entire import supply chain.

1.6.2 Ethical considerations

The research was conducted in line with the following principles: Prior to the survey, permission was sought from all stakeholder organisations in the supply chain, to conduct the study in their organisations. Regarding the individual respondents, the researcher explained the purpose of the research by means of a covering letter (Van Zyl *et al.,* 2014:151) and requested their participation. The questionnaire made provision for consent to participate (Van Zyl *et al*., 2014:86). In the consent part of the questionnaire, respondents were notified that their participation was voluntary, and they could withdraw from the survey at any time, if they wished to do so.

The conclusions, remedies, or findings of the completed research were shared with those participating respondents who indicated that they wished to have access to it, by providing them with an abbreviated research report (Eysenbach & Till, 2001:1104; Bloomberg & Volpe, 2008:73).

Further ethical aspects that the researcher adhered to during the research included (De Vos, Strydom, Fouché & Delport, 2011:86):

1. Avoidance of harm to respondents.
2. Informed consent from the respondents.
3. Refraining from deceiving the respondents.
4. Refraining from violating the respondents' privacy.

The researcher applied for ethical clearance from the College of Economic and Management Sciences (Unisa).

1.7 Importance of the Study

Considering the substantial financial impact that supply chain risks may have on the bulk commodity industry, this study will add considerable value for supply chain and logistics operators to gain a better understanding of the risk and cost associated with this bulk import supply chain. Limited research has been conducted into the bulk commodity import risks and mitigating strategies. This study will give supply chain managers a clear indication of most of the risks involved and also the associated mitigation options or strategies in bulk chemical import chains. The conclusion can be made that this study makes a valuable contribution to the existing body of knowledge concerning the risks involved, and possible mitigation options in the import of bulk commodity chemicals in the South African environment. In addition, this study provides a perspective that may be of interest to logisticians, supply chain practitioners, and other researchers.

1.8 Outline of Study

In this section an outline of the dissertation is provided.

The following chapters are included in the dissertation:

- **Chapter 1: Introduction and background to study –** A holistic overview of the topic and some background information are provided in this chapter. The chapter also outlines the focus of the study and identifies the problem statement from which the research objectives were identified. The research objectives include a primary objective and various secondary objectives. A brief discussion of the research method and key concepts of this dissertation are included in this chapter. Furthermore, this chapter includes discussions on ethical issues and the limitations to the study.
- **Chapter 2: Literature review – Supply chain –** This chapter mainly covers the current body of supply chain management literature. Key topic variables are defined and discussed. Specific topics that are covered in this chapter include the concepts of supply chain, supply chain management, supply chain framework, and the bulk commodity supply chain.
- **Chapter 3: Literature review – Risk management –** This chapter mainly covers the current body of risk management literature. Key topic variables and their relationships are defined and discussed in the chapter. The specific focus is on risks associated with import supply chains, risk mitigation strategies, risks associated with the bulk powder import, and port related risks.

- **Chapter 4: Research methodology –** This chapter outlines the research methods and strategy that was followed in the study. In addition, various aspects, including sampling and population, data collection, research instruments, and data analysis, are discussed.
- **Chapter 5: Analysis of data and discussion of results –** In this chapter the results of the research are presented. Various graphs and tables visually present the results. In addition, descriptive statistics are used to describe and discuss the results.
- **Chapter 6: Conclusion and recommendations –** This chapter summarises the results and presents a discussion on how the research objectives were attained. In addition, recommendations are made and opportunities for future research suggested.

CHAPTER 2: LITERATURE REVIEW:
SUPPLY CHAIN AND SUPPLY CHAIN MANAGEMENT

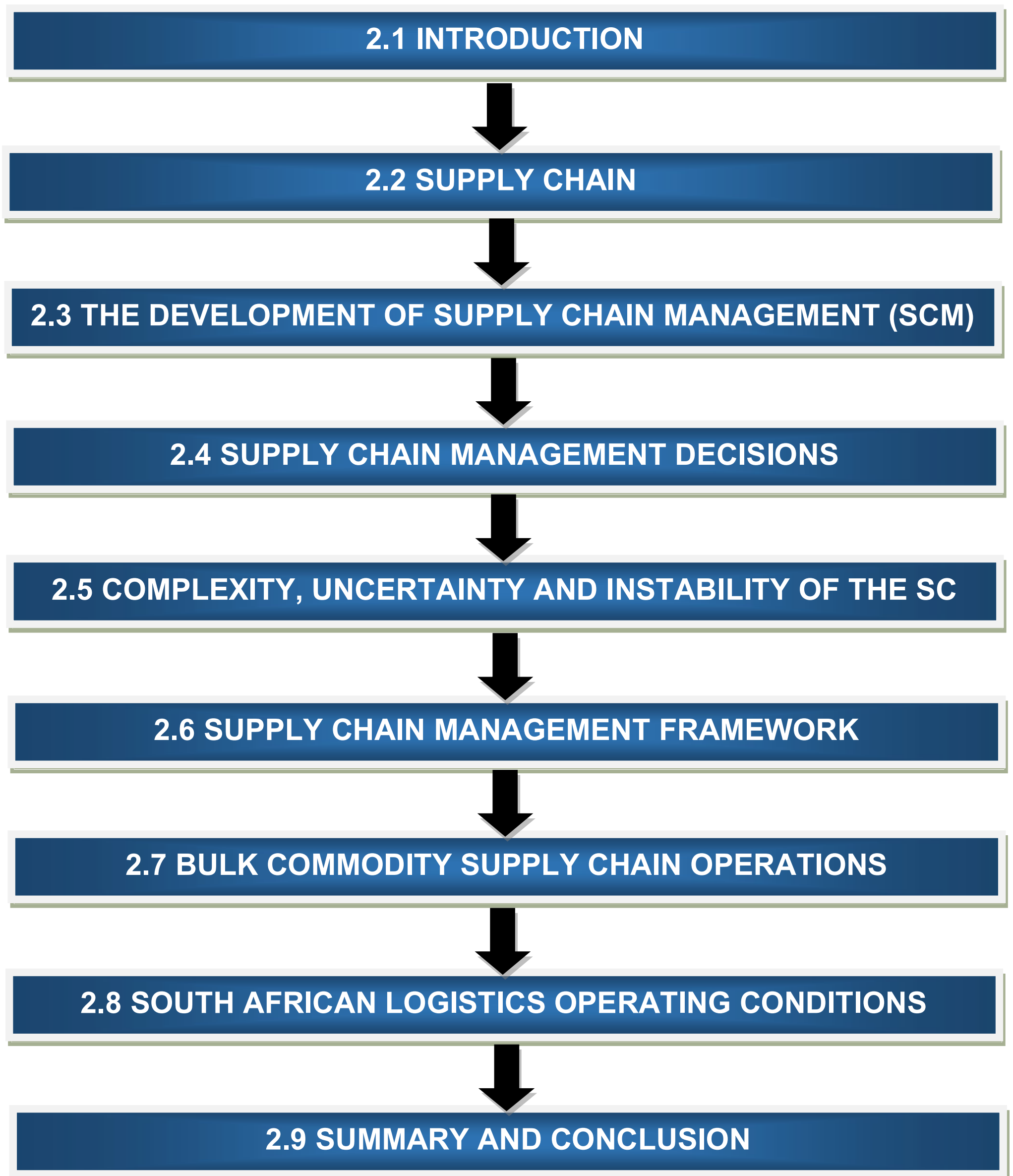

Figure 2.1: Flow diagram of Chapter 2.

Source: Compiled by researcher

2.1 Introduction

This study investigates supply chain risks in an import supply chain of bulk commodity chemicals. Chapter 2 presents an overview of the concepts of supply chain (SC), supply chain management (SCM), supply chain management framework, and how the bulk import supply chain operates from a logistics perspective.

2.2 Supply Chain

There are various definitions and perspectives of a supply chain (SC) and supply chain management (SCM). A supply chain is a group of organisations, usually three or more, that are linked in some way to upstream and/or downstream flows of products, services, finance, and information from the point of origin (source) to the customer (Handfield, Monczka, Giunipero & Patterson, 2011:13; Butkovic, Kauric & Mikulic, 2016:798).

According to Chopra and Meindl (2013:13), a supply chain consists of, "all parties involved, directly or indirectly, in fulfilling a customer request. The supply chain includes not only the manufacturers and suppliers, but also transporters, warehouses, retailers and even customers themselves."

Other definitions include those of Hugos (2018:1) and Wisner, Tang and Leong (2014:6), who describe a supply chain as consisting of organisations and business activities that are needed to design, make, deliver, and use products and/or services.

Typical supply chain stakeholders include (Chopra & Meindl, 2016:14):

- Customers
- Retailers
- Wholesales or distributors
- Manufacturers
- Raw material suppliers
- Intermediate or component suppliers

Each member in the supply chain is connected to upstream or downstream supply chain partners by means of product, information, or finance flow. A typical supply chain, as illustrated in Figure 2.2, consists of all the stakeholders mentioned in the previous section i.e., suppliers, manufacturers, distributors, retailers, and customers. All the stakeholders do not necessarily need to be present in the supply chain, as each supply chain may be different depending on the needs of the customer.

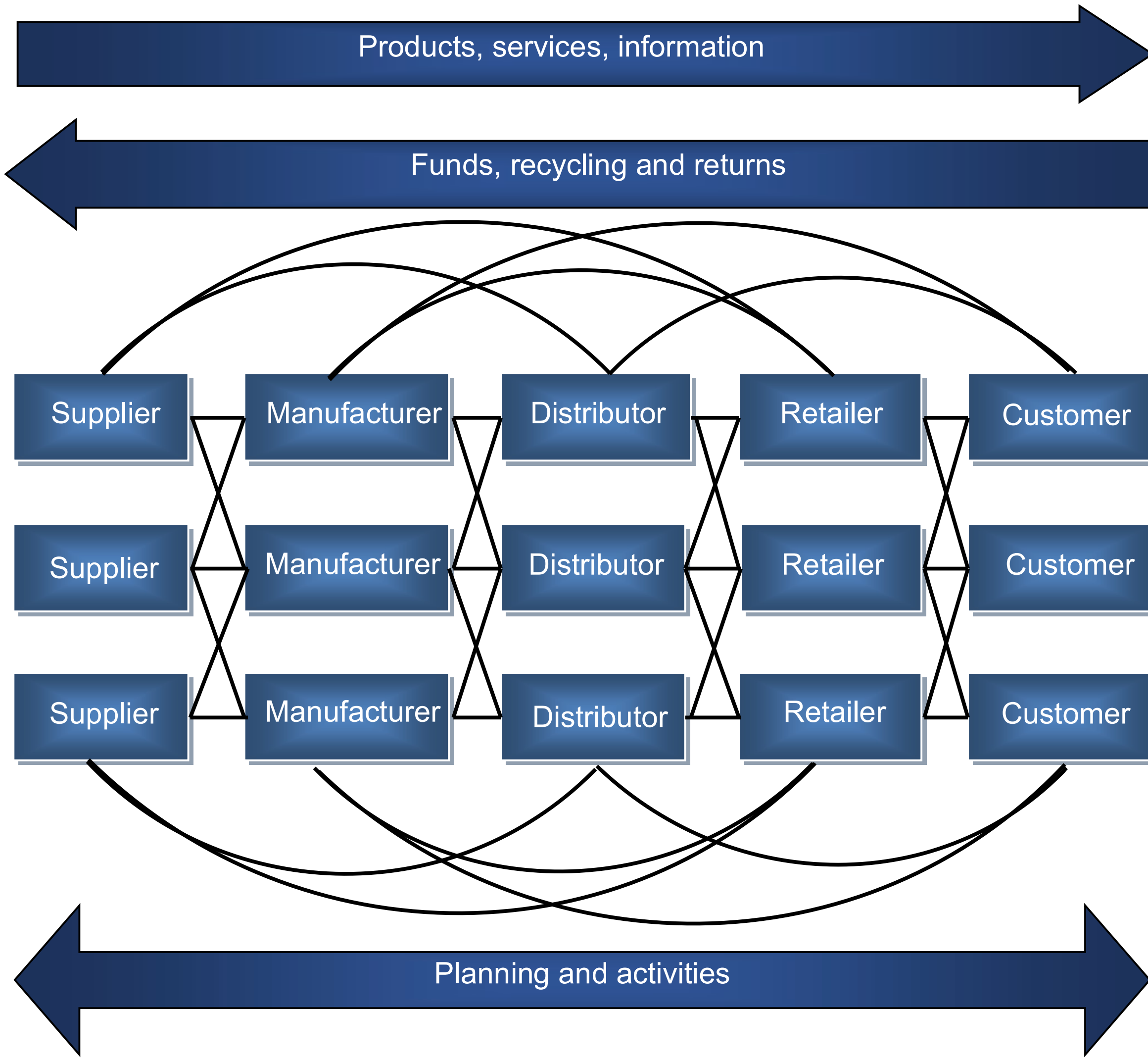

Figure 2.2: Supply chain stakeholders and flow.

Source: Chopra and Meindl (2013:15); Wisner *et al.* (2014:6)

The above-mentioned stakeholders are involved in a wide variety of supply chain management activities, which include: 1) Purchasing; 2) transport; 3) quality control; 4) demand and supply planning; 5) receiving, materials handling and storage; 6) inventory control; 7) order processing; 8) production planning, scheduling and control; 9) warehousing; 10) shipping; and 11) customer service (Handfield *et al.*, 2011:17).

The first activity, *purchasing,* is regarded as the group of activities of buying goods and/or services. It is the duty of purchasing to ensure that goods and/or services are procured in the right quantity, the right quality, the right time, the right price, and from the right suppliers. In order to achieve this, purchasing is tasked with activities which include supplier identification and selection, buying, negotiating and contracting, supplier measurement and improvement (Handfield *et al.*, 2011:10; Hugos 2018:64).

Transport (both inbound and outbound) is concerned with the movement of inventory through the supply chain from point of origin to point of destination. Transport modes consist of land, air, and sea transportation. Transport management includes activities such as selecting transport modes, route planning and optimisation, consolidation of shipments, carrier rate management, and carrier selection (Bowersox, Closs, Cooper & Bowersox, 2013:212; Hugos 2018:14).

Quality control involves the detection and prevention of quality problems through quality control procedures and processes (Handfield *et al.*, 2011:10). One of the philosophies applied in quality control is total quality management (TQM). TQM includes continuous improvement, problem solving, and measuring outcomes (Basheer, Hafeez, Hassan & Haroon, 2018:172).

Demand and supply planning is the task of aligning the supply capabilities of the organisation with the customers' demand requirements (Handfield *et al.*, 2011:18; Matsoma & Ambe, 2017:3; Zhang, 2018:9). This is achieved through activities such as demand-supply forecasting, demand-supply planning, demand-supply communication, and demand-supply influencing (demand planning is discussed in section 2.6.4 in detail).

Receiving, materials handling and storage are usually combined and termed as materials management. This activity deals with the inbound flow of inventory as it moves from the supplier to the purchaser. Activities included are receiving, staging, checking, put-away and storage, and ensuring that the correct quality and quantity of materials are received in a timely manner (Handfield *et al.*, 2011:18; Jusoh & Kasim, 2017:83).

Inventory control includes determining the level of inventory of finished goods to support customer requirements, e.g., monitoring the status of inbound shipments and performing calculations to determine safety stock and reorder points based on sales data (Handfield *et al.*, 2011:18; Bowersox *et al.,* 2013:53; Sabila, Mustafid & Suryono, 2018:1).

Order processing ensures that the customer receives their requested material when and where required. This includes accepting orders, processing or capturing orders, determining if production capacity is available, and coordinating order processing with order scheduling (Handfield *et al.*, 2011:19).

Production planning, scheduling, and control are responsible for determining a 'time-phased' schedule for production by developing a short-term production schedule. This production schedule ensures that customer demands are met while considering production constraints (Handfield *et al.*, 2011:19; Gyulai, Pfeiffer & Monostori, 2017:3657).

Warehousing involves the physical storage and safekeeping of finished goods, semi-finished goods, and raw materials to reduce damage, pilferage and loss, and to make available the inventory, when required, to support future sales. This is achieved by warehousing activities such as receiving, dispatch, checking, staging, and put-away (Handfield *et al.*, 2011:19; Boysen, de Koster & Weidinger, 2019:396).

Shipping involves the activities of physically getting the products ready for distribution, including packing, labelling, completing shipping documents, and arranging transport (Handfield *et al.*, 2011:19; Habazin, Glasnović & Bajor, 2017:59).

Customer service includes all activities related to ensuring the customers are satisfied with the product and/or service. This includes all activities prior to, during, and after the transaction (customer service management is further discussed in detail in section 2.6.3) (Handfield *et al.* ,2011:19; Nwulu & Kwokah, 2018:80; Al-Tarawneh & Al-Shourah, 2018:396).

It becomes clear from Figure 2.1 and the preceding discussion that a supply chain is a myriad of stakeholders and activities involving the flow of products, services, information, and funds from one stakeholder to the next in order to satisfy the customer's demand. The objective of the supply chain is to maximize overall value generated for the customer. In order to maximize the creation of value, a supply chain needs to reduce or minimize the supply chain cost (Chopra & Meindl, 2016:15). The value created (also known as supply chain surplus) in the supply chain can be expressed with the following formula:

Supply chain surplus = Customer value – Supply chain cost

The supply chain value (or surplus) is the difference between the customer value, the value the final product has to the customer, and the cost the supply chain accumulates by fulfilling the customer's demand (Chopra & Meindl, 2016:15). With all these stakeholders and activities in the supply chain, it becomes clear that there needs to be some management process that can proactively manage and coordinate the movement of these goods, services, information, and funds (also known as flows). This process is known as supply chain management (SCM) (Handfield *et al.,* 2011:13; Fredendall & Hill, 2016:8 Hugos, 2018:4).

Firstly, as mentioned above, an important supply chain management objective is to reduce overall supply chain cost. Global supply chains have encouraged, and at the same time forced, organisations to reduce cost through strategic sourcing (Stevens & Johnson, 2016:13). The ever-growing ambition to reduce cost through low-cost sourcing has led to supply chains being characterised by greater global reach. It is common practice today in supply chain to have multiple supply sources that are geographically separated from the customers. Secondly, supply chains have become more complex in the sense that more "links" exist in the supply chain. Supply chain stakeholders, unlike previously, not only deal with customers and suppliers, but with a wide variety of other stakeholders and functions including customer services, demand management, order fulfilment, manufacturing, product development, logistics, finance, and purchasing. Thirdly, supply chains are increasingly characterized by multi-tiered relationships and multi-tiered sourcing (Kamal & Irani, 2014:2; Stevens & Johnson, 2016:14).

2.3 The Development of the Supply Chain Management

Supply Chain Management (SCM) is certainly not a new concept, but over the years it has evolved. The value that supply chain management adds within organisations is no doubt indispensable and has increased over time. Historically, organisations viewed business simplistically by only considering their own customers and suppliers. In later years (in the 60's and 70's) organisations started understanding the complexities in supply chain and started seeing the importance of internal integration of functions, with the common goal of servicing the customer. Internal integration started with functions, including purchasing, operations and distribution. The main aim of this integration was to reduce cost and at the same time to improve customer service. This is where the concept of supply chain management (SCM) originated. In this internal integration, organisations embraced the concept of “internal customers”. The idea grew that by serving other internal departments as customers, at the same time, customer service to the end customer, was improved, even if they did not interface with the end customer. Information was being shared internally across the functions in the supply chain, thus improving reaction and decision times, which resulted in improved end customer satisfaction. Over time, it was realised that this internal focussing strategy was not enough and more had to be done (Mangan & Lalwani, 2016:4).

The use of technology and concepts like ERP (enterprise resource planning), MRP (material requirements planning), MRPII (manufacturing resource planning), JIT (Just-In-Time), TQM (total quality management) and lean philosophies started appearing to improve responsiveness to customer demands. Customers increasingly demand better products at lower prices and greater visibility within the supply chain (Stevens & Johnson, 2016:3; Lambert & Enz, 2016:1; el Shoghari & Abdallah, 2016:48; Al-Tarawneh & Al-Shourah, 2018:394). In order to comply with modern customer demands, organisations had no choice but to involve their suppliers and distributors (and their suppliers’ suppliers and distributors’ distributors) in their effort to reduce costs, producing more innovative products, and transparent supply chains. In Figure 2.3, the development of supply chain management and associated concepts, philosophies, and applications are plotted against a timeline to indicate the approximate time the different philosophies emerged.

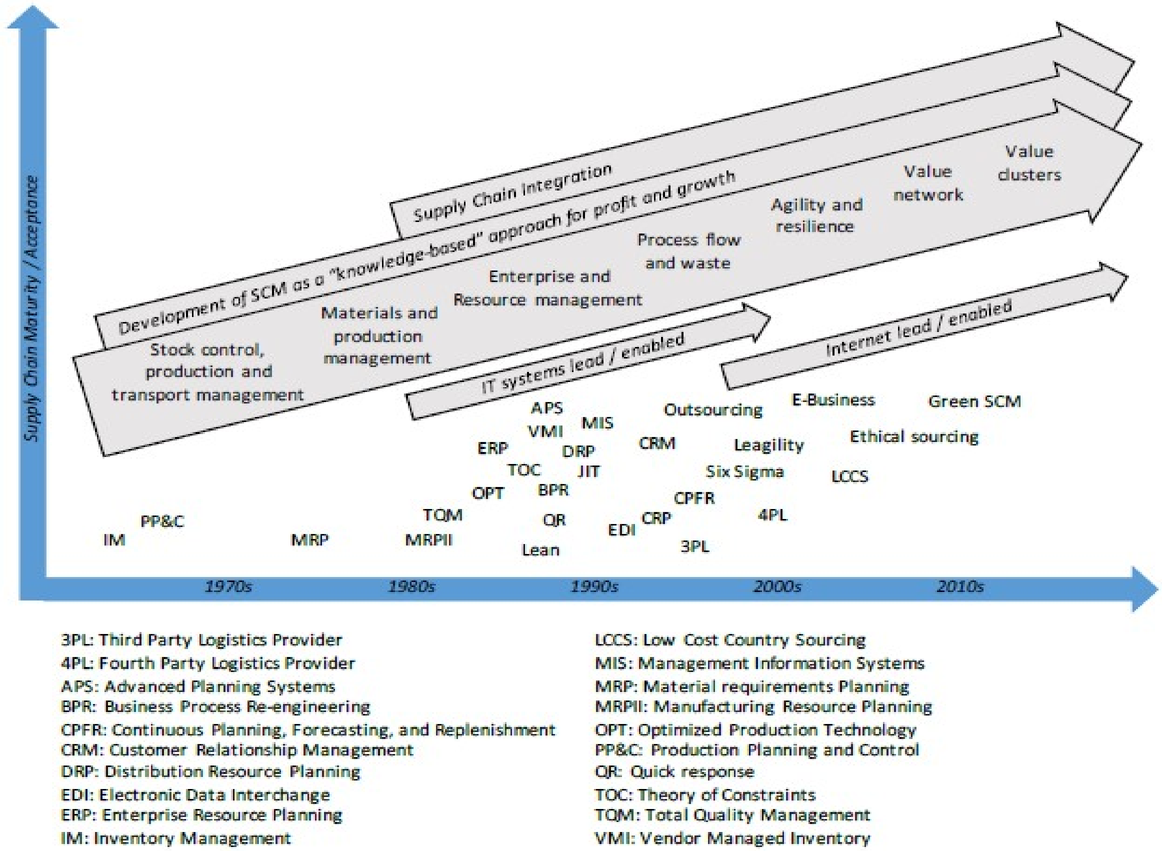

Figure 2.3: Evolution timeline of supply chain management (SCM).

Source: Stevens & Johnson (2016:8)

With reference to the preceding discussion, Christopher's (2016:2) defines supply chain management as, "SCM is the management of upstream and downstream relationships with suppliers and customers in order to deliver superior customer value at less cost to the supply chain as a whole". According to Handfield *et al.* (2011:12), supply chain management involves proactively managing the two-way movement or coordination of goods, services, information, and funds from the point of raw material to the end customer. Further, supply chain management is regarded as the coordination of production, inventory and transportation amongst all the stakeholders (or participants), both upstream and downstream, of the supply chain, with the objective to obtain best responsiveness and efficiency for the market and the customer to be served (Mangan & Lalwani, 2016:10; Hugos, 2018:4).

Regardless of the definition employed, the conclusions which can be drawn and the commonalities from the above definitions are:

1. Supply chain management is the proactive coordination and management of relationships.
2. There is a flow of products, services, information, and funds upstream and downstream.
3. The objective is to maximize customer value and reduce overall supply chain cost.

2.4 Supply Chain Management Decisions

Successful supply chain management (SCM) requires decisions in three phases or categories. Firstly, *supply chain strategy* involves the decisions related to the structure of the supply chain over the next few years, i.e., long-term decisions. This could include decisions related to outsourcing or deciding to keep the function in-house, location of warehouse facilities, storage strategy, and location and modes of transport (Chopra & Meindl, 2016:18; Mangan & Lalwani, 2016:4; Hugos, 2018:5). Secondly, *supply chain planning* involves the decision over a period from a quarter to a year, i.e., mid-term decisions. These decisions typically include which markets to serve, which location to serve, and inventory policies (Chopra & Meindl, 2016:19; Mangan & Lalwani, 2016:4). Thirdly, *supply chain operation* includes decisions with a weekly or daily time horizon. Typical decisions in this phase include decisions related to individual customer orders, how to allocate inventory, selecting the order delivery date to meet customer requirements, and generating a pick list in the warehouse (Chopra & Meindl, 2016:19; Hugos, 2018:6).

According to Hugos (2018:5), organisations must make a collective or individual decision during the management process of the supply chain. Decisions regarding the following *drivers* are important to ensure supply chain performance. There is some overlap between the SCM activities mentioned in 2.2 and the supply chain drivers. Below is the list of supply chain drivers (Chopra & Meindl, 2016:54; Hugos, 2018:10):

1. Production
2. Inventory
3. Location
4. Transport
5. Information

Production decisions include determining the rate of production, establishing the production capacity and size of the workforce (Hugos, 2018:54). After these questions have been answered a master production schedule can be drafted which considers capacities, workload, quality control, and equipment maintenance (Mangan & Lalwani, 2016:65; Hugos, 2018:5). It is important to understand the requirements of the customer and when it is required. It will be futile to manufacture a product which the customer does not require or want, and similarly, it would be pointless manufacturing the right product but not having it available at the right time. An important decision relating to production is to focus on product or function. Product-focus ensures that different operations are conducted to manufacture a specific product in completeness (e.g. final consumer products), while functional focus aims to conduct only limited operations that contribute to the final product as a whole, although the complete product is not manufactured. An example of the functional focus can be found in the automotive industry where individual parts are manufactured by 3rd party manufacturers or OEM's (Original Equipment Manufacturer) and is then assembled by the automotive manufacturer.

Inventory decisions include how much inventory to keep; where this inventory should be kept in the supply chain; and the form of the inventory, e.g. raw materials, semi-finished or finished goods (Hugos, 2018:54). Depending on uncertainty, decisions regarding safety stock also require consideration (Hugos, 2018:5). Safety inventory refers to the inventory held as "buffer" to mitigate the uncertainty in the supply chain due to forecast inaccuracies, increases, or fluctuations in demand. There is always a trade-off between safety stock and customer service level. Keeping a high level of inventory improves customer service, but keeping high inventory increases costs in the supply chain. A balance should be struck between amount of stock based on demand, and safety stock to cater for uncertainty. Important inventory decisions include cycle inventory, safety inventory and seasonal inventory. Cycle inventory refers to the inventory required to satisfy the demand between the periods of purchasing. If too large inventories are kept, aspects such as carry cost, damage and pilferage need to be considered as this could increase supply chain cost. Seasonal inventory is the inventory that is built up for high peak seasons demand when known increases in demand is observed or expected. The type of inventory, i.e., raw, semi-finished, or finished goods and amount of inventory will affect the next factor, namely location (Mangan & Lalwani, 2016:167).

Location of facilities has a long-term impact on the supply chain's performance since it is expensive to shut down or move a facility to a different location (Chopra & Meindl, 2016:121). A major factor to consider when deciding on the location of facilities is whether to centralise or decentralise. Centralisation would allow for economies of scale, while decentralisation will allow for more responsiveness due to being closer to the customer. A further factor to consider is whether to keep the warehouse facility close to the production or operations facility, or to move the warehouse facility closer to the customer (Chopra & Meindl, 2016:57; Albareda-Sambola, Landete, Monge & Sainz-Pardo, 2017:2). Various factors influence the location of facilities, including: 1) Location of supply sources; 2) facility, labour and material cost; and 3) transportation cost between facilities (Chopra & Meindl, 2016:129; Bowersox *et al.,* 2013:37; Górak, 2017:1457). It is important to locate stock in strategic places, depending on the supply chain's supply strategy.

Transportation decisions refers inter alia to the usage of the correct mode of transport, i.e., air, sea, rail, or road. Transportation decisions can become quite complex when considering route optimisation, scheduling, lead times, and suitability of the mode. Air transport is by far the quickest, but also the most expensive. Sea transport is relatively less expensive but has longer lead-times compared to air transport. Longer lead times increase uncertainty and higher inventory levels of safety or buffer stock need to be kept. Decisions relating to suitability of the mode of transport are important, as some products might not be suitable for transport by sea, for example, perishables with short shelf lives. It might also not make sense to transport a commodity material such as soda ash via airfreight due to the bulkiness and high cost of transport (Mangan & Lalwani, 2016:103; Hugos, 2018:5).

Information is a crucial aspect of supply chain as it is the connection and basis of decision-making. The more accurate the information (i.e. accurateness, timeless and completeness) that is supplied the better the quality of decisions that can be made. Information is used for coordinating daily activities, but also for forecasting and planning. Daily activities include and relate to the other four supply chain drivers: production, inventory, location, and transportation with their individual activities such as production schedules, inventory levels, mode of transport and transportation route as well as stock keeping locations. Forecasting and planning relate to activities of setting a monthly and quarterly forecast to meet customer demands (Mangan & Lalwani, 2016:221; Hugos, 2018:6).

From the preceding discussion it can be concluded that there are five drivers of supply chain, which are closely linked to each other, one affecting the other. If any one of the supply chain drivers are inadequate or not carefully considered, it can lead to an increase in *complexity, instability and uncertainty* in the supply chain, leading to an increased risk in the overall supply chain. Complexity, instability, and uncertainty will be briefly discussed below.

2.5 Complexity, Uncertainty and Instability of the Supply Chain

2.5.1 Complexity in supply chain

Complexity is an abstract concept about which many authors in the supply chain arena have tried to theorise. According to Turner, Aitken and Bozarth (2018:1440) supply chain complexity can be defined as "the level of detail complexity and dynamic complexity exhibited by the products, processes and relationships that make up a supply chain" (Perona & Miragliotta, 2004:103; Serdersan, 2013:533; Piya, Shamsuzzoha & Khadem, 2018:304). Detail complexity refers to the "distinct number of components or parts that make up a system", while dynamic complexity refers to the "unpredictability of a system's response to a given set of inputs, driven in part by the interconnectedness of the many parts that make up the system". Ucenic and Ratiu (2018:247) define SC complexity as "…quantitative differences between predicted and actual states which are associated with the variety caused by the internal and external drivers in supply chain".

Various factors contribute to complexity in supply chain. Piya *et al.* (2018:305) refer to these contributing factors as "drivers of complexity". Researchers Ucenic and Ratiu (2018:248) classify complexity into two categories based on their origin – internal factors and external factors. Table 2.1 below indicates the classification of some complexity drivers.

Table 2.1: Supply chain complexity drivers

Complexity driver	Internal / External factor
1. Product variety	Internal
1. Manufacturing processes	Internal
2. Internal communication and information sharing	Internal
3. Planning and scheduling	Internal
4. Organisational structure	Internal
5. Logistics and transportation	Internal and external
6. Marketing and sales	Internal and external
7. Customer needs	External
8. Competitor action	External
9. Product lifecycle	External
10. Government regulations and legal framework	External
11. Incompatible information technology	Internal and external
12. Number of suppliers	Internal and external
13. Supplier location	External
14. Number of customers	External
15. Company culture	Internal

Source: Piya *et al.* (2018:305); Ucenic and Ratiu (2018:248)

According to Maylor and Turner (2017:10), organisations can respond to these complexity drivers in three main ways: planning and control, relationship building, and operational flexibility. Other researchers have taken a different view by considering complexity reduction and complexity accommodation as responses (Turner *et al*. 2018:1442). One of the practical examples of how to deal with complexity, Turner *et al.*(2018:1443) propose investing in information systems and/or lateral relationship building, making use of advanced planning tools, and sharing information amongst supply chain stakeholders to better equip organisations to deal with complexity.

2.5.2 Uncertainty in supply chain

Uncertainty, as viewed from a supply chain perspective, is "risks which cannot be measured and whose outcomes cannot be predicted or insured against". "Uncertainty occurs when decision makers cannot estimate the outcome of an event or the probability of its occurrence," (Wang, Jie & Abareshi, 2015:2). Further, Wang *et al.* (2015:2) mention that uncertainty is "a risk that is immeasurable". The key difference between risk and uncertainty is that risk has a quantifiable measure for future events, whereas uncertainty does not (Prakash, Soni & Rathore, 2017:69). In other words, in this research on risk, SC uncertainty was a factor contributing towards risk. Uncertainties experienced in the SC could be one of many, but includes *inter alia* demand uncertainty, supply uncertainty, economic uncertainty, labour uncertainty, performance cycle uncertainty, policy uncertainty, logistics uncertainty, information uncertainty, customer-related uncertainty, and environmental uncertainty, all which contributes to the overall SC uncertainty (Childerhouse & Towill, 2004:585; Bowersox *et al.,* 2013:167; Wang, Jie & Abareshi, 2015:1; Prakash *et al.,* 2017:69). Uncertainty extends throughout the supply chain network and increases SC risk. Uncertainty is expressed in questions such as: What will my customers order? How many products should we have in stock? What stock will the customer order? How much should I procure? Will the supplier deliver the requested goods on-time and in-full (Patil, Shrotri & Dandekar, 2012:303)? Uncertainties lead to risks that need to be managed in the supply chain, which will be discussed in detail in Chapter 3.

2.5.3 Instability in supply chain

According to the Oxford dictionary, the definition of instability is the "state of being unstable" or the "lack of stability" with the tendency to be unpredictable or have erratic changes. Supply chain instability causes damage to organisations, consumers, and the economy through excessive inventories, poor customer service, and unnecessary capital investment (Sterman, 2006:1). Instability in the SC can involve various forms, of which political, economic, employment, financial, and social instability are but a few (Koilo & Grytten, 2019:63). The bullwhip effect, mainly caused by a lack of communication and/or information sharing of real time data in the SC, can lead to over-reaction at SC partners, the further away they are from the point of sale, which could lead to supply chain instability. The bullwhip phenomenon has the tendency for variability to increase at each level of a supply chain, from the point of customer sales to production (Sterman, 2006:1; Sterman, 2015:5). To effectively deal with instability, SC professionals need to consider and employ strategies like improving distribution networks, developing a distribution strategy, and tracking inventory holding. Further methods to reduce instability in the supply chain include making changes to the physical structure (e.g. lean manufacturing, multi-modal transport, third-party warehousing) and changes in information technology (e.g. point of sale data, ERPs, RFID) (Sterman, 2015:5; Koilo & Grytten, 2019:63).

2.6 Supply Chain Management Framework

With the evolution of SCM, various scholars and academics have tried to propose a framework for supply chain management. A framework is the basic structure underlying a system. A supply chain management framework refers to the most basic functions of the supply chain and how they interact with each other (Lambert, 2014:3; Lambert & Enz, 2016:7). In 2000, Lambert and Cooper (2000:67) proposed a conceptual supply chain management framework that was appropriate for the time. Since then, it has been updated by different researchers, with the latest version from Lambert and Enz (2016:7), depicted in Fig 2.4 below. This SCM framework depicts the various functions or business processes in the internal supply chain and how they interact with each other and with suppliers and customers in the supply chain. This framework clearly indicates that integration (internal, customer and supplier) is important to improve customer service and reduce risk, as the supply chain does not operate in insolation. Internal integration occurs between all the internal organisational functions e.g. logistics, purchasing, marketing, sales, finance, research, development, and production (this can be seen in the middle section of Figure 2.4). Customer integration occurs between the customer, end-customer, and the manufacturer (this can be seen on the right-hand side of Figure 2.4). Lastly, supplier integration occurs between tier one suppliers, tier two suppliers and the manufacturer (this can be seen in the left-hand side of Figure 2.4). Integration is discussed in detail in Chapter 3, section 3.12.

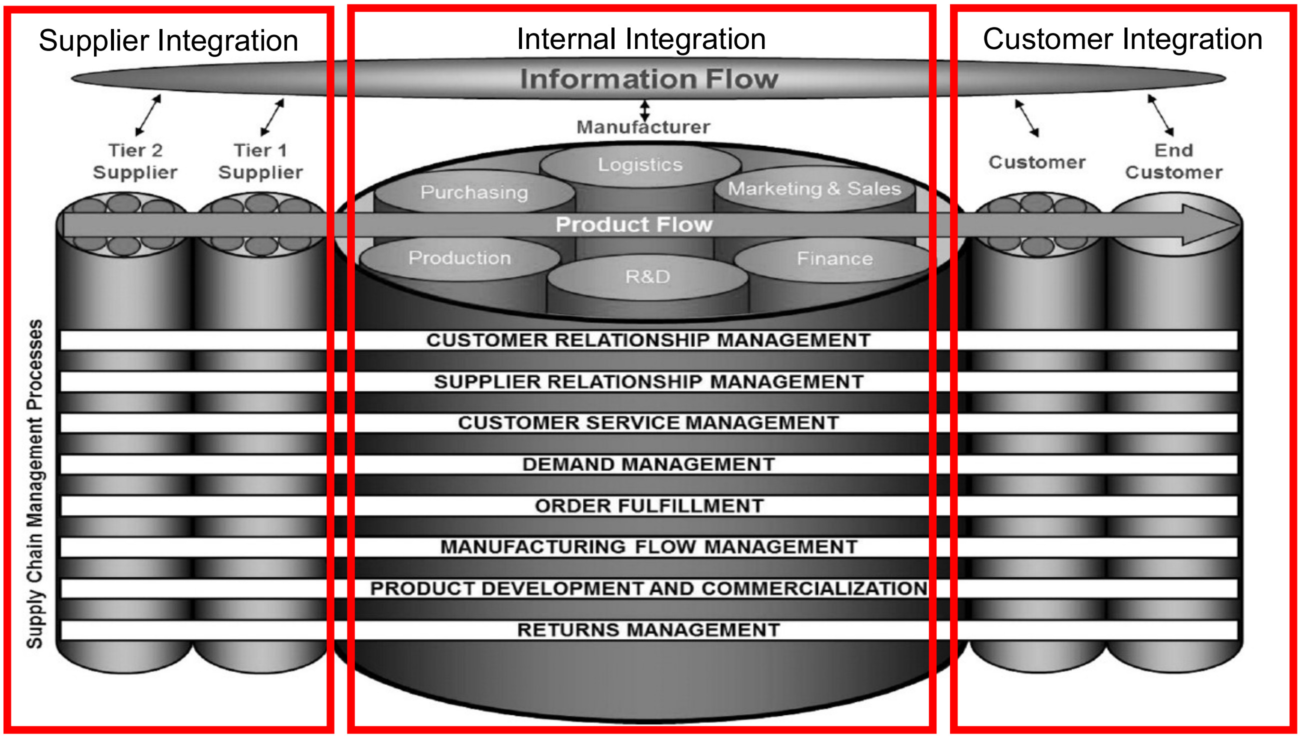

Figure 2.4: Supply chain management framework.

Source: Lambert and Enz (2016:7)

The internal supply chain functions are discussed in more detail below.

2.6.1 Customer relationship management

Customer relationship management (CRM) is not a new concept but has been around for almost as long as organisations have (Al-Hawary & Aldaihani, 2016:203; Adikaram & Khatibi, 2016:70; Debnath, Datta & Mukhopadhyay, 2016:299). Historically, relationships were built and fostered on the traditional basis, i.e., person-to-person (Al-Hawary & Aldaihani, 2016:203). As organisations grew and customers started being geographically separated from their suppliers, a different dynamic was involved due to different contact points and the introduction of information technology systems to aid in managing these relationships. The complexity of these buyer/seller relationships left a vacuum, as the aim was to move away from transactional relationships, and instead move towards partnerships or long-term win-win relationships. To manage these relationships, a process called customer relationship management (CRM) was employed. Organisations seek to improve their interactions with customers by gaining access to customer data and analysing customer value to improve profitability. This is achieved by removing the customers' operational barriers like lack of information technology, lack of trust, and lack of subject knowledge, thus gaining customer loyalty (Al-Hawary & Aldaihani, 2016:201).

CRM ensures a responsible, profitable, customer-oriented organisation (Wali, Uduma & Wright, 2016:3; Yerpude & Singhal, 2017:552). CRM is mainly described as a “process” because relationship management between suppliers and buyers includes managing the process of offering, acceptance, purchase, and consumption of goods and/or services (Wali *et al.*, 2016:4). CRM can be defined as a “strategic approach to marketing that focuses on developing and maintaining appropriate relationships with customers often with the aid of information technology (IT), or CRM systems” (Payne & Frow, 2005:168; Haislip & Richardson, 2017:16). Further, CRM is defined as “a comprehensive strategy and process that enables an organisation to identify, acquire, retain and nurture profitable customers by building and maintaining long-term relations with them” (Sin, Tse & Yim, 2005:1265; Adikaram & Khatibi , 2016:72). The above definitions make it clear that CRM revolves around buyer/seller relationships and the benefits which customers gain from those relationships.

The benefits of CRM were summarised by Debnath, Datta and Mukhopadhyay (2016:300) from other researchers’ work, and includes:

- Inter-organisational learning (Ho & Ganesan, 2013:93)
- Sharing of specialised knowledge (Ho & Ganesan, 2013:96)
- Customer loyalty and retention (Garnefeld, Eggert, Helm & Tax, 2013:28; Wetzel, Hammerschmidt & Zablah, 2014:12; Rahimi & Kozak, 2017:4)
- Customer satisfaction (Yim, Chan & Lam, 2012:11; Rahimi & Kozak, 2017:4)
- Increase in shareholder value (Payne & Frow, 2005:168)
- Customer referral (Garnefeld, Eggert, Helm & Tax, 2013:17)
- Providing strategic information (Rahimi & Kozak, 2017:4)
- Improve customer lifetime value (Rahimi & Kozak, 2017:4)
- Reduce operational cost and improve profitability (Rahimi & Kozak, 2017:4)

Various authors and resources studied different dimensions of CRM. One of the dimensions is the internal and external dimension. The internal dimension mainly focusses on organisational structures, cultural structures, and knowledge, whereas the external dimension refers to interactions with customers, like sharing information (Al-Hawary & Aldaihani, 2016:204). Another study identified five dimensions of CRM, including: 1) Information sharing; 2) customers’ involvement; 3) long-term relationship with customers; 4) joint problem-solving; and 5) technology-based CRM (Lin, Chen & Kuan-Shun, 2010:115; Al-Hawary & Aldaihani, 2016:204). These five dimensions will be discussed below. Other dimensions include key customer focus, organisational commitment, customer experience, process-driven approach, reliability, technology orientation, and knowledge management (Adikaram & Khatibi, 2016:74).

The information sharing dimension includes, but is not limited to, the exchange of "basic" information through various activities between the organisation and its customers. The organisation and customer usually share market needs information, customer preference information, sales information and new product launches (McEvily & Marcus, 2005:1034; Lin *et al.*, 2010:115; Al-Hawary & Aldaihani, 2016:205). In their research, Al-Hawary and Aldaihani (2016:213) propose a model that indicates that information sharing between suppliers and customers is part of the contributing dimensions which improves the innovative capabilities of an organisation. It stands to reason that innovative organisations are always a step ahead of competitors. After testing their proposed hypothesis, Al-Hawary and Aldaihani (2016:220) found a positive statistical effect on innovation capabilities through information sharing between the organisation, customers, and suppliers. By sharing information up- as well as downstream, it allows the customer to gain a better understanding of supply constraints, and at the same time allows the supplier to gain insight into the demands and ideas of the customer. An observant supplier can easily detect any potential threats and opportunities in the market and at the same time identify their strengths and weaknesses relative to that of their competitors.

The *customer involvement dimension* includes customer engagement in new product development and customer contribution concerning market demands and technical support to better equip the supplier to meet the customers' requirements. This customer engagement will also lead to the identification of the level of loyalty to the supplier, gauge the level of customer satisfaction, and at the same time give attention to the customers' complaints. Organisations are aware that the customer is their greatest asset. The key to unlocking this asset is to understand the impact customer involvement and customer relationship management has on the quality of service / product. The aim should therefore be to involve the customer to build a sustainable relationship to improve quality and address major issues of concern (Tseng & Wu, 2014:778; Al-Hawary & Aldaihani, 2016:212).

The *long-term relationship with customers dimension* is based on the premise of trust, commitment, two-way communication, and conflict management between the buyer/supplier. The whole idea is that both parties i.e. buyer/seller share the same goals, which should lead to a mutual win-win scenario for both parties involved (Al-Hawary & Aldaihani, 2016:206; Adikaram & Khatibi, 2016:74).

The *joint problem-solving dimension*, as the name suggests, is the cooperation and working together of the parties to find solutions and share responsibilities for difficult and unexpected situations (McEvily & Marcus, 2005:1034; Al-Hawary & Aldaihani, 2016:206). By working together and sharing resources it increases the technical capabilities, product quality, and builds on the concept of continuous improvement, and at the same time distributes the risk in the supply chain amongst stakeholders.

With *the technology-based CRM dimension*, techniques and technologies are used that facilitate a vast array of activities, including finding data and saving data in systems and customer relationship management software (Sin *et al*., 2005:1264; Al-Hawary & Aldaihani, 2016:206). Technology allows the organisation to connect directly with the customer through social media, which allows the gathering of data and ideas. The customer on the other hand can also use this platform to manage its relationship with the supplier and will most likely participate in the product innovation process (Sin *et al*., 2005:1264). Following CRM system implementation customer satisfaction, customer knowledge and customer retention improve (Haislip & Richardson, 2017:17).

Lastly, although the previous researchers have alluded to the dimensions of customer relationship management (CRM) as above, the researcher holds the view that the dimensions are inter-dependent. For example, customer involvement would need to precede or concurrently occur with information sharing. Similarly, long-term relationships are dependent on customer involvement. If a long-term relationship exists and the customer is involved, only then can the customer and supplier work together on joint problem solving. Technology, in CRM, should be used as an enabler to improve data collection, storage, analysis, and exchange, and should not be a replacement for relationship management.

2.6.2 Supplier relationship management

Due to the complexities associated with modern supply chains, the need has arisen for customers to manage the relationships with their suppliers. Organisations can deal with a few hundred to a few thousand suppliers, but relationships with key suppliers should be the focus (Lindgreen, Vanhamme, van Raaij & Johnston, 2013:73; Hingley, Lindgreen & Grant, 2015:3; Teller, Kotzab, Grant & Holweg, 2016:2). Due to the large number of suppliers, the phenomenon of longer-term contracts and the expectation of suppliers and customers to share more information have led to the development of supplier relationship management (SRM) (Njagi & Shalle, 2016:3). Supplier relationship management (SRM), like CRM, deals with the supplier-buyer relationship (SBR). These two concepts work together in the sense that the "supplier" applies CRM on the customer (buyer), and the "customer" applies SRM on the supplier. This allows for two-way communication and collaboration between supplier / buyer. One of the many SRM objectives is to develop a long-term partnership with the aim of improving supplier performance, thus resulting in a relationship where the benefits outweigh the cost of the relationship (Hamister, 2012:427; Teller *et al.,* 2016:3). This two-way collaboration and communication, depicted in Figure 2.5, from both the customer's (SRM) and supplier's perspective (CRM) clarifies these concepts.

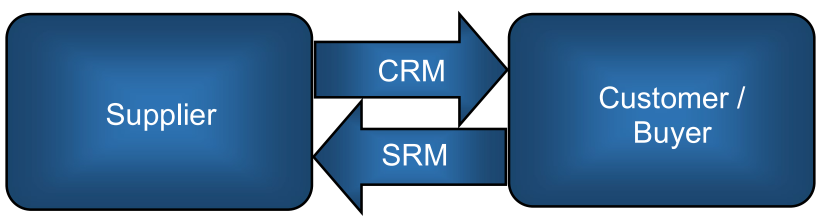

Figure 2.5: Relationship between SRM and CRM.

Source: Lambert (2014:9); Lambert and Enz (2016:9); Branská, Paták, Pecinová and Horák (2016:7)

SRM has been defined as "management of relationships between supply chain actors" and is also perceived as one of the most important aspects in SCM (Lambert & Schwieterman, 2012:340; Tidy, Wang & Hall, 2016:3296). SRM has also been defined as the "coordination, collaboration and information sharing between supply chain members" with the aim of improving business decisions to achieve a more efficient and effective result in terms of business performance and to gain a competitive advantage for the supply chain stakeholders (Gualandris, Golini & Kalchschmidt, 2014:258; Tseng, 2014:39; Oghazi, Rad, Zaefarian, Beheshti & Mortazavi, 2016:4804). In addition to the above definitions of SRM, other researchers have included terms in their definitions such as "comprehensive approach to managing enterprises' interactions" (Kosgei & Gitau, 2016:136) and "strategically planning and managing interactions" (Njagi & Shalle, 2016:3). Researchers like Soh, Jayaraman, Yen and Kiumarsi (2016:186) do not use the term SRM but prefer using buyer-supplier relationship (BSR) in their research. Although this is different terminology, both SRM and BSR are based on the same principles and can be regarded as interchangeable terms.

2.6.3 Customer service management

Customer service management (CSM) is regarded as the "face" of the organisation and is an important aspect of CRM in the supply chain framework (Nwulu & Kwokah, 2018:80; Al-Tarawneh & Al-Shourah, 2018:396). The purpose of customer service is to generate value for customers by building and maintaining positive relationships, thereby directly supporting CRM. The aim is to obtain customer knowledge and adapt to the customers' ever-changing needs. Flexibility and adding value will provide the customer with a competitive advantage over their competitors. A competitive advantage can be gained by providing support, both before and after the product is bought (el Shoghari & Abdallah, 2016:50; Yerpude & Singhal, 2017:552; Nwulu & Kwokah, 2018:80). Support refers to all activities, to provide the customer a single point of contact, including product availability, shipping dates, and order status, leading to improved customer satisfaction. According to Nwulu and Kwokah (2018:86) CSM has a significant impact and positive contribution to sales growth, profitability and market share, which are all objectives of any sustainable organisation (Tilokavichai, Sophatsathit & Chandrachai, 2012:13; Hassan & Ali, 2013:80; Melović, Mitrović, Djokaj & Vatin, 2015:803).

2.6.4 Demand management

Demand management (DM) in the SCM framework refers to activities that include demand forecasting, planning and order fulfilment amongst others (Zhang, 2018:9). DM is an important link in the SCM framework and is integrated into sales and operations planning (S&OP) with the aim of establishing, stimulating, and influencing customer demand (Boon-Itt, Wong & Wong, 2017:7). DM and its activity of demand planning is the "estimation of customer needs and other planning measures, as well as actions that illustrate planning in conjunction with other participants in the value chain" (Matsoma & Ambe, 2017:3). DM is of crucial importance as it has a considerable impact on two major aspects of an organisation, namely, revenue and inventory. Demand uncertainty can cause significant challenges in production planning and control, as this is usually caused by changes in orders, random capacity, unpredictable events, such as weather, human errors, and a lack of availability of information (Nemtajela & Mbohwa, 2016:702; Biçer, Hagspiel & De Treville, 2018:47). DM therefore has the responsibility to establish customer sales (and thus production) information, and manage the flows (product, service, information and funds) in order to meet the customers' requirements (Mohammadi & Mukhtar, 2017:176; Zhang, 2018:9; Al-Tarawneh & Al-Shourah, 2018:396). In their research, Ali, Babai, Boylan and Syntetos (2017:986) sketched three demand management scenarios: 1) No information shared or available; 2) inferred information (limited information shared or available); and 3) full information shared or available. The ideal scenario is full information sharing or availability to reduce risk and uncertainty. However, this is not always possible due to various reasons; including customers who are uncertain about their demand or are unwilling to provide the required information (scenario 1 and 2). With scenarios one and two, the demand forecast will not be accurate, thus exposing the supply chain to increased risk due to uncertainty (Zhang, 2018:36).

The main functions of DM include 1) demand forecasting; 2) demand planning; 3) demand communication; 4) demand influencing; and 5) demand management. In Table 2.2 below, each function of demand management is broken down into their respective key features.

Table 2.2: Demand management functions and key features

Function of demand management	Key features
Demand forecasting	Understand the market Understand the expectations of customers Good marketing strategies
Demand planning	Consider: - Capacity - Inventory - Backlog
Demand communication	Managing the process of: - Communicate input - Validate assumptions - Propose a demand plan

	- Reach consensus - Provide feedback and monitor performance
Demand influencing	Consider the various dynamics e.g. internal and external influences: External: - Marco economic conditions - Competition conditions - Consumer behaviour Internal: - Sales and marketing strategies
Demand management	Know the characteristics of projects and their needs at the beginning: - Cost - Risk - Manufacturing circle

Source: Zhang (2018:36)

2.6.5 Order fulfilment

The concept of order fulfilment (OF), if not understood properly, could be misinterpreted as just filling customer orders. OF includes a wide array of activities, such as defining customer requirements, designing the logistics network, filling customer orders, improving the organisation's capabilities to meet the customers' needs, and reducing total cost to serve the customer (Lambert & Enz, 2016:8; Mohammadi & Mukhtar, 2017:181; Al-Tarawneh & Al-Shourah, 2018:396; Manuela, 2019:2459).

2.6.6 Manufacturing flow management

From an operational point of view, manufacturing flow management includes all activities necessary to move products through the plants and to obtain, implement, and manage manufacturing flexibility in the supply chain (Al-Tarawneh & Al-Shourah, 2018:398; Manuela, 2019:2459). Reliability and flexibility are key concepts when discussing manufacturing flow management (MFM). Reliability not only refers to manufacturing reliability by manufacturing a variety of products at lowest possible cost, but also to suppliers and other key functions in the flow management process, e.g., receiving in the warehouse. Suppliers should be reliable in the sense that they deliver on their promises to ensure material is available, and the warehouse must be reliable to make available the material to manufacturing, within reasonable time, after quality checks have been completed. Flexibility is required from manufacturing to adapt to fluctuations in customer demand, due to uncertainty, as well as changes or customisation required to products. Flexibility is also required from suppliers and receiving, based on the need for production to be flexible to meet customers' changing needs. In their research, Al-Tarawneh and Al-Shourah (2018:404) found that MFM has a positive and significant effect on competitive advantage. Therefore, it can be concluded that one of the important aspects to be more competitive in the market is to have a proper MFM business process. Organisations can save as much as 3% to 7% of their revenues by integrating procurement, manufacturing, and logistics (Mohammadi & Mukhtar, 2017:181; Al-Tarawneh & Al-Shourah, 2018:405; Manuela, 2019:2462).

2.6.7 Product development and commercialisation

Product development and commercialisation (PDC) is the supply chain management (SCM) process that provides structure for developing and bringing to market new products jointly with customers and suppliers (Mohammadi & Mukhtar, 2017:182; Manuela, 2019:2462). An important aspect to consider during new product development is the integration of the organisation's suppliers and customers in the process of conceptualisation to final product to reduce the time to the market. If the time to the market can be reduced, the organisation will have a competitive advantage over its competitors by having its products on the shelves first. This is especially important with new product inventions and innovations.

2.6.8 Returns management

Returns management (RM) has become an extremely important dynamic in SCM literature, especially so in the retail industry (Chen, Anselmi, Falasca & Tian, 2017:251), but at the same time is also one of the most neglected aspects of SCM. Organisations spend large amounts of money on the returns of unwanted goods. Some scholars estimate that up to 16 billion US dollars are spent on the return of equipment in the electronics industry in the USA alone (Chen *et al*., 2017:252; Mohammadi & Mukhtar, 2017:182). RM refers to activities of reverse flow of goods from customers, i.e., reverse logistics and returns. Reverse logistics refers to and includes the physical moving of the materials from the customer back to the manufacturer or seller with the purpose to dispose or resell. Returns, on the other hand, refers to the resale, recycling, remanufacture, or disposal of the returned goods (Al-Tarawneh & Al-Shourah, 2018:396; Manuela, 2019:2459). RM has interfaces with many different processes in the supply chain, including interaction with customer relationship management (CRM), customer services (CS), demand management (DM), order fulfilment (OF), manufacturing flow management (MFM), supplier relationship management (SRM), product development (PD), and commercialisation (Chen *et al*., 2017:253; Mohammadi & Mukhtar, 2017:184).

In conclusion, Table 2.3 below summarises the internal business processes in the SCM framework and elaborates on sub process activities, which are categorised into strategic and operational sub-process activities.

Table 2.3: SCM framework business processes

Business process	Strategic sub-process activities	Operational sub-process activities
Customer Relationship Management	1. Review corporate and marketing strategy 2. Identify criteria for categorising customers 3. Provide guidelines for the degree of differentiating the product / service agreement 4. Develop framework of metrics 5. Develop guidelines for sharing process improvement benefits with customers	1. Differentiate customers 2. Prepare the accounts management team 3. Internally review the accounts 4. Identify opportunities with the accounts 5. Develop the product / service agreement 6. Implement the product / service agreement 7. Measure performance and generate profitability reports
Supplier Relationship Management	1. Review corporate, marketing, manufacturing and sourcing strategy 2. Identify criteria for categorising supplier 3. Provide guidelines for the degree of customisation of the product / service agreement 4. Develop framework of metrics 5. Develop guidelines for sharing process improvement benefits with suppliers	1. Differentiate suppliers 2. Prepare the supplier management team 3. Internally review the supplier 4. Identify opportunities with suppliers 5. Develop the product / service agreement and communication plan 6. Implement the product / service agreement 7. Measure the performance of product / service agreement

Customer Service Management	1. Develop customer service strategy 2. Develop response procedure 3. Develop infrastructure for implementing response procedure 4. Develop framework of metrics	1. Recognise event 2. Evaluate situations and alternatives 3. Implement solution 4. Monitor and report
Demand Management	1. Determine demand management goals and strategy 2. Determine forecasting procedure 3. Plan information flow 4. Determine synchronisation procedure 5. Develop contingency management system 6. Develop framework of metrics	1. Collect data and information 2. Forecast 3. Synchronise 4. Reduce variability and increase flexibility 5. Measure performance
Order Fulfilment	1. Review marketing strategies, supply chain structure and customer service goals 2. Define requirements for order fulfilment 3. Evaluate logistics network 4. Define plan for order fulfilment 5. Develop framework of metrics	1. Generate and communicate orders 2. Enter orders 3. Process orders 4. Handle documentation 5. Fill orders 6. Deliver orders 7. Perform post-delivery activities and measure performance
Manufacturing Flow Management	1. Review manufacturing, sourcing, marketing and logistics strategies 2. Determine degree of manufacturing flexibility required 3. Determine push / pull boundaries 4. Identify manufacturing constraints and determine capabilities	1. Determine routing and velocity through manufacturing 2. Manufacturing and material planning 3. Execute capacity and demand 4. Measure performance
Product Development and Commercialisation	1. Review corporate, marketing, manufacturing and sourcing strategies 2. Develop idea generation and screening processes 3. Establish guidelines for cross-functional product development team 4. Identify product rollout issues and constraints 5. Establish new product projects 6. Develop framework of metrics	1. Define new products and assess fit 2. Establish cross-functional product development team 3. Formalise new product development 4. Design and build prototypes 5. Evaluate make / buy decision 6. Determine channels 7. Product rollout 8. Measure process performance

Returns Management	1. Determine returns management goals and strategy 2. Develop avoidance, gatekeeping and disposition guidelines 3. Develop returns network and flow options 4. Develop credit rules 5. Determine secondary markets 6. Develop framework of metrics	1. Receive returns request 2. Determine routing 3. Receive return 4. Select disposition 5. Credit customer / supplier 6. Analyse returns and measure performance

Source: Mohammadi and Mukhtar (2017:183)

2.7 Bulk Commodity Supply Chain Operations

This study will be conducted in a bulk import supply chain. The following subsections will shed some light on the bulk supply chain operations in normal operational circumstances. A brief background will be provided of the properties and handling characteristics of bulk powder commodities.

2.7.1 Supply chain flow of dry bulk commodity

Dry bulk commodities are raw, unprocessed materials to be used in a manufacturing or production process at destination point. For this study, the selected bulk commodity is soda ash. The bulk commodities are usually shipped long distances in large unpackaged quantities by specialised sea dry bulk vessels, road tanker or tipper vehicles, and trains. The type of road transport vehicle used, usually consisting of a high-sided open truck design, is dependent on flowability. Typically, these trucks are fitted with a tipper mechanism, operated mechanically, which assist in the discharge rate. It can be used for a range of commodities, but usually more specifically for granular goods, for example, grain, or soda ash. Bulk cargo can be split into two categories, i.e., granular and non-granular. The important difference between the two categories is the flow properties, which will determine the use of either pneumatic or gravity-based material handling equipment (Kadigi, Mwathe, Dutton, Kashaigili & Kilima, 2014:37; Burl, 2019:106). Figure 2.6 depicts the normal flow of bulk commodities throughout the supply chain from point of origin to point of destination. From mining (point of origin), the raw materials are transported to the manufacturer of the bulk commodity. The bulk commodity is then shipped either via road or via rail in bulk vessels to the port. At the port, it is either directly loaded into a ship to be shipped to the import country, or it is kept at the port in storage in a warehouse or silo. Once ship cargo is ready, the bulk commodity is loaded into the ship's hatches via conveyor belt, corkscrew mechanisms, or pneumatic pumps from silos. The bulk offloading from the ship, at point of destination is usually more manual as mechanical grabs are used. At point of destination, the bulk could be stored in silos, warehouses, or be sold off and directly delivered to the customer (Laulajainen, 2006:4; Kadigi *et al.,* 2014:36).

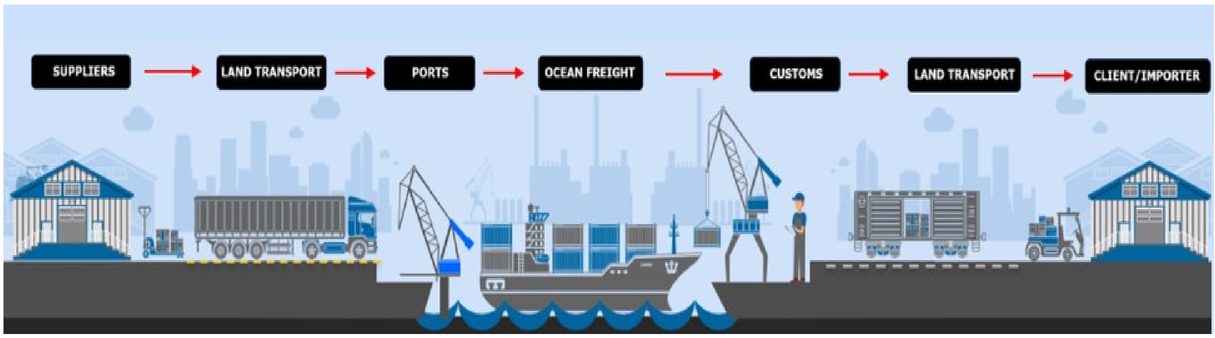

Figure 2.6: Flow of bulk commodities.

Source: www.jlktrade.com

2.7.2 Handling characteristics of bulk powder commodities

Bulk commodities have unique handling characteristics since they are not packaged into containers, packages, or drums like normal fast-moving consumer goods (FMCG). Flowability is important in bulk powder commodities, as this will affect the loading, offloading and handling times during ship berthing, as well as product quality. Flowability is the ability of bulk powders to flow freely. The flow behaviour is a combination of physical product characteristics, environmental conditions, equipment used for handling, storing, and processing (Laulajainen, 2006:4; Ganesan, Rosentrater & Muthukumarappan, 2008:425; Kadigi *et al.*, 2014:37). Various factors can affect the quality and flowability of these bulk commodities as explained below:

2.7.2.1. Moisture content and humidity

Moisture content is important in bulk powder, as this will influence micro bacterial growth. Many bulk powders, as is the case with soda ash, are hygroscopic in nature, which means it absorbs moisture and water easily. This aspect might affect the quality of the product, as it will become lumpy and unable to pass through the normal production process without being reworked (Laulajainen, 2006:5; Ganesan *et al.*, 2008:426). *Humidity*, just like moisture content, is important for bulk powders. Relative humidity of the air in a silo or warehouse could affect the properties of the materials. Standing water or high humidity at coastal cities or tropical areas could lead to the hygroscopic product absorbing the excess water.

2.7.2.2. Temperature

Extremely cold *temperatures* could affect the flowability of bulk powders as well. This happens when below freezing temperatures are experiences. The freezing temperatures bonds the particles, reducing flowability and making it lumpy (Laulajainen, 2006:8; Ganesan, *et al.,* 2008:427).

2.7.2.3 Pressure

Compacting *pressure* is a very important factor that affects the flow properties of bulk powders. When large volumes of product are stored in a ship's hull or road transport vehicle it may be subjected to compaction and vibration. This compaction and vibration could lead to the particles' size increasing, also causing lumpiness in the product (Laulajainen, 2006:8; Ganesan *et al*, 2008:428; Kadigi *et al.*, 2014:37).

2.8 South African Logistics Operating Conditions

In the following subsections, some of the unique operating conditions in the South African context will be explained. Although South Africa is relatively advanced regarding port facilities, port equipment, and road transport, in comparison to other countries in Africa (Gidado, 2015:161), various challenges are faced with the bulk import logistics chain of soda ash, of which an important challenge is the use of the port of Durban.

2.8.1. Durban port infrastructure, facilities and equipment

The most commonly and widely accepted definition of a port is a facility used to handle cargo and/or passengers between maritime and land-based modes of transport like road or rail transport (Anand & Grainger, 2017:3). However, this definition is a very simplistic way to define a port. In addition to the simple definition, Anand and Graigner (2017:4) view a port as an economic facility, a node in the global supply chain, and the centre of human activity.

Soda ash is imported in dry bulk through the Durban port. Therefore, the Durban port is a key supply chain stakeholder in this supply chain. With over 5000 vessel calls per year and R100 billion direct expenditure in the local maritime economy and value related activities, Durban port has become an advanced regional trade port for both the African continent and South Africa (Dyer, 2014:8). However, little expansion has been done at the port of Durban in the last few years, which has led to capacity constraints and port congestion. The National Ports Authority (NPA) is responsible for the maintenance and investment in port infrastructure, while South African Port Operations (SAPO) is responsible for all mechanical handling equipment like cranes, tractors, trailers, and saddle carriers (Foolchand, 2006:3; Gidado, 2015:161). Another aspect, as mentioned previously, is that soda ash is mainly transported by road transportation. This not only contributes to congestion in Durban port, but from a cost perspective, road transport is an expensive mode of transport. In general, it is said that road transportation is more expensive in Africa compared to other regions (Tchanche, 2019:301). This is partly due to the colonial history and inadequate infrastructure that exist in Africa. Further, it was found that roads in Maydon Wharf, which is within Durban port, were of a very low quality and in poor condition (Kunene & Allopi, 2013:367). Railways, once a successful and dominant mode of transport, have also deteriorated over the years due to lack of investment. Since soda ash is a commodity, and imported through Durban port, it is reliant on efficient and cost-effective operations, both from a transportation and port operations perspective. In South Africa, delays due to port inefficiency and lack of investment are a big problem (Bvepfepfe, 2019:61). Both Africa and South Africa have suffered at the hand of negative logistical factors, including the following factors:

1. Weakness in logistics operations.
2. Challenges in transportation from an infrastructure perspective.
3. Widely spread populations with long distances between them.
4. Relatively high transport cost to and from Africa.
5. Invisible and indirect costs due to inefficiencies like customs delays and port congestion (Bvepfepfe, 2019:71).

2.8.2. Logistic challenges and risks

In the broader context of supply chain, a further focus point of this study is on logistics risks in a soda ash import supply chain, including the unique risks relating to Durban port. Many studies have been done on supply chain and logistics problems in South Africa, particularly the logistics challenges at the Durban port. A synopsis of these challenges is provided below:

2.8.2.1 Logistics challenges

The South African government has not invested sufficiently in logistics infrastructure for decades, including roads, rail, and seaports. Non-investment, together with neglect and under-maintenance has led to a very fragile transport network in South Africa. According to SANRAL, 26% of municipal and provincial roads are in a poor or very poor condition, with 38% of roads in a good condition (Chakwizira, 2019:3). These statistics, together with the fact that 80% of South Africa's national road network is older than its designed lifespan of 20 years, paints a very bleak logistics picture. This increases the road network vulnerability and reduces the road network's resilience, as damage to this fragile network is a high probability (Chakwizira, 2019:3).

Findings of research studies on logistics challenges in South Africa indicated that problems are caused by the following factors:

1. South African organisations having limited collaboration with industry players and key stakeholders in their supply chains.
2. South African organisations understanding global trends and practices in supply chain and logistics management but not implementing such practices.
3. Limited co-operation between different modes of transport.
4. A lack of logistics planning in both the government and private sector (Foolchand, 2006:3; Viljoen, 2012:8; Gidado, 2015:161).

As indicated previously, soda ash is imported through the Durban port, which experiences many challenges. A major cause of import logistics problems in South Africa is the lack of rail capacity and port inefficiencies, including the following:

- Slow or delayed customs clearance.
- Congestion at port entry to a particular terminal for ships.
- Congestion of ships at port equipment or services.
- Congestion caused by cumbersome registration, licensing, or documentation process.
- Congestion of trucks within port or terminal.
- Congestion at the landside access route to the port (Gidado, 2015:162).

In a broader context, research by Loh and Thai (2015:320) on port-related supply chain disruptions (PSCD) found risks associated with security levels, infrastructure development, demand and supply imbalance, port congestion, and deteriorating employment relationships. Other researchers (Foolchand, 2006:3; Viljoen, 2012:8; Gidado, 2015:161; Desai, 2016:13; Mokone, 2016:21) focussed specifically on Durban port. They found that the South African ports are government owned, which has led to uncompetitive monopoly powers prevailing. The lack of competition has resulted in a single tariff book applying across all the South African ports. Further, they found that the average waiting time for a ship to berth, and the overall turnaround time increased in 2015 versus previous years, meaning the ships take longer to berth and offload.

Anand and Graigner (2017:14), did research on disruptions at different ports, including the ports of Kenya, Japan, New Zealand, Australia, Libya, UK and USA, between 2010 and 2011. They found that industrial action, earthquakes, flooding, political unrest, collisions between container vessels, and fire and explosions are among the top disruptions at their sample ports. The exposure to these risks and disruptions are of crucial importance, as 90% of Africa's international trade is done by sea (Bvepfepfe, 2019:75). Therefore, the infrastructure deterioration and port delays are a major concern for logistics and supply chain professionals (Kunene & Allopi, 2013:367; Chakwizira, 2019:3; Bvepfepfe, 2019:71). Although there are many risks and dwell times are long, Durban port's performance must be seen in context of the African continent. When compared to the rest of Africa, Durban port is performing relatively well in terms of dwell time, as can be seen in Figure 2.7 (Bvepfepfe, 2019:76):

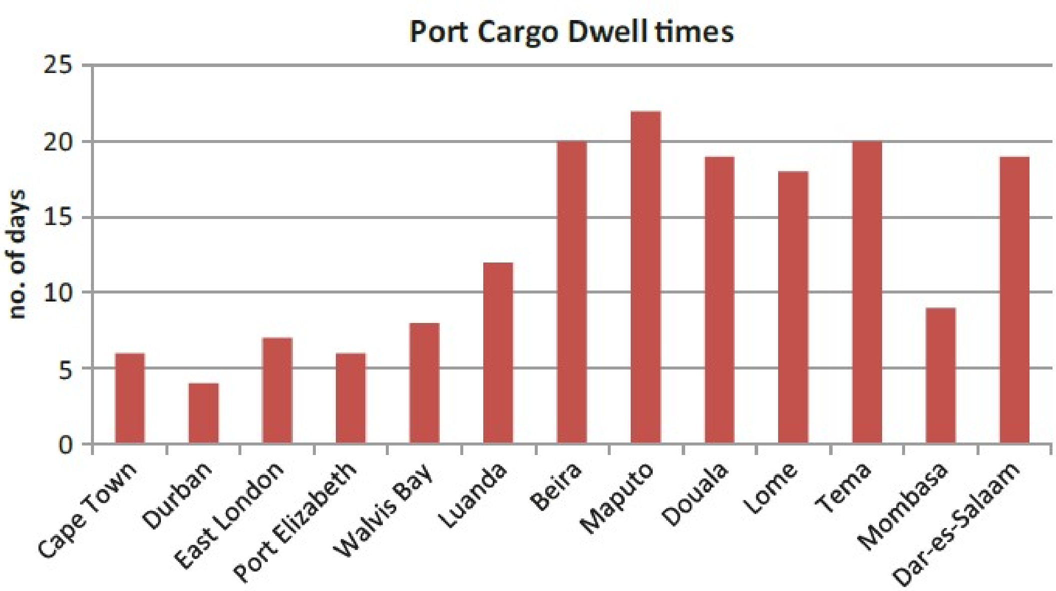

Figure 2.7: African ports dwell time.

Source: Bvepfepfe (2019:76).

In Figure 2.7 the number of days cargo dwell in the port is displayed for each individual African port in the scope of their research (Bvepfepfe, 2019:76). When viewed in context to the rest of the African ports, Durban port has the lowest dwell time relative to the rest. Dwell time is important as it is the amount of time that cargo spends in the port. This refers to the time when cargo arrives, to the time that cargo is discharged at the terminal. If dwell time can be minimized, logistics cost will be reduced as a result (Mokone, 2016:31). These various logistical challenges could lead to increased risk in the supply chain, which if left unmanaged can lead to major supply chain disruptions.

With the myriad of challenges in transportation, as discussed in section 2.8.2.1, the South African government has embarked on several initiatives to focus on logistics risk reduction. A few of the initiatives mentioned by Chakwizira (2019:4) are the Cape zone major coastal spill contingency, hazardous materials response plan, transportation of hazardous materials contingency plan, rail disaster plan and the multi-disciplinary incident plan, but to name a few that are relevant to this study. There are several other initiatives, as can be seen in Figure 2.8, which are relevant to air transport as well.

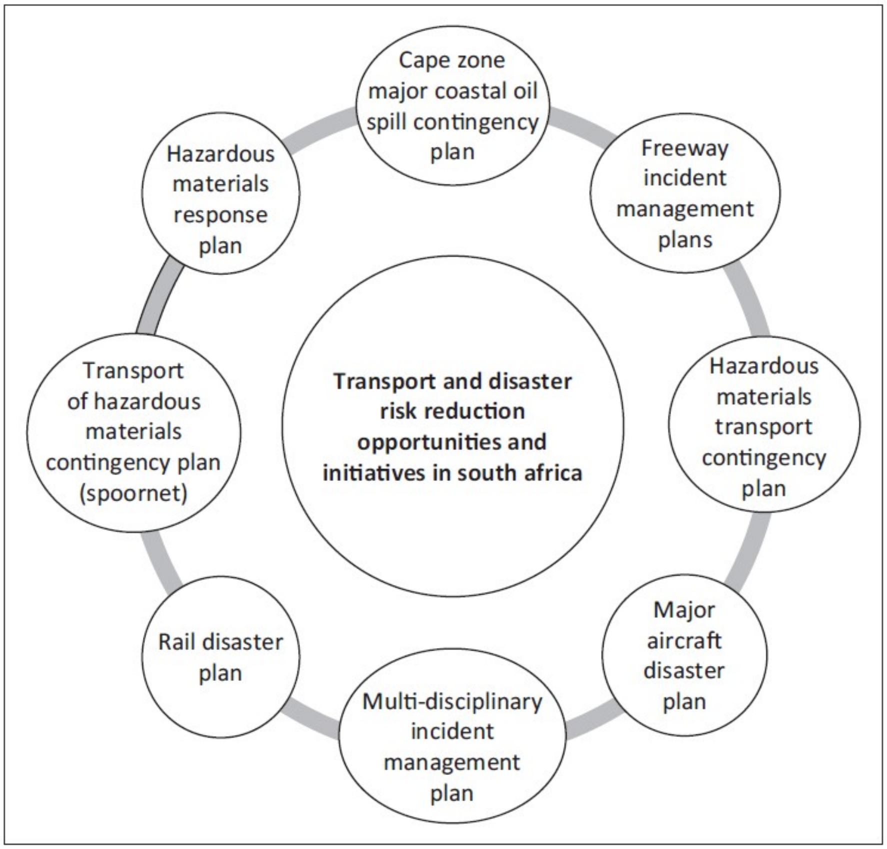

Figure 2.8: Transport and disaster risk reduction initiatives.

Source: Chakwizira, (2019:6).

According to sustainable development goals (SDG) and the National Development Plan (NDP 2030), it is crucial to manage transport risks in order to ensure the growth and development of South Africa (Chakwizira, 2019:1). To achieve this, South Africa has established a disaster risk reduction (DRR) plan. Disaster risk reduction can be defined as, “The systematic development and application of policies, strategies, and practises to minimise vulnerabilities and disaster risks throughout a society, to avoid (prevent) or to limit (mitigate and prepare) adverse impacts of hazards, within the broader context of sustainable development.” (UNISDR, 2009).

2.8.2.2 Logistics risks

The challenges in logistics infrastructure, as discussed in 2.8.2.1 pose risks for the economy and individual supply chains. Logistics risks will be covered in detail in Chapter 3.

2.9 Summary and Conclusion

In this chapter, a brief overview was given from a current literature point of view, on aspects related to supply chain, supply chain management, the associated framework, and the bulk supply chain. The concepts and complexities associated with SC were discussed, the various stakeholders in the SC were identified and the objective of supply chain was described to. Further concepts and definitions related to SCM and the evolution over the years have also been highlighted. The different supply chain decision factors have been discussed as production, inventory, location, transportation, and information. The supply chain management framework was as proposed by Lambert and Enz (2016:7) was discussed. The associated functions or processes within the framework included customer relationship management (CRM), supplier relationship management (SRM), customer service management (CSM), demand management (DM), order fulfilment (OF), manufacturing flow management (MFM), product development and commercialization (PDC) and lastly, returns management (RM). Finally, the chapter concluded with the bulk supply chain operations and its potential challenges as viewed from a logistics perspective in the South African context through the port of Durban.

CHAPTER 3: LITERATURE REVIEW:
RISK, SUPPLY CHAIN RISK AND RISK MANAGEMENT

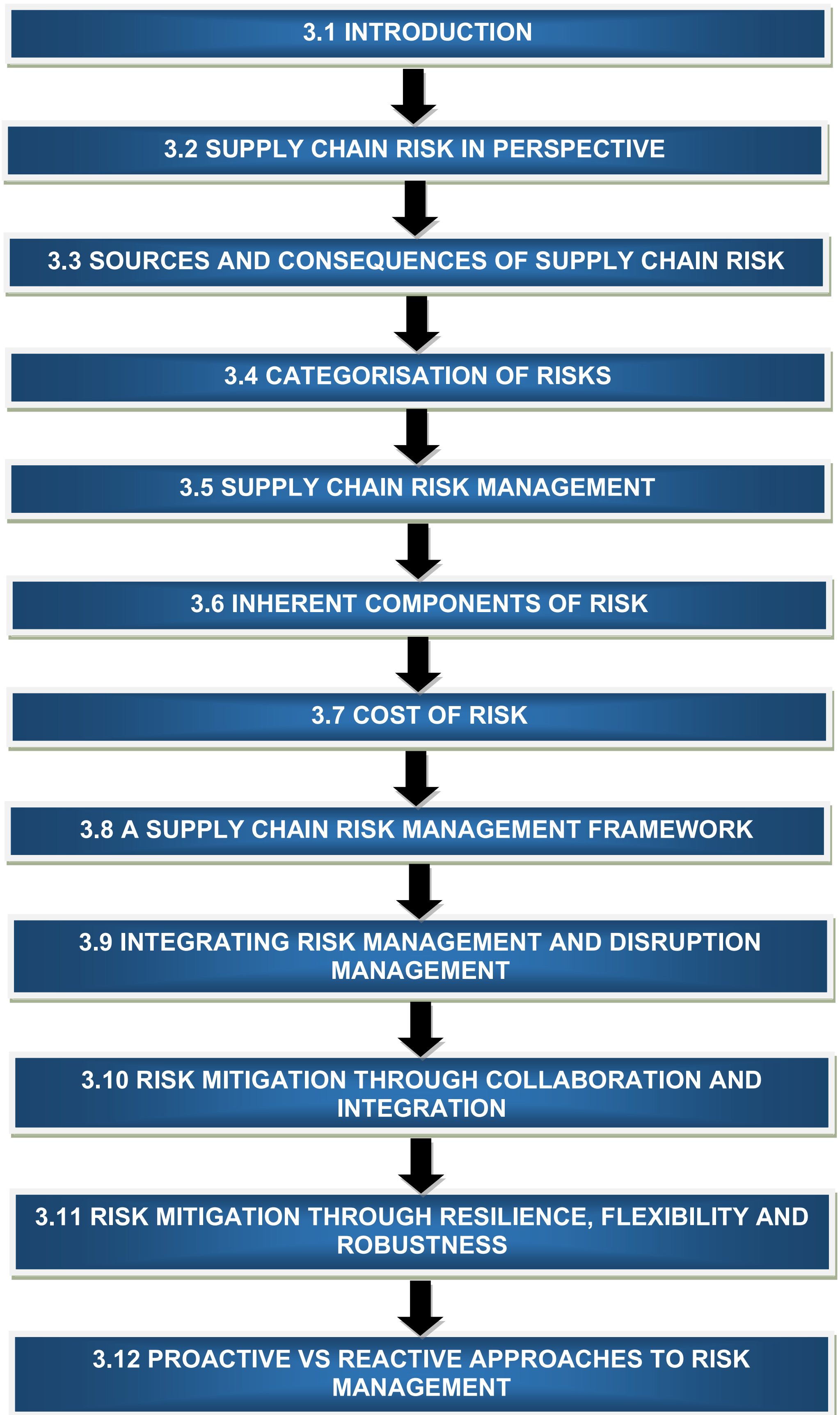

Figure 3.1: Flow diagram of Chapter 3.

Source: Compiled by researcher

3.1 Introduction

Chapter 3 provides an overview of the concepts related to risk management (RM), supply chain risk (SCR), and supply chain risk management (SCRM), and how these aspects relate to the bulk import supply chain. To understand risk, the concepts related to risk will be introduced first and will be put into context in the supply chain dynamics. Various supply chain risks exist, and these risks are perceived differently by organisations, which affect the orientation adopted by the organisation. Risks stem from either local or global origins and can be categorised according to internal and external risks or intentional and unintentional risks. If risks are not managed, it could result in disruptions with negative financial repercussions.

Firstly, as described in Chapter 2, one of supply chain management objectives is to reduce overall supply chain cost. Global supply chains have encouraged, but at the same time forced organisations to reduce cost through strategic sourcing (Stevens & Johnson, 2016:13). The ever-growing ambition to reduce cost through low-cost sourcing, has led to supply chains being characterized by greater global reach. It is common practice today to have multiple supply sources which are geographically separated from customers (Schorpp, Erhun & Lee, 2018:2). Secondly, supply chains have become more complex in the sense that more “links” exist in the supply chain. Supply chain stakeholders, unlike previously, not only deal with customers and suppliers, but with a wide variety of other stakeholders and functions, including customer services, demand management, order fulfilment, manufacturing, product development, logistics, finance, and purchasing. Thirdly, supply chains are increasingly characterized by multi-tiered relationships and multi-tiered sourcing, resulting in limited supply chain visibility (Stevens & Johnson, 2016:14; Schorpp, Erhun & Lee, 2018:2).

All these contributing factors lead to supply chains having a weak influence, reducing supply chain visibility due to the many supply chain stakeholders, and often little integration between the various role-players, leading to delays in information sharing and information distortion. Due to the lack of information sharing, non-availability of real-time information, degradation of communication, and the inability to plan and control, increased risk in the supply chain is inevitable. This, together with erratic supply and demand fluctuation leads to the "perfect storm" (Ralston, Blackhurst, Cantor & Crum, 2015:47; Stevens & Johnson, 2016:14). These *complex* relationships, *uncertainty* in demand and supply, and constant *instability* lead to an increase in supply chain risk.

In their research, Stevenson and Johnson (2016:14) propose the following function to represent supply chain risk, as can be seen in Fig 3.1. They are of the opinion that the compound effect of the "relentless pursuit of low-cost sourcing" can be expressed as:

Supply chain risk = Complexity x Uncertainty x Instability

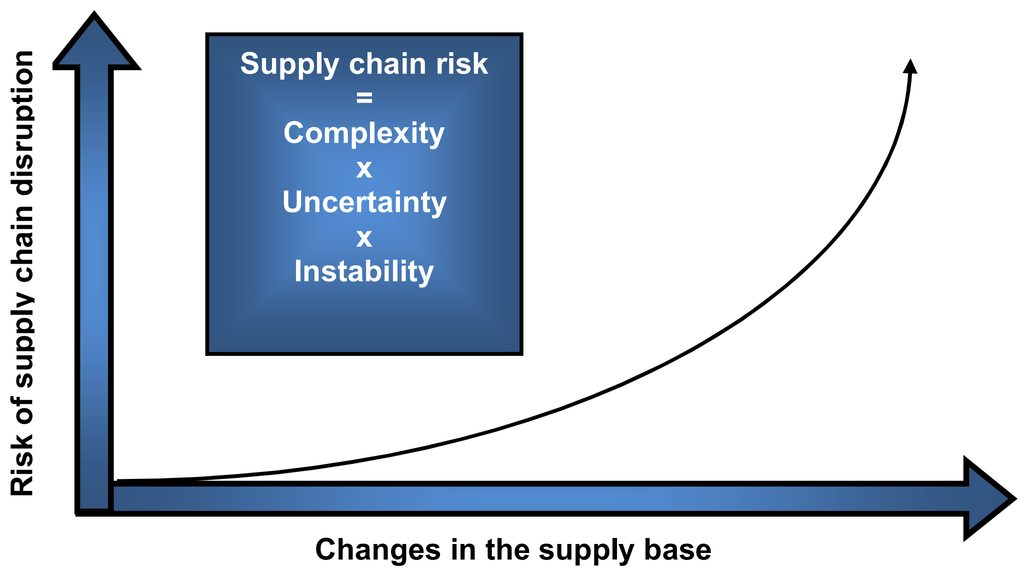

Figure 3.2: Supply chain risk.

Source: Stevens and Johnson (2016:14)

Stevenson and Johnson (2016:14) explain that supply chain risk increases as the complexity, uncertainty, and instability in the supply chain increases. When the risk in the supply chain increases; so, does potential supply chain disruptions. If the risk of supply chain disruptions is plotted against changes in the supply base, as indicated in Figure 3.2, then there is an increased risk of supply chain disruptions when there are increased changes in the supply base.

As mentioned in the introduction, section 3.1, and further elaborated in the above discussions, one of the contributing factors to risk is *uncertainty*. The key difference between risk and uncertainty is that risk has a quantifiable measure for future events, whereas uncertainty does not (Zomorrodi, 2016:518; Prakash, Soni & Rathore, 2017:69). In other words, in this research, SC uncertainty was a factor contributing towards risk.

To manage risk, better tools, such as demand planning, supply network planning, production planning and availability planning should be employed. Practical examples of managing SC risk could include the usage of seasonal workers during unforeseen peaks, using subcontractors to enable flexibility, using dual facilities for storing stock, product flexibility during manufacturing process, building of safety inventory during predictable peak periods, and employing postponement strategies in product assembly and/or manufacturing (see section 3.8.5).

3.2 Supply Chain Risk in Perspective

3.2.1 Risk management and supply chain risk

Risk management is the sub-set of activities within an organisation aimed at ensuring the most favourable outcome and the reduction of volatility or variability of that outcome. Risk management has its origins in the finance fraternities and disciplines and was first used in 1956 in the insurance industry (Hopkin, 2012:13; Botha, 2016:24). Researchers Tukamuhabwa, Stevenson, Busby and Zorzini (2015:5602) and Elluru, Gupta and Kaur (2017:2) divided risk management into two areas: proactive risk management, and reactive risk management from a resilience point of view. While proactive risk management refers to activities taking place before a risk incident, reactive risk management refers to planned actions to be executed after a risk incident has occurred. Reactive risk management is often referred to as *disruption management* and is discussed in detail later in section 3.9 (Schlüter, Sprenger, Spyridakos & Vryzidis, 2016:85).

Risk is defined as the effect of uncertainty on objects, whether positive or negative, or a deviation from the expected. An "object" can be an organisation or a set of integrated processes, such as a supply chain or logistic chain. Furthermore, risk is viewed as an event, a change in circumstances, or a consequence (AIRMIC; IRM, 2010; Hopkins, 2012:13; Verbano & Venturini, 2013:187; Botha, 2016:22; Hubbard, 2020:284).

This study will be conducted in an *import supply chain*. Therefore, a definition for risk from a supply (import) perspective can be regarded as "the potential occurrence of an incident or failure to seize opportunities with inbound supply in which its outcomes result in a financial loss for the purchasing (import) firm" (Zsidisin & Ritchie, 2009:1; Schlüter, Sprenger, Spyridakos & Vryzidis, 2016:86). With this definition in mind, it is easy to understand that there is a wide range of risks in the import supply chain. Table 3.1 provides a list of some of the risks that may be encountered in the import supply chain.

Table 3.1: Supply chain risks

Risks	Source reference
1. Regulatory and legal risk	Wagner and Bode (2006:303).
2. Infrastructure risk	
3. Capacity risk	Wildemann (2006:3).
4. Quality and service risk	
5. Financial risk	
6. Location risk	
7. Contractual risk	
8. Macroeconomic risk	Manuj and Mentzer (2008a:198).
9. Policy risk	
10. Competitive risk	
11. Resource-constraint risk	
12. Currency risk	
13. Transit time risk	
14. Forecast risk	
15. Quality risk	
16. Safety risk	
17. Disruption risk	
18. Survival risk	
19. Inventory risk	
20. Culture risk	
21. Dependency and opportunism risk	

22. Oil price increase risk	
23. Intellectual property (IP) risk	Tang and Tomlin (2009:236).
24. Behavioural risk	
25. Political risk	
26. Social risk	
27. SC visibility risk	Sodhi and Tang (2012:4).
28. IT system risk	
29. Exchange rate risk	
30. Market risk	Ali and Shukran (2016:336)
31. Human risk	
32. Financial risk	
33. Institutional risk	
34. Production risk	
35. Environmental risk	Moslemi, Hilmola and Vilko (2016:257).
36. Industry risk	
37. Organisational risk	
38. Problem-specific risk	
39. Decision-makers risk	
40. Supply risk	Truong Quang and Hara (2018:1373)
41. Operational risk	
42. Demand risk	
43. Macro / Micro risks	
44. Information risk	
45. Natural disaster	
46. Terrorism	Dolgui, Ivanov and Sokolov (2018:415)
47. Man-made disaster	
48. Natural disaster	
49. Piracy	
50. Political crises	
51. Financial crises	
52. Strikes / industrial action	
53. Legal contract disputes	

Source: Compiled by the researcher

The list above is not a complete list, but only examples of risks that might plague organisations and supply chains. This list was compiled from research done over the last 14 years. It is clear there are many different types of supply chain risks that can originate from various sources or occur due to various factors. The next section will elaborate further on the sources of supply chain risk.

Due to globalisation, organisations have gained access to more resources, making it easier to access import and export markets. With the expanded markets, organisations also had to expand their capabilities to match these expanding markets. These expanding markets resulted in greater competition between individual organisations and supply chains. This increased competition between organisations and supply chains resulted in renewed attention to the sustainability of organisations and supply chains, and risks that were previously regarded as insignificant have become crucial due to this increased exposure (Nishat Faisal, Banwet, & Shankar, 2006:535; Park, Nayyar & Low, 2013:28; Hirst & Thompson, 2019:248).

3.2.2. Logistics infrastructure risks

The risks in logistics infrastructure pose a potential disruption to the economy, individual supply chains, and in the import of goods, which is the focus of this study.

An efficient *transport network* is heavily dependent on investment and quality infrastructure to promote and enhance GDP growth and development. South Africa, however, has missed the opportunity for decades to invest in almost all areas of transport, including roads, rail and seaports (Chakwizira, 2019:3). Non-investment, together with neglect and under-maintenance has led to a very fragile transport network. As mentioned in section 2.8.2.1, according to SANRAL, 26% of municipal and provincial roads are in a 'poor' or 'very poor' condition, with 38% of roads in a good condition (Chakwizira, 2019:3). These statistics, together with the fact that 80% of South Africa's national road network is older than its designed lifespan of 20 years, paints a very bleak picture. This increases road network vulnerability and reduces the road network's resilience as damage to this fragile network is a high probability (Chakwizira, 2019:3).

In their research on the maritime disruptions in the UK industry, Adam, Brown, Nicholls and Tsimplis (2016:3) identified port risks as originated from: 1) human error; 2) mechanical or structural faults; 3) poor visibility; 4) rough seas; 5) snow and ice; 6) storm surge; and 7) windstorm. They also divide the logistical port risks into 5 categories namely: 1) least severe; 2) low severity; 3) moderate severity; 4) high severity; and 5) most severe. This classification could be applied as a benchmark for studies in port risks in the South African context as well. This will help determine how South Africa compares to first world countries in terms of the time and impact of the disruptions. According to Adam *et al*., (2016:4) the classification of port risks is as follow:

1. Least severe → less than 3 hours delay → e.g. rough sea conditions;
2. Low severity → minor damage to port and/or vessel;
3. Moderate severity → small spills;
4. High severity → flooding;
5. Most severe → severe port damage.

3.2.3. Logistics outsourcing and risk

With the increasing demand of manufacturing organisations to outsource non-core functions like logistics activities to third-party logistics providers (3PL) and fourth-party logistics providers (4PL), it is evident that this entails associated risk that needs to be managed and included in the risk management sphere. It is crucial for both 3PL's and 4PL's to manage and control their risk during the delivery process, which is of extreme importance when managing the quality of logistics services (Huang, Tu, Chao & Jin, 2019:1).

One of the many supply chain risks Haung *et al.* (2019:3) mention in their research is contract management. Contract management is important, as this is the foundation and measurement that will be used between the contracted parties. In their research, Haung *et al.* (2019:3) refer to consignment contracts, with revenue sharing, performance contracts, and price-dependant discount contracts as ways to manage the performance and risks in the supply chain. Due to the nature of 3PL and 4PL operations, it is of crucial importance that information is shared between the logistics service provider and the other contracted parties. This will ensure information asymmetry is eliminated, reducing not only the risk in the supply chain, but also improving and creating a more efficient supply chain overall (Haung *et al.*, 2019:3).

3.3 Sources and Consequences of Supply Chain Risk

Risks may arise from various sources and have far-reaching effects or consequences in the supply chain. Due to the globalization of supply chains, it is relevant to establish whether the risk originated locally or globally. By identifying the origins and their drivers, it could help with identifying suitable risk mitigation strategies. Figure 3.3 below shows a risk matrix developed by Sodi and Tang (2012:21). It categorises risk sources in four categories: operational risks, network risks, localisation risks and enterprise risks. It further indicates the local/global consequences of these risks (Sodhi & Tang 2012:22; Ho, Zheng, Yildiz & Talluri, 2015:5033; Rangel, de Oliveira & Leite, 2015:6869; Zomorrodi, 2016:523).

		Consequences	
		Local	Global
Risk Sources	Local	**Operational risks** Local risks stemming from supply and demand	**Network risks** Risks stemming from an organisation or region that spreads to impact the whole supply chain
	Global	**Localisation risks** Risks from corporate level decisions on specific markets or regions	**Enterprise risks** Risks from corporate level decisions that impact the entire supply chain

Figure 3.3: Risk matrix: Supply chain risk drivers and consequences.
Source: Sodhi and Tang (2012:21).

If the risk source is local and the effect or consequence is global, it will be categorised as a network risk stemming from an organisation or region that spreads to affect the whole supply chain. Similarly, if the risk source is local and the consequence is local, it will be categorised as operational risk stemming from supply and demand. The matrix shows what category of risk arises when considering the source of the risk and the consequence of the risk. Lastly, if the risk source is global and consequence is local the risk will be classified as localisation risk stemming from corporate level decisions in specific regions. If the risk source is global and the consequence is global the risk will be classified as enterprise risk which can affect the entire supply chain.

3.4 Categorisation of Risks

As indicated previously, risks in organisations and supply chains are usually categorised, classified, or grouped. Different authors and researchers have different versions of the categorising of risks. This categorisation of risk allows for easy identification of the underlying causes, whether internally or externally, but also identifies whether it is planned or unplanned. Zsidisin and Ritchie (2009:3), for example, are of the opinion that all supply chain risks fall into the following categories: 1) downtime and failure to satisfy the customer's requirements on time; 2) lost profit; 3) poor quality; and 4) reputational damage to the organisation. DuHadway, Carnovale and Hazen (2016:13), on the other hand, indicate four classifications of risk (depicted in Figure 3.4 below); namely, endogenous, exogenous, intentional and inadvertent.

3.4.1 Intentional and unintentional (inadvertent) risks

Figure 3.4 as proposed by DuHadway *et al*. (2017:12) explains that risks can be either intentional or unintentional. The difference between these two concepts is the *intention*. Intention is defined as a mental state that represents a commitment to carrying out an action or actions in the future. Intention involves mental activities such as planning and forethought (Mendelovici & Bourget, 2020:2). This means that when an action was done intentionally, it was planned, and when an unintentional action occurred, it was not planned. *Performance failure*, for example, is unintentional, while an "inside job" (internal dishonest behaviour) is intentional. Performance failure may be caused by poor quality controls, supplier bankruptcy, and scheduling failures, which reasonably, could not have been foreseen, and inexplicitly (unintentionally) caused harm to organisations. Inside jobs, on the other hand, include fraud, contract breech, and theft, with the explicit purpose to do harm to the organisation (DuHadway *et al*., 2017:12; Brusset & Teller, 2017:62).

3.4.2 Internal (endogenous) supply chain risks

Internal supply chain risks have their origin *within (endogenous)* the boundaries of the supply chain, e.g., risk from suppliers or customers that is under control of the supply chain (Brusset & Teller, 2017:62). Both performance failures and inside jobs (refer to 3.4.1) are examples of internal risks, according to Brusset and Teller (2017:63). In their research, Salamai, Hussain, Saberi, Chang and Hussain (2019:2) mention that in order to have a robust risk management process, it is important to consider both internal and external sources of supply chain risk. They have listed internal operational supply chain risks as risks in 1) planning; 2) sourcing; 3) making (producing); 4) delivery; and 5) returning, which is further explained in Table 3.2 below. This categorisation clearly reflects the process-modelling building blocks of SCOR (supply chain operations reference) model.

Table 3.2: Internal supply chain risks

Risk type	Internal risk type description
Plan risks	Occurs during the collection of input information when planning demand, supply, capacity and resources
Source risks	Occurs during the collection of information in the sourcing process and while establishing the availability of materials in the planning process of SCM
Make risks	Occurs during the obtaining of resources that is used to transform raw materials into products and/or services
Delivery risks	Occurs during requests for deliveries and during the transportation of products
Return risks	Occurs during the receiving of reverse material flows

Source: Salamai *et al*. (2019:5)

3.4.3 External (exogenous) supply chain risks

External supply chain risks have their origin *beyond (exogenous)* the boundaries of the supply chain, e.g., economic, social, and political risk (Brusset & Teller, 2017:62). These risks can also be either intentional or unintentional as DuHadway *et al*. (2017:12) point out. Figure 3.4 explains the relationship between *exogenous* factors and *intention*. *Force majeure* and *targeted strikes* are both *exogenous,* but the difference lies in the intention. *Force majeure* is unintentional, while targeted strikes are intentional. *Force majeure* is an unintentional disruption outside (*exogenous*) the supply chain, for instance, natural disasters, economic disruptions, and port closures. *Targeted strikes* originate from intentional actions, but from outside the supply chain like competitor driven disruptions, government intervention or protest actions (Brusset & Teller, 2017:63).

Table 3.3: External supply chain risks

Risk type	External risk type description
Environmental risks	Originate from outside the SC. Often related to economic, social, climatic and governmental factors. Leads to additional supply and demand risks
Business risks	Occurs because of exterior factors that impact on the organisation's management stability, finances, sales and/or purchases
Physical plant risks	Occurs due to events impacting the condition of an organisation's physical facilities and the requirements from governmental regulatory bodies

Source: Salamai *et al*. (2019:5)

External risks, according to the classification by Selamai *et al*. (2019:5) include: 1) environmental risk; 2) business risk; and 3) physical plant risk, as seen in Table 3.3. When combining and summarising the above classifying concepts, i.e., internal, external, intentional, and unintentional, DuHadway *et al*. (2019:185) proposed the matrix in Figure 3.4.

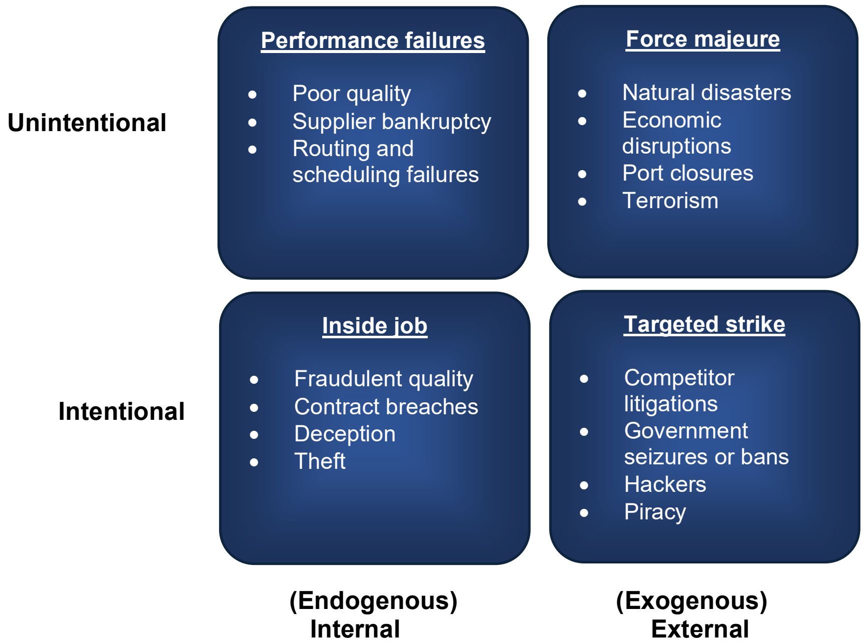

Figure 3.4: Classifications of risk.
Source: DuHadway *et al.* (2019:185)

3.5 Supply Chain Risk Management

Supply chain risk management (SCRM) can be defined as "a wide variety of strategies aiming to identify, assess, mitigate and monitor unexpected events or conditions which might have an impact, mostly adverse, on any part of a supply chain" (Baryannis, Validi, Dani & Antoniou, 2019:2179). In order to ensure that a robust and informed supply chain risk management (SCRM) process is achieved, Salamai *et al.* (2019:2) suggest that four "levels" of risk management need to be considered (visually represented in figure 3.5):

> *Level four* is risk management based on individual processes i.e. internal risk only. This level only considers risk at individual or departmental level within the organisation. This level is the least progressive and most elementary level.

Level three is risk management from an organisational perspective i.e., internal risk. This level is more advanced compared to level four, but still only considers organisational risk.

Level two is risk management from an end-to-end supply chain perspective i.e., internal and external risk. This level is the first level where both internal and external risks are considered.

Level one is risk management from the perspective of external events. This level is the most advanced of all levels and considers all risks internal and external to the supply chain (Salamai *et al.*, 2019:5).

To achieve a robust SCRM process, organisations need to strive to achieve Level 1 of the Salamai *et al.* (2019:6) model. This model follows a holistic approach, which considers both internal and external risks of the supply chain (Sayed & Sunjka, 2016:125; Hudnurkar, Deshpande, Rathod & Jakhar, 2016:188). As for intentional and unintentional risks, both classifications should be considered in the researchers' opinion, as is illustrated in Figure 3.4 as well.

Figure 3.5: Levels of SCRM.

Source: Compiled by researcher from Salamai *et al.* (2019:6)

3.6 Inherent Components of Risk

There is certain terminology applicable to risk management in organisations. The three most important concepts, also called the components of risk, are uncertainty, probability, and effect (Breakwell, 2014; Botha, 2016).

Uncertainty can be described as doubtful or unknown. One can distinguish between risk and uncertainty. Uncertainty is un-measurable, whereas risk is measurable (Knight, 1965:20; Dani, 2009:54; Gollier, 2018:6). *Probability* can be defined as the chance of an event happening (Botha, 2016:22; Gollier, 2018:43). Probability is the quantifying measure on which a risk assessment can be based (Mc Laughlin, 2015:40; Aqlan & Lam, 2015:5640; Qazi, Quigley & Dickson, 2015:1). According to Fan and Stevenson (2018:8), *probability* drivers are competitive pressures that might increase or decrease supply chain vulnerability. *Effect*, also known as consequence, is typically expressed as a multiple of simultaneous outcomes, many of which interact with one another (Ritchie & Brindley, 2000:575; Vieider, Lefebvre, Bouchouicha, Chmura, Hakimov, Krawczyk & Martinsson, 2015:17).

The relationship of the components of risk can be indicated by means of the following formula (Mc Laughlin, 2015:40; Aqlan & Lam, 2015:5640):

Risk (uncertainty) = Probability (chance of happening) x Consequence (effect)

3.7 Cost of Risk

Risks, when unmanaged lead to disruptions. Disruptions have a direct quantifiable negative effect on the finances of an organisation (Li, Zhen, Qi & Cai, 2016:2). These costs usually come in the form of overtime, premium freight, obsolete inventory, demurrage, storing charges, and penalties imposed by customers for late, or non-delivery (Hendricks & Singhal, 2008:780; Li et al., 2016:2). Not only can risks and disruptions be measured in monetary terms, but they can also have a negative indirect effect on the organisation's image or reputation, which is sometimes difficult to quantify and can translate into financial loss (van Hoek, Wagner, Lemke & Petersen, 2013:413). Such reputational damage is difficult to quantify because reputation is mainly built on cumulative perceptions of all stakeholders regarding the organisation's corporate image, products, brands, and culture.

In addition to the costs mentioned above, research done by Loh and Thai (2015:319) quantified costs associated with port-related supply chain disruptions, including port lockouts, strikes, and defective and inadequate handling equipment, which resulted in low productivity, inefficiencies, and damage or loss of cargo. Their conclusion was that, if not managed well, port risks can and will have a great negative financial impact on the organisation if no strategy exists to mitigate risks and to speedily react and recover from disruptions. Disruptions occur when risks are not properly identified and dealt with.

3.8 A Supply Chain Risk Management Framework

The scope of this study includes risk management in a supply chain context. Supply chain risk management (SCRM) is the process by which supply chain risks are identified, assessed, and an approach is selected to mitigate these risks (Park, Nayyar & Low, 2013:98; Zomorrodi, 2016:522; DuHadway, Carnovale & Hazen, 2019:190). There are certain steps to follow in the implementation of SCRM. The steps are represented in a framework and illustrated in Figure 3.6. These steps will be further discussed in sections 3.8.1 to 3.8.5.

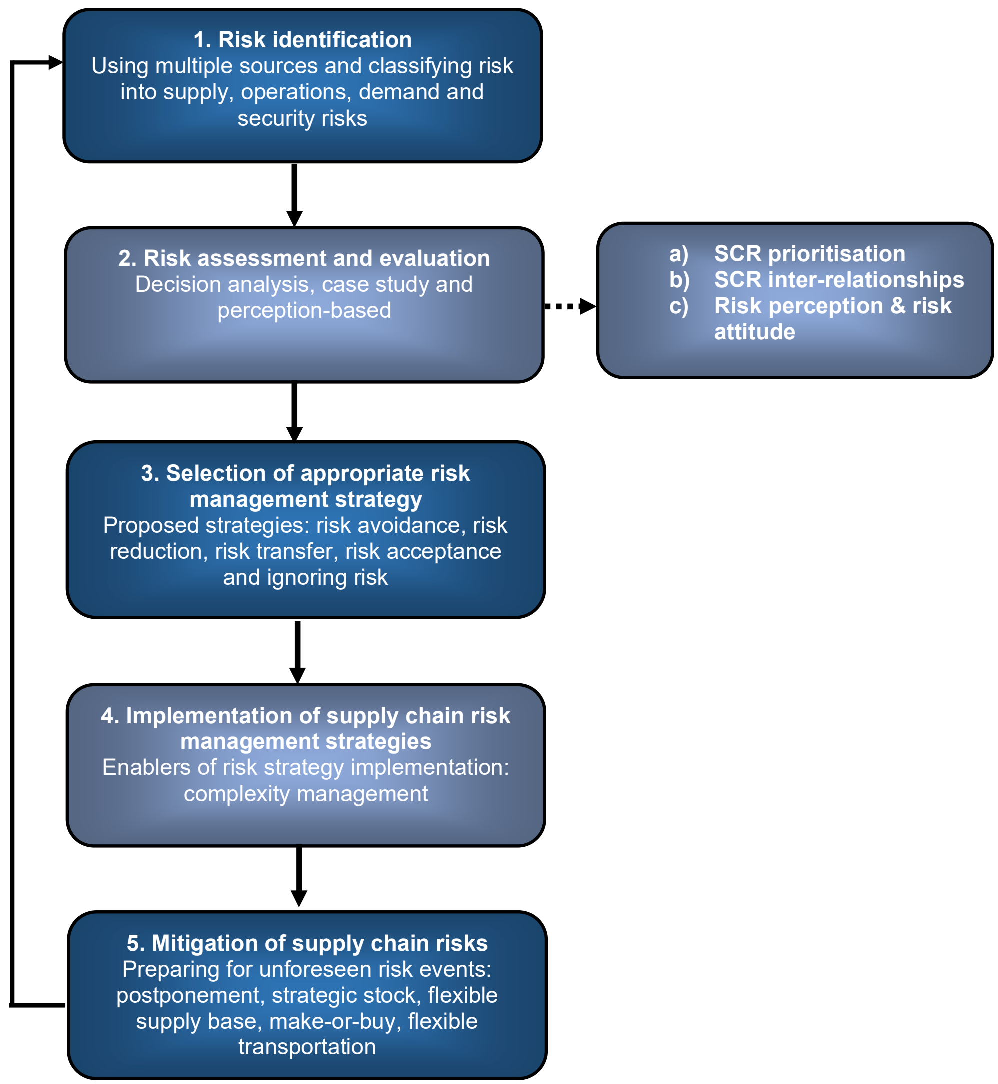

Figure 3.6: Supply Chain Risk Management framework.

Source: Adopted from Manuj and Mentzer (2008a:212); Park *et al.* (2013:99); DuHadway *et al.* (2019:190)

3.8.1 Identification of risk

The identification of risk aims to establish all relevant risks and recognise future uncertainties (Fan & Stevenson, 2018:8). For the identification of risk, the risks must be categorised (Manuj & Mentzer, 2008a:212). Many different types of categorisations of risks were discussed in this chapter. In this discussion of the steps in the supply chain risk management process (framework) a supply chain management-oriented categorization of risk, as suggested in Chapter 1 (section 1.2) is followed. According to this categorisation, risk can be categorised into four main groups: supply risks, operational risks, demand risks and security risks (Christopher & Peck, 2004:2; Dani, 2009:54; Sodhi & Tang, 2012:22; Bandaly, Satir, Kahyaoglu & Shanker, 2012:251; Botha, 2016:6; Moslemi, Hilmola & Vilko, 2016:256).

Supply risks negatively affect the timing, cost, and specifications of all inputs required by the organisation, whether the inputs are goods, services, or information. These inputs are usually sourced from organisations upstream from the focal organisation (Dani, 2009:54; Park *et al.*, 2013:99). According to Park *et al.* (2013:99), the *operational risks* are derived from the operations of the organisation in question. These operational risks can be subdivided into process risks and control risks. Process risks are those risks that cause disruptions in the organisation's value-added processes, including but not limited to design, manufacturing, and distribution. Control risks are those risks which refer to the controls used to govern processes. *Demand risks* are based on the failure to match production with consumer demand, whether it is due to changing consumer preferences, or imperfect communication between the organisation and downstream customer organisation (Dani, 2009:55; Park *et al.*, 2013:100). All risks not classified as supply, operations, or demand risks are usually grouped together as either environmental risks, *security risks or corporate risks* (Dani, 2009:55; Sodhi & Tang, 2012:22; Park *et al.,* 2013:100; Moslemi *et al.*, 2016:257).

3.8.2 Risk assessment and evaluation

The second step in the SCRM process is *risk assessment*. Risk assessment needs to be rapid and cost-effective (Fan & Stevenson, 2018:10). Risk assessment consists of taking the identified risks and assigning them with a significance, which in the end will assist with selecting a risk mitigation strategy (Park *et al.*, 2013:19). The most basic level of risk assessments centres around two questions: (1) What is the *probability* of a risk event occurring; and (2) what is the significance, impact, effect or *consequence* of that risk event (Park *et al.*, 2013:13; Mc Laughlin, 2015:41; Botha, 2016:22)? The risk assessment can be done based on data, decision analysis, case studies, perception, and/or expert judgment. According to Fan and Stevenson (2018:10), the risk assessment can be formal, informal, quantitative, or qualitative. Fan and Stevenson (2018:10) indicate that risk assessments are inherently subjective and to arrive at a more objective conclusion, a combination of objective data and subjective perception are needed. To adjust the analyst's perception, the following must be considered:

3.8.2.1 SCR prioritisation

Since not all risks are equally important, it is imperative to identify the most significant risks. It is highly unlikely that organisations can deal with all possible risks in their operations, as this requires large amounts of investment and time. Preference might be given to risk with a high consequence, or to risks which can be mitigated easily. By prioritising important risks, organisations can focus on a limited number of risks with limited resources at their disposal. Prioritising risks can be done by means of uncovering risk inter-relationships or risk assessment tools, such as, failure modes, effect analysis (EA), and analytic hierarchy process (AHP) (Mu & Carroll, 2016:32; Fan & Stevenson, 2018:11).

3.8.2.2 SCR Inter-relationships

Risks rarely, if ever, exist in isolation, but rather, are part of a set of inter-relationships with other risks, and are experienced as a domino effect across the whole supply chain (Fan & Stevenson, 2018:10). Classifying different types of dependence amongst various risks can help with the prioritising of SCR. According to Sarker, Engwall, Trucco and Feldmann (2016:451), risks can be classified in terms of inter-relationships into two categories: 1) positive dependence, i.e., where removing one risk helps eliminate or mitigate various other risks; and 2) negative dependence, where removing one risk may create other risks as an unintended consequence.

3.8.2.3 Risk perception and risk attitude

Organisations differ in their perception and attitude towards risk. This is mainly because organisations have different ways of dealing with decisions involving risk (Adebola Adeseun, Anosike, Garza-Reyes & Al-Talib, 2018:11; Guan & Tang, 2018:262; Chimwai &

Munyanyi, 2019:55). Risk perception is a subjective, predictive judgement and evaluation of the characteristics and severity of potential risk (Chimwai & Munyanyi, 2019:56). Risk attitude is an organisation's intentions to assess a risk in either a positive or negative manner and act accordingly.

In their research, Chimwai and Munyanyi (2019:56) proposed a conceptual model linking risk perception to risk attitude, as can be seen in Figure 3.7. Their proposed model indicates that perceived probability of occurrence, perceived probability of impact (effect) and perceived severity of impact (effect) are contributing factors to the overall risk attitude. The risk attitude will ultimately determine the risk management strategies the organisations will adopt, which will be explained in the subsequent sections (Guan & Tang, 2018:262; Chimwai & Munyanyi, 2019:57). A risk-averse manager or organisation is more likely to settle for a less rewarding avenue with lower risk, as opposed to an avenue which is more rewarding but with increased risk. On the other hand, a risk-taking manager or organisation would rather accept a more rewarding avenue with increased risk, over an avenue which is less rewarding with less risk (Guan & Tang, 2018:263; Adebola Adeseun, Anosike, Garza-Reyes & Al-Talib, 2018:12; Chimwai & Munyanyi, 2019:58).

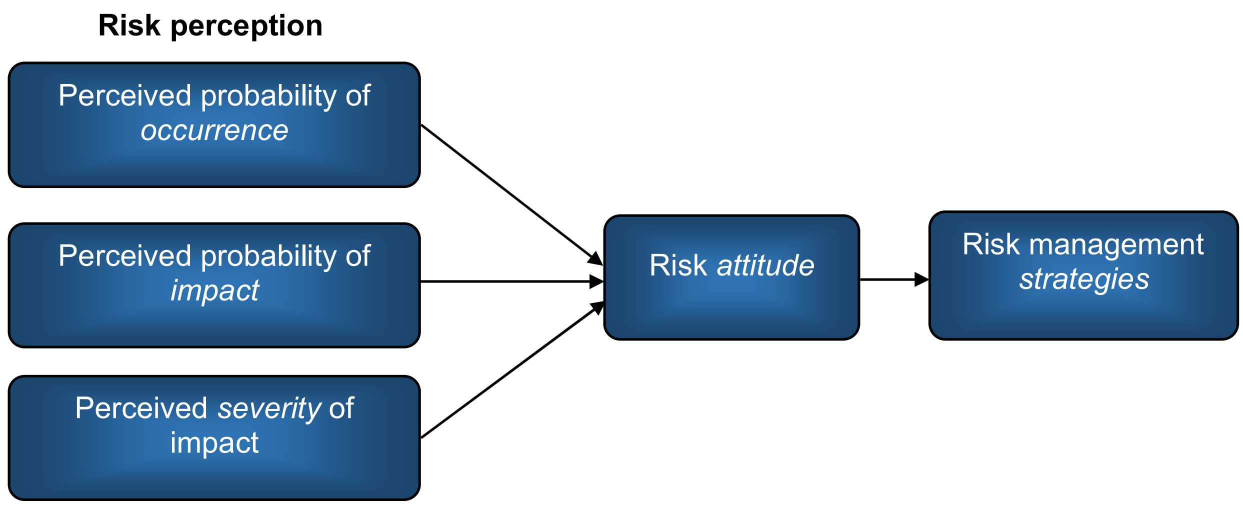

Figure 3.7: Risk perception and risk attitude conceptual model.

Source: Chimwai and Munyanyi (2019:57)

3.8.3 Selection of appropriate risk management strategy

According to the supply chain risk management framework, before the final step (risk mitigation) in the risk management process, can be achieved, a risk mitigation strategy must be selected (Park *et al*., 2013:14). Ample research and literature reviews have been conducted on supply chain risk mitigation strategies, including work from Jüttner, Peck and Christopher (2003:19); Tang (2006:479); Manuj and Mentzer (2008a:212, 2008b:212); Sodhi and Tang (2012:53); Elluru, Gupta, Kaur and Singh (2019:199). When analysing the content and findings of these studies, it can be concluded that the mitigating strategies are grouped into the following broad categories: risk avoidance, risk postponement, risk speculation, risk hedging, risk control, and sharing or transferring of risk (Park *et al.*, 2013:15; Bode & MacDonald, 2017:836; Yoon, Talluri, Yildiz & Ho, 2018:3645). Another risk management strategy, according to Fan and Stevenson (2018:12) and Aqlan and Lam (2015:5641), is risk acceptance and ignoring risk. These mitigation strategies will be discussed in the sections that follow. Aqlan and Lam (2015:5641) elaborate on a few mitigation strategies in their research and list these strategies as follow: 1) avoid risk; 2) reducing the frequency and consequences of risk; 3) transfer the risk by sharing risk or insurance cover; 4) accepting the risk; and 5) ignoring the risk. Table 3.4 reflects the mitigation strategies according to Aqlan and Lam (2015:5642) in the context of objectives, conditions for suitability and achievability.

Table 3.4: Risk mitigation strategies

1. Risk avoidance	a) *Objective* is to eliminate risk completely b) *Suitable* for high probability and high impact risk c) *Achieved* by changing method of operation or redesigning supply chain
2. Risk reduction	a) *Objective* is to reduce risk and not to eliminate b) *Suitable* for high probability and low impact risk c) *Achieved* by redundancy, more quality checks and operator training
3. Risk transfer	a) *Objective* is to transfer risk to another party b) *Suitable* for low probability and high impact risk c) *Achieved* by contracts and insurance
4. Risk acceptance	a) *Objective* is to accept risk b) *Suitable* for low probability and low impact risk c) *Achieved* by implementing contingency plans
5. Ignoring risk	a) *Objective* is risk not identified, studied and ignored b) *Suitable* for very low probability and very low impact c) *Achieved* no action required

Source: Adopted from Aqlan and Lam (2015:5642)

From the risk mitigation strategies contained in Table 3.4, a risk mitigation matrix has been compiled as presented in Figure 3.8 below.

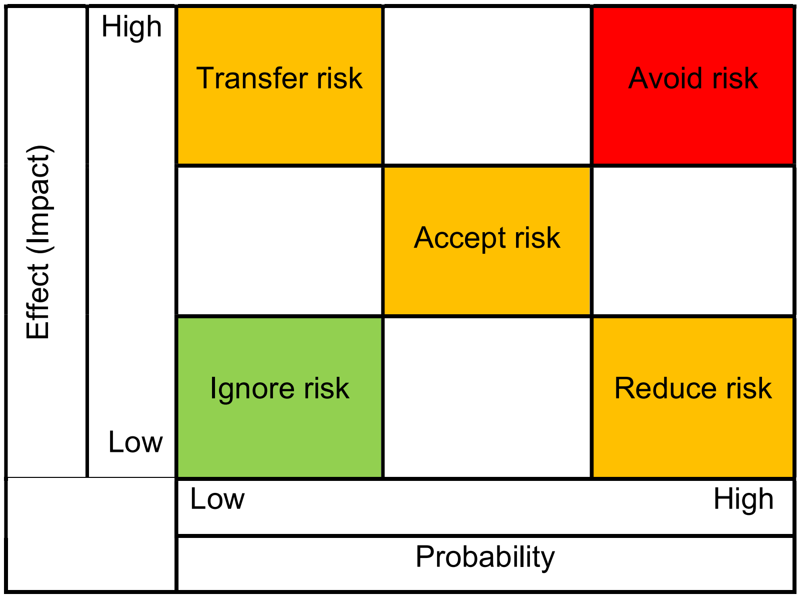

Figure 3.8: Risk mitigation matrix.

Source: Compiled by researcher from Aqlan and Lam (2015:2564)

When the effect and probability of an incident is low, a strategy of ignoring risk is appropriate, as the risk is too minute to consider material changes. Any combination of high effect and low probability or high probability and low effect requires transferring of risk, accepting risk, or reducing risk. If both effect and probability of an incident is high, a strategy to avoid risk is most suitable. It is relevant to indicate that one of the factors affecting the *effect* is the duration of the disruption. While disruptions like information technology failures, vehicle breakdowns and strikes could be relatively short, disruptions such as natural disasters and sole-supplier procurement could have long after-effects (Schmitt, Kumar, Stecke, Glover & Ehlen, 2016:6).

3.8.4 Implementation of supply chain risk management strategy

After the selection of the appropriate and most suitable risk mitigation strategy, naturally the actual *implementation* needs to follow. According to Park *et al*. (2013:16), some research is required as there is a lack of research in this area, especially around factors affecting implementation of strategies and the efficacy of these strategies. Chapter 2, section 2.5.1 reflects the complexities within the SCM arena. When navigating the implementation of risk management strategies, attention should be paid to the complexities.

3.8.5 Risk mitigation

The last step in the SCRM framework is the mitigation of risk. Risk mitigation seeks to actively reduce risk to an acceptable level and aims to reduce both the probability and consequence. The extent to which the risk is accepted, mitigated (reduced or transferred), or avoided will largely depend on the strategy that was selected and implemented. In this step it is of crucial importance to monitor, control, and manage the selected *risk mitigating* strategies by reviewing their impact on the performance of the supply chain operations (Zsidisin & Ritchie, 2009:1; Fan & Stevenson, 2018:13). Risk is not a static phenomenon, and therefore requires constant revaluation of how and when risk sources develop. Data management and developing monitoring systems and early-warning processes can be implemented to help with risk monitoring (Fan & Stevenson, 2018:13).

A potential risk mitigation strategy used in supply chain is postponement*. Postponement* is a strategy that uses product design standardisation to delay product differentiation (Tang, 2006:38; Varas, Maturana, Cholette, Mac Cawley & Basso, 2018:4133; Zinn, 2019:68). Postponement allows organisations to develop and manufacture a generic product, allowing customisation at the latest possible point in the supply chain to meet the customer demand and requirement. If demand fluctuates, this generic product can easily be converted or customised into a new variant of the product (Tang, 2006:479). According to Adabor and McMullen (2018:6), delayed product differentiation (DPD) can be used to minimize cost and delay additional investment into the product until the last possible moment, which will reduce risk. They also add that postponement can take on various forms, such as, place, form, time, labelling, packaging, assembly, and manufacturing. Postponing the purchasing of products until the point where the actual usage occurs, reduces not only the cost of ownership, but also the risk of shrinkage and obsolesce. In order for postponement not to have a negative impact on the total supply chain, as stock holding might get shifted from buyer to seller or visa verse, it is important to have a collaborative relationship between the parties i.e. buyer and seller (Zinn, 2019:68).

Another risk mitigations implementation strategy is keeping s*trategic stock* in case of disruptions. This stock is used as safety stock of critical components to ensure continuity of supply. Stock is kept in strategic areas that are shared between supply chain partners, which allows for sharing of inventory cost (Tang, 2006:39; Namdar, Li, Sawhney & Pradhan, 2018:2343; Puga, Minner & Tancrez, 2019:186).

A *flexible supply base* reduces risk in that continuity of supply can be guaranteed by having multiple suppliers and/or multiple supplying plants from different areas. By having multiple suppliers, the risk is spread when fluctuations in demand occur, and also when there are major disruptions, the nett impact is reduced. Another option is to use the same supplier, but supply from different plants in different countries (Tang, 2006:39; Simchi-Levi, Wang & Wei, 2018:1480; Song, Chen & Lei, 2018:3701).

Make-or-buy decisions enable organisations and their supply chains to become more resilient. Organisations usually decide to make core products or competencies in-house, while outsourcing non-core products. Specialised or customised products are manufactured in-house while standard products are outsourced to contract manufacturers (Tang, 2006:40; Serrano, Ramírez & Gascó, 2018:138; Brem & Elsner, 2018:1). The-make-or buy decision can reduce an organisation's risk by outsourcing non-core activities to a wide range of suppliers and service providers, thus spreading the risk across multiple partners in the supply chain.

Flexible transportation allows the supply chain to deal with disruptions proactively. Multi-modal transport models are a great way to reduce the risk of supply disruptions by making use of more than one mode of transport. Should a disruption occur, in one mode of transport, due to strike, weather, or any other related factor, the movement of goods can continue relatively unaffected. Second to multi-modal transport is multi-carrier strategies. Multiple-carrier strategy, similarly to flexible supply base, allows organisations to reduce risk by making use of multiple transporters to ensure the continuity of supply. The third strategy of flexible transportation is to make use multiple routes. Using the same routes should be avoided, as this will reduce the risk of material flow bottlenecking at certain points on the route, e.g., borders and ports. A good flexible transport strategy would include a combination of multi-modal, multi-carrier and multiple routes (Tang, 2006:41; Speranza, 2018:835; Markolf, Hoehne, Fraser, Chester & Underwood, 2019:182).

In sections 3.10 and 3.11 further supply chain risk mitigation strategies will be discussed.

3.9 Integrating Risk Management and Disruption Management

Nel, De Goede and Niemann (2018:4) believe that it is crucial for the focus to be shifted from the prevention of disruptions to responding and managing it. Therefore, they combined risk management and disruption management into one integrated model for managing disruption risks in the supply chain, as can be seen in Figure 3.9 (Golgeci & Ponomarov, 2013:611; Macdonald & Corsi, 2013:270).

Nel *et al.* (2018:4) see the SCRM process as two cycles: 1) risk management cycle; and 2) disruption management cycle. The risk management cycle consists of four cycles: 1) scope definition and risk identification; 2) risk quantification; 3) risk evaluation and treatment; and 4) risk monitoring. The disruption management cycle consists of 1) disruption detection; 2) disruption reaction; 3) disruption recovery; and 4) disruption learning (Meyer, Sejdovic, Glock, Bender, Kleiner & Riemer, 2018:3).

The disruption management cycle occurs when the risk management cycle failed to prevent a disruption from occurring. It can therefore be concluded that the risk management cycle is a proactive approach to prevent, mitigate, or reduce disruptions, whereas the disruption management cycle is a reactive approach to deal with disruptions which have already occurred (Nel *et al*., 2018:5). The first step of disruption management cycle, *disruption detection*, is to identify the characteristics and consequences of the disruption (Sheffi, 2015:36). The sooner organisations detect disruptions, the lower the impact or consequences will be. The second step, *disruption reaction*, is the cycle where organisations need to react timeously and speedily to disruptions to reduce the impact so that the SC can return to its normal operations. Reaction teams are usually created on an ad hoc basis, from various functions within the organisation to deal with the disruptions by creating visibility within the SC (Nel *et al.*, 2018:4). The third step, *disruption recovery*, is the cycle where alternative plans should be implemented if the strategies employed in the reaction phase are not successful. The fourth and last step, *disruption learning*, is the phase where the disruption has been successfully dealt with, but more importantly crucial lessons have been learnt to avoid future disruptions. This phase is usually characterised by the drafting of SC policies and procedure to enable the organisation to deal with similar disruption occurrences in future (Nel *et al*., 2018:4). It is after the disruption learning phase that the transition is made from *disruption management* to *risk management*.

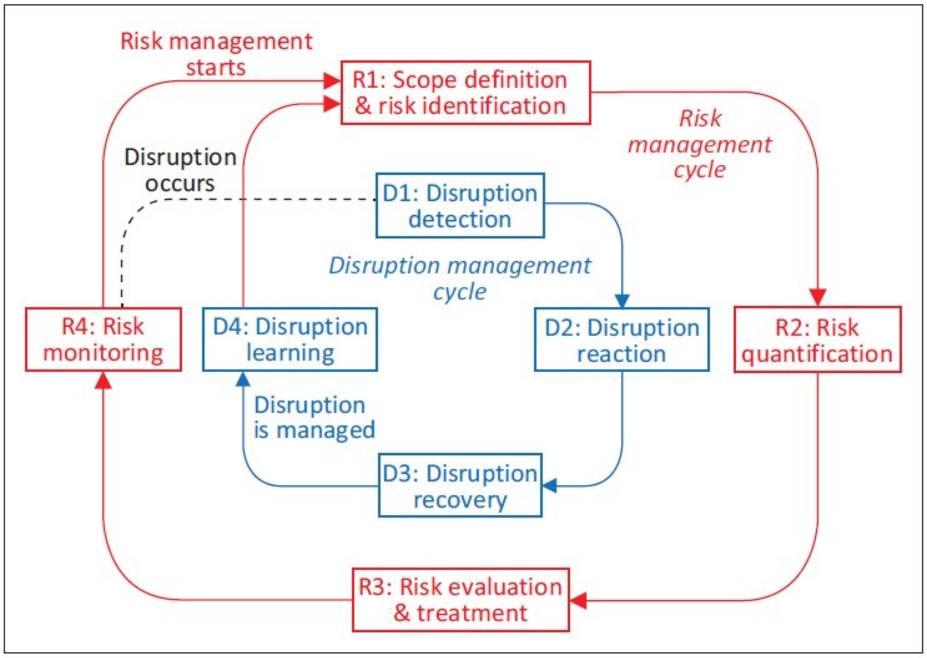

Figure 3.9: Integrated framework for managing disruption risk.

Source: Nel, De Goede and Niemann (2018:12).

Disruptions in the supply chain can originate in 1) the sourcing strategy; 2) inventory management; 3) production planning; and 4) control, as reflected in Figure 3.10. *Single sourcing* contributes to disruptions due to the lack of flexibility and risks attached to a single-supply source. When a disruption occurs at the single supply source, e.g., a natural disaster, no alternative source is available. The affected organisation needs to look for alternative sources, which may or may not be readily available, and which is usually a time-consuming process leading to loss of sales. Low levels or no *safety stock* in the supply chain is another contributing factor to disruptions. When a disruption occurs where no safety stock is available, the impact will be felt immediately, as opposed to when safety stock is available. Safety stock might not necessarily protect against the disruption, depending on duration, but can most certainly help in reducing the impact (Dolgui *et al.*, 2018:14). *Contingency plans*, otherwise known as "back-up" plans can take the form of business continuity plans (BCP). These plans are drafted and formalised in a document as potential plans during disruptions. These contingency plans could include alternative site supplies, moving stock around, finding and listing alternative suppliers, and any other relevant plans to ensure business continues as "normal" as possible during a disruption. Lastly, *spare capacity* is crucial to ensure that an organisation can deal with and recover from a disruption. By always ensuring there is spare capacity, the organisation will have the required resources to effectively recover from the disruption or make adaptions to increase production. Having spare capacity, on the other hand, creates a contradicting objective as the objective of an organisation is to operate as close to 100% capacity as possible to maximise profits and efficiency. This makes it difficult to justify additional capacity which is not used in daily operations.

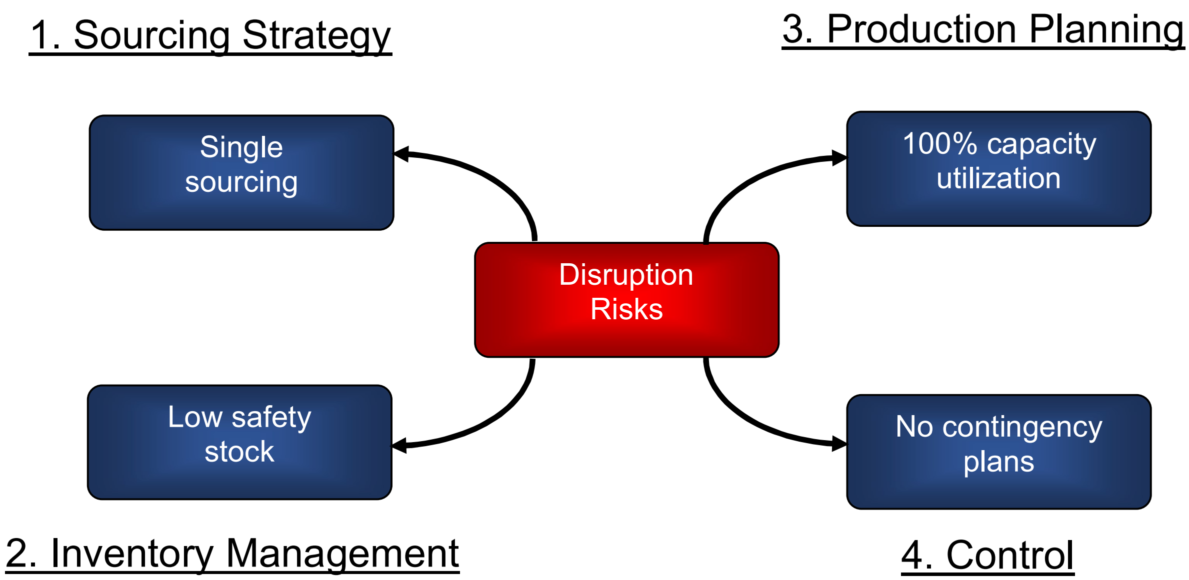

Figure 3.10: Internal organisational causes for SC disruptions.

Source: Dolgui *et al.* (2018:14).

3.10 Risk Mitigation through Collaboration and Integration

Collaboration can be defined as the coordinated efforts of organisations in the supply chain working towards mutual goals, developing processes or products jointly, redesign business practices, sharing the cost of investments, mitigating risks, or sharing information amongst supply chain stakeholders. Collaboration, if applied correctly, can be a powerful instrument for achieving an effective and responsive supply chain (Herczeg, Akkerman & Hauschild, 2018:1058; Singh, Garg & Sachdeva, 2018:149; Leising, Quist & Bocken, 2018:977; Neubert, Ouzrout & Bouras, 2018:2).

Inter-organisation relationships, or *collaboration*, enhance organisations' performance by mitigating risk (Chen, Sohal & Prajogo, 2013:2186). This improved performance is achieved by systematic identification of risk sources, contingency plans, and regular monitoring of developments (risk management process, discussed in section 3.8) in a supply chain context. The pooling of resources allows for the removal of duplication and, in the long run, contributes to cost savings in the supply chains. Short-term benefits could include operational efficiencies while the longer-term benefits include competitive advantage and increased profits. Research done by Banchuen, Sadler and Shee (2017:111) draws a strong link between inter-organisational collaboration and organisational performance. The improved organisational performance can be in the form of return on investment (ROI), profit margins, customer satisfaction, and market agility (Pradabwong, Braziotis Tannock & Pawar, 2017:2). This in turn will reduce risk in the supply chain, and therefore inter-organisational collaboration can be regarded as a tool to mitigate, or at least reduce risk. This collaboration is not focused on a transactional coordination between organisations in a supply chain, but rather a strategically positioned approach to interactions of organisations that could help manage critical supply chain risks. Collaboration facilitates the creation and sharing of knowledge in a supply chain and also encourages organisations to support each other during a disruption. The goal of collaboration, through information sharing, joint decision making, and communication, is to avoid disruptions (Adabor & McMullen, 2018:13).

Integration can be defined as the merging of the manufacturer and its suppliers (Huang *et al*. 2014:1). Integration is further defined as the "strategic collaboration with key supply chain partners and an effective and efficient management of intra- and inter-organisational activities related to the flow of products, services, information, finance and joint decision-making" (Jajja, Chatha & Farooq, 2018:127; Chaudhuri, Boer & Taran, 2018:3; Lu, Ding, Asian & Paul, 2018:5).

According to Jajja, Chatha and Farooq (2018:128), supplier and customer *process integration*, for example information sharing and coordinated operations, can lead to an improved agility performance that could help reduce the organisation's risks and provide a competitive advantage over rivals. Supply chain integration consists of 1) internal integration, meaning a functional integration; and 2) external integration, which includes supplier integration and customer integration. Jajja *et al.* (2018:128) found that *internal integration* had a weak link to agility performance. However, other researchers such as Brusset and Teller (2017:5) found a positive relationship between internal integration and agility performance. Shahbaz, Rasi, Ahmad and Rakiman (2019:63) found that supply chain integration leads to better supply chain performance with more accurate costings, increased coordination with suppliers, increased coordination between departments, and increased coordination with customers. To reduce overall supply chain risk, integration could be used as a mitigation tool during the SCRM framework. To establish what integration entails, Table 3.5 summarises the different types of supply chain integration and how each can be achieved. If integration does not take place, it opens the door to increased risk due to lack of information, reduced or delayed communication between supply chain stakeholders, and one-dimensional problem solving and decision-making (Shahbaz *et al.*, 2019:65).

Table 3.5: Supply Chain Integration

Integration Type	Achieved by
1. Internal Integration	Sharing information across departments
	Sharing a common vision
	Effective communication within the organisation
	Sharing of resources
	Joint planning for problem-solving
	Establish joint objectives
	Utilising cross-functional work teams
2. External Integration	
a. Supplier Integration	Sharing information with suppliers
	Participating in the sourcing decision
	Establish common goals with supplier
	Establish long-term relationship
	Supplier evaluation
	Performance metrics are shared
	Joint decision to improve cost efficiency
b. Customer Integration	Sharing information with customer
	Establish common goals with customer
	Establish long-term relationship
	Performance metrics are shared
	Follow-up for customer feedback
	Joint decision making to improve cost efficiency

Source: Adopted from Shahbaz *et al.* (2019:65).

In summary, both collaboration and integration could be used as a risk mitigation strategy during the SCRM framework, as indicated by previous research.

3.11 Risk Mitigation through Resilience, Flexibility and Robustness

3.11.1 Introduction

Resilience, as defined by Brusset and Teller (2017:59), is the "ability of a supply chain to return to normal operating performance, within an acceptable period of time, after being disturbed". Adabor and McMullen (2018:4) define supply chain resilience as "the system's ability to return to its original state or to a new, more desirable state." *Resilience* is often referred to as the capability to deal with SC risks effectively, therefore it is the capability to adapt and retain (Kwak, Seo & Mason, 2018:9). This operational capability is crucial to recover from disruptions in the supply chain and to develop strategies to become more robust and stronger. A supply chain is resilient when it can deliver goods and services during times of disruption, both internally and externally, and is able to recover quickly from these disruptions.

There are many ways to develop a more resilient supply chain, including collaboration between supply chain partners, planning, forecasting, vendor managed inventory (VMI), sharing of accurate real-time information between supply chain partners, improved visibility, IT integration, and reduced inventory (Brusset & Teller 2017:61).

According to Dolgui *et al*. (2018:13), the concept of supply chain resilience cannot be comprehensive without explaining it in the context of robustness, redundancy, recovery, and resistance as seen in Figure 3.11.

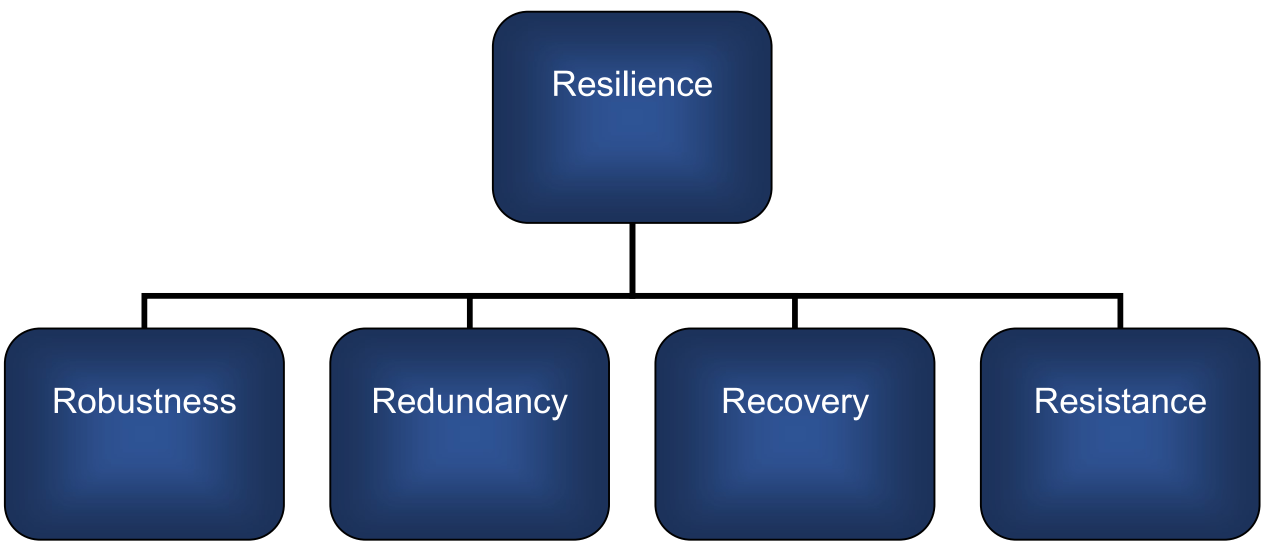

Figure 3.11: Resilience concept.

Source: Dolgui, Ivanov and Sokolov (2018:13).

Supply chain resilience requires both *resistance* and quick *recovery* to be robust. *Resistance* is the ability to withstand and protect the supply chain against disruptions, and then, once a disruption has occurred, to reduce time lost during recovery. *Recovery* involves getting the supply chain back to equilibrium after a disruption occurs. *Redundancy* is the ability to build additional capacity and alternative sourcing (Dolgui, Ivanov & Sokolov, 2018:13).

Robustness is defined as the "extent to which the supply chain is able to carry out its functions despite some damage done to it" (Saenz, Koufteros, Durach, Wieland & Machuca, 2015:16). *Robustness* improves the resilience of the supply chain to both internal and external risks and uncertainties. *Robustness*, like resilience, is also known as the capability to effectively deal with SC risks. The difference is that robustness relates to the capability to resist and sustain. The ultimate goal of supply chain risk management (SCRM) is to have a robust and resilient supply chain, as this will allow a supply chain to remain sustainable even when faced with risks and disruptions (Saenz *et al.*, 2015:16; Kwak, Seo & Mason, 2018:9; Monostori, 2018:111; Zhao, Scheibe, Blackhurst & Kumar, 2018:1).

Flexibility is discussed in detail with reference to the supply chain resilience frameworks in section 3.11.2 but can briefly be defined as the ability to "rapidly reconfigure key SC resources in an attempt to maintain competitiveness" (Gallego-Burin, Stevenson, Llorens-Montes & Perez-Arostegui, 2018:5).

There is a relationship between resilience, robustness, redundancy, and flexibility. Figure 3.12, below, indicates the relationship and ripple effect of all the concepts such as, proactive strategies and robustness, as well as reactive strategies and flexibility. The link between proactive strategies, risk mitigation, and robustness can be clearly seen in Figure 3.12. Similarly, the link between reactive strategies, recovery, and flexibility can be seen. According to Dolgui *et al.* (2018:4) the ripple effect occurs when disruptions effects are felt downstream in the SC. They indicate that the ripple effect deals with low-probability-high-impact disruptions, while the bullwhip effect deals with high-probability-low-impact.

According to Dolgui *et al.* (2018:12), the main reasons for the ripple effect in SC relate to the following: 1) single sourcing; 2) low-level safety technologies; 3) low safety stock; 4) 100% capacity utilization; 5) batching; and 6) no contingency plans.

Dolgui *et al.* (2018:14) mention in their research that SC robustness is linked to resistance and redundancy. It becomes evident that all these concepts, for example, redundancy, robustness, resilience, and flexibility are interwoven into a complex inter-relationship. In their research, resilience is connected to robustness, redundancy, and flexibility, all which have been discussed previously in this literature. They elaborate that robustness is a direct usage of redundancy, while flexibility is an indirect usage of redundancy. By increasing redundancy by means of increasing inventory, additional production, and alternative transport, the supply chain cost also unintentionally increases, which at the same time could lead to a potential increase in sales and customer service levels (Dolgui *et al.*, 2018:15). Building a resilient SC chain is a balancing act between robustness and flexibility to ensure that a positive effect is seen on service levels and cost.

In Dolgui *et al.* (2018:14) ripple effect model, they indicate reactive vs proactive strategies. Reactive strategies include parametric recovery, process recovery, and structural recovery. Under the proactive strategy, they include strategies such as risk mitigation inventory, redundant capacity, and backup facilities and channels (proactive and reactive strategy approaches will also be discussed in detail in section 3.12).

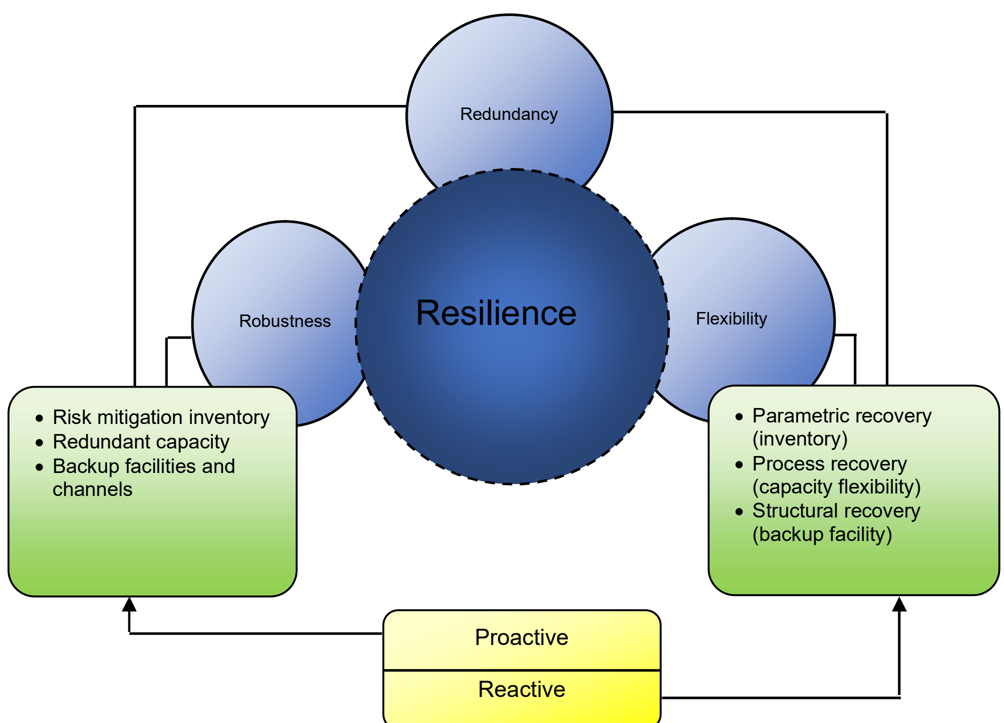

Figure 3.12: Ripple effect control elements.
Source: Dolgui, Ivanov and Sokolov (2018:14).

3.11.2 Supply chain resilience frameworks

In the 90s, large organisations adopted a comprehensive view on risk management by making use of risk management processes such as business continuity planning (BCP) and enterprise risk management (ERM). While processes like BCP and ERM certainly helped organisations to recover and at best avoid supply chain disruptions, they have their own limitations. According to Petit, Fiksel, Polyviou and Croxton (2015:79), these processes rely too heavily on risk identification, they depend on statistical information, and the aim of these processes is usually to return to stable operating conditions after a disruption. A more realistic, less procedural view must be adopted. Identifying latent opportunities in the risk landscape will allow an organisation to make better use of those identified opportunities than its competitors will (Pettit *et al*., 2015:80; Fiksel, 2015:81; Pettit, Croxton & Fiksel, 2019:57). Petit *et al.* (2015:81) propose a SCRAM *(supply chain resilience assessment and management) framework.* This framework allows organisations to identify and prioritise supply chain *vulnerabilities*, and at the same time identify *capabilities* which will address or strengthen these vulnerabilities. These SC vulnerabilities and SC capabilities are tabulated below in Table 3.6. Pettit *et al.* (2015:79) believes that by identifying the SC vulnerabilities and capabilities it will allow the SC to cultivate *resilience.*

Table 3.6: Supply chain vulnerabilities and capabilities

Supply chain vulnerabilities	Supply chain capabilities
Turbulence	Flexibility in sourcing
Deliberate threats	Flexibility in manufacturing
External pressures	Flexibility in order fulfilment
Resource limits	Capacity
Sensitivity	Efficiency
Connectivity	Visibility
	Adaptability
	Anticipation
	Recovery
	Dispersion

	Collaboration
	Organisation
	Market position
	Security
	Financial strength
	Product stewardship

Source: Adopted from Pettit *et al.* (2015:81).

According to Pettit *et al.* (2015:85), a balance between vulnerability and capabilities must be struck to achieve the "zone of balanced resilience", as indicated in Figure 3.13 below. As the vulnerabilities increase, organisations may be exposed to risk and need to improve their corresponding capabilities. Organisations cannot continue improving their capabilities indefinitely, as this will have a significant financial impact on the organisation's finances and resources. The zone of balanced resilience can be found between capabilities that match their respective vulnerabilities.

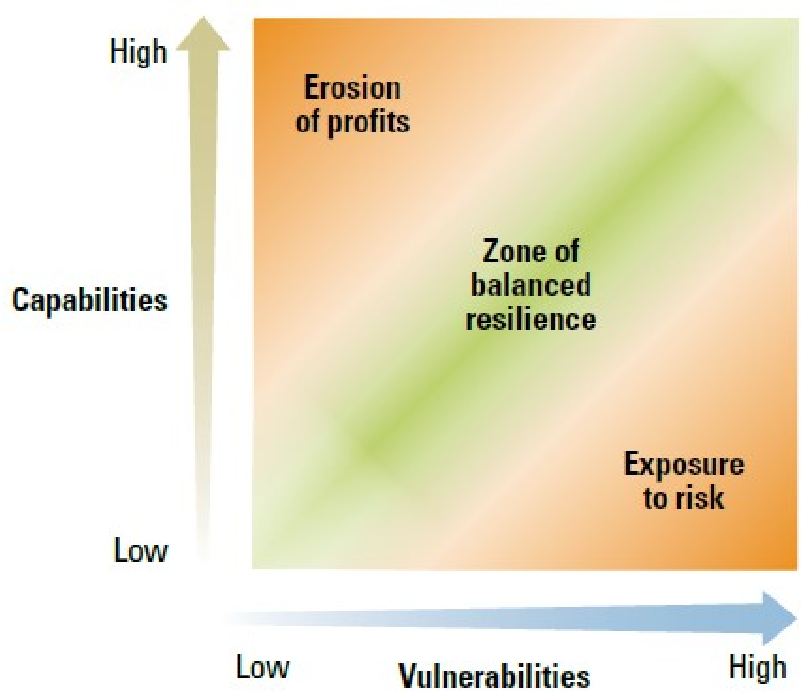

Figure 3.13: Zone of balanced resilience.
Source: Pettit *et al.* (2015:85).

Adabor and McMullen (2018:4) proposed a *supply chain resilience framework (SCRES)*, as reflected in Figure 3.14. In their framework, supply chain resilience is categorised into 1) supply chain resilience (SCRES) capabilities (left column in Fig 3.14); 2) resilience types (middle column in Fig 3.14); and 3) phases of supply chain resilience (right column in Fig 3.14). Under *SCRES capabilities*, efficiency-based capabilities, adaptive capabilities and collaborative capabilities are listed. The SCRES model assumes that a resilient supply chain has the capability to respond, recover, and transform after a disruption. These researchers are of the opinion that a resilient supply chain should not only have one of the *SCRES types*, but all three types i.e., engineering resilience (efficiency), ecological resilience (adaption), and evolutionary resilience (growth and renewal) as there are potential synergies and trade-offs between the different types of resilience.

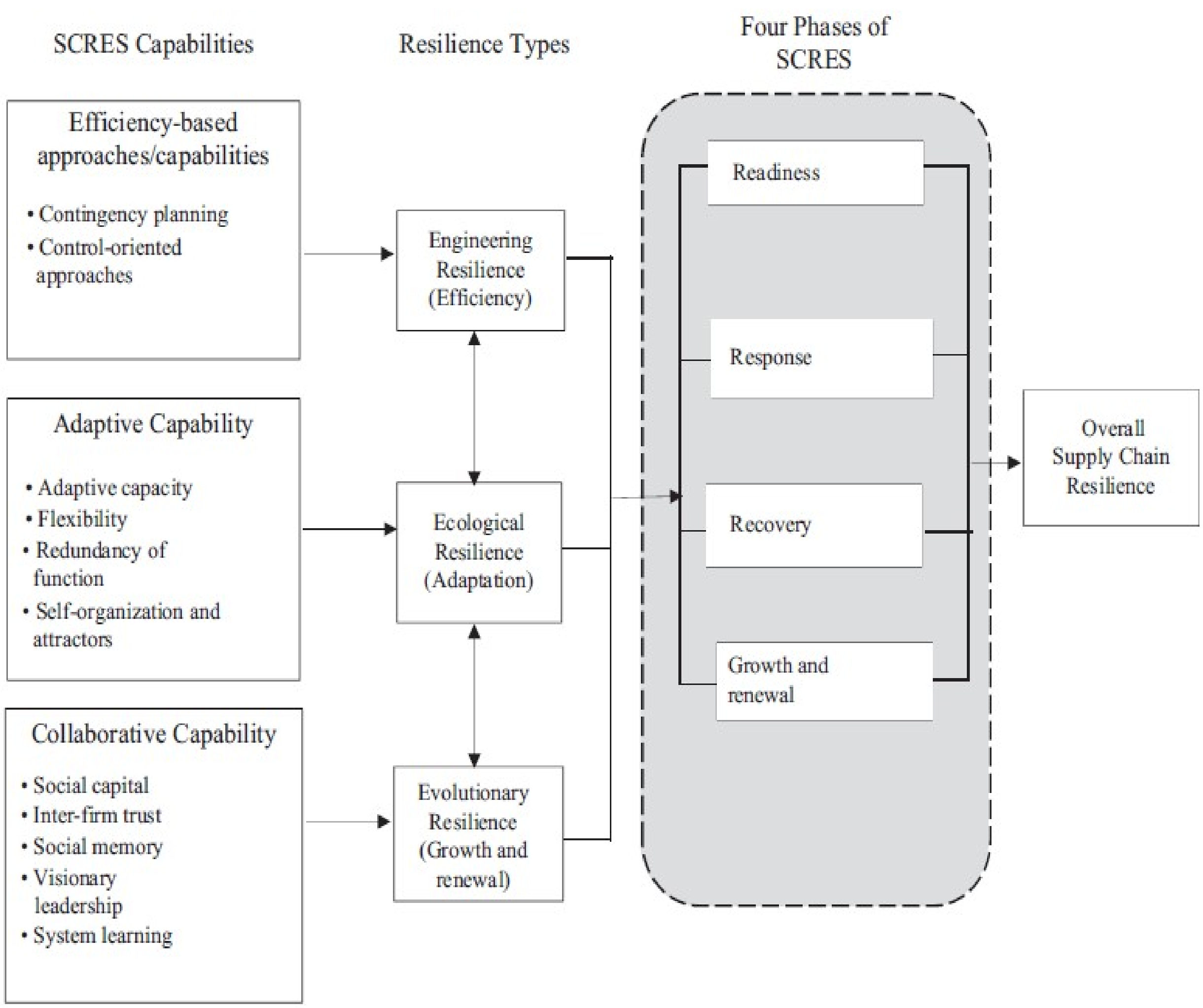

Figure 3.14: Framework for supply chain resilience.

Source: Adabor and McMullen (2018:4).

Under resilience types (middle column in Fig 3.14), *engineering resilience* refers to the ability of a system to return to an equilibrium or state of steadiness after a disturbance (Adabor & McMullen, 2018:6). The speed and resistance to disturbance are the two measures for engineering resilience. The faster a system can recover from a disturbance, the more resilient it is. This is mainly due to the efficiency of the engineering design because of contingency planning and control measures. Contingency planning involves developing responses and early warning systems that can monitor and detect disruptions before they occur. This could include business continuity planning (BCP), building agile supply chains, and using other strategies, such as, lean manufacturing, just-in-time (JIT), and postponement, as mentioned in the preceding section 3.8.5 – risk mitigation.

Ecological resilience is defined by how much disturbance the system can absorb while remaining within some critical parameters i.e., how much adaption can take place. Ecological resilience can be maintained by *redundancy*. Redundancy involves the use of excess capacity and inventory to manage and reduce risks and increase resilience, but at the same time could promote some inefficiency due to capacity duplication (Adabor & McMullen, 2018:9). An important element of ecological resilience is flexibility.

Flexibility is the ability of the supply chain to respond quickly to end-customer requirements. One of the pivotal tools mentioned by Brusset and Teller (2017:61) is sales and operations planning (S&OP) coupled with flexible transportation models as mentioned previously in section 3.8.5. Brusset and Teller (2017:60) found that increased *flexibility* leads to greater resilience of the supply chain but could not positively prove that improved *collaboration* increases resilience. According to Adabor and McMullen (2018:11), flexibility could be seen as both similar to, and as an alternative to redundancy. Redundancy refers to the strategic use of spare capacity and inventory to manage disruptions. When referring to flexibility in the supply chain, it generally means the scheduling or planning for an unforeseen disruption. On the other hand, agility in the supply chain context refers to the ability to respond to unplanned disruptions.

Evolutionary resilience has been defined as, "the ability of a complex socio-ecological system to change, adapt and transform in response to stresses and strains, whether external or internal." (Adabor & McMullen, 2018:12). According to this definition, it could be possible that after a disruption occurs, the system does not return to its previous normal equilibrium but might transform into a new system. This new system therefore requires transformation and reconfiguration (Ambulkar, Blackhurst & Grawe, 2015:112; Adabor & McMullen, 2018:12). Collaboration, based on goodwill and trust, is important in evolutionary resilience. This allows organisations to work together effectively to build and grow the supply chain's capacity known as adaptive capacity (Adabor & McMullen, 2018:13).

The *phases of SCRES* (right column in Fig 3.14), according to Adabor and McMullen's (2018:16) model is: 1) readiness; 2) response; 3) recovery; and 4) growth and renewal. A resilient supply chain should always be prepared for any disruptions, be able to respond timely to disruption, be able to "bounce back" to equilibrium status when unforeseen disruption occurs, and lastly, it should learn from experience by employing growth and renewal strategies to ensure that the same disruption does not occur again.

Overall supply chain resilience capabilities (SCRES) can only be achieved when a supply chain has developed three types of capabilities: efficiency-based capabilities, adaptive-based capabilities and collaborative capabilities. These capabilities will lead to 1) efficiency, through engineering resilience; 2) adaption, through ecological resilience; and 3) growth and renewal, through evolutionary resilience. Both resilience capabilities and the types of resilience will enable the SC to be in readiness for disruption, responsive to disruption, be able to recover from disruptions, and grow and renew after disruption (Adabor & McMullen, 2018:16).

3.11.3 Supply chain resilience assessment and management (SCRAM) tool

To mitigate or reduce risk in the supply chain, it was previously mentioned that a supply chain needs to be resilient. To establish whether the supply chain is resilient, Pettit, Croxton and Fiksel (2019:58) developed an assessment tool called SCRAM^{TM} (Supply Chain Resilience Assessment and Management). This assessment tool can be seen in Figure 3.15 below. The objective of the tool was to measure supply chain resilience. In their SCRAM^{TM} tool, Petit *et al.* (2019:59) explain that the gap between vulnerabilities and capabilities must be established. This gap is known as resilience gap. After the resilience gap has been established, improvement strategies can and should be developed to improve theses gaps. By developing disruption scenarios, potential disruption in the future can be predicted with their associated probability and their impact (effect). Analysis can then be done for scenarios where there is a low capability and high vulnerability, to ensure that the supply chain is more resilient with regards to vulnerabilities matching capabilities.

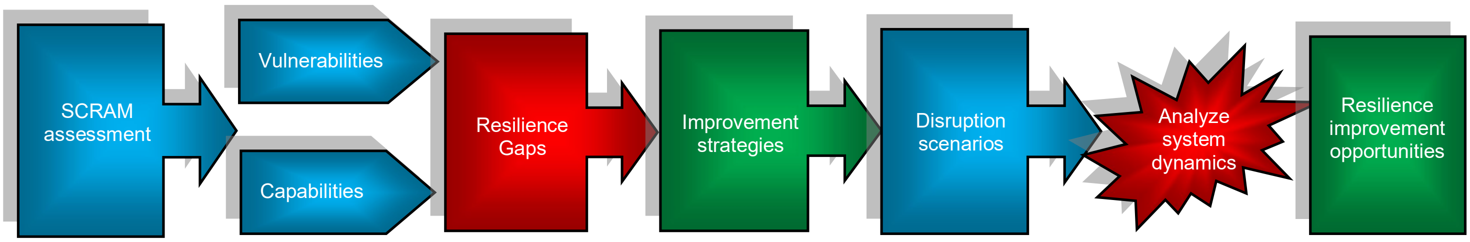

Figure 3.15: SC resilience assessment and management tool

Source: Pettit, Croxton and Fiksel (2019:59)

Advances in cloud and blockchain computing can benefit supply chain resilience capabilities by improving various aspects like supply chain visibility, access to blockchain information, sharing of trusted transaction data, and assist in invoicing, shipping and manufacturing systems integration. At the same time these new technological advances also expose the supply chain to vulnerabilities like blockchain security and malicious cyber-attacks (Petit *et al.*, 2019:59). In their research, Petit *et al.* *(*2019:59) draw the conclusion that there is limited research on the impact of resilience on organisations' performance. This is partly due to the difficulty of attaching a monetary value to all the disruption avoided, which an organisation may or may not be aware of, due to resilience. They do, however, highlight that preliminary finding have indicated that during a disruption, resilient supply chains have maintained a relatively flat metric with regards to operational performance like on-time delivery, product quality, and inventory levels (Petit *et al.*, 2019:63).

3.12 Proactive vs Reactive Approaches to Risk Management

Organisations can have a proactive or reactive approach to the management of risks. According to Snyder, Atan, Peng, Rong, Schmitt and Sinsoysal (2012:23), *proactive* strategies determine policies against future disruptions and consider the worst-case scenario. They further suggest that most inventory models are proactive in nature as they determine the optimal inventory to protect against future disruptions. These strategies could include inventory control strategies such as ordering and stocking decisions prior to disruptions, also known as contingency planning. On the other hand, *reactive* strategies consider actions after a disruption has occurred, and usually include sourcing strategies like product substitution or backup supply (flexible supply base). According to Snyder *et al.* (2012:9), previous studies indicate that organisations should opt for a combination of proactive and reactive approaches to reduce and mitigate risk more effectively, as opposed to using just proactive or reactive approaches. Elluru, Gupta and Kaur (2017:3) explain that proactive strategies are developed pre-disruptions, while reactive strategies are planned post disruption when considering the timing of the strategy decision relative to the disruption. Table 3.7 below indicates the various proactive and reactive strategies as summarised by Tukamuhabwa, Stevenson, Busby and Zorzini (2015:5601). It should be noted that some strategies can be both proactive and reactive depending on when and why they are applied.

Table 3.7: Proactive and reactive strategies

	Proactive Strategies		Reactive Strategies
1.	Supplier selection	1.	Building logistics capabilities
2.	Building logistics capabilities	2.	Building social capital and relational competence
3.	Building security	3.	Contingency planning
4.	Building social capital and relational competence	4.	Creating redundancy
5.	Co-opetition	5.	Demand management
6.	Contractual agreements	6.	Supply chain agility
7.	Public-private partnerships	7.	Increasing flexibility
8.	Risk management culture	8.	Increasing velocity
9	Increasing innovativeness	9.	Increasing visibility
10.	Increase visibility	10.	Supply chain collaboration
11.	Inventory management	11.	Use of information technology
12.	Knowledge management		
13.	Portfolio diversification		
14.	Supplier development		
15.	Supply chain collaboration		
16.	Supply chain network structure		
17.	Sustainability compliance		
18.	Use of information technology		

Source: Adopted from Tukamuhabwa, Stevenson, Busby and Zorzini (2015:5601)

3.13 Agility and Stability in Risk Management

3.13.1 Agility

Supply chain *agility* is the ability of a supply chain to adapt and respond quickly to constantly changing market, customer requirements, and demands. Further, agility is the ability to perform operational activities like reducing lead-time and shortening new product development in cooperation with other strategic supply chain partners. Loh and Thai (2015:3) indicate that agility and resilience are part of the characteristics required by an effective and efficient supply chain and port operations. Agility and resilience, according to them, require a high level of cooperation and integration between the members of the port community for port operations to be robust. Agility and resilient mitigation strategies of organisations influence SC performance and, to an extent, determines its competitiveness in the market (Dolgui *et al.* 2018:14).

Agility can be achieved through three methods. According to Treece, Peteraf and Leih (2016:13), the three methods include: 1) sensing; 2) seizing; and 3) transforming. They describe sensing as the ability of organisations to develop options to grow before any market competitors have come to the same conclusion. This can be achieved by sense making or using scenario planning to proactively create hypotheses about future implications of events and trends (Treece *et al*., 2016:13). Agility can further be achieved by seizing. Seizing refers to the ability of getting things done, like flexible sourcing, redesigning rule-bound hierarchies, and adopting innovative processes (Treece *et al*., 2016:13). The last method of achieving agility, according to Treece *et al*. (2016:13), is transforming. Transforming is about changing the status quo through, for example, "build-measure-learn", which means that during times of uncertainty it is best to build a minimum viable product (MVP) to launch. Then the organisation must learn quickly, adjust accordingly, and improve speedily (Treece *et al*., 2016:13). Agility can be used as a risk mitigation strategy in the supply chain.

3.13.2 Stability

Lastly, *stability* is important to ensure that strategic partnerships are fostered with key strategic suppliers to maintain a constant and reliable flow of information, material, and cash across the entire supply chain (Asgari, Nasrin, Nikbakhsh, Eshan, Hill, Alex, Farahani & Reza, 2016:14; Jajja *et al*., 2018:120). Stability is required to ensure that external integration can occur between the organisation and its suppliers and customers.

This stability will enable the supply chain to employ strategies such as SRM and CRM, which could aid as strategic risk mitigation tools.

3.14 Supply Chain Innovation in Risk Management

Supply chain innovation is a term used to describe the technological and process improvements, with the aim to generate information and solutions that will meet the customer requirements in new ways. Innovation is required to respond to ever-changing customer demands. The main aim, therefore, is to improve processes and operation capabilities. According to Kwak, Seo, and Mason (2018:4), market leading organisations attempt to integrate SC innovation into their operations, improving their logistical capabilities, which in the end will help them to reduce risk (Kwak, Seo & Mason, 2018:5). Process improvements could include, but are not limited to, new processes and procedures, new operational routines, or investment in technological systems. The focus of technology innovations is on improving integrated information systems, real-time tracking, and various innovative logistics equipment used to streamline and reduce the labour and capital required in the logistics processes, such as Enterprise Resource Management (ERP) and radio frequency identification (RFID) scanning (Kwak *et al.*, 2018). In their research, Kwak *et al.* (2018:23) found that SC innovation and risk management capabilities i.e., resilience and robustness, are supporting an organisation's competitive advantage over its rivals. The most significant finding in their research was that SC innovations have a noticeable influence on all dimensions of risk management capabilities (Kwak *et al*., 2018:23).

3.15 Summary and Conclusion

Supply Chain Risk Management (SCRM), as defined by Fan and Stevenson (2018:5) is, "*The identification, assessment, treatment, and monitoring of supply chain risks, with the aid of the internal implementation of tools, techniques and strategies and of external coordination and collaboration with supply chain members so as to reduce vulnerability and ensure continuity coupled with profitability, leading to competitive advantage."* The preceding sections discussed all the important aspects of risk, supply chain risks, and risk management, to get an in-depth view of the dynamics and related concepts of supply chain risk management. Supply chain risk was also expressed as a function of complexity, uncertainty, and instability, which were also discussed briefly as these add to the dynamic of supply chain risk. This literature review laid the foundation of the empirical study that enabled the researcher to answer the research objectives of identifying risks in the bulk soda ash powder import supply chain, including associated risks through the port of Durban.

CHAPTER 4: RESEARCH DESIGN AND METHODOLOGY

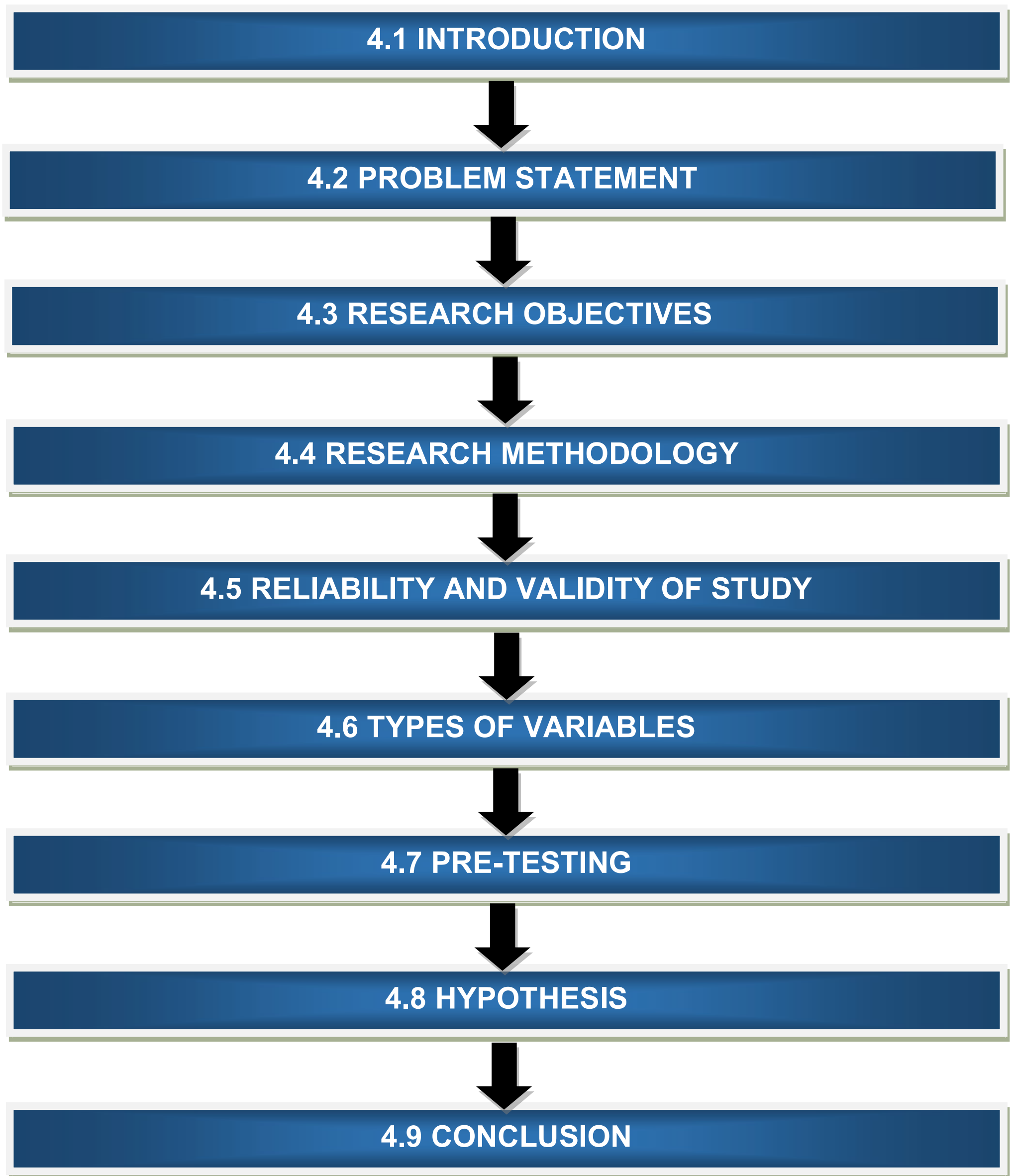

Figure 4.1: Flow diagram of Chapter 4.

Source: Compiled by researcher

4.1 Introduction

In Chapter 4, the various research aspects, such as research methodology, design, population, and sampling techniques used will be discussed in detail. The research instruments, data collection, data analysis, and the reliability and validity of this study will be discussed. Figure 4.1 above gives an overview of chapter 4 and its related concepts, which will be discussed further.

Research is defined as an action taken by a person to obtain data in a systematic way in order to ultimately increase the current body of knowledge (Saunders, Lewis & Thornhill 2012:5; Eicker, 2016:89; Gray, 2019:2). During the research process the data which is collected and interpreted is aimed at answering a specific research question (Quinlan, Babin, Carr, Griffin & Zikmund, 2015:2; Eicker, 2016:89).

As mentioned in Chapter 1, this research was carried out in two phases. Phase one consisted of a comprehensive literature review of relevant secondary data sources, such as articles in accredited journals and subject matter textbooks. The literature study was done, which included:

1. Exploring the concepts of supply chain and supply chain management (Chapter 2).
2. Exploring the concepts related to risk, supply chain risk and risk mitigation strategies (Chapter 3).

Phase two of the study consisted of the empirical research. In order to address the objectives of this research, a quantitative research approach was selected and followed. This research approach will be further discussed in detail in this chapter (Chapter 4) and its sub-sections dealing with the methodology aspect and research design.

4.2 Problem Statement

As discussed in Chapter 1, the bulk import and export supply chains involve inherent risks such as inefficiencies, delays, and infrastructure challenges. Previous research had been conducted on bulk commodity *exports* in South Africa, such as, bulk coal export, in which the associated risks became clear (Foolchand, 2006:2; Ganesan, Rosentrater & Muthukumarappan, 2008:426; Viljoen, 2012:19; Botha, 2016:34). Little to no research could be found on bulk *imports*, particularly the bulk import of soda ash and its associated supply chain risks in the South African context. Soda ash is an important source of, or input to economic activities in South Africa and it makes sense to investigate supply inefficiencies or risks that may cause a ripple effect throughout supply chains that use soda ash.

Ample research had been done on supply chain risk management and some research was done in general bulk supply chain operations in various geographical areas such as

Nigeria, Tanzania, and Kenya (Kadigi, Mwathe, Dutton, Kashaigili & Kilima, 2014:37; Gidado, 2015:161), but no research could be found that combined all the focus areas indicated in the previous paragraphs into one research study.

The problem statement of this study could thus be formulated in the following main research question:

What are the risks experienced by a bulk soda ash import supply chain and how are these risks managed?

4.3 Research Objectives

4.3.1 Primary research objective

The primary research objective is to identify and describe the supply chain risks in a bulk soda ash powder import supply chain from a South African perspective and to determine how these risks are managed.

4.3.2 Secondary research objectives

The secondary research objectives in this study are as follows:

- **a)** To explore and describe bulk supply chains and bulk commodity operations and operating conditions in South Africa, by means of a literature study.
- **b)** To explore and describe risks, risk management and mitigation strategies in commodity supply chains, by means of a literature study.
- **c)** To identify and explore the supply chain risks in the soda ash supply chain in South Africa, by means of an empirical (survey) study.
- **d)** To identify and describe the risk management and mitigating practices used in a bulk soda ash import supply chain, by means of an empirical (survey) study.
- **e)** To determine the relationships between the different risk factors and mitigation strategies with the aid of inferential statistics.

4.4 Research Methodology

According to Gray (2019:4), research consists of well-defined steps in chronological order. These steps are summarised below in Figure 4.2 and will be discussed in detail in the subsections which follow.

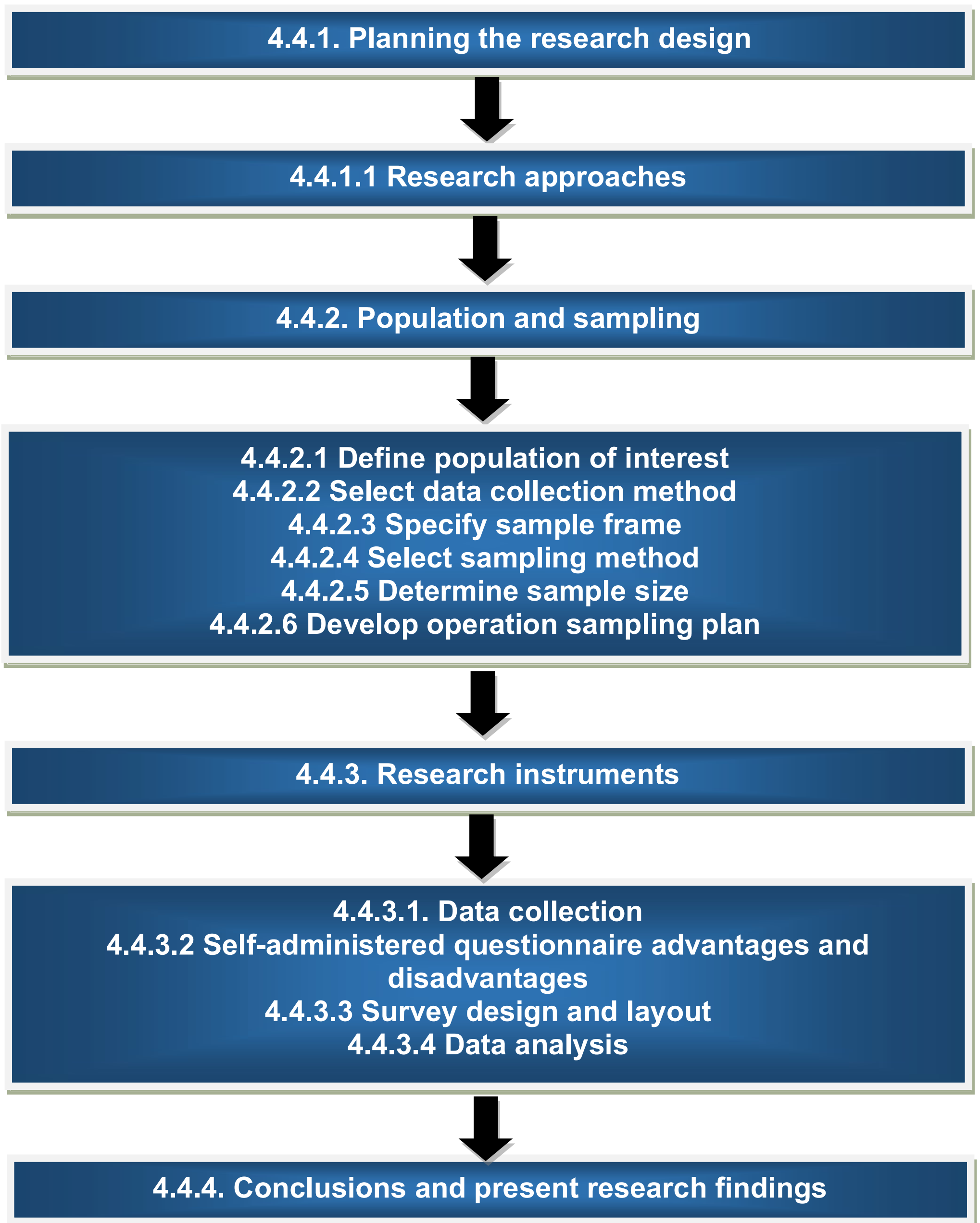

Figure 4.2: Steps in research.

Source: Adopted from De Vos *et al.* (2011:15); Gray (2019:4).

4.4.1 Planning the research design

The aim of research design is to provide specific direction for procedures in a research study and can be regarded as a blueprint of the plan on the proposed methods and procedures for collecting and analysing the needed information (Zikmund, Babin, Carr & Griffin, 2010:66; Creswell, 2013:3; Van Zyl, Salkind & Green, 2014:397; Eicker, 2016:89). The research design includes the description of data sources, how data will be collected, and the analysis of the data (Saunders *et al*., 2012:159; Swedberg, 2018:2). According to Saunders *et al.* (2012:159) three research designs are available, which include: exploratory, causal (explanatory), and descriptive research designs.

Exploratory research design is used when the objective is to determine the general nature of research questions. Open-ended questions are used to gain a deeper understanding of the topics and related concepts. This type of research is used when clarification is required on a specific research problem (Saunders *et al.,* 2012:171; Swedberg, 2018:2). This method is mostly used with qualitative research with the advantage that it is open to change. Methods employed for this type of research include interviews with experts, one-on-one interviews, and focus groups (Saunders *et al.,* 2012:171; Swedberg, 2018:2).

Explanatory, also known as causal, research design is used to determine the effect of one variable on another variable by making use of experiments to determine the inter-connection between the two variables. The word causal is used due to this method describing the "causal" relationship between the variables. The objective of this type of research is to describe the relationship between the variables (Saunders *et al.,* 2012:171; Lewis, 2019:7).

Descriptive research, lastly, is used to define and describe characteristics of a given situation of various objects, people, organisations, or environments (Zikmund *et al.*, 2010:55). According to Tustin *et al*. (2005:86), descriptive research aims to explain the who? what? when? where? and how? questions of the research problem. Structured and quantitative methods are used for this type of design, for example questionnaires (Atmowardoyo, 2018:198). Further, *descriptive research* aims to describe the current characteristics of an existing phenomenon. The degree of control over the variables does not exist or is very low. Typical keywords associated with this type of research are "describe", interview or literature reviews.

Research, according to Van Zyl *et al.* (2014:11), consists of two design types: 1) non-experimental research; and 2) experimental research. Non-experimental research focuses on the relationship between variables without considering the cause-and-effect relationships that exists between the variables. The methods used for non-experimental research is descriptive, historical, correlation.

Historical research focuses on past events which occurred with no or very low degree of control over variables (Gray, 2019:24).

Correlation research examines the past, current, and future relationships between variables and has a low to medium degree of control over the variables (Van Zyl *et al.,* 2014:11; Gray, 2019:24).

Experimental research, on the other hand, examines the cause-and-effect relationship between variables. The methods used for experimental research are true experimental and quasi-experimental (Van Zyl *et al.*, 2014:10; Gray, 2019:25). *True experimental research* tests current true cause-and-effect relationships. There is a high degree of control over the variables. *Quasi experimental* tests the current or past casual relationships without having full control over the variables. Figure 4.3 below illustrates these research designs with reference to non-experimental and experimental research.

Figure 4.3: Different research designs.
Source: Adopted from Van Zyl *et al.* (2014:11).

This study made use of non-experimental, descriptive and correlation research designs. The best suitable research approach therefore was quantitative research (as described below). Quantitative research allowed the describing of risks in the supply chain, risk mitigation strategies employed, and aided in determining the importance of risks in the bulk import supply chain.

4.4.1.1 Research approaches

In this sub-section the specific details pertaining to the research approaches will be discussed. The research methodology is the plan that will enable the researcher to answer the research problem and achieve the research objectives (Mouton, 2011:5; Eicker, 2016:2). According to Wu and Patel (2014:97), research methodology presents the philosophical framework in which the research project is developed and the way in which problems are addressed. The research approach can be regarded as a general discipline that consists of various tools for developing scientific knowledge and elements involved in both theoretical and empirical research (Mitra & Borza, 2015: 47). Research approaches can be an inquiry within qualitative, quantitative, or mixed methods approaches. Figure 4.4 below gives an overview of these approaches.

Figure 4.4: Different research approaches.

Source: Adopted from Queirós, Faria and Almeida (2017:374).

The different types of research approaches illustrated in Figure 4.4 include qualitative, quantitative and mixed methods. Each one of these methods uses different sources to obtain their data. Qualitative research sources include observation, ethnography, field research, focus groups, case studies, structured interviews, and unstructured in-depth interviews.

Observation is the collection of information by means of observing a phenomenon in the natural environment (Queirós *et al.*, 2017:376). Observation can be one of two types: direct observation or participant observation. With direct observation, the researcher is directly adjacent to the phenomenon being studied, although the researcher is not a participant of the study. Participant observation, on the other hand, is where the researcher is an active participant in the study (Van Zyl *et al.*, 2014:215).

Ethnography is a different method of observation because it includes interviews with the participants, either in their natural setting or afterwards (Queirós *et al.*, 2017:376).
Field service usually occurs over a long period of time and is the collection of data in the field, giving the researcher an in-depth perception of people and processes (Queirós *et al.*, 2017:376).

A *focus group* is a gathering of a group of people, which is moderated by a researcher, allowing the researcher to observe and interact, with the purpose of gathering information, generating insight, establishing how group members reach decisions, and encouraging group interaction (Van Zyl *et al.*, 2014:217).

Case studies are used to investigate complex situations with multiple variables but provide a great amount of detail and often personal descriptions allowing for the challenging of current theoretical assumptions (Van Zyl *et al.*, 2014:216; Queirós *et al.*, 2017:377).

Structured interviews make use of close-ended questions and require the interviewee to provide an explicit answer to the question. Structured interviews are used to compare the various responses from the respondents, with each other (Van Zyl *et al.*, 2014:199; Queirós *et al.*, 2017:377).

In-depth interviews, also referred to as unstructured interviews, make use of open-ended questions, allowing the interviewee to elaborate and explain their response. Unstructured interviews provide rich information and allow for additional follow up questions (Van Zyl *et al.*, 2014:199; Queirós *et al.*, 2017:378). Table 4.1 below lists all the advantages and disadvantages of each of the prior discussed qualitative methods.

Table 4.1: Advantages and disadvantages of qualitative methods

Method	**Advantages**	**Disadvantages**
Observation	– Data collected at the same time as event occurrence – Not dependent on someone's response – Flexible and oriented to knowledge discovery	– Very time consuming – Reliant on the observer's objectivity – Significant preparation is required – Data is difficult to collect in real-time
Ethnography	– Observation and interviews with direct respondents – In-depth findings – Explore new lines of research	– Very time consuming – Concise and precise conclusions are difficult to obtain – Deep knowledge of the problem is a prerequisite
Field research	– Detailed data – The role and relevance of social context is emphasized	– Generalisation is difficult – Data needs to be obtained from a large number of people and/or groups – Depends on the researcher's objectivity – Documenting observations is a challenge
Focus groups	– Detailed information about group – Opportunity to seek clarification – Lower cost compared to individual interviews	– Groups can be hard to control and manage – Some people do not always participate in discussion – Difficult to generalise to the whole population
Case studies	– Detailed information about individuals – Provide opportunity to change current theoretical	– Cause-effect relationship is difficult to establish – Generalisation to population is difficult

	assumptions – Can be used as an alternative focus group, but also as an alternative to focus groups	– Potential ethical issues of confidentiality – Case studies are difficult to create as they do not suite all respondents
Structured interviews	– Well-structured and organised answers – Easy to compare feedback from respondents – Large sample can be reached – Easy to replicate – Less time intensive and is quick to conduct	– Very rigid – Flexibility in response choice is low – Detailed data difficult to obtain – Time consuming to prepare for interview
In-depth interviews (Unstructured interviews)	– Detailed and insightful information is obtained – Requires less participants to get good insights – Suitable for informal environments	– Time consuming – Relatively expensive – Long verification process to compare information – Cannot be generalised – To avoid bias, respondents must be selected carefully

Source: Queirós *et al*. (2017:379)

In quantitative research, the source of information includes field experiments, simulation, surveys, correlation studies, and multivariate analysis. *Field experiments* are conducted in the real-life environment and involve the isolation and manipulation of one of the variables being measured to test the effect (Queirós *et al.*, 2017:380).

Simulation makes use of mathematical techniques and modelling, with the use of computer software. This modelling or simulation is used to describe the behaviour of the system (Queirós *et al.*, 2017:381).
Surveys collect data directly from the persons, or respondents, who are involved in the research, by making use of a set of pre-defined questions presented to them (Nardi, 2018:3).

Correlation study is used to determine whether there is a relationship between the variables. Unlike field experiments, in correlation studies there is no manipulation of any variable (Nardi, 2018:12).

Multivariate analysis makes use of methods that allow the researcher to explore the relationships between variables (Queirós *et al.*, 2017:381). Table 4.2 below lists the advantages and disadvantages of each of the prior discussed quantitative methods.

Table 4.2: Advantages and disadvantages of quantitative methods

Method	Advantages	Disadvantages
Field experiments	– Natural setting is used for research – Large scale research – Respondents are not influenced by observations	– Difficult to control variables – Difficult to replicate the study – Potential ethical problems regarding confidentiality
Simulation	– Complex phenomenon can be studied – Compressed timeline allowing behaviour to be quickly established – What-if questions can be tested and answered	– Deep subject knowledge is required for modelling – Expensive – Time consuming – Specialised hardware and software required
Surveys	– Limited development time – Relative low cost – Easy data collection and analysis using statistical methods – Large audiences can be reached – Representativeness may be high – Researcher bias is low, subjectivity of researcher does not affect outcomes	– Reliability of the study is dependent on the quality of answers and survey structure – Structure is rigid – Does not capture emotions and behaviour of respondents
Correlation study	– Different domains and vast amount of information can be explored – Degree of association of variables can be easily calculated – No manipulation of variables is required	– No direct cause-effect can be inferred – Lacks internal and external validity – Does not provide a conclusive reason of why variables correlate
Multivariate analysis	– Various statistical tests and	– Most complex out of all

	techniques can be employed – Different domains and vast amount of information can be explored – Process has technical rigor	techniques – Requires the use of specialised statistical software

Source: Queirós *et al*. (2017:382)

Table 4.3 below summarises qualitative, quantitative, and mixed research approaches according to their philosophy, strategy, method, and practices.

Table 4.3: Research approaches

Tend to or typically…	**Qualitative approach**	**Quantitative approach**	**Mixed method approach**
Philosophical assumptions	– Constructivist / advocacy / participatory knowledge claims – Focus on quality (nature and essence)	– Post-positive knowledge claims – Focus on quantity (how much, how many)	– Pragmatic knowledge claims
Employ these strategies of inquiry	– Phenomenology / grounded theory, ethnography, case study, narrative, observation, field research, focus groups, structured interviews and in-depth interviews	– Surveys, experiments, simulations, correlation study and multivariate analysis	– Sequential, concurrent and transformative
Employ these methods	– Open-ended questions, emerging approaches, text or image data – Sample is small, non-random and purposeful	– Close-ended questions, predetermined approaches and numeric data – Sample is large, random and representative	– Both open –and close ended questions, both emerging and predetermined approaches and both quantitative and qualitative data analysis
Use these practices of research as the researcher	– Positions him-or herself – Collects participant meanings – Focuses on single concept or phenomenon	– Test or verifies theories or explanations – Identifies variables to study – Relates variables in	– Collects both quantitative and qualitative data – Develops a rationale for mixing

	– Brings personal values into the study – Studies the context or setting of participants – Validates the accuracy of findings – Makes interpretations of data – Creates an agenda for change or reform – Collaborates with participants – Goal is to understand, describe, discover and get meaning – Findings are comprehensive, holistic and richly descriptive	questions or hypotheses – Uses standards of validity and reliability – Observes and measures information numerically – Uses unbiased approaches – Employs statistical procedures – Goal is to predict, control and confirm – Findings are precise and numerical	– Integrates the data at different stages of inquiry – Presents visual pictures of the procedure in the study – Employs the practices of both quantitative and qualitative research

Source: Adopted from Creswell (2013:47) and Merriam (2015:18)

This research study followed a quantitative research approach. A survey with close-ended questions in the form of a web-based questionnaire was distributed to respondents via e-mail. This method was selected because it has a low development time, low cost, easy data collection, a wide geographical area can be surveyed, and researcher bias is low.

4.4.2 Population and Sampling

The target *population* is the people, events, and/or records that contain the required information to answer the research questions (Cooper & Schindler, 2011:2; Gray, 2019:85). According to Walliman (2011:6) the population can have the following characteristics. They can be: 1) homogenous where all cases are similar; 2) stratified where the population contains strata or layers; 3) proportionally stratified where the population contains strata known as proportions; 4) grouped by type where distinctive groups exist; and 5) grouped by location where the population is geographically scattered (Gray, 2019:86). The population for this study was limited to the borders of South Africa i.e., all stakeholders involved in South Africa in the import supply chain of soda ash. For this study, the exact population size was not known.

According to Ghauri, Grønhaug and Strange (2020:162), a sample is a portion of the population and is representative of the greater population from which the sample is drawn. The sample should be representative of the population if the conclusions are to be extended for the greater population, based on the characteristics of the population. According to Tustin *et al.* (2005:336) and Zikmund, D'Alessandro, Winzar, Lowe and Babin (2017:27), a sample must be selected based on the following steps depicted in Figure 4.5:

Figure 4.5: Steps in developing a sample plan.

Source: Tustin *et al.* (2005:339); Zikmund *et al.* (2010:391); Zikmund *et al*. (2017:27)

4.4.2.1 Define population of interest

The target *population* for this study consisted of individuals working at all the businesses (stakeholders) in the soda ash import supply chain, from the moment the vessel with the soda ash reaches the shores of South Africa to the point of delivery at the consignee (importer). These stakeholders included employees at chemical distributors and importers, South African Portnet, and all the relevant subcontractors involved with warehousing and distribution in the import supply chain of soda ash. The questionnaire was therefore distributed to the supply chain management staff and other stakeholders, including purchasing, operations, logistics, and marketing functions. As already mentioned, the population size was not exact and easy to determine due to the many stakeholders and many individuals in many different functions in the import supply chain.

The researcher made use of an online search via Braby's and LinkedIn to establish the number of stakeholders in the population, which can be divided into the following categories:

- Category 1: Chemical importers (480 companies identified)
- Category 2: 3rd party service providers i.e., clearing and forwarding and shipping companies (78 companies identified)
- Category 3: Road transportation companies (distribution) (790 companies)

- Category 4: Port facilities and infrastructure (1 company)
- Category 5: Warehousing (351 companies identified)

Braby's is a business directory which gives details of businesses by location and contact details. LinkedIn is a platform, used by business professionals to interact and connect with each other and share common interest topics. The researcher used both search tools to collect the e-mail addresses and contact details of the stakeholders the researcher wished to include.

4.4.2.2 Select data collection method

The data collection method is discussed in more detail in section 4.4.3.1. The researcher used both primary and secondary data in this study. Primary data was obtained by a self-administered questionnaire to enable the researcher to conduct quantitative data analysis. Secondary data was obtained by doing a literature study on articles, books and journals in accredited journals to lay the foundation for the empirical research (Zikmund *et al.*, 2017:27).

4.4.2.3 Specify sample frame

As mentioned above, the researcher made use of Braby's and LinkedIn via the internet to get a comprehensive list of stakeholders involved in the supply chain. As can be seen above, the list of stakeholders, i.e., the greater population is quite vast. From the search a total of 1700 stakeholders were identified, and a list compiled from which the sample was selected. The researcher only selected those individuals and stakeholders that are actively involved in the supply chain of bulk soda ash import.

4.4.2.4 Select sampling method

There are two types of *sampling* procedures: 1) probability sampling; and 2) non-probability sampling. Probability sampling techniques tend to provide the most reliable representation of the greater population, while non-probability sampling mostly rely on the judgment of the researcher, or on chance. Probability sampling is based on random methods to select the sample, but as highlighted above, not all populations are homogenous (Walliman, 2011:96; Gray, 2019:87). Due to this characteristic the specific techniques like simple random sampling, stratified sampling and cluster sampling must be used to ensure the sample is representative.

Non-probability sampling, on the other hand, is based on selection by non-random methods. This method is particularly useful when quick surveys need to be done and when it is difficult to gain access to the greater population. The drawback of this technique is that is does not provide a strong basis for generalisation to the whole population. The techniques used in non-probability sampling are accidental sampling, quota sampling, and the snowball technique (Walliman, 2011:96; Gray, 2019:87). A sample consisting of individuals actively involved with the operations of importing bulk soda ash powder was selected.

The *sampling* procedure the researcher used for this research was non-probability sampling, but more specifically a combination of quota sampling, purposive sampling and snowball sampling (Ghauri *et al*., 2020:166). With this sampling procedure the researcher endeavoured to gather a sample of individuals actively involved in the soda ash import supply chain, which included all stakeholders, different management levels and functions in the import supply chain. The population size was not exactly known, but the sampling was drawn from the categories above (section 4.4.2.1). The researcher aimed to obtain enough completed questionnaires to ensure that more advanced statistical analysis could be conducted.

4.4.2.5 Determine the sample size

The sample size (N) selected for this study was 413. The sample selected was done based on the researcher's judgment to ensure that the respondents were involved with soda ash import. Judgment sampling, also known as purposive sampling, allowed the researcher to fulfil the purpose by ensuring all the respondents had certain characteristics (Zikmund *et al.*, 2010:405; Ghauri *et al.*, 2020:168). The sample was therefore guaranteed to meet the requirements to answer the specific research objectives relating to the risks of bulk import supply chains. The researcher had to select managers and other staff in organisations involved in the bulk import supply chain, i.e., all supply chain and logistics employees actively involved in the import supply chain.

4.4.2.6 Develop operational sampling plan

Table 4.4 below indicates the sampling plan for this research, broken down into the respective empirical research sampling aspects.

Table 4.4: Operational sampling plan

Sampling Aspect	Description
Survey area	Imports through Durban port in South Africa.
Survey population	All stakeholders involved in import supply chains (approx. 1700)[1].
Sample frame	All stakeholders involved in the bulk import supply chain of soda ash.
Sampling method	Non-probability purposive sampling, combined with quota and snowball sampling.
Sample size (N)	413

Source: Compiled by researcher

4.4.3 Research instruments

Research instruments are the plans and procedures for research that span the decisions from broad assumptions to detailed methods of data collection and data analysis (Creswell, 2013:219).

4.4.3.1 Data collection

There are two main types of data: 1) primary data collection; and 2) secondary data collection. *Primary data* gathering, which is seen as the data closest to the truth, includes observation by submerging oneself into the day-to-day life of the subjects by "fitting in" or "blending-into" the natural setting (Walliman, 2011:102; Zikmund *et al.,* 2017:28). For example, experiments are a primary method of data collection. Primary data collection is mainly achieved when the researcher aims to isolate an event or variable so that it can be investigated without the interference of the surrounding environment. The objectives are aimed at gathering data about "cause-and-effect" (Walliman, 2011:102; Zikmund *et al.,* 2017:28). Primary data is gathered by four main methods including: 1) observation, 2) measurement, 3) interrogation and 4) participation (Walliman, 2011:102; Zikmund *et al*., 2017:28). Another method of collecting primary data is through surveys which makes use of questionnaires. Questionnaires can have open format questions or closed format questions (Krosnick, 2018:266; Brace, 2018:55; Gray 2019:194).

[1] A search was conducted on Brabys and LinkedIn to establish the estimated supply chain professional involved in the soda ash supply chain. Refer to 4.4.2.1.

1. In open format questions the respondents are free to answer in their own content and style. Questions typical to this format include: “What are the most significant risks in bulk import supply chains?”
2. In closed format questions, on the other hand, the respondents must choose from a pre-determined set of answers. Typical questions in a closed format questionnaire could include a layout and questions as per the sample below:

		1	2	3	4	5
		Strongly disagree	**Disagree**	**Uncertain**	**Agree**	**Strongly agree**
	Supply chain risks					
		1	**2**	**3**	**4**	**5**
1.	Labour strikes are a major risk to the import supply chain of bulk soda ash imports					
2.	Port delays are a major risk to the import supply chain of bulk soda ash imports					
3.	Political risk is a major risk to the import supply chain of bulk soda ash imports					
4.	Terrorism is a major risk to the import supply chain of bulk soda ash imports					

The full questionnaire used in this study can be seen in Appendix A at the end of this dissertation.

Secondary data refers to data sources which either interpret or record primary data and is less “accurate” than the primary counterpart mentioned earlier. Secondary data comes in many shapes, for instance news bulletins, magazines, newspapers, documentaries, internet, and journals (Walliman, 2011:72; Gray 2019:194).

A combination of primary and secondary data collection was used in this study. Secondary data was obtained through a relevant literature study on the risk in supply chains (Chapter 3) and an overview of supply chain concepts (Chapter 2). Articles from accredited journals, Google Scholar, and other university library sources were used for the literature study. The literature study was used as a basis to develop a questionnaire for use in the primary *data collection*. Primary data was collected by means of a self-administered web survey, utilising a questionnaire with close-ended questions. Emails containing a link to the web survey (Lime Survey) were sent to the targeted sample. Figure 4.6 below indicates the different types of self-administered questionnaires. Self-administered questionnaires consist of two main groups namely, paper questionnaires and electronic questionnaires. Paper questionnaires can be distributed by means of mail (post), in-person-drop-off, inserts and facsimile (fax). Electronic questionnaires can be conducted by means of e-mail, internet websites (e.g. Survey Monkey / Lime Survey), interactive kiosk, and mobile phones. In Figure 4.6 below, the green highlighted section indicates the chosen instruments for data collection in this study, namely, electronic questionnaires making use of e-mail and internet website (Brace, 2018:36; Gray, 2019:204).

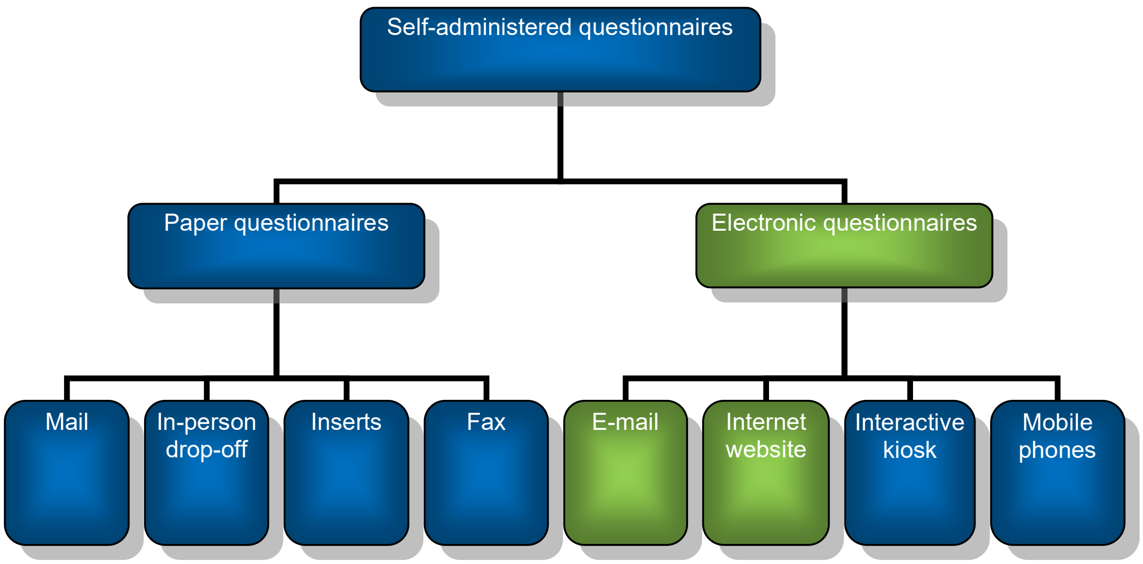

Figure 4.6: Self-administered questionnaires.

Source: Zikmund *et al.* (2010:219); Brace (2018:37); Gray (2019:108)

There are three types of close-ended questions in questionnaires. According to Tustin *et al.* (2005:397) and Brace (2018:66), these include 1) dichotomous; 2) multichotomous; and 3) scale response. Dichotomous is the most common close-ended response. In dichotomous respondents are only provided with two possible answers, which are usually in the form of “yes” or “no” answers. The second type, multichotomous, also known as multiple-choice response, is where the respondents are provided with more than two possible answers to choose from. The last type, scale response, is the most comprehensive close-ended question, and captures the completeness and intensity of the response (Tustin *et al*, 2005:400; Brace, 2018:67).

According to Quinlan *et al.* (2015:107) close-ended questions can be of four measurement types, including nominal scales, ordinal scales, interval scales, and ratio scales. These will be elaborated on below:

- ***Nominal scales:*** This is when a number (or letter) is used as identification of an object or category. Example 1 = yes and 2 = no or 1 = male and 2 = female. Potential questions for this type of scale could look like: "Does terrorism, in your view, contribute as a major risk in the bulk import supply chain?" 1. Yes, 2. No (Brace, 2018:70; Gray, 2019:287).

- ***Ordinal scales:*** This allows the respondents to select the magnitude or degree of agreement to a specific statement. This type of scale also provides information about direction and/or ranking. For example: "Terrorism contributes as a major risk in the bulk import supply chain?" (Brace, 2018:71; Gray, 2019:288).

  1. Strongly disagree; 2. Disagree; 3. Uncertain; 4. Agree; 5. Strongly agree

- ***Interval scales*****:** This scale is like the ordinal scales, with the key difference that the value could be interpreted more meaningfully. An interval scale uses a unit of measure to indicate quantities. The value of zero does not indicate that a variable is absent (Brace, 2018:74; Gray, 2019:288).

- ***Ratio scales:*** This scale is like the interval scale, except that the value zero means that the variable is absent (Brace, 2018:75; Gray, 2019:289).

The questions in this research questionnaire were close-ended questions, which allowed the respondents to select the statements they mostly agreed with (Van Zyl *et al*., 2014:199; Brace, 2018:70). In this questionnaire both ordinal and nominal scales were used, developed by Renis Likert (Zikmund, *et al.,* 2010:405; Krosnick, 2018:268: Brace, 2018:86). With this, the 'Likert scale', respondents indicate their opinions of how strongly they agree or disagree with carefully constructed statements, ranging from very positive to very negative or vice versa. There can be five response alternatives: strongly disagree, disagree, uncertain, agree, and strongly agree, although the number of alternatives may range from three to nine (Zikmund, *et al*., 2010:405). To distribute the questionnaire, the researcher compiled a list of all the relevant e-mail addresses to which the questionnaires and a link to the website for the web survey would be sent. This technique was chosen by the researcher because the questionnaires could be self-administered and respondents from a wide geographical area could participate in the research (Van Zyl *et al*., 2014:148).

4.4.3.2 Self-administered questionnaire advantages and disadvantages

According to Zikmund *et al.* (2010:219) and Brace (2018:41), there are several advantages and disadvantages to self-administered questionnaires. The main advantages and disadvantages are listed in Table 4.5.

Table 4.5: Advantages and disadvantages of self-administered questionnaires

Advantages	Disadvantages
– Geographic flexibility	– Absence or non-response from respondents
– Give access to large populations	– Respondents cannot ask questions or clarify concepts or misunderstandings
– Inexpensive	– Respondents can easily loose interest
– Respondents can respond at their own leisure	– Low response rate
– Gives respondents assurance of anonymity	– Language barriers, literacy and interpretation might influence the outcome of result

Source: Compiled by researcher

4.4.3.3 Survey design and layout

A research instrument is an extremely important component of gathering data. When designing the questionnaire, the researcher considered the following factors (Maree & Pietersen, 2009b:158; Krosnick, 2018:291; Brace, 2018:17):

- *Instructions* need to be clear and concise in order to obtain accurate results. The various sections in the questionnaire must include a clear explanation of what each section entails and what the objectives are. The instructions are also critical to ensure that the respondents are interested and remain interested to complete the questionnaire (Brace, 2018:157; Gray, 2019:201).
- *Appearance of the survey questionnaire* is important to ensure that the respondent remains interested and that he/she is motivated to complete the survey. The survey

questionnaire therefore needs to be user-friendly, easy to read and understand, and the flow of the questions needs to be logical (Brace, 2018:113).

- *Completion time of the survey* is extremely important to ensure that the respondents remain engaged; therefore, the length of the assessment should not be exhausting. The aim of this study was to have a completion time of 20 min (Brace, 2018:176).
- *Question sequence* must flow logically. Important aspects to consider are the question formats, question content, and question wording (Brace, 2018:44).
- *Types of questions* this survey made use of were close-ended questions to which the respondents had to answer to a predetermined selection of options. A sample of the question rating scale can be seen in Table 4.6 below:

Table 4.6: Sample of question rating scale

Rating	Code
Strongly disagree	1
Disagree	2
Uncertain	3
Agree	4
Strongly agree	5

Source: Compiled by researcher

4.4.3.4 Data Analysis

After the data was collected as described above, the researcher analysed the data by means of statistical analyses. *Data analysis* is the application of reasoning to understand the data gathered in its raw and simplest form. This allowed the researcher to draw statistical inference and make use of descriptive techniques to report the information in diagrams and statistical graphs. The researcher made use of Microsoft Excel to present the information in graphs and tables (Zikmund *et al*., 2010:403; Van Zyl *et al*., 2014:421). Table 4.7 describes each type of data analysis technique and its objectives and methods.

Table 4.7: Categories of data analysis techniques

Category	Aim	Method of analysis
Descriptive	The aim is to describe the distribution of the sample: – Frequency	Univariate – focusing on one variable

	– Central tendency – Dispersion	
Associative	The aim is to assess the association of the position of one variable with the likely position of another variable: – Correlation – Analysis of variance – Regression analysis	Bivariate – comparing two variables
Causative	The aim is to determine the network of relationships between variables – Factor analysis – Path analysis – Regression analysis	Multivariate – comparing more than two variables
Inferential	The aim is to estimate the population characteristics from sample characteristics and the sample differences to the population differences.	Multivariate

Source: de Vos et al. (2011:251)

Descriptive and inferential data analysis was used in this study as the objective was to describe the distribution of the frequency and tendency, and also to estimate the characteristics of the population from the sample.

4.4.4 Conclusions and presenting research findings

In Chapter 5, the analysis of the data collected and a detailed discussion of the findings of this study is given. In Chapter 6 the conclusions and recommendations are provided.

4.5 Reliability and Validity of Study

Reliability is achieved when a test measures the same thing more than once and the results remain the same (i.e. the results are consistent) (Van Zyl *et al.*, 2014:115; Krosnick, 2018:272; Gray, 2019:93). Various methods exist to ensure that the reliability of the research is maintained. Methods for measuring reliability are: 1) inter-rater reliability; 2) test-retest reliability; 3) parallel forms; and 4) internal consistency (Sauro, 2015:1).

Inter-rater reliability is the degree or extent to which the raters (also referred to as observers) respond in the same way when measuring the same phenomenon.

Test-retest reliability is achieved when participants answer a questionnaire and at a later stage have them redo the questionnaire again. A correlation can then be drawn between the two sets of measures. If the correlation is high ($r>0.7$) the reliability has been achieved. This test is not often carried out due to the time-consuming aspect of having to repeat the questionnaire and the logistics associated with carrying out this test (Sauro, 2015:1).

Parallel-forms reliability involves comparing the results of two tests on two groups constructed in the same way and with the same content. The correlation between the two group's results can be drawn. To achieve reliability, a high correlation with no systematic differences needs to be achieved (Sauro, 2015:1).

Internal consistency reliability, which is the most frequently used method, involves measuring the consistency of the results across items. This consistency can be measured with Cronbach Alpha, sometimes referred to as Alpha coefficient (Sauro, 2015:1). An acceptable value for reliability is for the Alpha coefficient to be above 0.70.

The researcher measured the reliability of the questionnaire (internal consistency) by calculating the Alpha coefficient (Sauro, 2015:1). Generally, it is accepted that Cronbach's Alpha value above 0.70 is acceptable to ensure reliability.

When the research was conducted, consideration was given to the following threats that could potentially reduce the reliability (Saunders *et al*., 2012:192; Krosnick, 2018:285):

1. *Participant error* includes any factor that could potentially alter the way in which the respondent or stakeholder performs, giving inaccurate responses that distort the results and may cause the data to be unreliable, for example, not fully understanding the questions or rushing to complete the questionnaire without sufficient time (Brace, 2018:18).
2. *Participant bias* includes any factor that could alter the way the respondent provides their feedback due to their prejudice or perception, which could be either consciously or subconsciously. This includes respondents acting in a way that they

think the researcher wants them to act or selecting answers in questionnaires they think the researcher wants them to select (Brace, 2018:21).

3. *Researcher error* includes any factor that could affect the researcher's ability to interpret the feedback from the respondents correctly (i.e. misinterpret). For example, a tired or ill-prepared researcher could contribute to this error.
4. *Researcher bias* is the conscious or subconscious phenomenon which occurs when researchers try to influence the results of their work in order to get the outcome they want. A typical example of this is the unethical behaviour of inventing or "massaging" the results.

Validity, on the other hand, indicates if significant and useful inferences can be drawn from the scores on specific instruments (Creswell, 2013:219; Krosnick, 2018:272). Saunders *et al.* (2012:193) identified five forms of validity to guarantee the quality of research. These include: 1) internal validity; 2) content validity; 3) criterion-related validity; 4) construct validity and 5) external validity (Van Zyl *et al*., 2014:124; Brace, 2018:11; Gray, 2019:91). Each one of these concepts is described in Table 4.8 and an explanation is offered of how each is achieved.

Table 4.8: Types of research validity

Type of validity	Achieved when
Internal validity	The research can demonstrate a causal relationship between two variables or when a questionnaire's intended measurables are achieved successfully
Content validity	The measurement questions in the questionnaire provide enough cover of the investigated questions, i.e., each question needs to relate to an objective of the study
Criterion-related validity	The "competence" of the measures makes truthful predictions, when a study produces accurate estimates on performance or when the study's prediction of future performance is accurate
Construct validity	The researcher uses enough definitions and measures of variables
External validity	The research findings can be generalised to other groups or settings

Source: Saunders *et al.* (2012:192); Van Zyl *et al.* (2014:124); Brace (2018:11); Gray (2019:91)

4.6 Types of Variables in Quantitative Research

A variable is defined as anything that varies or changes from one instance to another (Zikmund, *et al.,* 2010: 119). According to Van Zyl *et al.* (2014:23) a variable is synonymous with the words 'changeable' and 'unsteady'. In quantitative research there are several variables which can be classified according to their function as listed and described below (Van Zyl *et al.*, 2014:24; Barua & Sinha, 2015:8; Hoy & Adams, 2015:31):

- ***Dependent variable (DV):*** This is a measured, predicted or monitored variable expected to be affected by manipulation of an independent variable. This variable is also referred to as criterion variable (CV), result variable (RV), or outcome variable (OV). A dependent variable is the presumed effect variable and is the variable which is examined as the outcome of a research project.
- ***Independent variable (IV):*** This variable can be manipulated by the researcher to examine its effect. This variable will thereby have an effect on the dependent variable. Other terms used for this variable is predictor variable (PV), factor (F), or treatment variable (TV).
- ***Intervening variable (IVV):*** This is a variable that affects the observed phenomenon but cannot be measured or manipulated.
- ***Moderating variable (MV):*** This is a variable relating to the dependent or independent variable and is believed to have a significant effect on the originally stated IV-DV relationship. This variable is also referred to as the interacting variable.
- ***Extraneous variable (EV):*** This variable is related to either the dependent or independent variable. The EV is excluded or is not part of the research study. This variable is also referred to as the threatening variable.
- ***Control variable:*** This is a variable which is introduced to help interpret the relationship between the various variables. The control variable is related to the dependent variable. This variable is also referred to as restricting variable.

4.7 Pre-Testing the Research Instrument

According to Krosnick (2018:295), pre-testing is defined as the "formal evaluation carried out before the main survey". In this study pre-testing was the evaluation of the questionnaire before it was sent out to the respondents (Krosnick, 2018:295). Pre-testing is important to ensure that the language used, and the questions asked are appropriate and relevant. Pre-testing can also be used to "fine-tune" the study objectives and highlight any flaws in the questionnaire. The methods used in this study included logistics expert reviews and reviews by university academics, which aided in identifying flaws in the questionnaire (Brace, 2018:161).

4.8 Hypothesis

Quantitative research requires the formulation of a hypothesis in the form of statements that express the relationships between variables (Kumar, 2013:2; Van Zyl *et al.*, 2014:7; Gray, 2019:301). A hypothesis is a formal statement describing an "educated guess" of the relationships between variables subjected to verification through a research study (Zikmund *et al.,* 2010:403; Babikir, Habour & Elwahab., 2010:3; Creswell, 2013:129; Gray, 2019:301).

The hypotheses related to this study include:

$H1_0$: The distribution of *risk and strategies* is the same across the various parts of the bulk import supply chain including:

1. 3rd party logistics services
2. Clearing and forwarding
3. Importer / buyer
4. Other
5. Port related services
6. Transport
7. Warehousing

$H2_0$: The distribution of *risk and strategies* are the same across the number of years' experience groups in the bulk import supply chain as defined by the categories:

1. Between 1 – 3 years' experience
2. 3 - 5 years' experience
3. 5 – 10 years' experience
4. More than 10 years' experience

$H3_0$: The distribution of *risk and strategies* are the same across the level or position groups within the organisation in the bulk import supply chain as defined by the categories:

1. Operational level
2. Lower management level
3. Middle management level
4. Top management level

$H4_0$: The distribution of *risk and strategies* are the same across the different obtained educational qualifications in the bulk import supply chain:

1. Matric / Grade 12
2. Tertiary certificate / Diploma
3. Bachelor's degree
4. Post graduate degree

4.9 Conclusion

Chapter 4 started with an overview and introduction to research. A brief description was given of the problem statement, which linked the primary and secondary objectives of the study to this problem statement. A detailed discussion outlined all the research methodologies that were applied in this study, including the research design, research approaches, population, sampling, research instruments, data collection, and data analysis. This chapter also discussed the reliability and validity of this study and how the researcher ensured that it was achieved. A brief discussion outlined the types of variables relevant to research and the pre-testing methods applied to this research. Lastly, this chapter ended with the hypotheses that were tested in this study.

CHAPTER 5: ANALYSIS OF DATA AND DISCUSSION OF RESULTS

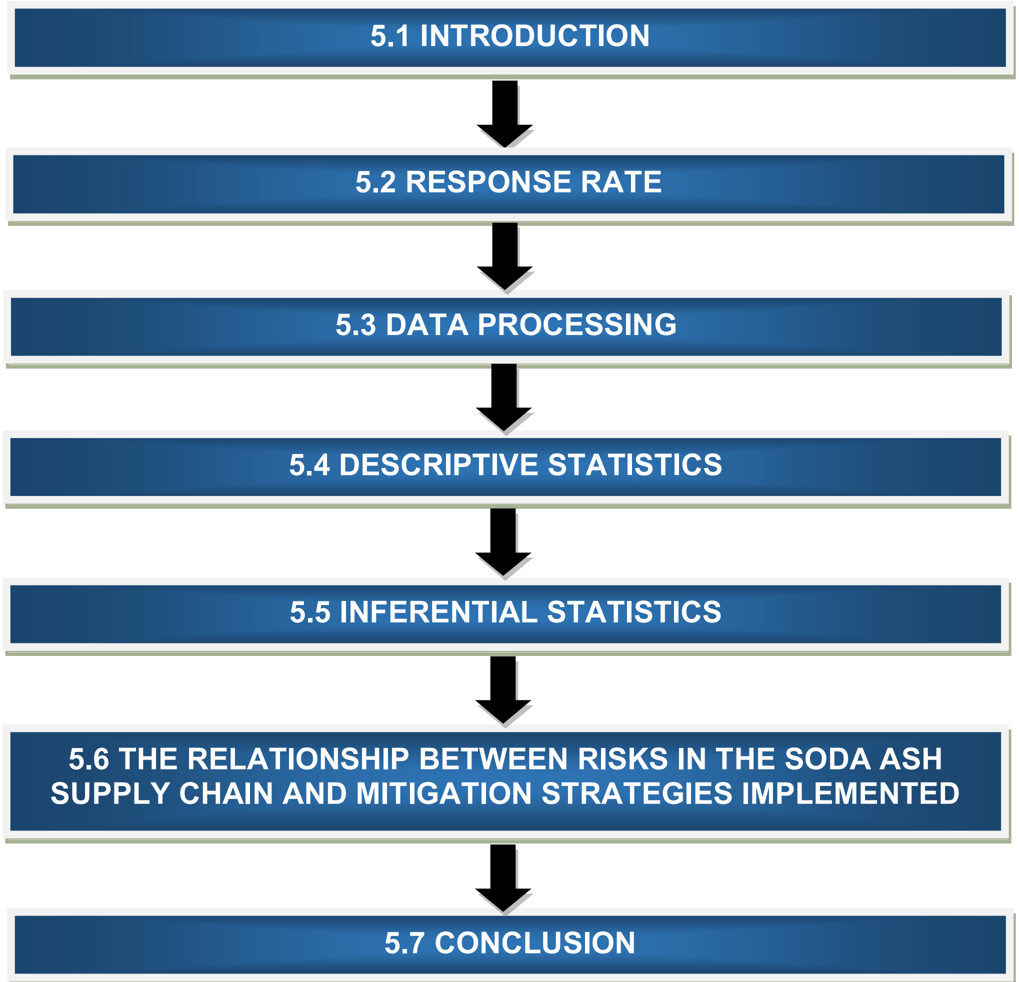

Figure 5.1: Flow diagram of Chapter 5

Source: Compiled by researcher

5.1 Introduction

The results of the empirical research are presented in Chapter 5. Various graphs and tables visually present the results. In addition, descriptive and inferential statistics are used to describe and discuss the results. The data analysis of this research study was done by testing the hypothesis as formulated in Chapter 4, section 4.8, with the aim of achieving the empirical research objectives. Research objectives *c, d* and *e* of the study were addressed by means of empirical research. These objectives include:

c) To identify and explore the supply chain risks in the soda ash supply chain in South Africa, by means of an empirical (survey) study.

- **d)** To identify and describe the risk management and mitigating practices used in a bulk soda ash import supply chain, by means of an empirical (survey) study.
- **e)** To determine the relationships between the different risk factors and mitigation strategies with the aid of inferential statistics.

As mentioned in Chapter 1, this research was carried out in two phases. Phase one consisted of a comprehensive literature review of secondary data sources, such as in accredited journals and subject matter textbooks. Phase two of the study consisted of the empirical research. In order to address the objectives of this research a quantitative research approach was selected and followed. It is the focus of this chapter to describe the results of the empirical research by means of descriptive and inferential statistical analysis.

5.2 Response Rate

The link to the web-based survey was sent to a total of 413 potential respondents actively involved in the bulk import supply chain, via e-mail and LinkedIn. The researcher also contacted known respondents in the bulk import supply chain via telephone to complete the survey telephonically, especially so for the operational level respondents who did not have access to internet, a personal computer (PC) and/or a smartphone to complete the survey themselves. A total of 103 responses were received. Out of the 103 responses, only 89 (86.4%) responses were valid (fully completed) as the other 14 (13.6%) either completed the survey halfway or not at all, rendering the incomplete surveys redundant. The response rate for fully completed surveys, and therefore for this study, was 21.5%. Potential reasons for the relatively low response rate could include the complexity of the subject and questions, together with a relatively long questionnaire. The researcher found that some respondents only completed half or in some cases only one question of the survey and never came back to complete it. This could be due to the relatively long time (20 min) it took to complete the survey, which led to respondents becoming disengaged. Another scenario could be that a potentially unforeseen event occurred during the survey and the respondent's intent was to complete it at a later stage but never did.

5.3 Data Processing

The data gathered from the completed questionnaires were exported into Microsoft Excel after being coded from the survey tool Lime Survey. The data was analysed by making use of the statistical software program known as SPSS v27. The development of the charts used to graphically represent the results was done in Microsoft Excel and Power BI.

5.4 Descriptive Statistics

Descriptive statistics, according to Investopedia (2021), are brief descriptive coefficients that summarise a given data set. This data set can either be a representation of the entire or sample population. According to Salkind (2012:162), descriptive statistics are further defined as simple measures of the distribution's central tendency and variability. Descriptive statistics further help the researcher to explain the data more accurately and in greater detail than graphical displays, although graphical displays may form part of it (Jones & Bartlett Learning, 2012).

Descriptive statistics enable the researcher to describe (and compare) variables numerically. The researcher's research question(s) and objectives, although limited by the type of data, should guide his/her choice of statistics (Saunders *et al.*, 2009: 444).

The aim of descriptive statistics is to describe the distribution of the sample in terms of:

1. Frequency tables for categorical and ordinal data.
2. Central tendency (mean and median) and dispersion (standard deviation) for continuous variables.

5.4.1 Sample respondent profiles

A summary of the respondent profiles can be seen in Table 5.1 below. Since this was an anonymous survey, only non-identifiable profile information was gathered, like role in the supply chain, years of experience, level in the organisation, and educational qualification.

Table 5.1: Summary of the respondent profiles

Respondent characteristics	N	Percent (%)
Role in the import supply chain:		
Importer / Buyer	14	15.7
Warehousing	13	14.6
Transport	10	11.2
Clearing and forwarding	14	15.7
Port related services	12	13.5
3rd party logistics services	11	12.4
Other	15	16.9
Years of experience:		
< 1 year	3	3.4
1 – 3 years	11	12.4
3 – 5 years	22	24.7
5 – 10 years	26	29.2
> 10 years	27	30.3
Position within organisation:		
Operational level	12	13.5
Lower management level	20	22.5
Middle management level	29	32.6
Top management level	11	12.4
No response	17	19.0
Educational qualification:		
Matric / Grade 12	22	24.7
Tertiary certificate / Diploma	25	28.1
Bachelor's degree	13	14.6
Honour's degree	7	7.9
Master's degree	4	4.5
Doctoral degree	1	1.1
No response	17	19.1
Total	89	100

Source: Compiled by researcher

5.4.1.1 Role in the bulk import supply chain

The sample for this study consisted of 89 respondents who are actively involved in the import supply chain of soda ash. The respondents' roles were fairly similarly distributed across importers / buyers (15.7%), warehousing (14.6%), transport (11.2%), clearing and forwarding (15.7%), port related services (13.5%), 3rd party logistics services (12.4%) and other activities (16.9%) as seen in Figure 5.2. The roles which were indicated in the comments in the "other activities" include: supply chain advisory specialists, sales, production, exports, bagging services, and "various" which indicates that this group of respondents were involved with multiple activities or a combination of activities in the soda ash supply chain. The data indicates that respondents of a wide variety of roles had taken part in the survey, giving a balanced opinion across the supply chain.

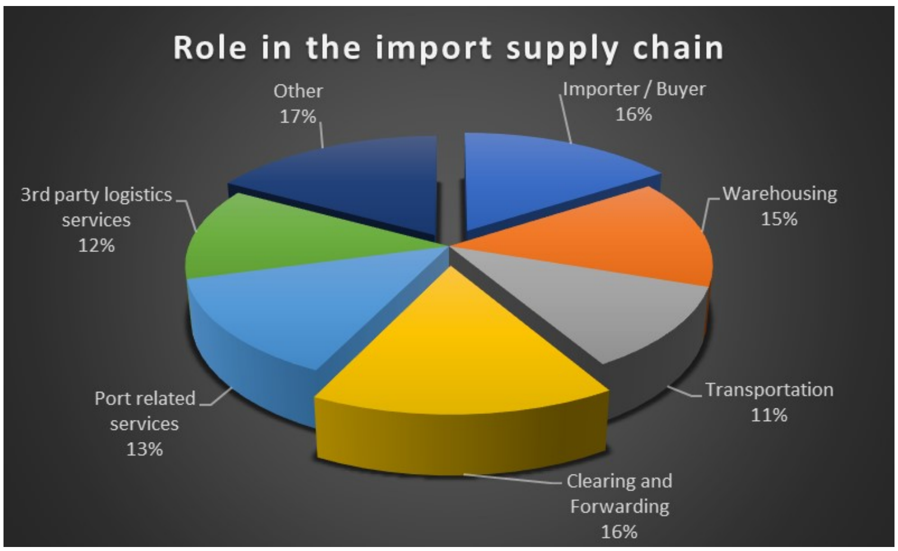

Figure 5.2: Respondents' role in the import supply chain (n = 89)

Source: Compiled by researcher

5.4.1.2 Years of experience in bulk import supply chain

More than half of the respondents (59.5%) have more than 5 years of work experience, with most of these respondents (30.3% of total sample) having more than 10 years' experience, as seen in Figure 5.3. This indicates that the respondents have extensive experience in bulk import supply chain, having worked for extended periods in the industry, and thus had intimate knowledge and experience in terms of the bulk imports operation.

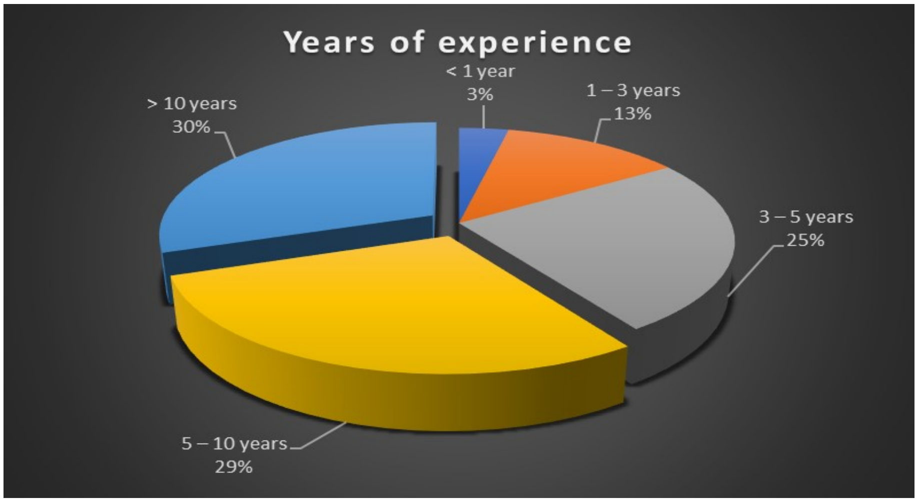

Figure 5.3: Respondents' years of experience (n = 89)

Source: Compiled by researcher

5.4.1.3 Position within the organisation

The level within the organisation of almost a third (32.9%) of the respondents was middle management, followed by lower management level (22.5%). A fairly high number (19%) of respondents decided not to respond as can be seen in Figure 5.4. This is mainly due to the reason that this was a voluntary question in the survey. From the data it is clear that a notable portion of the respondents have good insights and knowledge about their organisation's strategies when dealing with risks in the bulk import supply chain, and also are able to influence decisions and strategies implemented to a certain extent.

Figure 5.4: Respondents position within the organisation (n = 89)

Source: Compiled by researcher

5.4.1.4 Educational qualification

The highest educational qualification of over half of the respondents (52.8%) was a matric or tertiary diploma/certificate as seen in Figure 5.5. A fairly low percentage (13.5%) of respondents have a post graduate qualification.

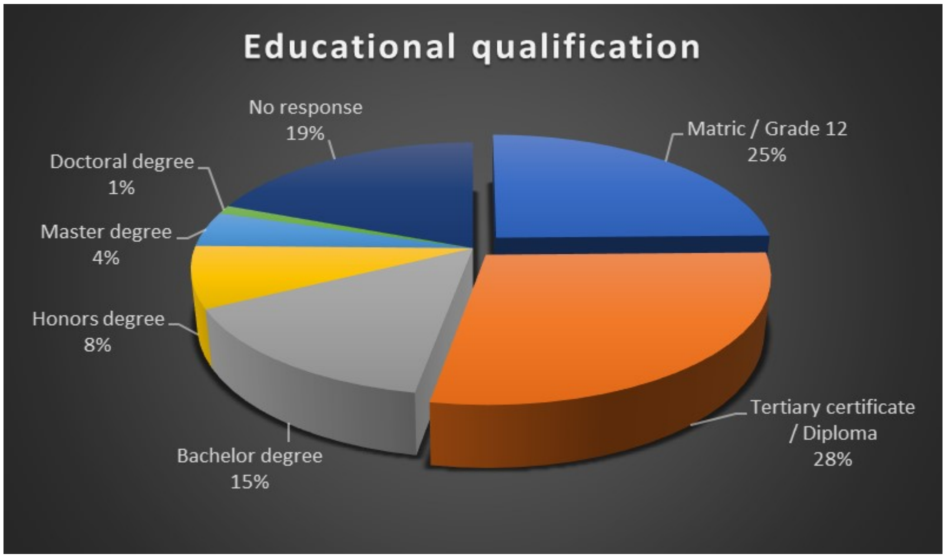

Figure 5.5: Respondents' educational qualifications (n = 89)

Source: Compiled by researcher

5.4.2 Major risks to the import supply chain of bulk soda ash

This section is aimed at addressing research objective *c*:

- **c)** To identify and explore the supply chain risks in the soda ash supply chain in South Africa, by means of an empirical (survey) study

Figure 5.6 below illustrates all the major risks in the import supply chain of bulk soda ash which the respondents had to rate on a scale of 1 to 5, where 1 is strongly disagree, 2 is disagree, 3 is uncertain, 4 is agree and 5 is strongly agree. Almost all the respondents indicated that they agree or strongly agree that *port delays* (96.7%) and 'black swan' events such as the COVID-19 *pandemic* (91%) are major risks to the soda ash import supply chain. It is clear from the results that the respondents in the bulk import supply chain strongly feel that the port is suffering from chronic port delays, as it ranked the highest out of all 17 of the major risks listed with a mean of 4.54. It is also no surprise that a major risk such as the COVID-19 pandemic scored remarkably high and has a mean of 4.61. The main reason for this is that the survey was conducted at a time when the South

African Government imposed restrictions and lockdowns, at varying levels, to try and reduce the COVID-19 infection rate.

Other major risks the respondents agreed and strongly agreed with, by an exceptionally large percentage, are labour strikes (84.3%) and infrastructure deterioration (82.1%). The data indicates that the respondents felt strongly about labour strikes being a major risk plaguing not only the bulk specific industry, but also the greater supply chain. The acknowledgement of the risks related to infrastructure deterioration is also evident from the data and is testament to the fact that supply chains will be negatively impacted by the lack of maintenance of infrastructure.

The risks the respondents were uncertain about (highest percentage uncertain responses) included political instability / unrest (22.5%), oil price increases (16.9%), and internal organisational risk (16.9%) (The study was completed before the unrest of July 2021, which plagued KwaZulu Natal and Gauteng provinces). The risks the respondents disagreed and strongly disagreed with mostly include the risks of terrorism (70.8%) and logistics outsourcing (32.6%). The fact that 70,8% of respondents disagreed and strongly disagreed that terrorism is a major risk makes sense in the South African context, although this does not eliminate the risk completely as 20.2% of respondents felt it was a major risk, perhaps outside of the South African context.

When considering the mean for explorative purposes, Table 5.2 below gives an indication of each listed risk in question B1.1 to B1.17:

Table 5.2: Summary of mean for question B1 (major risks)

	Mean	Analysis N
B1.1. Labour strikes	4.29	89
B1.2. Port delays	4.54	89
B1.3. Political instability / unrest	3.69	89
B1.4. Terrorism	2.29	89
B1.5. Infrastructure deterioration	4.20	89
B1.6. Governmental regulations	3.94	89
B1.7. Oil price increases	3.91	89
B1.8. Natural disasters	3.91	89
B1.9. Supply chain complexity	3.79	89
B1.10. Supply chain uncertainty	3.81	89

B1.11. Supply chain instability	3.79	89
B1.12. Logistics outsourcing	3.47	89
B1.13. Supply risk	3.83	89
B1.14. Demand risk	3.76	89
B1.15. Pandemic outbreaks e.g. COVID	4.61	89
B1.16. Internal organisational risk	3.28	89
B1.17. External organisational risk	3.91	89

Source: Compiled by researcher

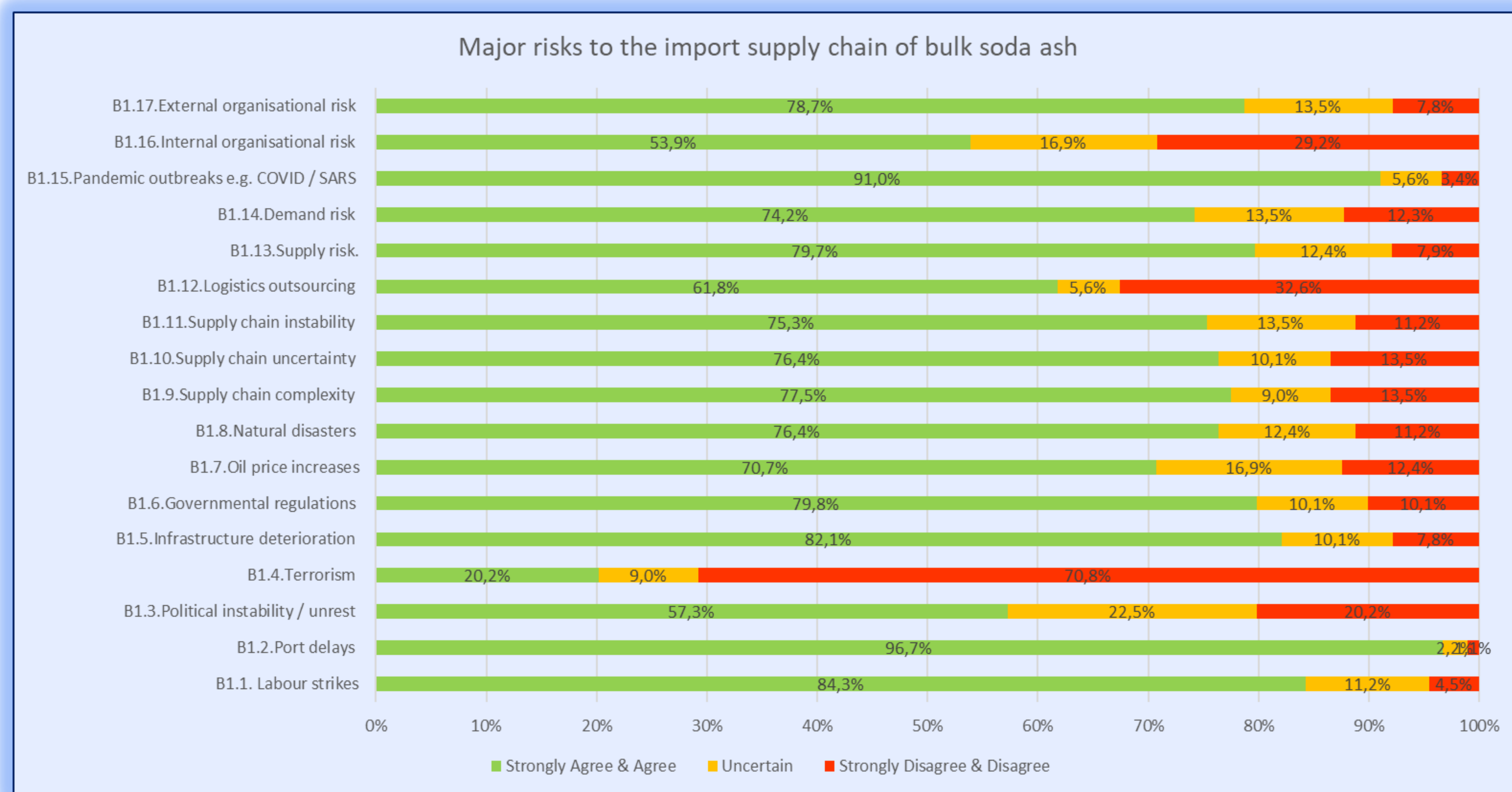

Figure 5.6: Major risks to the import supply chain of bulk soda ash (n = 89)

Source: Compiled by researcher

5.4.3 Active management of risks by organisations and the results of unmanaged supply chain risks

This section and subsections are aimed at addressing research objective *d*:

d) To identify and describe the risk management and mitigating practices used in a bulk soda ash import supply chain, by means of an empirical (survey) study.

Figure 5.7 below illustrates the response to the questionnaire (question B2.1) when asked if "supply chain risks are left unmanaged it could lead to an unnecessary negative financial impact". To this question almost all respondents agreed and strongly agreed (94.4%) that there would be unnecessary financial impact if risks are left unmanaged. A small percentage of respondents (4.5%) disagreed and strongly disagreed with the statement, while 1.1% were uncertain as to whether there would be an unnecessary financial impact.

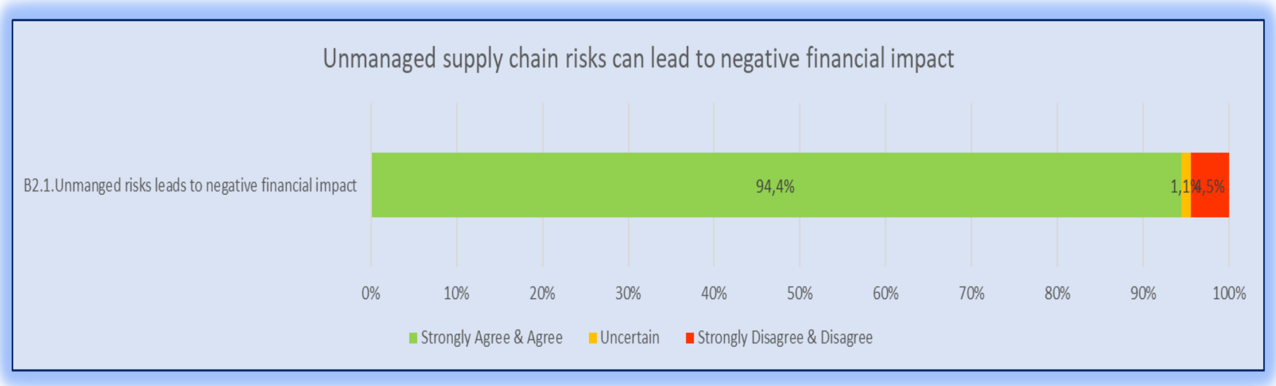

Figure 5.7: Unmanaged supply chain risks (n = 89)

Source: Compiled by researcher

When asked if their organisations actively manage risks in the supply chain (question C1), a remarkably high percentage (89.9%) of the respondents confirmed that their organisations do actively manage supply chain risks. As can be seen in Figure 5.8, only 10.1% of respondents said that their organisations do not actively manage supply chain risks.

Figure 5.8: Active management of risks in the supply chain (n = 89)

Source: Compiled by researcher

5.4.4 Proactive vs reactive management of risk and supply chain risk management framework

When asked if the respondents' organisations manage risks proactively and/or reactively, a large majority of the respondents agreed and strongly agreed (85.4%) that their organisations deal proactively with risks, while 11.2% disagreed and strongly disagreed. A total of 3.4% of respondents were uncertain if their organisation deals proactively with risks.

Regarding reactive management of risks, an almost equal percentage of respondents agreed and strongly agreed (46.0%) that their organisation deals with risk reactively, while respondents who disagreed and strongly disagreed were 46.1%. The data seems to indicate that reactive management of risks is also an alternative strategy to manage risks in the soda ash import supply chain. It must be noted, depending on the risk, that the organisation might choose to either deal proactively or reactively with it. In certain instances, it might be better to deal with a risk reactively, as opposed to planning proactively how to manage it.

Respondents who were uncertain whether their organisations deal reactively with risks were 7.9%. The results for proactive versus reactive management of risks can be seen in Figure 5.9 below in a graphically representation.

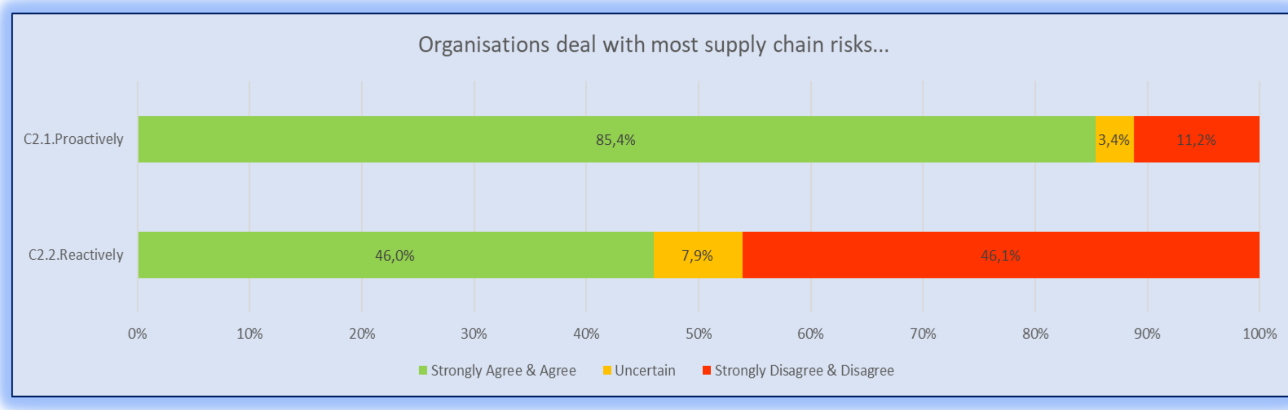

Figure 5.9: Proactive vs reactive management of supply chain risks (n = 89)

Source: Compiled by researcher

In Figure 5.10 the results related to the use of the supply chain risk management (SCRM) framework can be seen (questions C3.1 - C3.3). The respondents were asked to indicate how strongly they disagree or agree with the statements and were asked if their organisation uses the framework for 1) risk identification; 2) risk assessment; and evaluation; and 3) implementation of the identified risk mitigation strategies. Related to 'risk identification', a large majority of respondents (89.9%) agreed and strongly agreed that their organisation makes use of the SCRM framework for risk identification.

With regard to the second use of the supply chain risk management framework, namely 'risk assessment and evaluation', just more than three quarters of the respondents (76.4%) agreed or strongly agreed that their organisation use the framework for this aspect.

The last aspect of the use of the SCRM framework, namely the 'implementation of identified risk mitigation strategies', yielded a total of approximately two thirds (66.3%) of respondents who agreed or strongly agreed. A total of 20.3% of respondents disagreed or strongly disagreed, while 13.5% of respondents were uncertain as to whether their organisation use the SCRM framework to implement identified risk mitigation strategies.

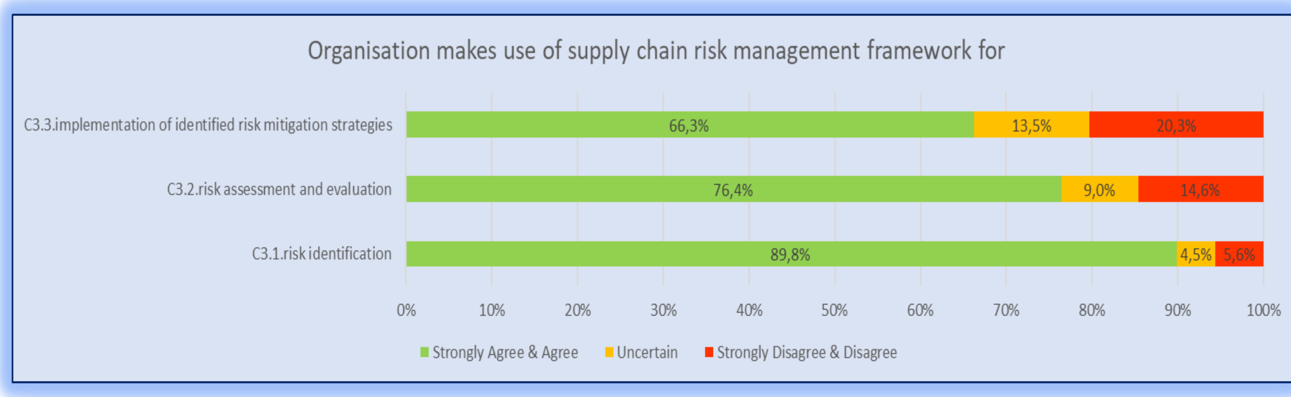

Figure 5.10: The use of the supply chain risk management framework (n = 89)

Source: Compiled by researcher

An interesting trend can be seen in the data when comparing the phases of the SCRM framework, i.e., 1) risk identification; 2) risk assessment and evaluation; and 3) implementation of identified risk mitigation strategies. The trend indicates that 89,8%, 76.4%, and 66.3% of respondents agreed and strongly agreed that their organisations make use of the respective phases of the SCRM framework. This seems to indicate that many organisations in the bulk import supply chain most likely make use of risk identification as a first phase of the SCRM framework. In the second phase of the SCRM framework, they appear to use risk identification to a lesser extent, i.e., the evaluation and assessment of risks. The least used phase of the SCRM framework is the implementation of the identified risk mitigation strategies. Further to this, the level of uncertainty increases with each phase (4.5%, 9.0% and 13.5%), which indicates that the respondents were uncertain of whether their organisation uses this phase of the SCRM framework. Lastly, the respondents who disagree and strongly disagree with each phase seem to follow the same trend as the uncertainty, i.e., increase with each phase (5.6%, 14.6% to 20.3%). This also indicates that some respondents disagree and strongly disagree with the fact that their organisation makes use of these phases of the SCRM framework.

5.4.5 Risks the import soda ash supply chain are dealing with

Figure 5.11 below illustrates to what extent the organisations involved in the import supply chain of soda ash deal with certain risks. The respondents had to rate the question on a scale of 1 to 5, where 1 is not at all, 2 is to a small extent, 3 is to a moderate extent, 4 is to a large extent and 5 is to a very large extent. The risks that soda ash supply chain members experience most, to a large and very large extent, include pandemic outbreaks e.g., COVID-19 (87.7%), port delays (85.4%) and logistics outsourcing (82%). The data indicates, yet again, the situation the country found itself in 2020 with varying levels of lockdowns and restrictions imposed by government and the extent to which the soda ash supply chain had to deal with the COVID-19 crisis and its related complexities. In addition, the COVID-19 pandemic was a global phenomenon with most governments implementing lockdowns to varying degrees in different countries in the world. It is therefore obvious that the importation of soda ash would be impacted. Further, the data indicates that the supply chain struggles and is plagued with port delays as most respondents experienced it to a large and very large extent in their daily operation. Lastly, risks involved with outsourcing are dealt with to a large and very large extent in the bulk soda ash import supply chain. It is inevitable that there would be outsourcing to third party logistics providers (3PL) as no single entity has the resources and equipment to manage the full supply chain due to the large volume and scale.

Other risks, which at least two thirds of the respondents deal with to a large and very large extent, include labour strikes (77.5%), infrastructure deterioration (74.2%) and external organisational risk (66.2%). The data indicates, as is the case in South Africa generally, that the soda ash import supply chain deals with labour strikes to a large and very large extent, which is in line with the opinion of Tenza (2020:519). Second to this, the data confirms that infrastructure deterioration is an all too familiar risk the respondents must deal with in their daily operation. An interesting result is the fact that to a large and very large extent the majority of respondents have experienced risks outside of their organisation, which is usually beyond the scope of their direct control and influence. These include risks like labour strikes, infrastructure deterioration, COVID-19, and port delays as listed above.

The risks the respondents deal with, with the highest percentage of “to a moderate extent”, include oil price increases (43.8%), supply chain complexity (31.5%), and supply chain instability (29.2%). The data confirms that respondents, albeit a minority percentage, in the soda ash import supply chain acknowledge that oil price increases pose a potential risk to the supply chain as it directly affects the cost of fuel for road transport and the bunker fuel of the ships transporting the bulk. The complexities associated with the soda ash industry, such as supply constraints, port delays, and various other factors are also highlighted by the fact that 31.5% of respondents experienced complexities in their supply chain to a moderate extent. This is worsened by the fact that 29.2% of respondents also dealt with supply chain instability to a moderate extent.

Lastly, the risks the respondents deal with, with the highest percentage of “to a small extent or not at all” include terrorism (74.2%), political instability / unrest (40.5%), internal organisational risk (37.1%), and lastly demand risk (31.5%). The data confirms that the soda ash import supply chain is least likely to deal with terrorism in the South African context.

A summary of the mean for explorative purposes is indicated in Table 5.3 below for each listed risk in question C4.1 to C4.17.

Table 5.3: Summary of mean for question C4 (risks dealing with)

	Mean	Analysis N
C4.1. Labour strikes	4.21	89
C4.2. Port delays	4.34	89
C4.3. Political instability / unrest	2.90	89
C4.4. Terrorism	1.92	89
C4.5. Infrastructure deterioration	4.04	89
C4.6. Governmental regulations	3.60	89
C4.7. Oil price increases	3.10	89
C4.8. Natural disasters	3.53	89
C4.9. Supply chain complexity	3.54	89
C4.10. Supply chain uncertainty	3.52	89
C4.11. Supply chain instability	3.55	89
C4.12. Logistics outsourcing	4.35	89
C4.13. Supply risk	3.40	89
C4.14. Demand risk	3.39	89
C4.15. Pandemic outbreaks e.g. COVID	4.39	89
C4.16. Internal organisational risk	3.19	89
C4.17. External organisational risk	3.83	89

Source: Compiled by researcher

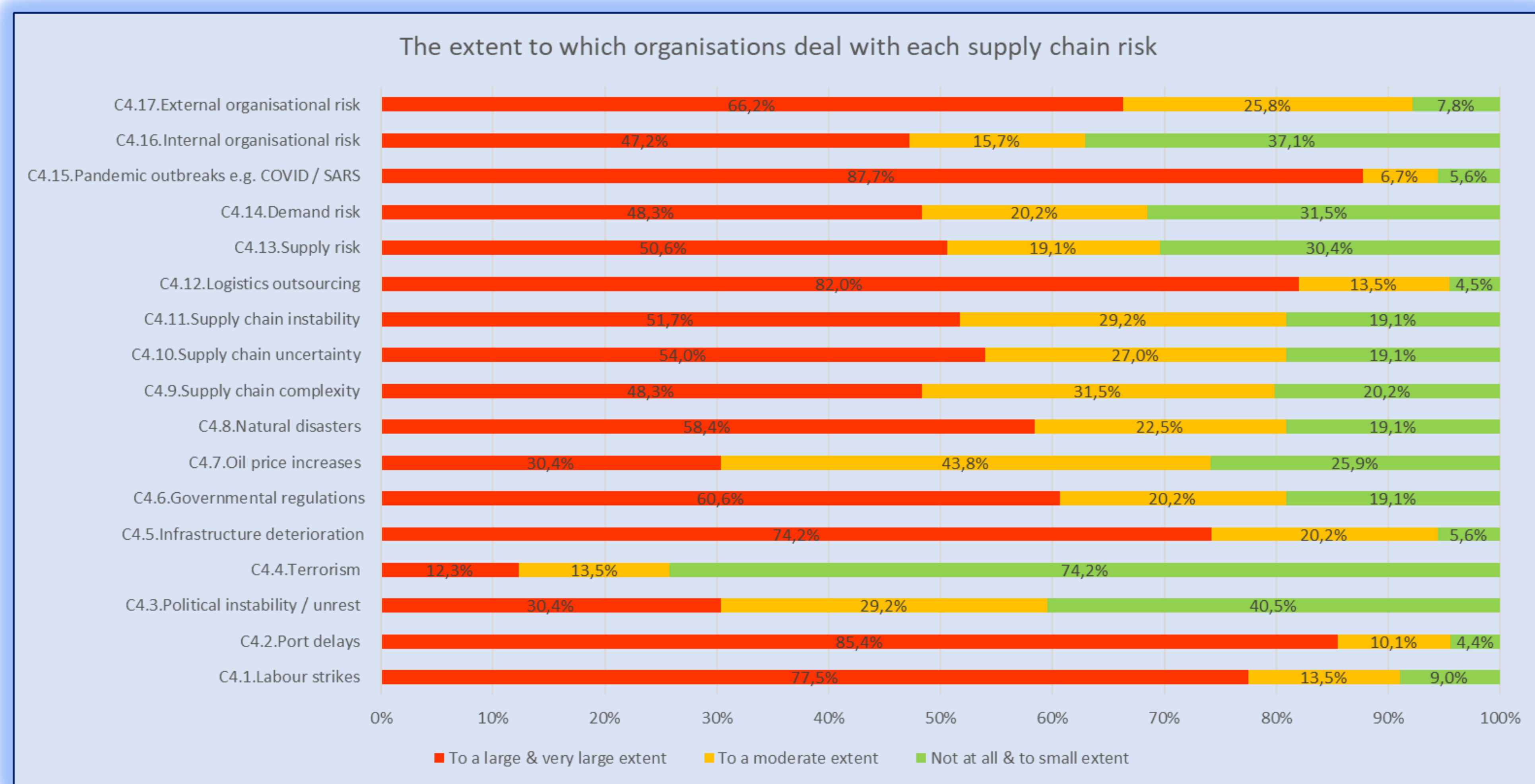

Figure 5.11: Supply chain risks organisations deal with (n = 89)

Source: Compiled by researcher

5.4.6 Risk mitigation strategies in soda ash import supply chains

Figure 5.12 below illustrates all the risk mitigation strategies that organisations in the import bulk soda ash supply chain use, which the respondents rated with 1 strongly disagree, 2 disagree, 3 uncertain, 4 agree and 5 strongly agree. Almost all the respondents indicated that they agree or strongly agree (with above 90%) that their organisation makes use of the following mitigation strategies:

- Flexible transport (95.5%)
- Collaboration with suppliers and/or customers (95.5%)
- Resilient supply chain (95.5%)
- Works toward integration with suppliers and/or customers (94.4%)
- Robust (strong) supply chain (94.4%)
- Flexible supply chain (93.3%)
- Stable (constant) supply chain (93.3%)
- Agile (responsive) supply chain (92.1%)

With all the above mitigation strategies listed (above 90%), it can be argued that the organisation has direct control over them or can at least influence the implementation of the risk mitigation strategy. It can also be said that the above strategies are 'best practices' in SCM and are characteristics of a fully integrated supply chain (Alicke, Rexhausen & Seyfert, 2017:3; Anwer, Garza-Reyes & Kumar, 2018:5; Singh, Soni & Badhotiya, 2019:105; Albertzeth, Pujawan, Hilletofth & Tjahjono, 2020:6).

Other risk mitigation strategies the respondents agreed and strongly agreed with, by a large percentage (but under 90%), is flexible supply base (82%) and innovation (77.6%). Similar to the prior mentioned mitigation strategies, flexible supply base can also be controlled or influenced by the organisation but limited in that there are only a handful of soda ash manufacturers in the world, which are of varying quality and from geographically dispersed areas (Fayezi, Zutshi & O'Loughlin, 2017:24; Namdar, Li, Sawhney & Pradhan, 2018:6).

The mitigation strategies the respondents were uncertain about mostly included product postponement (15.7%) and make-or-buy, i.e., insourcing vs outsourcing options (14.6%).

The risk mitigation strategies the respondents disagreed and strongly disagreed with, mostly include product postponement (25.8%) and make-or-buy i.e. insourcing vs outsourcing options (16.8%). The data confirms that there is limited scope in the import supply chain of soda ash for product postponement and outsourcing vs insourcing. The reason for this is likely due to the nature of the soda ash industry. Since soda ash is imported in dry bulk vessels (ships) most of the time and kept in a warehouse at port to be delivered in bulk to the customer, it poses limited opportunities to postpone the product form. At best, the bulk can be bagged into 25kg, 50kg, and 1200kg bags if the customer requires a smaller quantity. In most of the cases the soda is hauled by dry bulk trucks to the customer for offloading into their silos. As mentioned earlier, outsourcing is dealt with to a large and very large extent in the bulk soda ash import supply chain, as no single entity has the resources and equipment to manage the full supply chain due to the large volume and scale, hence it is inevitable to make use of outsourcing to a 3rd party logistics provider (3PL). Limited scope exists with regards to decisions of outsource vs insource as a large amount of capital is required to purchase equipment required to handle bulk soda ash.

A summary of the mean for explorative purposes is indicated in Table 5.4 below for each listed mitigation strategy in question C5.1 to C5.13.

Table 5.4: Summary of mean for question C5 (mitigation strategies)

	Mean	Analysis N
C5.1. Product postponement	3.35	89
C5.2. Placement of strategic stock	3.81	89
C5.3. Flexible supply base	4.04	89
C5.4. Make-or-buy i.e. insourcing vs outsourcing options	3.71	89
C5.5. Flexible transport	4.54	89
C5.6. Collaboration with suppliers and / or customers	4.53	89
C5.7. Works towards integration with suppliers and / or customers	4.54	89
C5.8. Resilient supply chain	4.42	89
C5.9. Flexible supply chain	4.44	89
C5.10. Robust (strong) supply chain	4.46	89
C5.11. Agile (responsive) supply chain	4.40	89
C5.12. Stable (constant) supply chain	4.46	89
C5.13. Innovation	3.98	89

Source: Compiled by researcher

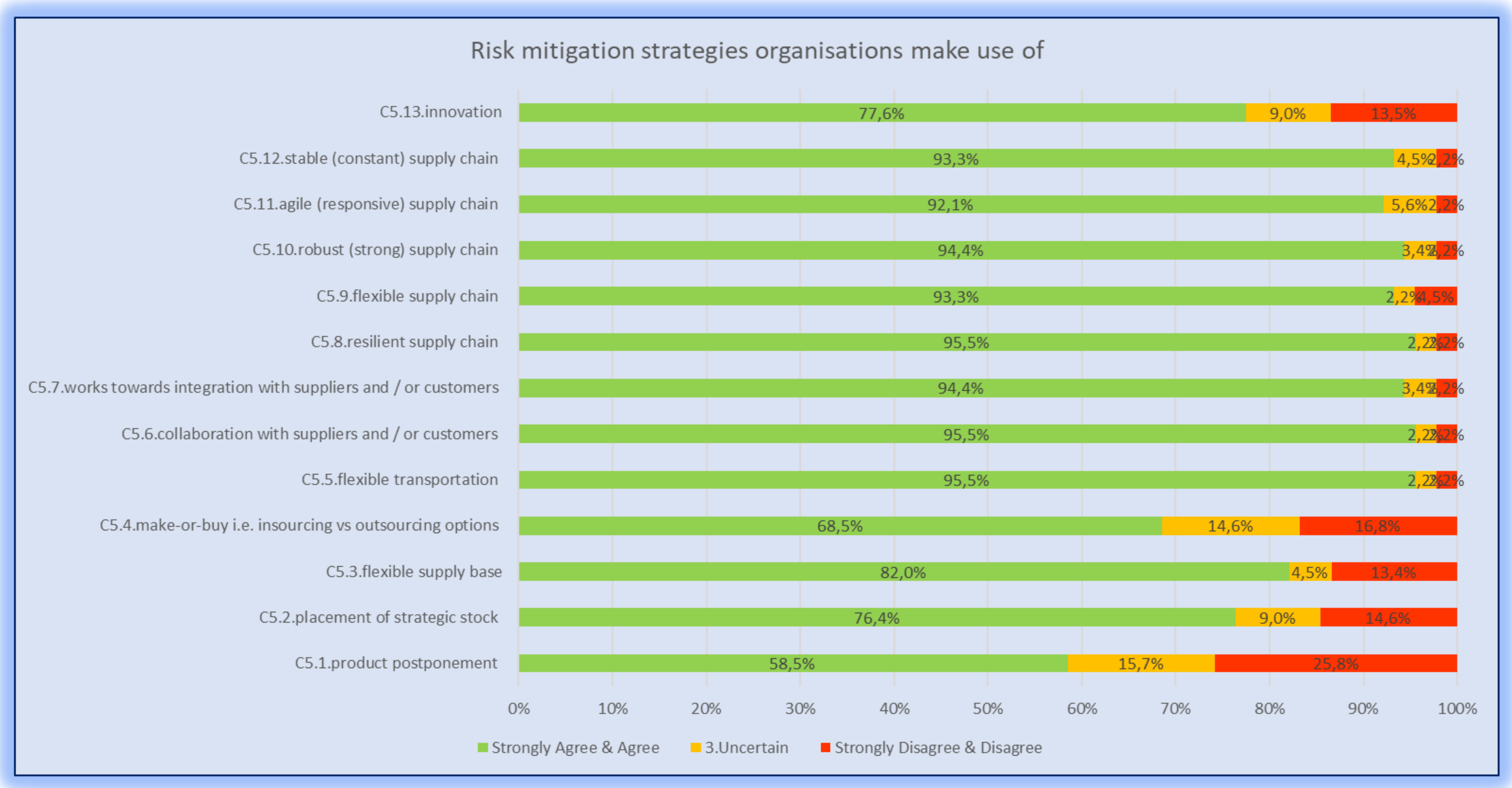

Figure 5.12: Risk mitigation strategies (n = 89)

Source: Compiled by researcher

5.4.7 Ways of dealing with major supply chain risks in the import of bulk soda ash

Figure 5.13 below illustrates how respondents believe their organisations deal with respective risks in the import supply chain of bulk soda ash. The respondents could select either: 1) Avoid the risk (AV); 2) Reduce the risk (RE); 3) Transfer the risk (TR); 4) Accept the risk (AC); and 5) Ignore the risk (IG).

The risk with the highest percentage of avoidance (AV), also one of the least risks experienced (refer to Table 5.5, item C6.4) is:

- Terrorism (51.7%)

The risks which the highest percentage of the respondents indicated ‘reducing the risk’ (RE) are:

- Supply chain instability (78.2%)
- Internal organisational risk (78.2%)
- Demand risk (75.9%)
- Infrastructure deterioration (74.7%)

The risks which the highest percentage of the respondents indicated ‘transfer the risk’ (TR) are:

- Oil price increases (25.3%)
- External organisational risk (16.1%)

The risks which the highest percentage of the respondents indicated ‘accept the risk’ (AC) are:

- Natural disasters (56.3%)
- Governmental regulations (50.6%)

Although very low, the risks which the highest percentage of the respondents indicated that they ‘ignore the risk’ (IG) are:

- Terrorism (8.0%)
- Natural disasters (3.4%)

The risks the respondents will mostly *reduce* is supply chain instability (78.2%) and internal organisational risk (78.2%) which, in line with the risk mitigation strategies mentioned in section 5.4.6, is achieved by making use of collaboration with suppliers and/or customers, having a robust (strong) supply chain and integrating with suppliers and/or customers to reduce the supply chain risks. Further, on the risks the respondents said they will *accept*, natural disasters (56.3%) were the highest. The fact that most organisations are willing to accept this risk could be a potential indication that these organisations prefer not to cover natural disasters in their insurance policies or don't have insurance cover at all. If they had opted to take insurance cover for natural disasters, they could transfer the risk. The risk most likely to be *transferred* is oil price increases (25.3%). This is potentially due to the 'easiness' of passing these cost increases onto distributors and/or end-consumers and may therefore not have been perceived as a 'real' risk. The risk most likely to be *ignored* is terrorism (8.0%). This could be partially because, in the South African context, terrorism is not a major risk. This does not mean that the risk does not exist; it merely indicates that it was not perceived as a major risk in the South African context at the time of the study.

A summary of the mean for explorative purposes is indicated in Table 5.5 below for each listed major logistics risk in question C6.1 to C6.17.

Table 5.5: Summary of mean for question C6 (ways of dealing with risks)

	Mean	Analysis N
C6.1. Labour strikes	3,805	89
C6.2. Port delays	3,448	89
C6.3. Political instability / unrest	3,310	89
C6.4. Terrorism	4,034	89
C6.5. Infrastructure deterioration	3,770	89
C6.6. Governmental regulations	2,874	89
C6.7. Oil price increases	2,989	89
C6.8. Natural disasters	2,805	89
C6.9. Supply chain complexity	3,793	89
C6.10. Supply chain uncertainty	3,770	89
C6.11. Supply chain instability	3,874	89
C6.12. Logistics outsourcing	3,529	89
C6.13. Supply risk	3,828	89
C6.14. Demand risk	3,839	89
C6.15. Pandemic outbreaks e.g. COVID	3,575	89
C6.16. Internal organisational risk	4,011	89
C6.17. External organisational risk	3,690	89

Source: Compiled by researcher

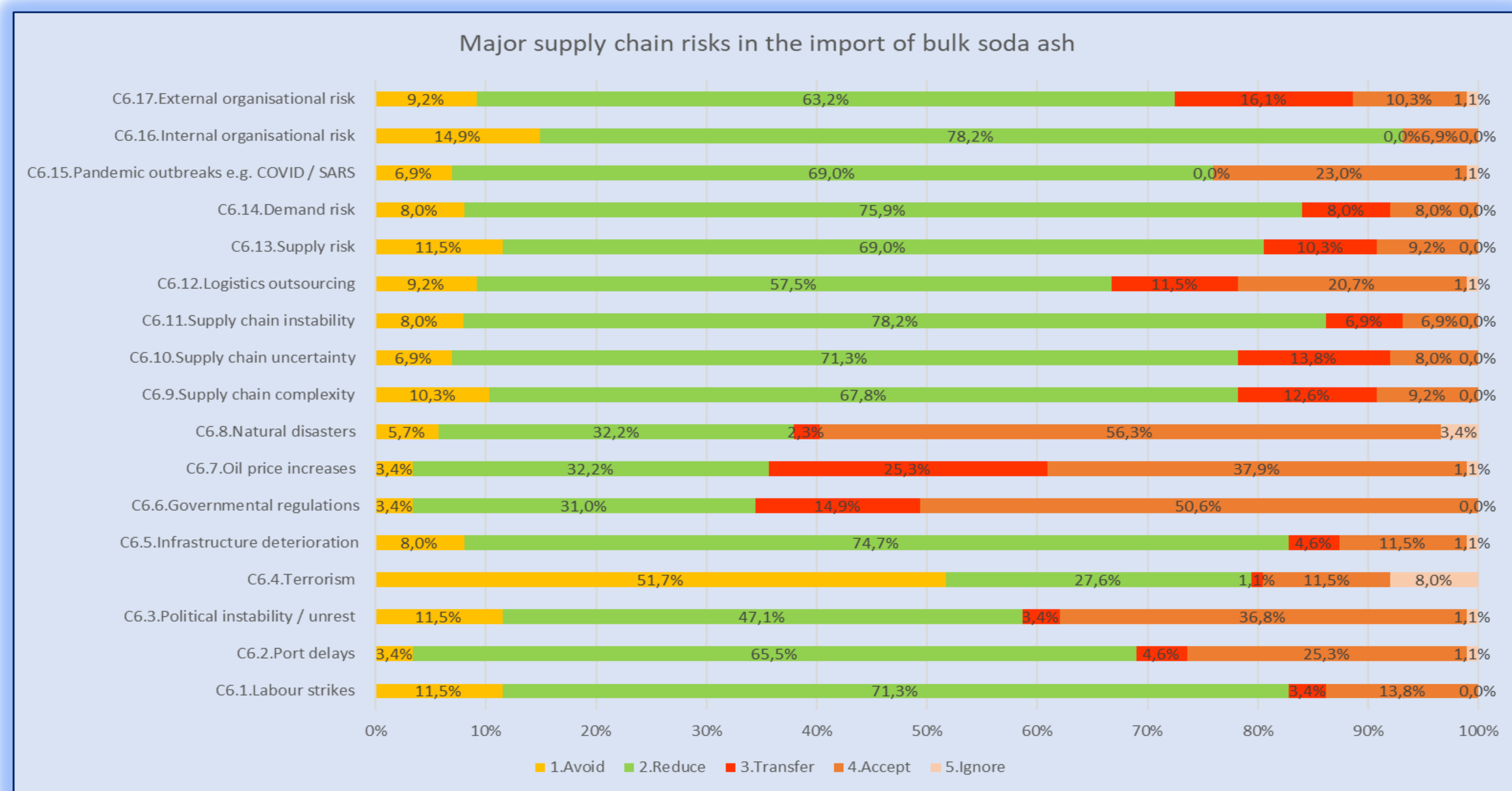

Figure 5.13: Ways of dealing with major supply chain risks (n = 89)

Source: Compiled by researcher

5.4.8 Major logistics risks in the import supply chain of bulk soda ash

Figure 5.14 below illustrates all the *major logistics risks* in the import supply chain of bulk soda ash which the respondents rated with 1 strongly disagree, 2 disagree, 3 uncertain, 4 agree and 5 strongly agree. Almost all the respondents indicated that they 'agree or strongly agree' that the following are major logistics risks to the import supply chain of soda ash:

- Port waiting times for a ship to berth (94.2%)
- Congestion of trucks within port or terminals (94.2%)
- Invisible and indirect costs due to port congestion (94.1%)
- Congestion at the landside access route to ports (93.0%)

The data confirms that the soda ash import supply chain feels strongly about the negative impact of berthing times, congestion of trucks at port terminals, invisible or indirect cost due to congestion, and congestion at landside access to the port, as all these risks scored extremely high (93% and above).

Other major logistics risks the respondents 'agreed and strongly agreed' with, by a large percentage, include:

- Congestion of ships at port equipment or services (90.7%)
- A lack of logistics planning by the government (90.7%)
- Low productivity at port (90.7%)
- Mechanical faults in machinery / equipment at port (90.7%)

A strong indication (above 90%) was given by respondents on the lack of logistics planning by government, congestion of ships at port equipment or services, low productivity, and mechanical faults at port equipment. It is clear from the data that the soda ash import supply chain is not satisfied with the overall performance from a port services, equipment and congestion perspective.

The logistics risks the respondents with the highest percentage of were 'uncertain' include:

- Rough seas (29.1%)
- Storm surge at seas (26.7%)
- Windstorms at seas (26.7%)

The data indicates that more than a quarter of the respondents were unsure of whether rough seas, storms surges at sea, and windstorms at sea are a major logistics risk to the soda ash import supply chain.

The logistics risks the respondents with the highest percentage of ‘disagreed and strongly disagreed’ include:

- Relatively high transport cost in South Africa (15.1%)
- Poor visibility at port (10.5%)

A small percentage (15.1%) of respondents of the soda ash import supply chain do not perceive relatively high transport cost in South Africa to be a major logistics risk. Together with this, a small percentage (10.5%) of respondents do not believe that poor visibility at the port poses a significant logistics risk in the import supply chain of soda ash.

A summary of the mean for explorative purposes is indicated in Table 5.6 below for each listed major logistics and port risk in question D1.1 to D1.18:

Table 5.6: Summary of mean for question D1 (port and logistics risks)

	Mean	Analysis N
D1.1. Port road infrastructure (e.g. docking space, access roads)	4.384	89
D1.2. Port facilities (warehouse, cranes)	4.337	89
D1.3. Mechanical faults in machinery / equipment at port	4.372	89
D1.4. Low productivity at port	4.372	89
D1.5. Industrial actions at port	4.384	89
D1.6. Poor visibility at port	3.767	89
D1.7. Rough seas	3.674	89
D1.8. Storm surge at seas	3.663	89
D1.9. Windstorms at seas	3.744	89
D1.10. National road infrastructure	4.384	89
D1.11. Invisible and indirect costs due to customs delays	4.221	89
D1.12. Invisible and indirect costs due to port congestion	4.407	89
D1.13. Relatively high transport cost in South Africa	4.047	89
D1.14. A lack of logistics planning by government	4.512	89
D1.15. Congestion of ships at port equipment or services	4.372	89
D1.16. Congestion of trucks within ports or terminals	4.430	89
D1.17. Congestion at the landside access route to ports	4.407	89
D1.18. Port waiting times for a ship to berth	4.326	89

Source: Compiled by researcher

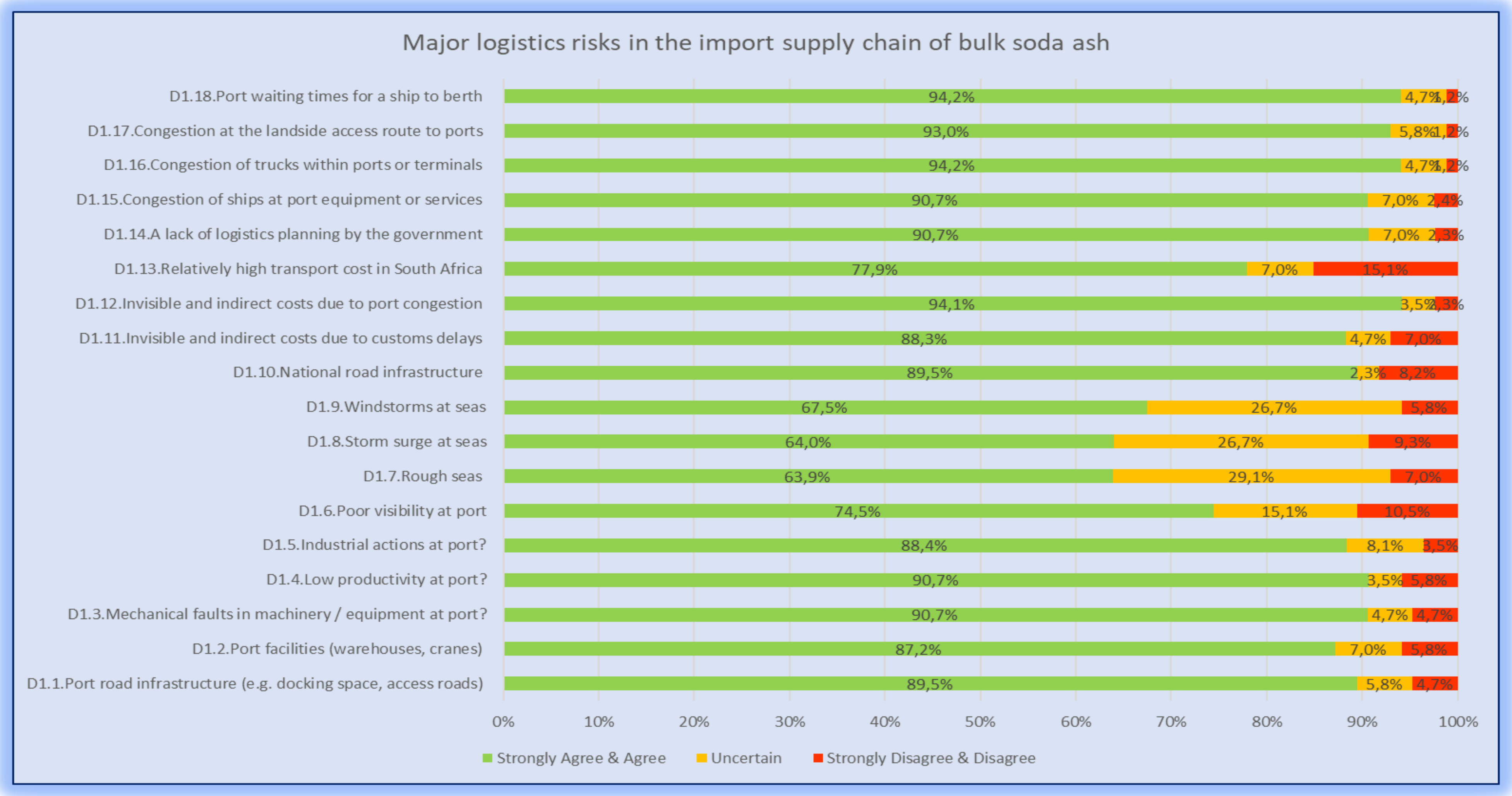

Figure 5.14: Major logistics risks in the import supply chain of bulk soda ash (n = 89)

Source: Compiled by researcher

5.5 Inferential Statistics

This section is aimed at addressing research objective *e*:

e) To determine the relationships between the different risk factors and mitigation strategies with the aid of inferential statistics

The aim of inferential statistics, by making use of t-tests and ANOVA (one-way analysis of variance), is to test for statistical significance between the variables being measured. Skewness and kurtosis were also assessed for each variable to determine the correct statistical inferential methods to be used.

Inferential statistics help the researcher to make decisions about how the data collected relates to the original hypotheses, and how they might be generalisable to a larger number of subjects than those that were tested (Salkind, 2012:161). According to Kim (2015: 540), there are two types of statistical inference: parametric and non-parametric methods. The major distinction between them lies in the underlying assumptions about the data to be analysed. Parametric statistics involve numbers with known, continuous distributions (Zikmund *et al.,* 2010:517). When the data is interval or ratio scaled, and the sample size is large, parametric statistical procedures are appropriate. Non-parametric statistics are appropriate when the numbers do not conform to a known distribution.

5.5.1 Exploratory Factor Analysis (EFA)

According to Taherdoost, Sahibuddin and Jalaliyoon (2014), exploratory factor analysis is a complex and multivariate statistical technique commonly employed in information systems, social science, education, and psychology. In EFA, the investigator has no expectations of the number or nature of the variables, and as the title suggests, it is exploratory in nature (Williams, Onsman & Brown, 2010:3). Furthermore, it allows the researcher to explore the main dimensions to generate a theory, or model, from a relatively large set of latent constructs often represented by a set of items.

Explorative factor analysis (EFA) was conducted on each of the five questions related to 1) major supply chain risks; 2) the extent to which these risks are dealt with; 3) risk mitigation strategies; 4) how risks are managed; and 5) logistics and port risks in the soda ash bulk import supply chain.

5.5.1.1 Major risks to the import supply chain of bulk soda ash

Questions B1, C4, C5, D1 (section 5.5.1.1, section 5.5.1.2, section 5.5.1.3 and section 5.5.1.5) were analysed making use of principal axis factoring extraction method with promax Kaiser normalisation rotation method to determine the dimensionality of each of the subsections per question. Factors with Eigenvalues above 1 were accepted in the factor structures of the various questions.

Cronbach's alpha coefficient was calculated and used to determine the internal consistency (reliability) of each of the identified factors with the threshold stated in the literature as 0.5 (acceptable); 0.6 (satisfactory for exploratory research); and 0.7 for previously used instruments (Hinton, Brownlow, McMurray & Cozens, 2004: 358).

The Kaiser-Meyer Olkin Measure (KMO) of Sampling Adequacy (0.877) and the Barlett's Test of Sphericity, which was statistically significant (p= 0.000), both indicate that a factor analysis is appropriate for section B1. Table 5.7 below shows the final factor loadings of each risk in the bulk soda ash supply chain.

Table 5.7: Summary of the factors for question B1 (major risks)

	KMO & Barlett's test (sig. value)	**% Variance explained**	**Factor loadings**			
B1. Major risks	0.877 p < 0.001	67.38%	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**
B1.1. Labour strikes			.425			
B1.2. Port delays					.768	
B1.3. Political instability / unrest						.733
B1.4. Terrorism						.573
B1.5. Infrastructure deterioration			.531			
B1.6. Governmental regulations			.435			
B1.7. Oil price increases					.319	
B1.8. Natural disasters			.802			
B1.9. Supply chain complexity			.823			
B1.10. Supply chain uncertainty			.703			
B1.11. Supply chain instability			.783			
B1.12. Logistics outsourcing				.372		
B1.13. Supply risk				.765		
B1.14. Demand risk				.654		
B1.15. Pandemic outbreaks e.g. COVID			.553			
B1.16. Internal organisational risk				.639		
B1.17. External organisational risk			.756			

Source: Compiled by researcher

The analysis identified *four factors* based on the Eigenvalue criterion of Eigenvalues greater than one. The Eigenvalues greater than one explains 67.38% of the total variance, broken down into the following factors as seen in Table 5.7, indicating the final factor loadings for each factor with the first factor explaining 43.89%, the second factor 9.37%, the third factor 8.11% and the fourth factor 6.01%. The Cronbach Alpha values were 0.901; 0.747; 0.507; and 0.586 respectively, of which two factors (three and four) had a low but still acceptable Cronbach alpha. The factors are labelled as external SC risks (F1), internal SC risks (F2), high probability risks (F3) and low probability risks (F4).

Table 5.8: Factor of major risks with corresponding Cronbach values

Factors	Cronbach's Alpha
F1. External SC risks	0.901
F2. Internal SC risks	0.747
F3. High probability risks	0.507
F4. Low probability risks	0.586

Source: Compiled by researcher

5.5.1.2 Extent to which organisations deals with major risks in the import soda ash supply chain

The Kaiser-Meyer Olkin Measure (KMO) of Sampling Adequacy (0.860) and the Barlett's Test of Sphericity, which was statistically significant (p= 0.000), both indicate that a factor analysis is appropriate for section C4. Table 5.9 below shows the final factor loadings of each risk in the bulk soda ash supply chain.

Table 5.9: Summary of the factors for question C4 (extent of dealing with risks)

	KMO & Barlett's test (sig. value)	% Variance explained	Factor loadings		
C4. Major risks	0.860 p < 0.001	69.14%	**Factor 1**	**Factor 2**	**Factor 3**
C4.1. Labour strikes				.701	
C4.2. Port delays				.719	
C4.3. Political instability / unrest					.671
C4.4. Terrorism					.767
C4.5. Infrastructure deterioration				.744	
C4.6. Governmental regulations					.352
C4.7. Oil price increases					.523
C4.8. Natural disasters				.708	
C4.9. Supply chain complexity			1.044		

	KMO & Barlett's test (sig. value)	% Variance explained	Factor loadings		
C4.10. Supply chain uncertainty			.853		
C4.11. Supply chain instability			1.000		
C4.12. Logistics outsourcing				.810	
C4.13. Supply risk			.786		
C4.14. Demand risk			.796		
C4.15. Pandemic outbreaks e.g. COVID				.699	
C4.16. Internal organisational risk			.817		
C4.17. External organisational risk				.412	

Source: Compiled by researcher

The analysis identified *three factors* based on the Eigenvalue criterion of Eigenvalues greater than one. The Eigenvalues greater than one explains 69.14% of the total variance, broken down into the factors as seen in Tables 5.11, indicating the final factor loadings for each factor with the first factor explaining 42.32%, the second factor 19.47% and the third factor 7.35%. The Cronbach Alpha values were 0.953; 0.858; 0.788 respectively, thus all above 0.7. The factors are labelled as micro-environment risks (F1), macro-environment risks (F2), and country specific risk (F3).

Table 5.10: Factors of major risks with corresponding Cronbach values

Factors	Cronbach's Alpha
F1. Micro-environment risks	0.953
F2. Macro-environment risks	0.858
F3. Country specific risks	0.788

Source: Compiled by researcher

5.5.1.3 Risk mitigation strategies in soda ash import supply chains

The Kaiser-Meyer Olkin Measure (KMO) of Sampling Adequacy (0.857) and the Barlett's Test of Sphericity, which was statistically significant (p= 0.000), both indicate that a factor analysis is appropriate for selection. Table 5.12 below shows the final factor loadings of each risk mitigation strategy in the bulk soda ash supply chain.

Table 5.11: Summary of the factors for question C5 (risk mitigation strategies)

	KMO & Barlett's test (sig. value)	% Variance explained	Factor loadings	
C5. Mitigation strategies	0.857 $p < 0.001$	63.70%	**Factor 1**	**Factor 2**
C5.1. Product postponement				.771
C5.2. Placement of strategic stock				.691
C5.3. Flexible supply base				.808
C5.4. Make-or-buy i.e. insourcing vs outsourcing options				.550
C5.5. Flexible transport			.601	
C5.6. Collaboration with suppliers and / or customers			.850	
C5.7. Works towards integration with suppliers and / or customers			.833	
C5.8. Resilient supply chain			.899	
C5.9. Flexible supply chain			.830	
C5.10. Robust (strong) supply chain			.817	
C5.11. Agile (responsive) supply chain			.740	
C5.12. Stable (constant) supply chain			.801	
C5.13. Innovation			.462	

Source: Compiled by researcher

The analysis identified *two factors* based on the Eigenvalue criterion of Eigenvalues greater than one. The Eigenvalues greater than one explains 63.70% of the total variance, broken down into the following factors as seen in tables 5.13 indicating the final factor loadings for each factor with the first factor explaining 46.44% and the second factor explaining 17.26%. The Cronbach Alpha values were 0.912 and 0.797 respectively, both above 0.7. The factors are labelled as SC mitigation strategies (F1) and product specific mitigation strategies (F2).

Table 5.12: Factors of mitigation strategies with corresponding Cronbach values

Factors	Cronbach's Alpha
F1. SC mitigation strategies	0.912
F2. Product specific mitigation strategies	0.797

Source: Compiled by researcher

5.5.1.4 Ways of dealing with major supply chain risks in the import of bulk soda ash

Question C6 (section 5.5.1.4) was analysed making use of principal component analysis factoring extraction method with varimax Kaiser normalisation rotation method to determine the dimensionality of each of the subsections due to a communality problem within the PAF solution to find a solution. Factors with Eigen values above 1 were accepted in the factor structures of the various questions.

The Kaiser-Meyer Olkin Measure (KMO) of Sampling Adequacy (0.761) and the Barlett's Test of Sphericity, which was statistically significant (p= 0.000), both indicate that a factor analysis is appropriate for section C6. Table 5.13 below shows the final factor loadings of each risk in the bulk soda ash supply chain and how they are being dealt with.

Table 5.13: Summary of the factors for question C6 (ways of dealing with risks)

	KMO & Barlett's test (sig. value)	**% Variance explained**	**Factor loadings**				
C6. Major risks	0.761 p < 0.001	68.32%	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**
C6.1. Labour strikes				.543			
C6.2. Port delays				.380			.680
C6.3. Political instability / unrest				.356		.586	
C6.4. Terrorism						.869	
C6.5. Infrastructure deterioration				.681			
C6.6. Governmental regulations					.795		
C6.7. Oil price increases					.789		
C6.8. Natural disasters					.691		
C6.9. Supply chain complexity			.826				
C6.10. Supply chain uncertainty			.914				
C6.11. Supply chain instability			.887				
C6.12. Logistics outsourcing				.718			
C6.13. Supply risk				.542			
C6.14. Demand risk			.512				
C6.15. Pandemic outbreaks e.g. COVID				.381			
C6.16. Internal organisational risk			.772				
C6.17. External organisational risk				.701			

Source: Compiled by researcher

The analysis identified *five factors* based on the Eigenvalue criterion of Eigenvalues greater than one. The Eigenvalues greater than one explains 68.32% of the variance, broken down into the following factors as seen in tables 5.15 indicating the final factor loadings for each factor. The single question that loads onto factor 2 and 5, question 6.2, were studied and decided to be grouped with factor 2 with which it aligns. As a factor cannot consist of a single question, it does not form a factor (question 6.4). Question 6.3 could be part of either factor 2 or factor 4. After studying the items in each factor as well as the low Cronbach Alpha value for factor 4, it was decided that question 6.3 aligns more with factor 2. The Cronbach Alpha values were 0.884, 0.782 and 0.681 respectively, all above or very close to 0.7. Cronbach Alpha values above 0.6 is considered satisfactory for exploratory research. The factors are labelled as SC specific risks (F1), external organisational risk (F2) and high probability risks (F3).

Table 5.14: Factors in dealing with major risks with corresponding Cronbach values

Factors	Cronbach's Alpha
F1. SC specific risks	0.884
F2. External organisational risk	0.782
F3. High probability risks	0.681

Source: Compiled by researcher

5.5.1.5 Logistics risks to the import supply chain of bulk soda ash

The Kaiser-Meyer Olkin Measure (KMO) of Sampling Adequacy (0.871) and the Barlett's Test of Sphericity, which was statistically significant (p= 0.000), both indicate that a factor analysis is appropriate for selection. Table 5.15 below shows the final factor loadings of each port and logistics risk in the bulk soda ash supply chain.

Table 5.15: Summary of the factors for question D1 (port and logistics risks)

	KMO & Barlett's test (sig. value)	**% Variance explained**	**Factor loadings**	
D1. Port and logistics risks	0.871 p < 0.001	65.82%	**Factor 1**	**Factor 2**
D1.1. Port road infrastructure (e.g. docking space, access roads)			.895	
D1.2. Port facilities (warehouse, cranes)			.944	
D1.3. Mechanical faults in machinery / equipment at port			.827	
D1.4. Low productivity at port			.713	

	KMO & Barlett's test (sig. value)	% Variance explained	Factor loadings	
D1.5. Industrial actions at port			.631	
D1.6. Poor visibility at port				.434
D1.7. Rough seas				.978
D1.8. Storm surge at seas				1.041
D1.9. Windstorms at seas				.815
D1.10. National road infrastructure			.820	
D1.11. Invisible and indirect costs due to customs delays			.616	
D1.12. Invisible and indirect costs due to port congestion			.638	
D1.13. Relatively high transport cost in South Africa			.531	
D1.14. A lack of logistics planning by government			.831	
D1.15. Congestion of ships at port equipment or services			.738	
D1.16. Congestion of trucks within ports or terminals			.727	
D1.17. Congestion at the landside access route to ports			.772	
D1.18. Port waiting times for a ship to berth			.704	

Source: Compiled by researcher

The analysis identified *two factors* based on the Eigenvalue criterion of Eigenvalues greater than one. The Eigenvalues greater than one explains 65.82% of the total variance, broken down into the following factors as seen in Table 5.15. The Cronbach Alpha values were 0.905 and 0.889 respectively, both above 0.7. The factors are labelled as port and logistics risks (F1) and maritime risks (F2).

Table 5.16: Factors for port and logistics risks with corresponding Cronbach values

Factors	Cronbach's Alpha
F1. Port and logistics risks	0.905
F2. Maritime risks	0.889

Source: Compiled by researcher

5.5.2 Factor descriptive analysis

Descriptive statistics (mean, median, standard deviation, minimum, maximum, skewness and kurtosis) for the fourteen newly identified factors are provided in Table 5.17.

Table 5.17: Descriptive statistics of the various factors identified in section 5.5.1

Factor	N	Mean	Std Deviation	Skewness	Kurtosis
1.External supply chain risk	89	4.0275	0.70179	-1.143	1.208
2.Internal supply chain risk	89	3.5871	0.85122	-0.698	0.452
3.High probability risk	89	4.2247	0.72304	-0.762	-0.012
4.Low probability risk	89	2.9888	1.07126	0.186	-0.495
5.Micro-environment risk	89	3.4326	1.08906	-0.081	-1.116
6.Marco-environment risk	89	4.0995	0.72633	-1.390	2.844
7.Country specific risk	89	2.8792	0.91710	0.378	-0.087
8.Supply chain mitigation strategies	89	4.4182	0.61523	-2.357	10.211
9.Product specific mitigation strategy	89	3.7275	1.05303	-1.153	0.947
10.Supply chain specific risk	89	3.8575	0.559966	-1.348	3.572
11.External organisational risk	89	3.6193	0.56781	-0.925	1.480
12.Natural and political risks	89	2.8889	0.77796	0.634	-0.364
13.Port logistics risk	89	4.3538	0.60895	-1.165	1.379
14.Maritime risk	89	3.7122	0.69343	-0.225	0.343

Source: Compiled by researcher

From Table 5.17, it can be seen that factor 7, country specific risk, had the lowest mean value (Me = 2.8792). This indicates that, amongst the participants, the tendency was towards neutral (neither agree nor disagree) on country specific risk which includes political instability / unrest, terrorism, governmental regulation and oil price increases. This indicates that participants either have, on average, a neutral opinion or that they have similar percentages of disagreement and agreement, resulting in an average close to neutral. The highest mean value was observed for the factor 8 (Me = 4.4182) indicating that the highest level of agreement, amongst the participants, was on supply chain mitigation strategies which includes flexible transport, collaboration with suppliers and/or customers, working towards integrations between suppliers and / or customers, resilient supply chain, flexible supply chain, robust (strong) supply chain, agile (responsive) supply chain, stable (constant) supply chain and innovation.

The skewness and kurtosis values also indicated that the factor variables can be assumed to be normally distributed as the values lie between -2 and +2 (George & Mallery, 2010), except for factors 6, 8 and 10 where factor 8 had a skewness value exceeding -2 and a kurtosis value exceeding 2. Factors 6 and 10 had kurtosis values exceeding 2. Inferential techniques used are appropriate or robust for deviation of normality, such as the Pearson correlation coefficient (Havlicek & Peterson,1976:1319).

5.5.3 Pearson Correlation analysis

Further inferential statistics were done to determine the statistical significance, direction and strength of the relationships between the 14 different factors identified in section 5.5.1. Pearson correlation coefficients were used to determine the relationships between the different combinations of the 14 factors and the results are summarised Table 5.18 in a matrix.

The results in Table 5.18 indicate that statistically significant relationships exist at the 1% level (all the blocks highlighted in blue) of significance between all combinations of the 14 factors highlighted in Table 5.17 above. A strong correlation exits with a Pearson correlation value greater than 0.5, moderate correlation exits between 0.3 - 0.5 and a weak correlation exits between 0 - 0.3. The positive values of the correlation coefficient varied between 0.287 and 0.691, indicating an almost moderate to strong relationship between the variables as summarised below in Table 5.18. The negative values of the correlation coefficient varied between -0.350 and -0.274 indicating a moderate to weak relationship between the variables as summarised below in Table 5.18. For a positive correlation when the values for one factor increase the other factor also increases. For a negative correlation when the values for one factor increase the other factor decreases.

As can be seen in Table 5.18, a strong positive correlation exists between external supply chain risk and 1) internal supply chain risk (.631), 2) high probability risk (.623), 3) macro-environment risk (.673) and 4) port logistics risk (.662). The most likely reason for the strong correlation between said factors include the fact that a supply chain is an inter-connected and inter-dependant system. If the external supply chain risks, high probability risks, macro environment risk and port and logistics risk increase, because all these factors are external supply chain risks, it would mean that the organisation's internal supply chain risk will also increase.

As can be seen in Table 5.18, a strong positive correlation exits between high probability risks and 1) low probability risk (.502); 2) macro-environment risk (.597); and 3) port logistics risks (.540). The same argument would apply regarding the inter-connected and inter-dependant relationship of factors in the supply chain for the strong correlation which exists between high probability risks and the other factors mentioned earlier.

A strong positive correlation also exists between low probability risk and country specific risk (.629). Although terrorism and political instability are country specific factors, in the South African context, both terrorism and political instability were seen as a low probability risk. Therefore, if the country specific risk increases, so does the low probability risk. Further a strong positive correlation exists between macro-environment risk and port logistics risk (.691) as both factors are inter-related and external to the organisation. A strong positive correlation exists between country specific risk and micro-environment risk (.640).

Table 5.18: Matrix of Pearson correlation values indicating the relationships between the factors

	1.External Supply Chain Risk	2.Internal Supply Chain Risk	3.High Probability Risk	4.Low Probability Risk	5.Micro-Environment Risk	6.Macro-Environment Risk	7.Country Specific Risk	8.Supply Chain Mitigation Strategies	9.Product Specific Mitigation Strategies	10.Supply Chain Specific Risk	11.External Organisational Risk	12.Natural and political risks	13.Port Logistics Risk	14.Maritime Risk
1.External Supply Chain Risk	1													
2.Internal Supply Chain Risk	.631**	1												
3.High Probability Risk	.623**	.478**	1											
4.Low Probability Risk	.454**	.397**	.502**	1										
5.Micro-Environment Risk	0,128	.365**	.418**	.446**	1									
6.Macro-Environment Risk	.673**	.421**	.597**	.313**	.253*	1								
7.Country Specific Risk	.343**	.449**	.408**	.629**	.640**	.423**	1							
8.Supply Chain Mitigation Strategy	0,168	0,141	.330**	0,090	.325**	.478**	.232*	1						
9.Product Specific Mitigation Strategy	0,156	.319**	0,162	.215*	.442**	.213*	.310**	.287**	1					
10.Supply Chain Specific Risk	-0,071	-0,028	-0,011	0,146	0,164	-0,088	0,048	0,100	0,108	1				
11.External Organisational Risk	0,028	0,090	0,140	0,115	0,107	0,032	0,139	.239*	0,089	.596**	1			
12.Natural and political risks	-0,192	-0,123	-.239*	-0,155	-.257*	-.350**	-0,187	-0,041	-0,029	0,187	.372**	1		
13.Port Logistics Risk	.662**	.495**	.540**	.334**	0,172	.691**	.251*	.214*	0,139	-0,040	-0,011	-.274**	1	
14.Maritime Risk	.303**	.399**	.369**	.373**	.415**	.264*	.374**	.240*	.299**	0,100	0,137	-0,183	.435**	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
Source: Compiled by researcher

5.5.4 Non-parametric analysis

Non-parametric statistics are suitable when the variable being analysed does not conform to any known or continuous distribution (Zikmund *et al.,* 2013:516). The Kruskal-Wallis test can be used when three or more independent groups need to be compared based on a single variable. It is useful to apply this test when the sample groups from the population is small, the distribution of the data is not a normal distribution, or if the data type is ordinal.

5.5.4.1 Hypothesis

The following set of hypotheses can be formulated:

$H1_0$: The distribution of *risk and strategies* is the same across the various parts (stakeholders) of the bulk import supply chain including:

1. 3rd party logistics services
2. Clearing and forwarding
3. Importer / buyer
4. Other
5. Port related services
6. Transport
7. Warehousing

$H1_1$: The distribution of *risk and strategies* is not the same across the various parts of the bulk import supply chain in:

1. 3rd party logistics services
2. Clearing and forwarding
3. Importer / buyer
4. Other
5. Port related services
6. Transport
7. Warehousing

Each of the 14 identified factors is tested separately by means of non-parametric analysis.

5.5.4.1.1 Kruskal-Wallis Test for the area in which respondents are active in the soda ash supply chain

In Table 5.19, the results indicated that there is a statistically significant difference, at the 5% level of significance, between the areas of the bulk import supply chain in which the respondents were active regarding the set of factors indicated below. The results indicated that there is a significant difference between participants involved in the various parts of the supply chain, specifically regarding 1) internal supply chain risk and 2) product specific mitigation strategies (significance <0.05 as highlighted in blue).

Table 5.19: Non-parametric test results used to test the hypotheses with Kruskal-Wallis Test

Factor	N	Test statistic	Degree of freedom	Asymptotic Sig. (2-sided test)
1.External supply chain risk	89	8.867	6	0.181
2.Internal supply chain risk	89	13.870	6	0.031
3.High probability risk	89	4.279	6	0.639
4.Low probability risk	89	2.240	6	0.896
5.Micro-environment risk	89	6.313	6	0.389
6.Marco-environment risk	89	5.277	6	0.509
7.Country specific risk	89	5.118	6	0.529
8.Supply chain mitigation strategies	89	9.957	6	0.126
9.Product specific mitigation strategy	89	23.073	6	0.001
10.Supply chain specific risk	89	3.528	6	0.740
11.External organisational risk	89	3.096	6	0.797
12.Natural and political risks	89	4.142	6	0.657
13.Port logistics risk	89	3.129	6	0.792
14.Maritime risk	89	4.440	6	0.617

a. The significance level is .050.

b. Asymptotic significance is displayed.

Source: Compiled by researcher

Table 5.20: Pair-wise comparison for internal supply chain risk across the different parts of the soda ash supply chain

Part of the bulk soda ash supply chain	Sig.
6.Transport 1.3rd party logistics services	0,959
6.Transport 5.Port related services	0,181
6.Transport 3.Importer / buyer	0,037
6.Transport 2.Clearing and forwarding	0,028
6.Transport 4.Other	0,016
6.Transport 7.Warehousing	0,013
1.3rd party logistics services 5.Port related services	0,188
1.3rd party logistics services 3.Importer / buyer	0,037
1.3rd party logistics services 2.Clearing and forwarding	0,028
1.3rd party logistics services 4.Other	0,015
1.3rd party logistics services 7.Warehousing	0,013
5.Port related services 3.Importer / buyer	0,460
5.Port related services 2.Clearing and forwarding	0,392
5.Port related services 4.Other	0,283
5.Port related services 7.Warehousing	0,238
3.Importer / buyer 2.Clearing and forwarding	0,903
3.Importer / buyer 4.Other	0,736
3.Importer / buyer 7.Warehousing	0,636
2.Clearing and forwarding 4.Other	0,831
2.Clearing and forwarding 7.Warehousing	0,724
4.Other 7.Warehousing	0,881
Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .050.	
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.	

Source: Compiled by researcher

The null hypothesis ($H1_0$) was rejected for *internal supply chain risk*. This means that the participants in the various parts of the soda ash import supply chain did not uniformly experience internal supply chain risks. Depending in which area the participant was active in the import soda ash supply chain would determine the relative internal risks they experienced. The pairwise comparisons indicate between which combinations of areas the statistically significant differences arise. The areas are highlighted in blue in Table 5.20 and include the following combinations: Transport – Importer/buyer; Transport – Clearing and forwarding; Transport – Other; Transport – Warehousing; 3rd party logistics services – Importer/buyer; 3rd party logistics services – Clearing and forwarding; 3rd party logistics services – Other; and 3rd party logistics services – Warehousing.

Lastly, in the summary in Table 5.21, the mean ranks provide insight into which parts of the supply chain, in comparison with the other groups, agree the most and the least. Warehousing had the highest mean rank; therefore, it had the highest tendency to agree more regarding risks in the internal supply chain versus 3rd party logistics services who had the lowest mean rank, and therefore had the tendency to agree the least regarding risks in the internal supply chain.

Table 5.21: Mean ranking by groups in the soda ash supply chain for internal supply chain risk

		N	Mean Rank
Internal supply chain risk	1. 3rd party logistics services	10	27,60
	2. Clearing and forwarding	13	54,42
	3. Importer / buyer	12	42,29
	4. Other	14	49,75
	5. Port related services	14	50,93
	6. Transport	11	28,18
	7. Warehousing	15	52,97
	Total	89	

Source: Compiled by researcher

Table 5.22: Pair-wise comparison for product specific mitigation strategies across the parts of the soda ash supply chain

Part of the bulk soda ash supply chain	Sig.
6.Transport 1.3rd party logistics services	0,176
6.Transport 7.Warehousing	0,024
6.Transport 3.Importer / buyer	0,004
6.Transport 5.Port related services	0,005
6.Transport 2.Clearing and forwarding	0,002
6.Transport 4.Other	0,000
1.3rd party logistics services 7.Warehousing	0,378
1.3rd party logistics services 3.Importer / buyer	0,145
1.3rd party logistics services 5.Port related services	0,150

1.3rd party logistics services 2.Clearing and forwarding	0,100
1.3rd party logistics services 4.Other	0,002
7.Warehousing 3.Importer / buyer	0,558
7.Warehousing 5.Port related services	0,548
7.Warehousing 2.Clearing and forwarding	0,433
7.Warehousing 4.Other	0,024
3.Importer / buyer 5.Port related services	0,970
3.Importer / buyer 2.Clearing and forwarding	0,840
3.Importer / buyer 4.Other	0,091
5.Port related services 2.Clearing and forwarding	0,876
5.Port related services 4.Other	0,114
2.Clearing and forwarding 4.Other	0,138
Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .050.	
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.	

Source: Compiled by researcher

The null hypothesis ($H1_0$) was rejected for *product specific mitigation strategies*. This means that the participants in the various parts of the soda ash import supply chain did not uniformly make use of the same product specific mitigation strategies. Depending in which area the participant was active in the import soda ash supply chain would determine their relative product specific mitigation strategies applied. The pairwise comparisons indicate between which combinations of areas the statistically significant differences arise. The areas which marked the biggest differences are highlighted in blue in Table 5.22 and include the following combinations: Transport – Warehousing; Transport – Importer/buyer; Transport – Port related services; Transport – Clearing and forwarding; Transport – Other; 3rd party logistics services – Other; and Warehousing – Other.

Lastly, in the summary in Table 5.23, the mean ranks provide insight into which parts of the supply chain, in comparison with the other groups, agree the most and the least. Warehousing had the highest mean rank; therefore, it had the highest tendency to agree more regarding product specific mitigation strategies versus 3rd party logistics services which had the lowest mean rank, and therefore had the tendency to agree the least regarding product specific mitigation strategies in the supply chain.

Table 5.23: Mean ranking by groups in the soda ash supply chain for product specific mitigation strategies

		N	Mean Rank
Product specific mitigation strategies	1. 3rd party logistics services	10	17,75
	2. Clearing and forwarding	13	42,23
	3. Importer / buyer	12	48,42
	4. Other	14	48,04
	5. Port related services	14	50,00
	6. Transport	11	32,95
	7. Warehousing	15	64,17
	Total	89	

Source: Compiled by researcher

A summary of the results can be seen in Table 5.24 below:

Table 5.24: Summary of the hypotheses results

Hypotheses	Result
$H1_0$ ***Internal supply chain risk*** distribution is the same across the various parts of the import soda ash supply chain	Null hypothesis rejected
$H1_0$ ***Product specific mitigation strategies*** distribution is the same across the various parts of the import soda ash supply chain	Null hypothesis rejected

Source: Compiled by researcher

5.5.4.1.2 Kruskal-Wallis Test for the number of years of experience in the soda ash supply chain

The following set of hypotheses can be formulated:

$H2_0$: The distribution of *risk and strategies* are the same across the number of years' experience groups in the bulk import supply chain as defined by the categories:

1. Between 1 – 3 years' experience
2. Between 3 - 5 years' experience
3. Between 5 – 10 years' experience
4. More than 10 years' experience

$H2_1$: The distribution of *risk and strategies* are not the same across the number of years' experience groups in the bulk import supply chain as defined by the categories:

1. Between 1 – 3 years' experience
2. Between 3 - 5 years' experience
3. Between 5 – 10 years' experience
4. More than 10 years' experience

In Table 5.25, the results indicated that there is a statistically significant difference, at the 5 % level of significance, between the *number of years' experience* in the import supply chain with regards to the set of identified factors, each tested separately. It indicated that there is a significant difference across the years of experience in the supply chain specifically with regards to 1) Micro-environment risk, 2) Country specific risk, 3) Supply chain mitigation strategies, 4) Product specific mitigation strategy and 5) Maritime risk (significance <0.05 as highlighted in blue). Pairwise comparisons are subsequently done to indicate between which combinations of areas the statistical significance arise.

Table 5.25: Non-parametric test results used to test the hypotheses with Kruskal-Wallis Test

Factor	N	Test statistic	Degree of freedom	Asymptotic Sig. (2-sided test)
1.External supply chain risk	89	3.865	3	0.276
2.Internal supply chain risk	89	5.105	3	0.164
3.High probability risk	89	7.474	3	0.058
4.Low probability risk	89	7.624	3	0.054
5.Micro-environment risk	89	8.587	3	0.035
6.Marco-environment risk	89	4.285	3	0.232
7.Country specific risk	89	16.042	3	0.001
8.Supply chain mitigation strategies	89	8.041	3	0.045
9.Product specific mitigation strategy	89	15.429	3	0.001
10.Supply chain specific risk	89	4.708	3	0.194
11.External organisational risk	89	6.620	3	0.085
12.Natural and political risks	89	7.276	3	0.064
13.Port logistics risk	89	4.600	3	0.204
14.Maritime risk	89	9.713	3	0.021

a. The significance level is .050.

b. Asymptotic significance is displayed.

Source: Compiled by researcher

Table 5.26: Pair-wise comparison for micro-environment risks across the number of years' experience in the soda ash supply chain

Categories of years of experience	Sig.
1. Between 1 – 3 years' experience 2. Between 3 - 5 years' experience	0,397
1. Between 1 – 3 years' experience 3. Between 5 - 10 years' experience	0,100
1. Between 1 – 3 years' experience 4. More than 10 years' experience	0,007
2. Between 3 - 5 years' experience 3. Between 5 - 10 years' experience	0,376
2. Between 3 - 5 years' experience 4. More than 10 years' experience	0,037
3. Between 5 - 10 years' experience 4. More than 10 years' experience	0,213
Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .050.	
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.	

Source: Compiled by researcher

The areas which marked the biggest differences are highlighted in blue in Table 5.26. An example of this is depending on the years of experience the participants had, they did not uniformly agree on the micro-environment risks experienced. There was a marked difference between the less experienced (1-3 years' experience) participants compared to the more experienced participants (greater than 3 years' experience). The null hypothesis ($H2_0$) was rejected for *micro-environment risks*. This would indicate that depending on the years of experience the participant had in the soda ash import supply chain, they would have experienced or have awareness of different types of micro-environment risks.

Lastly, in the summary in Table 5.27, the mean ranks provide insight into which parts of the supply chain, in comparison with the other groups, agree the most and the least. The group with more than 10 years' experience had the highest mean rank; therefore, it had the highest tendency to agree more regarding the micro-environment risks, versus the group with 1 – 3 years' experience which had the lowest mean rank, and therefore had the tendency to agree the least regarding micro-environment risks.

Table 5.27: Mean ranking by years of experience in the soda ash supply chain for micro-environment risks

		N	Mean Rank
Micro-environment risks	1. Between 1 – 3 years' experience	14	32,11
	2. Between 3 - 5 years' experience	22	39,57
	3. Between 5 - 10 years' experience	26	46,17
	4. More than 10 years' experience	27	54,98
	Total	89	

Source: Compiled by researcher

Table 5.28: Pair-wise comparison for country specific risks across the number of years' experience in the soda ash supply chain

Categories of years of experience	**Sig.**
1. Between 1 – 3 years' experience 2. Between 3 - 5 years' experience	0,128
1. Between 1 – 3 years' experience 3. Between 5 - 10 years' experience	0,014
1. Between 1 – 3 years' experience 4. More than 10 years' experience	0,000
2. Between 3 - 5 years' experience 3. Between 5 - 10 years' experience	0,311
2. Between 3 - 5 years' experience 4. More than 10 years' experience	0,010
3. Between 5 - 10 years' experience 4. More than 10 years' experience	0,108
Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .050.	
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.	

Source: Compiled by researcher

The areas which marked the biggest differences are highlighted in blue in Table 5.28. An example of this is depending on the years of experience the participants had, they did not uniformly agree on the country specific risks experienced. There was a marked difference between the less experienced (1-3 years' experience) participants compared to the more experienced participants (greater than 3 years' experience). The null hypothesis ($H2_0$) was rejected for *country specific risks*. This would indicate that depending on the years of experience the participant had in the soda ash import supply chain, they would have experienced or have awareness of different types of country specific risks.

Lastly, in Table 5.29, the mean ranks provide insight into which parts of the supply chain, in comparison with the other groups, agree the most and the least. The group with more than 10 years' experience had the highest mean rank; therefore, it had the highest tendency to agree more regarding country specific risks versus the group with 1 – 3 years' experience who had the lowest mean rank, and therefore had the tendency to agree the least regarding country specific risks.

Table 5.29: Mean ranking by years of experience in the soda ash supply chain for country specific risks

		N	Mean Rank
Country specific risks	1. Between 1 – 3 years' experience	14	25,79
	2. Between 3 - 5 years' experience	22	39,16
	3. Between 5 - 10 years' experience	26	46,71
	4. More than 10 years' experience	27	58,07
	Total	89	

Source: Compiled by researcher

Table 5.30: Pair-wise comparison for supply chain mitigation strategies across the number of years' experience in the soda ash supply chain

Categories of years of experience	**Sig.**
1. Between 1 – 3 years' experience 3. Between 5 - 10 years' experience	0,024
1. Between 1 – 3 years' experience 4. More than 10 years' experience	0,023
1. Between 1 – 3 years' experience 2. Between 3 - 5 years' experience	0,007
3. Between 5 - 10 years' experience 4. More than 10 years' experience	0,995
3. Between 5 - 10 years' experience 2. Between 3 - 5 years' experience	0,548
4. More than 10 years' experience 2. Between 3 - 5 years' experience	0,548
Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .050.	
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.	

Source: Compiled by researcher

The areas which marked the biggest differences are highlighted in blue in Table 5.30. An example of this is depending on the years of experience the participants had, they did not uniformly agree on the supply chain mitigation strategies employed. There was a marked difference between the less experienced (1-3 years' experience) participants compared to the more experienced participants (greater than 3 years' experience). The null hypothesis ($H2_0$) was rejected for *supply chain mitigation strategies*. This would indicate that depending on the years of experience the participant had in the soda ash import supply chain, they would have experienced or have awareness of different types of supply chain mitigation strategies employed.

Lastly, in the summary in Table 5.31, the mean ranks provide insight into which parts of the supply chain, in comparison with the other groups, agree the most and the least. The group with 3 – 5 years' experience had the highest mean rank; therefore, it had the highest tendency to agree more regarding supply chain mitigation strategies versus the group with 1 – 3 years' experience who had the lowest mean rank, and therefore had the tendency to agree the least regarding supply chain mitigation strategies.

Table 5.31: Mean ranking by years of experience in the soda ash supply chain for supply chain mitigation strategies

		N	Mean Rank
Supply chain mitigation strategies	1. Between 1 – 3 years' experience	14	27,71
	2. Between 3 - 5 years' experience	22	51,36
	3. Between 5 - 10 years' experience	26	46,90
	4. More than 10 years' experience	27	46,94
	Total	89	

Source: Compiled by researcher

Table 5.32: Pair-wise comparison for product specific mitigation strategies across the number of years' experience in the soda ash supply chain

Categories of years of experience	Sig.
1. Between 1 – 3 years' experience 2. Between 3 - 5 years' experience	0,056
1. Between 1 – 3 years' experience 4. More than 10 years' experience	0,007
1. Between 1 – 3 years' experience 3. Between 5 - 10 years' experience	0,000
2. Between 3 - 5 years' experience 4. More than 10 years' experience	0,424
2. Between 3 - 5 years' experience 3. Between 5 - 10 years' experience	0,033
4. More than 10 years' experience 3. Between 5 - 10 years' experience	0,157
Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .050.	
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.	

Source: Compiled by researcher

The areas which marked the biggest differences are highlighted in blue in Table 5.32. An example of this is depending on the years of experience the participants had, they did not uniformly agree on the product specific mitigation strategies employed. There was a marked difference between the less experienced (1-3 years' experience) participants compared to the more experienced participants (greater than 5 years' experience). The null hypothesis ($H2_0$) was rejected for *product specific mitigation strategies*. This would indicate that depending on the years of experience the participant had in the soda ash import supply chain, they would have experienced or have awareness of different types of product specific mitigation strategies.

Lastly, in the summary in Table 5.33, the mean ranks provide insight into which parts of the supply chain, in comparison with the other groups, agree the most and the least. The group with 5 – 10 years' experience had the highest mean rank; therefore, it had the highest tendency to agree more regarding product specific mitigation strategies versus the group with 1 – 3 years' experience who had the lowest mean rank, and therefore had the tendency to agree the least regarding product specific mitigation strategies.

Table 5.33: Mean ranking by years of experience in the soda ash supply chain for product specific mitigation strategies

		N	Mean Rank
Product specific mitigation strategy	1. Between 1 – 3 years' experience	14	24,39
	2. Between 3 - 5 years' experience	22	41,20
	3. Between 5 - 10 years' experience	26	57,12
	4. More than 10 years' experience	27	47,11
	Total	89	

Source: Compiled by researcher

Table 5.34: Pair-wise comparison for maritime risk across the number of years' experience in the soda ash supply chain

Categories of years of experience	Sig.
1. Between 1 – 3 years' experience 4. More than 10 years' experience	0,022
1. Between 1 – 3 years' experience 2. Between 3 - 5 years' experience	0,015
1. Between 1 – 3 years' experience 3. Between 5 - 10 years' experience	0,002
4. More than 10 years' experience 2. Between 3 - 5 years' experience	0,797
4. More than 10 years' experience 3. Between 5 - 10 years' experience	0,353
2. Between 3 - 5 years' experience 3. Between 5 - 10 years' experience	0,531
Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .050.	
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.	

Source: Compiled by researcher

The areas which marked the biggest differences are highlighted in blue in Table 5.34. An example of this is depending on the years of experience the participants had, they did not uniformly agree on the maritime risks experienced. There was a marked difference between the less experienced (1-3 years' experience) participants compared to the more experienced participants (greater than 3 years' experience). The null hypothesis ($H2_0$) was rejected for *maritime risks*. This would indicate that depending on the years of experience the participant had in the soda ash import supply chain, they would have experienced or have awareness of different types of maritime risks.

Lastly, in the summary in Table 5.35, the mean ranks provide insight into which parts of the supply chain, in comparison with the other groups, agree the most and the least. The group with 5 – 10 years' experience had the highest mean rank; therefore, it had the highest tendency to agree more regarding maritime risks versus the group which had 1 – 3 years' experience who had the lowest mean rank, and therefore had the tendency to agree the least regarding maritime risks.

Table 5.35: Mean ranking by years of experience in the soda ash supply chain for maritime risks

		N	Mean Rank
Maritime risk	1. Between 1 – 3 years' experience	14	26,71
	2. Between 3 - 5 years' experience	22	47,50
	3. Between 5 - 10 years' experience	26	52,06
	4. More than 10 years' experience	27	45,65
	Total	89	

Source: Compiled by researcher

A summary of the results can be seen in Table 5.36 below:

Table 5.36: Summary of the hypotheses results

Hypotheses	Result
$H2_0$ ***Micro-environment risk*** distribution is the same across number of years of experience	Null hypothesis rejected
$H2_0$ ***Country specific risk*** distribution is the same across number of years of experience	Null hypothesis rejected
$H2_0$ ***Supply chain mitigation strategies*** distribution is the same across number of years of experience	Null hypothesis rejected
$H2_0$ ***Product specific mitigation strategy*** distribution is the same across number of years of experience	Null hypothesis rejected
$H2_0$ ***Maritime risk distribution*** is the same across number of years of experience	Null hypothesis rejected

Source: Compiled by researcher

5.5.4.1.3 Kruskal-Wallis Test for the management level or position in the soda ash supply chain

The following set of hypotheses can be formulated:

$H3_0$: The distribution of *risk and strategies* are the same across the level or position groups within the organisation in the bulk import supply chain as defined by the categories:

1. Operational level
2. Lower management level
3. Middle management level

4. Top management level

H3₁: The distribution of *risk and strategies* are not the same across the level or position groups within the organisation in the bulk import supply chain as defined by the categories:

1. Operational level
2. Lower management level
3. Middle management level
4. Top management level

In Table 5.37, the results indicated that there is a statistically significant difference, at the 5 % level of significance, between the position or *management level* groups within the organisation with regards to the 14 identified factors in the import supply chain. It indicated that there is a significant difference across the position or level within the organisation in the supply chain specifically with regards to 1) Port logistics risk and 2) Maritime risk (significance <0.05 as highlighted in blue).

Table 5.37: Non-parametric test results used to test the hypotheses with Kruskal-Wallis Test

Factor	N	Test statistic	Degree of freedom	Asymptotic Sig. (2-sided test)
1.External supply chain risk	72	5.378	3	0.146
2.Internal supply chain risk	72	5.281	3	0.152
3.High probability risk	72	5.920	3	0.116
4.Low probability risk	72	3.558	3	0.313
5.Micro-environment risk	72	2.776	3	0.427
6.Marco-environment risk	72	6.892	3	0.075
7.Country specific risk	72	7.185	3	0.066
8.Supply chain mitigation strategies	72	1.474	3	0.688
9.Product specific mitigation strategy	72	5.860	3	0.119
10.Supply chain specific risk	72	3.080	3	0.379
11.External organisational risk	72	2.508	3	0.474
12.Natural and political risks	72	4.397	3	0.222
13.Port logistics risk	72	9.199	3	0.027
14.Maritime risk	72	9.761	3	0.021

a. The significance level is .050.

b. Asymptotic significance is displayed.

Source: Compiled by researcher

Table 5.38: Pair-wise comparison for port logistics risks across the management level or position in the soda ash supply chain

Category of level or position	Sig.
4. Top management level 1. Operational level	0,187
4. Top management level 2. Lower management level	0,130
4. Top management level 3. Middle management level	0,003
1. Operational level 2. Lower management level	0,962
1. Operational level 3. Middle management level	0,158
2. Lower management level 3. Middle management level	0,108
Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .050.	
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.	

Source: Compiled by researcher

The areas which marked the biggest differences are highlighted in blue in Table 5.38. The null hypothesis ($H3_0$) was rejected for *port logistics risks*. This would indicate that depending on the level or position within the organisation the participant was, they would have experienced or are aware of different types of port logistics risks. There was a marked difference between the experience or awareness of middle-level management participants compared to the higher-level management (top management level) for port logistics risks.

Lastly, in the summary in Table 5.39, the mean ranks provide insight into which level of the supply chain, in comparison with the other levels, agree the most and the least. Middle management had the highest mean rank; therefore, it had the highest tendency to agree more regarding port logistics risks, versus top management level which had the lowest mean rank, and therefore had the tendency to agree the least regarding port logistics risks.

Table 5.39: Mean ranking by level in the soda ash supply chain for port logistics risks

		N	Mean Rank
Port logistics risk	1. Operational level	12	34,08
	2. Lower management level	20	34,45
	3. Middle management level	29	44,19
	4. Top management level	11	22,59
	Total	72	

Source: Compiled by researcher

Table 5.40: Pair-wise comparison for maritime risks across the management level or position in the soda ash supply chain

Category of level or position	Sig.
4. Top management level 1. Operational level	0,429
4. Top management level 2. Lower management level	0,178
4. Top management level 3. Middle management level	0,005
1. Operational level 2. Lower management level	0,631
1. Operational level 3. Middle management level	0,049
2. Lower management level 3. Middle management level	0,086
Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .050.	
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.	

Source: Compiled by researcher

The areas which marked the biggest differences are highlighted in blue in Table 5.40. The null hypothesis ($H3_0$) was rejected for *maritime risks*. This would indicate that depending on the level or position within the organisation the participant was, they would have experienced or are aware of the different types of maritime risks. An example of this is depending on level or position of the participant, they did not uniformly agree on the maritime risks experienced. There was a marked difference in experience or awareness between the middle-level management participants compared to the higher-level management (top management level) for maritime risks. There was also a marked difference between the experience or awareness of the lower-level management participants (operational level) compared to the higher-level management (middle management) for maritime risks.

Lastly, in the summary in Table 5.41, the mean ranks provide insight into which level of the supply chain, in comparison with the other levels, agree the most and the least. Middle management had the highest mean rank; therefore, it had the highest tendency to agree more regarding maritime risks, versus top management level which had the lowest mean rank, and therefore had the tendency to agree the least regarding maritime risks.

Table 5.41: Mean ranking by level in the soda ash supply chain for port maritime risks

		N	Mean Rank
Maritime risk	1. Operational level	12	31,00
	2. Lower management level	20	34,58
	3. Middle management level	29	44,74
	4. Top management level	11	24,27
	Total	72	

Source: Compiled by researcher

A summary of the results can be seen in Table 5.42 below:

Table 5.42: Summary of the hypotheses results

Hypotheses	Result
$H3_0$ ***Port logistics risk*** distribution is the same across the level or position within the organisation	Null hypothesis rejected
$H3_0$ ***Maritime risk*** distribution is the same across the level or position within the organisation	Null hypothesis rejected

Source: Compiled by researcher

5.5.4.1.4 Kruskal-Wallis Test for the highest obtained educational qualification in the soda ash supply chain

The following set of hypotheses can be formulated:

$H4_0$: The distribution of *risk and strategies* are the same across the different obtained educational qualifications in the bulk import supply chain:

1. Matric / Grade 12
2. Tertiary certificate / Diploma
3. Bachelor's degree
4. Post graduate degree

$H4_1$: The distribution of *risk and strategies* are not the same across the different obtained educational qualifications in the bulk import supply chain:

1. Matric / Grade 12
2. Tertiary certificate / Diploma
3. Bachelor's degree
4. Post graduate degree

In Table 5.43, the results indicated that there is a statistically significant difference, at the 5 % level of significance, between the various levels of *education* regarding supply chain mitigation strategies in the soda ash import supply chain (significance <0.05 as highlighted in blue).

Table 5.43: Non-parametric test results used to test the hypotheses with Kruskal-Wallis Test

Factor	N	Test statistic	Degree of freedom	Asymptotic Sig. (2-sided test)
1.External supply chain risk	72	0.634	3	0.889
2.Internal supply chain risk	72	1.667	3	0.644
3.High probability risk	72	2.447	3	0.485
4.Low probability risk	72	2.113	3	0.549
5.Micro-environment risk	72	1.564	3	0.667
6.Marco-environment risk	72	2.812	3	0.421
7.Country specific risk	72	2.591	3	0.459
8.Supply chain mitigation strategies	72	9.084	3	0.028
9.Product specific mitigation strategy	72	3.430	3	0.330
10.Supply chain specific risk	72	3.088	3	0.378
11.External organisational risk	72	3.597	3	0.308
12.Natural and political risks	72	5.669	3	0.129
13.Port logistics risk	72	2.643	3	0.450
14.Maritime risk	72	4.743	3	0.192

a. The significance level is .050.

b. Asymptotic significance is displayed.

Source: Compiled by researcher

Table 5.44: Pair-wise comparison for supply chain mitigation strategies across the highest obtained educational qualification in the soda ash supply chain

Highest qualification obtained	Sig.
2.Tertiary certificate / Diploma 4. Post graduate degree	0,448
2.Tertiary certificate / Diploma 1. Matric / Grade 12	0,012
2.Tertiary certificate / Diploma 3.Bachelor's degree	0,014
4.Post graduate Degree 1.Matric / Grade 12	0,196
4.Post graduate Degree 3.Bachelor's degree	0,154
1.Matric / Grade 12 3.Bachelor's degree	0,760
Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .050.	
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.	

Source: Compiled by researcher

The areas which marked the biggest differences are highlighted in blue in Table 5.44. The null hypothesis ($H4_0$) was rejected for *supply chain mitigation strategies*. This would indicate that depending on the highest obtained qualification, respondents would have opted to use a different supply chain mitigation strategy. There was a marked difference between the Matric/Grade 12 respondents compared to the Tertiary certificate/Diploma respondents and similarly a marked difference between Tertiary certificate/Diploma respondents and the bachelor's degree respondents.

Lastly, in the summary in Table 5.45, the mean ranks provide insight into which educational qualification in the supply chain, in comparison with the different qualifications, agree the most and the least. Bachelor's degree had the highest mean rank; therefore, it had the highest tendency to agree more regarding supply chain mitigation strategies, versus Tertiary certificate / diploma which had the lowest mean rank, and therefore had the tendency to agree the least regarding supply chain mitigation strategies.

Table 5.45: Mean ranking by educational qualification in the soda ash supply chain for supply chain mitigation strategies

		N	Mean Rank
Supply chain mitigation strategy	1. Matric / Grade 12	22	42,98
	2. Tertiary certificate / Diploma	25	27,80
	3. Bachelor's degree	13	45,19
	4. Post graduate Degree	12	33,33
	Total	72	

Source: Compiled by researcher

A summary of the results can be seen in Table 5.46 below:

Table 5.46: Summary of the hypotheses results

Hypotheses	Result
$H4_0$ ***Supply chain mitigation strategies*** distribution is the same across the different obtained educational qualifications in the bulk import supply chain	Null hypothesis rejected

Source: Compiled by researcher

5.6 The Relationship between Risks in the Soda Ash Supply Chain and Mitigation Strategies Implemented

Multiple regression modelling was used to investigate the statistical significant risk predictors (twelve independent variables - micro-environment risk, macro-environment risk, internal supply chain risk, maritime risk, natural and political risks, supply chain specific risk, low probability risk, external supply chain risk, external organisational risk, country specific risk, port logistics risk and high probability risk) of product mitigation strategies and supply chain mitigation strategies.

Regression analysis is a statistical method used to investigate the functional relationship amongst a set of variables. These relationships can be expressed by means of a model which connects the dependent (response) variable with the explanatory (predictor, regressor or independent) variable (Chatterjee & Hadi, 2015:1). Regression analysis can, broadly, be divided into simple linear regression and multiple linear regression (Montgomery, Peck & Vining, 2021:2). The regression analysis, for the purpose of this study, was conducted by making use of multiple linear regression modelling.

5.6.1 Product specific mitigation strategies

Table 5.47 below provides a summary of the regression modelling results

Table 5.47: Summary of regression modelling results for product specific mitigation strategies

Model	**Independent variables**	**Standardized Beta and significance**
	Micro-environment risk	0,425***
	Macro-environment risk	0,270
	Internal supply chain risk	0,197
	Maritime risk	0,154
	Natural and political risks	0,142
	Supply chain specific risk	0,051
	Low probability risk	0,023
	External supply chain risk	0,013
	External organisational risk	-0,051
	Country specific risk	-0,097
	Port logistics risk	-0,131
	High probability risk	-0,195
Adjusted R^2	0.164	
F (p value)	2.440 (.010)	

** Denotes $p < 0.1$, ** denotes $p < 0.05$, ***denotes $p < 0.01$*

Source: Compiled by researcher

The results of the original model indicated that:

(i) The adjusted R^2 value was small and showed that 16.4% of the variation in the dependent variable, product specific mitigation strategies, can be explained by the respective set of independent variables in the model.

(ii) The F-test for regression is statistically significant for the model (the beta coefficients do differ significantly from zero – p value <0.05).

(iii) The standardized beta values and associated statistical significance indicate that micro-environmental risk was the only statistically significant predictor of product specific mitigation strategies. The relationship was positive and of moderate strength ($\beta = 0.425$).

The results from the above model, in Table 5.48, concludes that the extent to which micro-environment risks are addressed in the organisation plays a major role in the decision of which product specific mitigation strategies to employ. It must also be noted that micro-environment risks had a mean of 3.4326, which means it leans towards a neutral tendency amongst respondents. The respondents neither agreed nor disagreed with each other. It, however, makes sense that the product specific mitigation strategy relates to the specific environment of the soda ash supply chain and the "micro" operational environment it operates in. As mentioned previously the micro-environment factors to be considered when deciding on a product specific mitigation strategy include supply chain complexity, supply chain uncertainty, supply chain instability, supply risk, demand risk and internal organisational risk.

5.6.2 Supply chain mitigation strategies

Table 5.48 below provides a summary of the regression modelling results

Table 5.48: Summary of regression modelling results for supply chain mitigation strategies

Model	**Independent variables**	**Standardized Beta and significance**
	Macro-environment risk	0,738***
	Micro-environment risk	0,270**
	Maritime risk	0,164
	Natural and political risks	0,148
	External organisational risk	0,139
	High probability risk	0,089
	Supply chain specific risk	-0,006
	Internal supply chain risk	-0,050
	Low probability risk	-0,099
	Country specific risk	-0,143
	External supply chain risk	-0,183
	Port logistics risk	-0,205
Adjusted R^2	0.319	
F (p value)	4.441 (.000)	

** Denotes p < 0.1, ** denotes p< 0.05, ***denotes p < 0.01*

Source: Compiled by researcher

The results of the original model indicated that:

(i) The adjusted R^2 value was moderate and showed that 31.9% of the variation in the dependent variable, supply chain mitigation strategies, can be explained by the respective set of independent variables in the model.

(ii) The F-test for regression is statistically significant for the model (the beta coefficients do differ significantly from zero – p value <0.001).

(iii) The standardized beta values and associated significance indicate that Macro-environment risk (strong positive relationship) and micro-environment risk (weak positive relationship) were statistically significant predictors of supply chain mitigation strategies.

The results from the above model, in Table 5.48, indicates that the extent to which both macro-environment and micro-environment risks are addressed in the organisation play a major role in the decision of which mitigation strategies to employ. Naturally, supply chain mitigation strategies relate to the overall supply chain environment of soda ash and would therefore need to include not only the micro-environment risks but also the macro-environment risks. Further to the micro-environment risks, mentioned above in section 5.6.1, further consideration should be given to the macro-environment risks, which include labour strikes, port delays, infrastructure deterioration, natural disasters, logistics outsourcing, pandemic outbreak and any further external organisational risks when deciding on an overall supply chain mitigation strategy for soda ash. Here it must be noted that macro-environment risks had a mean of 4.0995, which means it had a tendency towards “agree” amongst respondents indicating that most respondents had a level of agreement on this factor.

5.7 Conclusion

The aim of this chapter was to address the primary objective as well as the secondary objectives c, d and e of the study by means of empirical research. The remainder of the secondary research objectives (a and b) were addressed in Chapter 2 and Chapter 3 respectively by means of a literature study.

This chapter started with a discussion on the response rate as well as the data processing method for the study. An overall demographic profile was provided on the sample of respondents, which included 1) the role in the import supply chain; 2) years of experiences; 3) position held within the organisation; and lastly, 4) educational qualifications. This study was well represented from the various parts of the import supply chain and was almost evenly spread across importers / buyers, warehousing, transport, clearing and forwarding, port related services, 3PL logistics service providers and various other parts of the supply chain. In terms of years of experience, it can be concluded that the respondents were well experienced with 59% of respondents having more than 5 years’ experience in the import soda ash supply chain. When considering the level of management, 68% of the respondents were in a management position (lower, middle or top management). Lastly, based on educational qualification the majority (56%) of respondents had some form of post-high school qualification.

To address objective c of the study, descriptive statistics were used to describe and identify the major risks in the import supply chain of bulk soda ash. The major risks, with exceptionally high agreement between respondents, included port delays and pandemic outbreaks, i.e., COVID-19. Further notable risks identified included labour strikes and infrastructure deterioration.

To address objective d of the study, descriptive statistics were used to describe and identify the risk management and risk mitigation strategies in the import supply chain of bulk soda ash. To this end, 94.4% of respondents agreed that if supply chain risks are left unmanaged, it could lead to a negative financial impact. It was also found that 89.9% of organisations do actively manage their supply chain risks, while 85.4% choose to proactively manage supply chain risk and 46.0% reactively manage their supply chain risk. Organisations do make use of the supply chain risk management framework to manage their risks. 89.8% of organisations uses the first phase (risk identification), 76.4% of organisations make use of the second phase (risk assessment and evaluation), and lastly, 66.3% of organisations make use of the third phase (implementation of identified risk mitigation strategies) to manage their supply chain risks. The risks the organisations mostly dealt with in the import soda ash supply chain include COVID-19, port delays, and logistics outsourcing. The risk mitigation strategies employed mostly include flexible transport, collaboration with suppliers and/or customers, and having a resilient supply chain. Related to logistics risks, it was identified that port waiting times for ship berthing, congestion of trucks within port or terminals, and invisible and indirect cost due to port congestion were major risks.

To address objective e of the study, inferential statistics were used to determine the relationships between the different risk factors and mitigation strategies. In this section, the various major risks identified were grouped together into factors by means of exploratory factor analysis (EFA). There were four factors identified, which included F1. External SC risks; F2. Internal SC risks; F3. High probability risks; and F4. Low probability risks. The same EFA was applied with the extent to which the risks were dealt with in the import supply chain of soda ash. A total of three factors were identified, which included F1. Micro-environment risks; F2. Macro-environment risks; and F3. Country specific risks.

Again, the same EFA principle was applied to the risk mitigation strategies identified and a total of two factors were identified, which included F1. SC mitigation strategies; and F2. Product specific mitigation strategies. When considering the ways in which the major supply chain risks were being dealt with, three groupings were identified which include F1. SC specific risks; F2. External organisational risks; and F3. High probability risks. When considering port and logistics risks two factors were identified. These factors include F1. Port and logistics risks; and F2. Maritime risks.

As part of the literature review a number of risks and risk mitigation strategies were identified and discussed in Chapter 3. The empirical results, as discussed earlier in this chapter, coincides with the risks and mitigation strategies initially identified and discussed in the literature review. In table 3.1. risks like macroeconomic risk, political risk, infrastructure risk, natural disasters, terrorism, political risk and industrial action were identified. The empirical results indicate that these are the same risks the bulk soda ash respondents identified as being relevant and experienced these risks in varying degrees in their daily operations. The same holds true for the mitigation strategies employed in the bulk soda ash supply chain.

The last section of this chapter focused on the testing of the various hypotheses, made in Chapter 4, by means of non-parametric analysis, which will be summarised in Chapter 6. Lastly, the chapter concluded with a brief regression analysis discussion of the various independent variables when compared to the dependant variables, i.e., product specific mitigation strategies and supply chain mitigation strategies.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

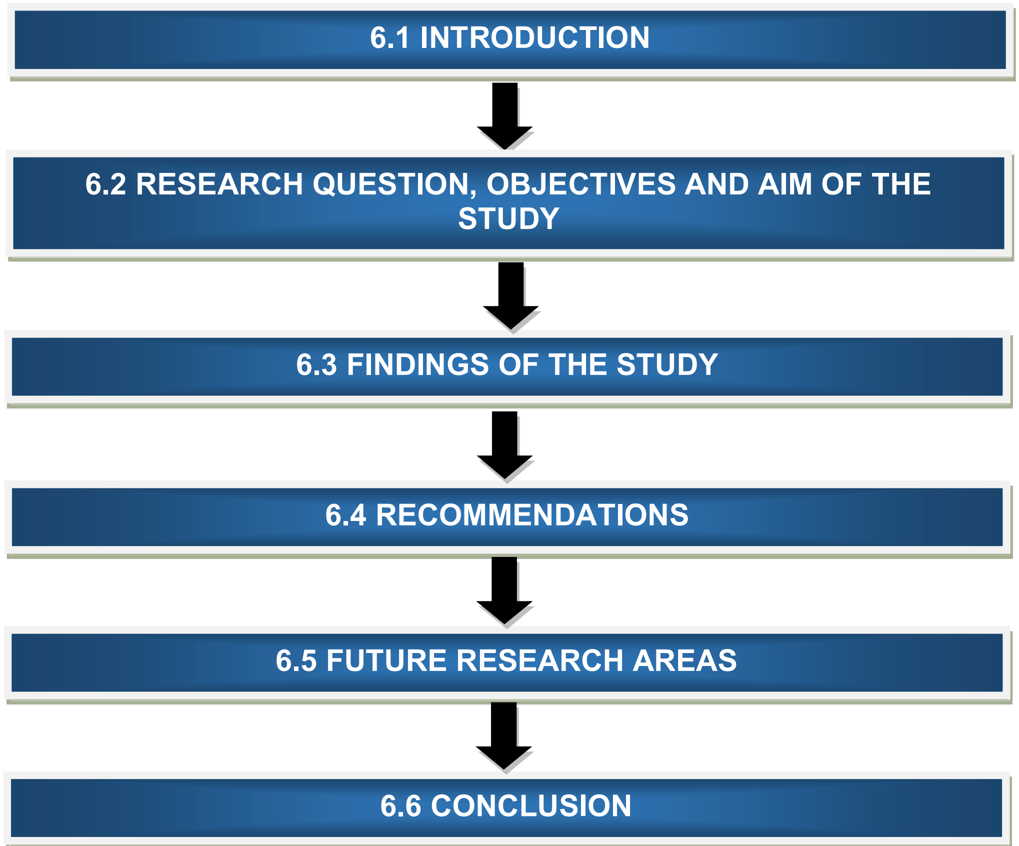

Figure 6.1: Flow diagram of Chapter 6

Source: Compiled by researcher

6.1 Introduction

This chapter summarises the findings and presents a discussion on how the primary and secondary research objectives of the study were attained. In addition, recommendations are made and opportunities for future research are suggested.

6.2 Research Question, Objectives and Aim of the Study

6.2.1 Research question

The problem statement of this study can be formulated in the following main research question:

What are the risks experienced by a bulk soda ash import supply chain and how are these risks managed?

6.2.2 Primary and secondary research objectives

6.2.2.1 Primary objective

The primary research objective was to identify and describe the supply chain risks in a bulk soda ash powder import supply chain from a South African perspective, and to determine how these risks are managed.

6.2.2.2 Secondary objectives

The secondary research objectives were as follows:

- **a)** To explore and describe bulk supply chains and bulk commodity operations and operating conditions in South Africa, by means of a literature study.
- **b)** To explore and describe risks, risk management and mitigation strategies in commodity supply chains, by means of a literature study.
- **c)** To identify and explore the supply chain risks in the soda ash supply chain in South Africa, by means of an empirical (survey) study.
- **d)** To identify and describe the risk management and mitigating practices used in a bulk soda ash import supply chain, by means of an empirical (survey) study.
- **e)** To determine the relationships between the different risk factors, risk management and mitigation strategies with the aid of inferential statistics.

6.2.3 Aim of the study

Soda ash is an important source of, and input into economic activities in South Africa. As such, the main aim of this study was to investigate supply chain risks that may cause a ripple effect throughout supply chains that use soda ash.

6.3 Findings of the Study

In Chapter 2 and 3 a literature review was conducted to identify the import supply chain risks and to give context of risks in the supply chain management environment.

A short summary can be seen, in Table 6.1, of the objectives and how they were addressed in the literature review and empirical research below:

Table 6.1: Summary of the research objectives

Research objectives	Section
Primary research objective: The primary research objective is to identify and describe the supply chain risks in a bulk soda ash powder import supply chain and to determine how these risks are managed.	
Secondary research objective:	
a) To explore and describe bulk supply chains and bulk commodity operations and operating conditions in South Africa, by means of a literature study	Chapter 2
b) To explore and describe risks, risk management and mitigation strategies in commodity supply chains, by means of a literature study	Chapter 3
c) To identify and explore the supply chain risks in the soda ash supply chain in South Africa, by means of an empirical (survey) study	Section 5.4.2, 5.4.5 & 5.4.8
d) To identify and describe the risk management and mitigating practices used in a bulk soda ash import supply chain, by means of an empirical (survey) study	Section 5.4.3, 5.4.4 & 5.4.6 & 5.4.7
e) To determine the relationships between the different risk factors and mitigation strategies with the aid of inferential statistics	Section 5.5

Source: Compiled by researcher

From an empirical point of view, a research questionnaire was chosen to address the study objectives. The questionnaire used during this research, was divided into the following sections:

1. **Section A: General information** – This section gathered general information from the respondents, such as the area in which they were active, and years of experience.
2. **Section B: Risk identification** – This section explored and identified the risks associated with the bulk import of soda ash and the associated negative financial impact on the soda ash supply chain.
3. **Section C**: **Risk mitigation strategies** – This section aimed to identify the risk mitigation strategies employed to manage risks in the bulk import supply chain of

soda ash and to identify the extent to which the supply chain risks are being experienced.

4. **Section D**: **Port and logistics environment** – This section aimed to identify the risk and challenges specifically relating to the logistics and port environment in South Africa that affects the import supply chain of soda ash.

Lastly, there was also non-compulsory biographical information gathered, such as level in the organisation and highest obtained qualification.

6.3.1 Summary of the empirical research findings - descriptive statistics

To address the objectives of the study, both descriptive and inferential statistics were used to obtain the desired results. In the following sections a summary will be given of the empirical research findings, making use of descriptive statistics.

6.3.1.1 Respondent profiles

6.3.1.1.1 Role in the bulk soda ash import supply chain

The distribution of the respondents was almost evenly spread across the various roles (or parts) in the import supply chain of soda ash (importer / buyer, warehousing, transport, clearing and forwarding, port related services, 3rd party logistics services and other). This indicates that all roles within the import supply chain of soda ash were almost equally represented in this study. The highest represented category was “other” (17%), which includes supply chain advisory specialists, sales, production, exports, bagging services, and “various”. The latter group of respondents were involved in multiple activities, or a combination of activities in the soda ash supply chain. The lowest represented category was transport, with 11% of the respondents.

6.3.1.1.2 Years of experience in bulk soda ash import supply chain

Most respondents (30%) in this study had more than 10 years’ experience, with 59.5% of respondents having more than 5 years of work experience. Most of the respondents; therefore, had a very good understanding of the import supply chain of soda ash. Only 3% of the respondents had less than 1 year of work experience.

6.3.1.1.3 Position within the organisation

Most of the respondents were from the middle management level (33%) in the organisations in the import supply chain of soda ash, with the lowest representation from the top management level (13%).

6.3.1.1.4 Educational qualification

Most of the respondents had a tertiary certificate or diploma (28%) followed by Matric / Grade 12 (25%).

6.3.1.2 Major risks identified in the soda ash import supply chain

The top 5 major risks in the import supply chain of soda ash *identified* during this study include the following from highest to lowest percentage:

1. Port delays (96.7%)
2. Pandemic outbreaks e.g. COVID / SARS (91.0%)
3. Labour strikes (84.3%)
4. Infrastructure deterioration (82.1%)
5. Governmental regulation (79.8%)

This study identified that most respondents strongly agree and agree that port delays (96.7%) and infrastructure deterioration (82.1%) are major risks to the import soda ash supply chain. These findings are confirmed by prior research done on South African ports, as discussed in the literature review in Chapter 2 section 2.8.

The study questionnaire was distributed and completed in 2020, during the worldwide outbreak of the COVID 19 pandemic, and many countries were forced into hard lockdowns. It would be on this premise that most respondents agreed and strongly agreed that pandemic outbreaks, i.e., COVID / SARS (91.0%) were identified as a major risk.

Another two major risks the respondents strongly agreed and agreed with are labour strikes (84.3%) and governmental regulation (79.8%) pertaining specifically to the South African environment (micro-environment). These findings have also been highlighted and identified by previous research done as highlighted in Chapter 3, Table 3.1. The other important findings, from this study, include that 94.4% of respondents agreed and strongly agreed that if supply chain risks are left unmanaged, it can lead to negative financial impact. A positive finding was that 89.9% of respondents said that their organisations do actively manage supply chain risks.

6.3.1.3 Proactive vs reactive supply chain risk management

When asked whether their organisations proactively or reactively deal with supply chain risks, 85.4% of respondents strongly agreed and agreed that their organisations proactively manage risks, while 46% said that their organisations deal reactively with supply chain risks.

6.3.1.4 Supply chain risk management framework

When asked if their organisations make use of the supply chain risk management framework, 89.8% said that their organisations make use of risk identification, 76.4% said they used risk assessment and evaluation, and 66.3% make use of the implementation of these identified risk mitigation strategies. The intriguing part of this finding is the fact that there is a decreasing trend to use the subsequent parts of the supply chain framework. 89.8% of the organisations made use of the first phase of the SCRM framework (i.e. risk identification). Only 76.4% made use of the second phase (i.e. risk assessment and evaluation) and the lowest (66.3%) percent made use of the third phase (implementation of the identified risk mitigation strategies).

6.3.1.5 Major risks experienced in the soda ash import supply chain

The top 5 major risks in the import supply chain of soda ash which was *experienced* to a large and a very large extent by the respondents included the following from highest to lowest percentage:

1. Pandemic outbreaks e.g. COVID / SARS (87.7%)
2. Port delays (85.4%)
3. Logistics outsourcing (82.0%)
4. Labour strikes (77.5%)
5. Infrastructure deterioration (74.2%)

It is no surprise that 87.7% of respondents had dealt with pandemic outbreaks, as this had been thrust into the limelight since 2020 with the worldwide COVID 19 outbreak and associated lockdowns. These outbreaks and lockdowns were not only a risk that was experienced by the soda ash industry but was also experienced by the broader global supply chain community worldwide.

The rest of the top 5 major risks experienced by the respondents were all South African related environmental risks. All these risks were dealt with to a large and very large extent, which includes port delays, logistics outsourcing, labour strikes, and infrastructure deterioration, all of which are not new to South Africa.

6.3.1.6 Risk mitigation strategies used in the soda ash import supply chain

The top five risk mitigation strategies employed by organisations in the import supply chain of soda ash include the following from highest to lowest percentage:

1. Flexible transport (95.5%)
2. Collaboration with suppliers and/or customers (95.5%)
3. Resilient supply chain (95.5%)
4. Works toward integration with suppliers and/or customers (94.4%)
5. Robust (strong) supply chain (94.4%)

6.3.1.7 Ways of dealing with major risks in the soda ash import supply chain

The respondents were provided with a list of 5 ways of dealing with the identified risks. These 5 ways included to: 1) avoid the risk (AV); 2) reduce the risk (RE); 3) transfer the risk (TR); 4) accept the risk (AC); and 5) ignore the risk (IG). A summary of the top three approaches respondents used to deal with the risks are indicated in Table 6.2 (a full detailed breakdown can be seen in section 5.4.7 in Chapter 5).

Table 6.2: Summary of the ways of dealing with risk

Ways of dealing with risk	Risks
1. Avoid the risk (AV):	→ Terrorism (51.7%) → Internal organisational risk (14.9%) → Supply risk (11.5%) → Political instability / unrest (11.5%) → Labour strikes (11.5%)
2. Reduce the risk (RE):	→ Supply chain instability (78.2%) → Internal organisational risk (78.2%) → Demand risk (75.9%)
3. Transfer the risk (TR):	→ Oil price increases (25.3%) → External organisational risk (16.1%) → Governmental regulations (14.9%)

4. Accept the risk (AC):	→ Natural disasters (56.3%) → Governmental regulations (50.6%) → Oil price increases (37.9%)
5. Ignore the risk (IG):	→ Terrorism (8.0%) → Natural disasters (3.4%)

Source: Compiled by researcher

6.3.1.8 Major logistics risks identified in the soda ash import supply chain

The top 5 major logistics risks in the import supply chain of soda ash identified during this study include the following from highest to lowest percentage:

1. Port waiting times for a ship to berth (94.2%)
2. Congestion of trucks within port or terminals (94.2%)
3. Invisible and indirect costs due to port congestion (94.1%)
4. Congestion at the landside access route to ports (93.0%)
5. Congestion of ships at port equipment or services (90.7%)

6.3.2 Summary of the empirical research findings – inferential statistics

To address the objectives of the study, both descriptive and inferential statistics were used to obtain the desired results. In the following sections a summary will be given of the empirical research findings, making use of inferential statistics.

6.3.2.1 Exploratory factor analysis (EFA)

In the exploratory factor analysis (EFA) all the risks and mitigation strategies were investigated for data reduction, and potential factors were identified for each section (Section B, C & D of the questionnaire). In section B, the risks in the import supply chain, four factors were identified which included: 1) external supply chain risks; 2) internal supply chain risks; 3) high probability risks; and 4) low probability risks. When asked to which extent their organisations experience certain risks, three factors were identified which include: 1) micro-environment risks; 2) macro-environment risks; and 3) country specific risks. On the other hand, risk mitigation strategies were grouped into two factors which include: 1) supply chain mitigation strategies; and 2) product specific mitigation strategies. Three factors emerged when respondents were asked how they deal with certain risks (section C of the questionnaire). These factors were identified as 1) supply chain specific risks; 2) external organisational risks; and 3) high probability risks. Logistics risks (section D of the questionnaire) were grouped into the following factors 1) port logistics risks; and 2) maritime risks.

6.3.2.2 Pearson correlation analysis

With the Pearson correlation analysis, the positive strong statistically significant relationships of the 14 factors identified at the 1% level are summarized in Table 6.3.

Table 6.3: Summary of the 14 identified factors with positive strong statistically significant relationships

Factor	Correlated factor(s)
1) External supply chain risk	→ internal supply chain risk (.631) → high probability risk (.623) → macro-environment risk (.673) → port logistics risk (.662)
2) High probability risks	→ low probability risk (.502) → macro-environment risk (.597) → port logistics risks (.540)
3) Low probability risk	→ country specific risk (.629)
4) Macro-environment risk	→ port logistics risk (.691)
5) Country specific risk	→ micro-environment risk (.640)

Source: Compiled by researcher

6.3.2.3 Non-parametric analysis

In this section the hypotheses listed in Chapter 4 were tested. The hypotheses include:

H1$_0$: The distribution of *risk and strategies* is the same across the various parts of the bulk import supply chain

H2$_0$: The distribution of *risk and strategies* are the same across the number of years' experience of respondents in the bulk import supply chain

H3$_0$: The distribution of *risk and strategies* are the same across the level or position groups of respondents within the organisation in the bulk import supply chain

H4$_0$: The distribution of *risk and strategies* are the same across the different obtained educational qualifications of respondents in the bulk import supply chain:

The Table 6.4 indicates a summary of the results of the hypotheses.

Table 6.4: Summary of the hypotheses results

Hypotheses	Result
$H1_0$ ***Internal supply chain risk*** distribution is the same across the various parts of the import soda ash supply chain	Null hypothesis rejected
$H1_0$ ***Product specific mitigation strategies*** distribution is the same across the various parts of the import soda ash supply chain	Null hypothesis rejected
$H2_0$ ***Micro-environment risk*** distribution is the same across number of years of experience of respondents	Null hypothesis rejected
$H2_0$ ***Country specific risk*** distribution is the same across number of years of experience of respondents	Null hypothesis rejected
$H2_0$ ***Supply chain mitigation strategies*** distribution is the same across number of years of experience of respondents	Null hypothesis rejected
$H2_0$ ***Product specific mitigation strategy*** distribution is the same across number of years of experience of respondents	Null hypothesis rejected
$H2_0$ ***Maritime risk distribution*** is the same across number of years of experience of respondents	Null hypothesis rejected
$H3_0$ ***Port logistics risk*** distribution is the same across the level or position of respondents within the organisation	Null hypothesis rejected
$H3_0$ ***Maritime risk*** distribution is the same across the level or position of the respondents within the organisations	Null hypothesis rejected
$H4_0$ ***Supply chain mitigation strategies*** distribution is the same across the different obtained educational qualifications of respondents in the bulk import supply chain	Null hypothesis rejected

Source: Compiled by researcher

6.3.2.4 Regression analysis

Multiple regression modelling was used to investigate the statistical significant risk predictors (twelve independent variables - micro-environment risk, macro-environment risk, internal supply chain risk, maritime risk, natural and political risks, supply chain specific risk, low probability risk, external supply chain risk, external organisational risk, country specific risk, port logistics risk, and high probability risk) of product mitigation strategies and supply chain mitigation strategies were considered.

6.3.2.4.1 Product specific mitigation strategies

The results concluded that when product specific mitigation strategies are chosen, micro-environment risks play a major role in the decision of which product specific mitigation strategies to employ. It must also be noted that micro-environment risks had a mean of 3.4, which could indicate either a split opinion (similar proportions agree or disagree or were neither in agreement nor disagreement).

6.3.2.4.2 Supply chain mitigation strategies

The results concluded that when supply chain mitigation strategies are chosen, both macro-environment and micro-environment risks play a major role in the decision of which mitigation strategies to employ. Further to the micro-environment risks, mentioned above in section 6.3.2.4.1, further consideration should be given to the macro-environment risks, which include labour strikes, port delays, infrastructure deterioration, natural disasters, logistics outsourcing, pandemic outbreak, and any further external organisational risks when deciding on an overall supply chain mitigation strategy for soda ash. Macro-environment risks had a mean of 4.1, which means it had a tendency towards “agree” amongst respondents, indicating that on average, respondents agreed on this factor.

6.4 Recommendations

In terms of the findings of both the literature review and the empirical study into the bulk import supply chain of soda ash, is recommended that:

1. The players/stakeholders/organisations in the bulk soda ash import supply chain should familiarise themselves with the potential industry specific supply chain risks and ensure that they have adequate strategies to manage these risks. Special attention should be given to the major risks like COVID-19, port delays, labour strikes, and infrastructure deterioration.

2. Although 89.9% of organisations in the soda ash import supply chain deal actively with their risks, 10.1% of the bulk soda ash import supply chain still fail to actively manage their supply chain risk, and this poses a potential negative financial impact for them. It is therefore recommended that these organisations start to actively manage their supply chain risk.
3. Organisations in the soda ash import supply chain use the supply chain management framework in all the phases of risk management, i.e., risk identification, risk assessment and evaluation, and implementing the identified mitigation strategies.
4. Organisations in the soda ash import supply chain make use of flexible transport, collaboration with suppliers and/or customers, and building a resilient supply chain as part of their strategies to manage their supply chain risks.
5. Organisations in the bulk soda ash import supply chain should familiarise themselves with the potential logistics risks at the ports of South Africa and should ensure that they have adequate strategies to manage these risks. Special attention should be given to the major logistics risks like port waiting times for a ship to berth, congestion of trucks within port or terminals, invisible and indirect costs due to port congestion, and lastly congestion at the landside access route to ports.

6.5 Future Research Areas

Potential future research possibilities could include:

1. Extending the scope of the research to include the entire supply chain, including the export and/or any other part of the supply chain.
2. Conducting similar research for import in other industries and/or commodities.
3. Conducting a qualitative study in the soda ash import supply chain to obtain rich information about the most important risks identified in this study and appropriate mitigation strategies.

This study has opened up various potential avenues for future research opportunities in the field of risk management in supply chain.

6.6 Conclusion

This research highlighted that supply chain risk and the associated mitigation strategies is a vitally important aspect of the supply chain. It is clear from the findings that most of the organisations in the bulk soda ash import supply chain realise that risk management is important, although a small minority still fail to view this as important. Many organisations realise the potential negative financial impact that unmanaged supply chain risk can pose to the entire supply chain.

The primary research objective was to identify and describe the supply chain risks in a bulk soda ash powder import supply chain and to determine how these risks are managed. This objective was achieved by:

- **a)** Exploring and describing the bulk supply chains and bulk commodity operations and operating conditions in South Africa by means of a literature study,
- **b)** Exploring and describing risks, risk management, and mitigation strategies in commodity supply chains, by means of a literature study.
- **c)** Identifying and exploring the supply chain risks in the soda ash supply chain in South Africa by means of an empirical (survey) study.
- **d)** Identifying and describing the risk management and mitigating practices used in a bulk soda ash import supply chain, by means of an empirical (survey) study.
- **e)** Determining the relationships between the different risk factors and mitigation strategies with the aid of inferential statistics.

Since very little research has been conducted specifically into the import soda ash supply chain in South Africa, and since soda ash is an important commodity, the main aim of this study was to investigate the supply risks that may cause a ripple effect throughout supply chains that use soda ash.

Supply chain risks, in their entirety, will never be completely eliminated, but it is of crucial importance that managers in the supply chain identify the relevant supply chain risks they deal with and react appropriately by implementing strategies in order to manage these risks.

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APPENDIX A: RESEARCH QUESTIONNAIRE

CONSENT TO PARTICIPATE

Thank you for your willingness to participate in this study. In line with ethical research guidelines, we promise anonymity and confidentiality of your response and participation. You can withdraw your participation any time through the process of answering the questions. However, your inputs are important to us.

Do you give consent to participate in this survey, as outlined in the "informed consent form"? Please only select one option. If yes is selected this will be deemed your "electronic" signature to the consent form attached in the survey e-mail.			
1.Yes		2.No	

SECTION A: GENERAL INFORMATION

This section and the statements relate to general information about you and your organisation's role in the bulk import supply chain of soda ash.

A1. In which part of the bulk soda ash import supply chain are you mostly active? Please only select one option.	
1.Importer / buyer	
2.Warehousing	
3.Transportation	
4.Clearing and forwarding	
5.Port related services	
6. 3rd party logistics services	
7.Other (please specify)	

A2. How many years of experience do you have in bulk commodity supply chain management / logistics?									
1.Less than 1 year		2.Between 1 – 3 years		3. Between 3 – 5 years		4.Between 5 - 10 years		5.More than 10 years	

SECTION B: RISK IDENTIFICATION

This section and the statements relate to identifying the risks associated with the bulk import of soda ash.

B1. Please indicate how strongly you agree or disagree with the statements below, selecting only one option per statement. Please use the level of agreement indicators below. 1.Strongly disagree 2. Disagree 3. Uncertain 4. Agree 5. Strongly agree **A major risk to the import supply chain of bulk soda ash is:**					
	1.	2.	3.	4.	5.
B1.1. **Labour strikes**					
B1.2. **Port delays**					
B1.3. **Political instability / unrest**					
B1.4. **Terrorism**					
B1.5. **Infrastructure deterioration**					
B1.6. **Governmental regulations**					
B1.7. **Oil price increases**					
B1.8. **Natural disasters**					
B1.9. **Supply chain complexity**					
B1.10. **Supply chain uncertainty**					
B1.11. **Supply chain instability**					
B1.12. **Logistics outsourcing**					
B1.13. **Supply risk**.					
B1.14. **Demand risk**					
B1.15. **Pandemic outbreaks** e.g. COVID / SARS					
B1.16. **Internal organisational risk**					
B1.17. **External organisational risk**					

B2. Please indicate how strongly you agree or disagree with the statement below, selecting only one option. 1.Strongly disagree 2. Disagree 3. Uncertain 4. Agree 5. Strongly agree	1.	2.	3.	4.	5.
B2.1. When supply chain risks are left **unmanaged** it could lead to an unnecessary negative **financial impact**.					

SECTION C: RISK MITIGATION STRATEGIES

This section and the statements relate to identifying the risk mitigation strategies employed to manage risks in the bulk import supply chain of soda.

C1. Does your organisation actively manage risks in the supply chain?			
1.Yes		2.No	

C2. Please indicate how strongly you agree or disagree with the statements below, selecting only one option per statement. 1.Strongly disagree 2. Disagree 3. Uncertain 4. Agree 5. Strongly agree **My organisation deals with most supply chain risks…**	1.	2.	3.	4.	5.
C2.1. **proactively**					
C2.2. **reactively**					

C3. Please indicate how strongly you agree or disagree with the statements below, selecting only one option per statement. 1.Strongly disagree 2. Disagree 3. Uncertain 4. Agree 5. Strongly agree **My organisation makes use of a supply chain risk management framework for ...**	1.	2.	3.	4.	5.
C3.1. **risk identification**					
C3.2. **risk assessment and evaluation**					
C3.3. **implementation of identified risk mitigation strategies**					

C4. Please rate the extent to which your organisation deals with each supply chain risk on a scale of 1 to 5 where: 1. not at all, 2. to a small extent, 3. to a moderate extent, 4. to a large extent., 5. to a very large extent.	1.	2.	3.	4.	5.
C4.1. Labour strikes					
C4.2. Port delays					

C4.3. Political instability / unrest					
C4.4. Terrorism					
C4.5. Infrastructure deterioration					
C4.6. Governmental regulations					
C4.7. Oil price increases					
C4.8. Natural disasters					
C4.9. Supply chain complexity					
C4.10. Supply chain uncertainty					
C4.11. Supply chain instability					
C4.12. Logistics outsourcing					
C4.13. Supply risk					
C4.14. Demand risk					
C4.15. Pandemic outbreaks e.g. COVID / SARS					
C4.16. Internal organisational risk					
C4.17. External organisational risk					

C5. For each one of the following statements about risk mitigation strategies indicate how strongly you agree or disagree with your organisation making use of it. Select only one answer at each statement. 1.Strongly disagree 2. Disagree 3. Uncertain 4. Agree 5. Strongly agree	1.	2.	3.	4.	5.
C5.1. **product postponement**					
C5.2. **placement of strategic stock**					
C5.3. **flexible supply base**					
C5.4. **make-or-buy i.e. insourcing vs outsourcing options**					
C5.5. **flexible transportation**					
C5.6. **collaboration with suppliers and / or customers**					
C5.7. **works towards integration with suppliers and / or customers**					
C5.8. **resilient supply chain**					

C5.9. **flexible supply chain**					
C5.10. **robust (strong) supply chain**					
C5.11. **agile (responsive) supply chain**					
C5.12. **stable (constant) supply chain**					
C5.13. **innovation**					

C6. For each supply chain risk in the table below indicate how your organisation will most probably deal with the risk. AV = Avoid the risk; RE = Reduce the risk; TR = Transfer the risk; AC = Accept the risk; IG = Ignore the risk	AV.	RE.	TR.	AC.	IG.
C6.1. Labour strikes					
C6.2. Port delays					
C6.3. Political instability / unrest					
C6.4. Terrorism					
C6.5. Infrastructure deterioration					
C6.6. Governmental regulations					
C6.7. Oil price increases					
C6.8. Natural disasters					
C6.9. Supply chain complexity					
C6.10. Supply chain uncertainty					
C6.11. Supply chain instability					
C6.12. Logistics outsourcing					
C6.13. Supply risk					
C6.14. Demand risk					
C6.15. Pandemic outbreaks e.g. COVID / SARS					
C6.16. Internal organisational risk					
C6.17. External organisational risk					

SECTION D: PORT AND LOGISTICS ENVIRONMENT

This section and the statements relate to identifying the risks and challenges in logistics and the port environment in South Africa which will affect the bulk import supply chain of soda ash.

D1. Please indicate how strongly you agree or disagree with the statements below, selecting only one option per statement. 1.Strongly disagree 2. Disagree 3. Uncertain 4. Agree 5. Strongly agree **The following poses a great risk to imports in the soda ash supply chain:**	1.	2.	3.	4.	5.
D1.1. Port **road infrastructure** (e.g. docking space, access roads)					
D1.2. **Port facilities** (warehouses, cranes)					
D1.3. **Mechanical faults in machinery / equipment** at port?					
D1.4. **Low productivity** at port?					
D1.5. **Industrial actions** at port?					
D1.6. **Poor visibility** at port					
D1.7. **Rough seas**					
D1.8. **Storm surge** at seas					
D1.9. **Windstorms** at seas					
D1.10. **National road infrastructure**					
D1.11. Invisible and indirect costs due to **customs delays**					
D1.12. Invisible and indirect costs due to **port congestion**					
D1.13. Relatively **high transport cost** in South Africa					
D1.14. A **lack of logistics planning** by the government					
D1.15. Congestion of ships **at port equipment or services**					
D1.16. Congestion of **trucks within ports** or terminals					
D1.17. Congestion at the **landside access route to ports**					
D1.18. Port **waiting times for a ship to berth**					

ADDITIONAL INFORMATION

This section is supplementary information only and is not compulsory to complete.

D2. Please indicate your current position or level within your organisation.	
1.Operational level	
2.Lower management level	
3.Middle management level	

4.Top management level	

D3. What is you highest obtained educational qualification?	
1.Matric / Grade 12	
2.Tertiary certificate / Diploma	
3.Bachelor degree	
4.Honors degree	
5.Master degree	
6.Doctoral degree	

WE THANK YOU FOR YOUR PARTICIPATION!!

APPENDIX B:
ETHICAL CLEARANCE CERTIFICATE

UNISA university of south africa

UNISA DEPARTMENT APPLIED MANAGEMENT RESEARCH ETHICS REVIEW COMMITTEE (DAM-RERC)

Date: 28 November 2020

ERC Reference # : 2020_CEMS_DAM_009
Name: Mr. Jacque Barend Kruger
Student #: 47410345

Dear Mr. Jacque Barend Kruger

Decision: Ethics Approval from October 2020 to October 2023

Researcher(s): Mr. J.B. Kruger
076 174 5249 / 082 626 2 085 / jacquekruger@gmail.com

Supervisor (s): Prof J.A. Badenhorst
082 4497507 / hanniebw@gmail.com

Working title of research:
Supply chain risks in a bulk import supply chain of commodity chemicals

Qualification: Mcom Supply Chain & Procurement Management

Thank you for the application for research ethics clearance by the Unisa DAM Ethics Review Committee for the above-mentioned research. Ethics approval is granted for three years.

*The **medium risk application** was **reviewed** by the DAM Ethics Review Committee in October 2020 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment. The decision was approved on the 28th of October 2020.*

The proposed research may now commence with the provisions that:

1. The researcher will ensure that the research project adheres to the relevant guidelines set out in the Unisa Covid-19 position statement on research ethics attached.
2. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.

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www.unisa.ac.za

3. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the DAM Committee.
4. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
5. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
6. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
7. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
8. No field work activities may continue after the expiry date (10/2023). Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

*The reference number **2020_CEMS_DAM_009** should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Yours sincerely,

Mrs C Poole
Chair: DAM-RERC
E-mail: damrerc@unisa.ac.za
Tel: (012) 433-4668

Prof RT Mpofu
CEMS DED
(on behalf of Prof Mogale

Prof M Mogale
Executive Dean: CEMS
E-mail: mogalmt@unisa.ac.za
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APPENDIX C:
LANGUAGE & TECHNICAL EDITING

Marianne Kapp Language Services – marscaro@gmail.com

Cape Town
13 Dec. 2021

To whom it may concern,

This letter confirms that the manuscript detailed below was edited for proper English language grammar, punctuation, spelling, and overall style by a qualified and highly experienced native English-speaking editor:

Manuscript title: **Supply chain risks in a bulk import supply chain of commodity chemicals**

Author: **Jacque Barend Kruger**

Neither the research content nor the author's intentions were altered in any way during the editing process. The editor makes no claim as to the accuracy of the research content or objectives of the author. The document above as edited is grammatically correct and ready for publication; however, the author has the ability to accept or reject the editor's suggestions and changes after the editing process is complete, and prior to submission to any journal or examining body.

Marianne Kapp
0824813300

APPENDIX D:
TURNITIN DIGITAL RECEIPT

turnitin

Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

Submission author:	Jacque Kruger
Assignment title:	Complete dissertation/thesis for examination
Submission title:	SUPPLY CHAIN RISKS IN A BULK IMPORT SUPPLY CHAIN OF C...
File name:	410345_KRUGER_JB_FINAL_ALL_CHAPTERS_22_10_2021_Latest...
File size:	4.58M
Page count:	240
Word count:	63,229
Character count:	360,765
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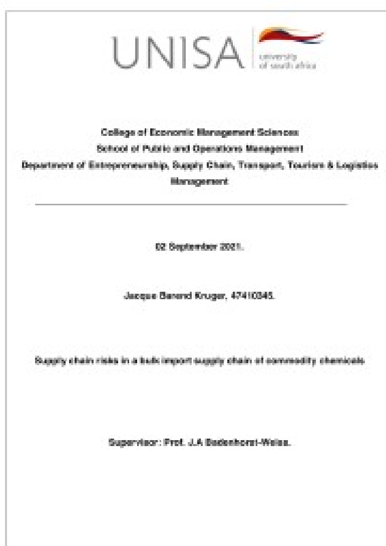
Submission ID:	1687360537


UNISA university of south africa

College of Economic Management Sciences
School of Public and Operations Management
Department of Entrepreneurship, Supply Chain, Transport, Tourism & Logistics Management

02 September 2021.

Jacque Barend Kruger, 47410345.

Supply chain risks in a bulk import supply chain of commodity chemicals

Supervisor: Prof. J.A Badenhorst-Weiss.