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Risk Management in Supply Chain Information Flow: A study of selected Food Processing Companies in South Africa.

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A research dissertation submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, in fulfilment of the requirements for the degree of Master of Science in Industrial Engineering.

10 March 2023

Dedication.

This dissertation is dedicated in loving memory of my dearest Father,

Thebeetsile Simon Motang “Morwa-Koma”

And my dearest Grandparents – Matlhoko & Motang

‘’Plant a tree in honor of your loved ones. Each time you pass, remember the legacy of your special someone’’

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PLAGIARISM DECLARATION TO BE SIGNED BY ALL HIGHER DEGREE STUDENTS.

SENATE PLAGIARISM POLICY: APENDIX ONE.

I Otshepeng Eddison Matlhoko (Student number: 1799877) am a student registered for the degree of Master of Science in Industrial Engineering in the academic year 2022.

I hereby declare the following:

I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original sources) is wrong.

I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.

I have followed the required conventions in referencing the thoughts and ideas of others.

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Signature:_____ _____ date: 10 March 2023

Risk Management in Supply Chain Information Flow: A study of selected Food Processing Companies in South Africa.

Abstract.

As the Food Processing Industry continues to expand and becomes increasingly complex, by the same token, a number of problems encountered arise (Nguegan & Mafini, 2017). Such problems include, but are not limited to, more dynamic, differentiated and complex consumer demand, distorted supply chain information flow, the need for effective practices and the need to meet the dynamic market requirements (Grunert, 2003; Singhal, *et al*, 2011). All of these problems pose risks to the business performance and the supply chain management effectiveness, resulting in rising costs and declining competitiveness. Given that information is considered important tool for decision making and keeps all supply chain components updated, it was crucial to study information flow risk factors and the mitigation strategies employed by Food Processing Companies to better comprehend developments within the industry (Nguegan & Mafini, 2017). Through following the qualitative research approach, it was established that effective risk management lies in the ability of the senior leaders and management to make good decisions. It is apparent that policies and procedures are almost invariably not enough, and, in consequence, the onus is on senior leaders and management to take policies and procedures a step further by implementing a holistic risk management program which can surge business chances of success and lessen the possibility of failure (Frigo & Anderson, 2011; Singh & Singh, 2019; Sunjka & Emwanu, 2013).

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Acronyms.

SAIIE	Southern African Institute for Industrial Engineering
ICT	Information & Communication Technology
IT	Information Technology
HR	Human Resources
SA	South Africa
SADC	Southern African Development Community
RVAA	Regional Vulnerability Assessment Analysis
PEST	Political, Economic, Social and Technological
FAO	Food and Agriculture Organisation
SCRM	Supply Chain Risk Management
RPA	Robotic Process Automation
GDP	Gross Domestic Product
CRQ	Critical Research Question,
TQ	Theory Questions,
IQ	Interview Questions
KPI	Key Performance Indicators
SAP	System Applications and Products
ERP	Enterprise Resource Planning
BIS	Business Information Systems
HREC	Human Research Ethics Committee

Chapter 1: Introduction.

1.1 Purpose of the Study.

The purpose of this study is to examine how Food Processing Companies in South Africa manage risk pertaining to supply chain information flow. Eventually, this study will help in determining the impact of contemporary risk management in supply chain information flow**.**

1.2 Research Background/Context.

Houlihan (1985) initially defined the supply chain as 'a system consisting of suppliers, producers, distributors/warehouses, retailers and customers in which physical materials flow downwards and information flows in two directions' (Sahil *et al* 2019). Information flow, material flow and financial flow links stakeholders involved with each other from both ends of the supply chain. Furthermore, these days the successes that organisations eventually enjoy relying upon the most efficient management of the integration and coordination of the entire supply chain, including members of the supply chain (Sahil *et al* 2019). Various authors regard the sharing of information as an important tool that enables the planning, coordination and integration of supply chain activities (Lotfi *et* al, 2013).

1.2.1 Information sharing: integration and coordination.

As mentioned above Information flow connects the firm's diverse stakeholders which include internal functional areas or departments, as well as the external supply chain partners; all of whom are an integral part of the organisation's welfare and indeed security (Zahra *et al*, 2013). Integration relates to the specific building blocks that ensure the long-term collaboration of the stakeholders within the supply chain; and these building blocks are choice of partners, network organisation and inter-organisational collaboration, as well as leadership (Stadtler *et al,* 2015). The choice of partners begins with assessing the supply chain activities involved in producing a product or offering a service for a certain market segment. Here, supply chain activities are allocated to members of the supply chain as per their core competencies (Stadtler

et al, 2015). Network organisation and inter-organisaitonal collaboration are a necessity as information and know-how is shared openly among members of the supply chain. Leadership, being the third of the integration building blocks, pertains to the decisions made within supply chain based on the shared information. The coordination of material, financial and information flows involve three fundamental aspects; ultilisation of information and communication technology, process orientation and advanced planning; all of which allow the supply chain to operate more timely, economically and flexibly (Stadtler *et al,* 2015).

1.2.2 Information sharing benefits.

The benefits derived from the timely, efficient and smooth sharing of information in the supply chain are mainly realised in the areas of cost and inventory reduction, optimised utilisation of capacity, efficiency of processes, on-time problem detection, improved visibility, and reduced cycle time (Yang & Zhang, 2013; Lotfi *et al*. (2013). According to Baihaqi et al (2013) there was a study conducted by Lewis to assess how outsourcing performance in the supply chain was affected by information sharing. In this study Lewis found a substantial relationship between outsourcing performance and information sharing. In addition to the aforementioned benefits there is increased productivity, elimination of the bullwhip effect, a quicker response and on-time delivery, improved utilisation of resources, as well as the possibility of tracking and tracing (David, 2015). These wide spanning benefits of information sharing inevitably foster the development of networks better forecasting, and improved customer satisfaction (David, 2015). Thus, resulting in a more agile, aligned and adaptive supply chain (Yang & Zhang, 2013).

Yet, even with the attendant benefits of information sharing it does not necessarily mean that stakeholders sharing information are willing to do so; with those stakeholders willing to share information doing so in either a predetermined way or spontaneously (Du *et al* 2011). According to Paulina (2015) while the types of information shared include planning information, financial information, production information, performance information, quality information and demand information; the willingness to share information reflects the quality of the information shared. “In the supply chain context, willingness to share information is a trade-off between efficiency

and the responsiveness of the information resources; what information is shared depends on the economics and technology thereof" (Du *et al* 2011).

1.2.3 Information sharing: risks and mitigation.

While information sharing in the supply chain has numerous and varied benefits, it is not without risk. Sharing of information suggests a higher exposure of supply chains to many kinds of risks known as 'information risks', which have arguably become the most substantial business risk (Colicchia *et al*, 2019). According to Zahra *et al*. (2013), the common identifiable supply chain information flow risk factors include: the cost and reliability of information technologies given that the high priced acquisition of new technologies may not yield reliable results, anti-trust regulations, development of company's capabilities to use the information effectively which may be resource-draining, compromised confidentiality that places an organisation's security at risk, accuracy and speed of information that isn't always reliable, and issues of incentives, among others. In addition to the aforementioned risk factors, Saxton (2006) states that the disruption of the supply chain information flow may escalate the attendant supply chain risks in the organisation as well as increase operational and reputational costs.

Yet more than the risks organisations stand to incur as a result of information sharing, the challenge of 'risk information sharing reluctance' amongst supply chain partners exists. According to Saglam *et al* (2020) risk information sharing in the supply chain relates to the practise in which supply chain partners share important and patented information pertaining the supply chain. The reluctance of risk information sharing therefore means that supply chain partners actively withhold risk information, and thus organisations within the supply chain cannot adequately assess their potential losses (Fan *et al,* 2017). This reluctance may be due to the sometimes-unequal nature of information exchange amongst supply chain partners. Yang *et al* (2017) states that an organisation may feel a loss of power when sharing too much information with the buyer, and that "when the dyadic relationship between buyer and supplier is strong then effective information sharing will occur amongst stakeholders." Ultimately, risk information sharing is an important risk mitigation strategy as it fosters collaboration in the supply chain as it pertains to the managing of risks in the supply chain (Saglam *et al,* 2020).

In order to mitigate supply chain risks, contingency actions must be established, such as the instituting of policies to eliminate risks, the constant improving of information technology (IT) infrastructure as well as human resource development (Pienaar & Vogt, 2009). It is thus imperative that information flow risks be managed so as to reach the ultimate goals of the supply chain; two of the most important being cost reduction and improved customer satisfaction (Pienaar & Vogt, 2009). Studies in IT as well as the supply chain show that IT plays an important role in improving both the efficiency and effectiveness of supply chain information flow (Prajogo & Olhager, 2012; Vanpoucke *et al*., 2017). However, companies must acknowledge the issues emerging within IT operations; such as the lack of interfacing between IT systems as well as other identifiable information flow risk factors.

1.3 Research Motivation.

1.3.1 Information flow risks: the supply side.

Various studies within the ambit of IT and the Supply Chain have investigated the many risks that may occur in the supply chain; yet research on this topic specifically within the Food Processing Companies in South Africa is wholly insufficient. Information flow risks within the supply chain of agro-food processing companies in South Africa can be located within the continuum of the challenges facing agriculture and farming in South Africa. This is because according to Thow *et al* (2018) the local food processing industry supports local farmers by sourcing locally and avoiding imports due to the associated costs, resulting in 2/3 of the 2 million tonnes of agricultural commodities purchased per year being local. According to Sikora *et al* (2020) there are challenges that Southern Africa faces which place constraints to food production, and these diverse challenges include but are not limited to agricultural transformations and growing populations. As such challenges relating to food processing in South Africa must be viewed from a multidisciplinary perspective.

1.3.2 Information flow risks: the demand side.

Food Processing Companies in South Africa also tackle risks pertaining to supply chain information flow due to a wide variety of available consumer products; consumer demand and preferences which tend to change over time. As a result, companies are obligated to constantly accumulate consumer demand information in order to make sensible business decisions regarding distribution of supply. According to Greenberg (2017) a central feature of the food processing sector in South Africa is the diverse distribution to both corporate wholesalers & retailers, as well as to what Euromonitor refers to as 'traditional markets' which include small grocers, spaza shops, street vendors and the like. Both these channels of distribution, 'corporate' and 'traditional', then make the products procured from agro-food processing companies available for purchase to the consumer or man on the street, so to speak. It is thus the relationship and subsequent information exchange between these stakeholders that may pose information flow risk in the supply chain.

1.3.3 Information flow risk management.

While every company is subject to business risk factors that affect their competitiveness, for food processing companies in South Africa, business risk factors that pose a particular risk to the supply chain information flow are intimately tied with the supply side as pertains agricultural challenges facing South African farmers, as well as attendant difficulties arising from the demand side where 'corporate' and 'traditional' wholesalers/retailers are concerned .Managing these risk factors should be at the forefront of every food processing company's strategic vision. Contemporary risk management in supply chain information flow has the potential to deliver a range of benefits including enabling companies to proactively respond to risks as well as implement integrated approaches and contingency plans. This will result in achieving long-term business success and the reduction of vulnerability to supply chain information flow risks. In addition, the successful management of the supply chain information flow risks will also provide a great opportunity for companies to realise the cost saving opportunities and potentially escalate their competitive advantage, thus realising the two important goals of the supply chain.

1.4 Problem Statement.

As the food Processing Sector in a country continues to grow exponentially and increase in its complexity, so do the challenges encountered in that industry from both the supply and demand sides (Nguegan & Mafini, 2017). From the supply side the challenges faced in the agricultural sector which lead to food production constraints directly impact the food processing sector's supply chain (Sikora *et al,* 2020). From the demand side, the diverse distribution stakeholders lead to challenges that include but not limited to; more dynamic, differentiated and complex consumer demand; a distorted supply chain information flow; the need for effective practices; and the necessity to meet the dynamic market requirements (Grunert, 2003; Singhal *et al*., 2011). All of these challenges pose risks in the supply chain information flow, which in turn adversely affects business performance as well as the supply chain management effectiveness; and this accumulatively results in escalated costs and declining competitiveness. Considering that the flow of information in the supply chain is utilised as a resource for decision making and also keeps all the supply chain components updated, it is critical to investigate information flow risk factors and the mitigation strategies employed by Food Processing Companies in South Africa in order to better understand how information flow risk is managed through developments – which invariably span the gamut; from developments in IT systems, to HR information policies – within the food processing industry in South Africa. Sustained research in the food processing industry in South Africa can contribute to solving several problems within the aforementioned industry such as uncertainties in demand and supply, network system problems which lead to needless time-wasting, poor customer service, high inventory levels and lost sales. All of these lead to improved decision making that is necessary for the further growth and success in the Food Processing Industry in South Africa (Nguegan & Mafini, 2017).

1.5 Research Question.

What are the risk management strategies employed by Food Processing Companies in South Africa in order to manage risks in supply chain information flow?

1.6 Research Objectives.

The objectives of this research are to:

- Examine the extent to which agricultural challenges in South Africa contribute to information flow risk in the supply chain of selected food processing companies in SA.
- Analyse the ways in which the diverse distribution landscape of 'corporate' and 'traditional' wholesalers/retailers' impact on information flow and attendant risks in the supply chain of selected food processing companies in SA.
- Assess how selected Food Processing Companies in South Africa manage risk in supply chain information flow.
- Determine the impact of risk management on the supply chain information flow of selected food processing companies in South Africa.
- Develop from empirical data a conceptual framework for supply chain information flow risk management

1.7 Assumptions.

The following assumptions are made regarding this study.

- The instrument to be used will elicit reliable responses.
- The respondents will have a thorough understanding of the questions they will be asked.
- The interviewees will have truthful and candid answers to the interview questions.
- The inclusion criteria of the questionnaire are appropriate and therefore assures that the participants have all experienced the same or similar phenomenon of the study.

1.8 Delimitations and scope.

This study intends to create understanding of the risk management strategies employed by managers in food processing companies, in order to effectively manage risk in supply chain information flow. A manager's perception and cognition (subjective risk perception) of risk often determines the approach businesses employ to manage risk. This study will be conducted in Gauteng as undeniably various Food Processing Companies are based in Gauteng. Only qualified and experienced supply chain executives will be interviewed. Since these executives share similar characteristics (skills and experience) they are best positioned to serve the objectives of this study. Participants considered were those that held either a professional or formal qualification in any supply chain related field and had garnered a minimum of two years' work experience in a supply chain environment. These were the key and necessary requirements prior to a participant signing a consent form.

There is no sample size for this study as it will be determined by the concept of data saturation. Data saturation point is reached when the collection of new data does not reveal new information. That is the point where the researcher discontinues new data collection, the research objectives have been achieved, and a sample size is thus determined.

1.9 Structure of report.

Introduction	Introduction of the study to provide a background and purpose of the study
Literature Review	A literature review outlining the various themes discovered in the research regarding supply chain information flow in general and particularly in the Food Processing Sector in South Africa

Methodology	Research methods clearly outlining what method was applied in the study and why it was applied
Results / Findings	Results given indicating what was found in the study
Discussion	Interpreting and describing the significance of the study findings relating back to literature reviewed and introductory research statement
Conclusion	Conclusion re-stating main arguments and correspondingly re-iterating the most important evidence to justify those results/findings
Recommendations	Specific directions that can be taken as a result of findings
References	List of all reference used in the study as a way of justifying and acknowledging the contributions of other researchers
Appendices	Appendices included to add the extra information to the report

Chapter 2: Literature Review.

2.1 Introduction.

In this chapter, literature on the information flow risk management in the supply chain of the South African food processing sector is reviewed to establish a foundational knowledge for the study and explore any potential gaps. The literature reviewed covers in general the following topics and their selected sub-themes, namely: agro-food system in South Africa, the food processing sector in South Africa, supply chain information flow, and supply chain risk management.

2.2 The Agro-food system in South Africa.

In order to address the information flow risks in the supply chain of the South African food processing sector, one must recognise the inextricable link of which the sector is a part within the broader South African agro-food system. According to Greenberg (2017) the life cycle of a commodity is broken down into various stages or ‘nodes’ in the production or value chain system; with all the nodes in the process being interrelated. Figure 1. represents the schematic overview of the agro-food system in South Africa. Here, the food processing/manufacturing node is more or less centrally positioned with two nodes/processes occurring upwards (Inputs and Primary Production) and one downwards (Consumer markets: with products accessed from Wholesale and Retail, Food Service, Consumer Food Service, Institutional and Hospitality industries) of it (Greenberg, 2017).

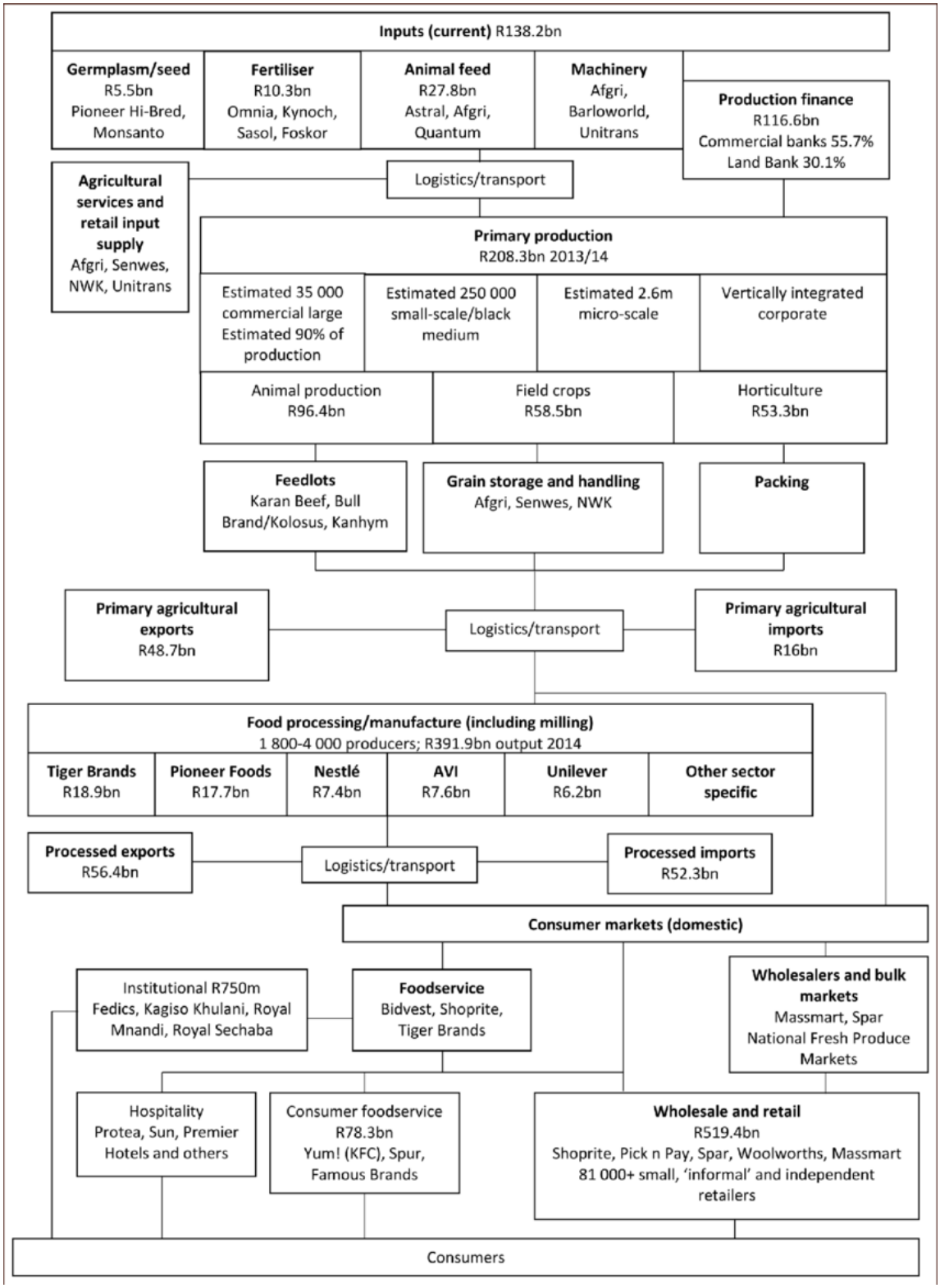


Figure 1: Schematic overview of the agro-food system in South Africa.

Source: Greenberg, 2017.

2.2.1 The Agro-food system in SA: Primary production (agricultural sector) challenges.

Based on the aforementioned Figure 1, there exists an interlinked nature between the nodes within the agro-food system in South Africa. Upon assessing the link between the food processing/manufacturing node and the Inputs as well as Primary Production (collectively forming part of the agricultural sector) node, it is apparent that the latter supplies the former with the agricultural produce (animal production, field crops, horticulture etc.) required to process consumer goods. Put another way, the Agricultural sector in South Africa acts as the supplier to the food processing sector in South Africa for goods which will then be procured by the Consumer node through intermediary nodes like Wholesalers, Retailers, Food services etc. It is because of this interconnectedness between the various nodes within the agro-food system that the challenges faced by one of the nodes will invariably affect one or all the nodes.

According to Sikora *et al* (2020) there are three interrelated issues which combined pose challenges for the South African (and indeed Southern Africa as a whole) agricultural sector. These issues, namely, smallholder production, food insecurity, as well as land tenure are central as to whether the agricultural sector can overcome its challenges or not.

South Africa is one of five countries in Southern Africa which were identified by SADC's RVAA report as having 'the most food insecure people' in 2017; whereby agricultural production was hampered by human and animal disease outbreaks, as well as unpredictable weather events such as cyclones and droughts to name a few (SADC, 2018). Closely tied to this is the reality that in all the aforementioned countries (including South Africa) there is a relatively large percentage of smallholders. This is a diverse group with evidence pointing to the increased unequal access to essential resources such water and livestock. Consequently, the size of many land holdings amongst smallholders is decreasing (Sikora *et al.* 2020). Land tenure challenges in South Africa – which is closely tied to the nature of smallholdings – stem from the unequal distribution of land access, a remnant of the country's troubled history. Here, again the issue of unequal access to resources by smallholdings emerges, which makes smallholder farms in the region unsustainable economically; or for livelihoods for that matter (Lowder *et al,* 2016).

2.2.2 Agricultural challenges: the impact on food processing companies in SA.

But how do the aforementioned agricultural problems impact on food and how does unpredictable climate conditions, among other issues, lead to lower than desired crop yields? This is a pertinent question considering that smallholder farms in particular experience lower than desired yields for cereal crops for example realising yields less than 30% of achievable yields (Sikora *et al,* 2020). A follow up question becomes, how is this reality impacting the ability of food processing companies in South Africa to supply the market? According to Sikora *et al* (2020) the problem of food insecurity in Southern Africa which are due to unfavourable regional conditions have a huge adverse impact in the agri-food/food processing industries. For example, companies in the business of producing breakfast cereals stand in need of sufficient output of crops and this lower than expected yields would invariably impact on the supply of cereal crops required to fulfil planned production quantities. Zingore *et al* (2011) suggests that the problem of soil fertility decline which is most prevalent in smallholder farms leads to the 'corresponding decline in crop productivity', a problem which again trickles down to those food processing companies relying on the said crops.

2.3 The Food Processing Sector in South Africa.

Food processing is widely considered the largest manufacturing sector in South Africa (Food and Beverages in South Africa, 2015). Das & Rajyalakshmi (2015) define food processing as the transformation of raw food ingredients into liquid, solid, preserved and value-added food. The South African Food Processing Industry (2011) classifies the food-processing sector within the following ten categories: dairy products; meat and meat products; fruit and vegetables; fish and fish products; animal feeds; oils and fats; beverages; bakery and confectionary; milled grain products; and other foods.

''The level of concentration by food sector, however, underestimates the extent of concentration because a number of individual firms are involved in several food groups. Tiger Oats, for instance, is involved in the production of milled products (wheat and maize), processed fruit and vegetables, confectionary items, as well as dairy and meat products'' (Mather 2005, p16; The South African Food Processing Industry, 2011).

It has been established that South Africa has a large number of secondary Food Processing Industries, and half of the companies operating in the Food Processing Industry are located in Gauteng (Food and Beverages in South Africa, 2015). The impact of the Food and Beverage industry on the South African economy cannot be understated; the sector accounted for 25.2% of the total manufacturing production in South Africa in 2016-2017 (Industrial Development Corporation, 2018). According to the Department of Trade and Industry, 2018, this sector contributes a significant 3.1% of manufacturing value add as percentage of gross domestic product and employs approximately 183 502 individuals.

It is further worth noting that this sector has proved to have strong up and downstream linkages where value is added (Department of Trade and Industry, 2018). Upstream, the sector links with various agricultural suppliers across a range of farming products and models. While downstream, outputs are used as both intermediate products in which further value is generated as well as finished products which are marketed through a diverse range of wholesale and retail chains (Department of Trade and Industry, 2018).

Despite significant contributions of this industry in the economy, it continues to encounter various challenges, which prevent it from reaching its full potential and further develop (Nguegan & Mafini, 2017). Due to globalisation and the demise of the apartheid regime, the food processing industry in the country has changed significantly; all while the purchasing power of most racial groups has steadily improved (Nguegan & Mafini, 2017). The industry faces challenges of unpredictable customer demand and preferences, owing to greater product variety and increased globalisation (Nguegan & Mafini, 2017; Agigi *et al*, 2016).

According to Mercer (2011) and Nguegan & Mafini (2017) other factors contributing to the challenges faced by the food processing industry include: information exchange as it relates to the incompatibility of technological systems and technology development due to lack of investment in technology, inadequate food security and inferior quality brought on by hygiene issues, perishability in terms of food expiring sooner than it ought to, market access in terms of inability to penetrate the market, infrastructure deficiencies and scarcity, regulatory issues in terms of non-compliance, financial constraints, lack of equipment and raw materials, social issues such as

systemic poverty, environmental concerns in terms of compliance with regulations and minimising pollution, lack of education and training, and land stewardship. All of these Political, Economic, Social and Technological (PEST challenges impact on the business performance and supply chain management effectiveness within the food processing industry (Nguegan & Mafini, 2017).

2.3.1. The Food Processing Sector in SA & the domestic consumer markets.

The schematic overview of the agro-food system in South Africa (Figure 1.) illustrates the link between the food processing industry node and the (domestic) consumer markets node in the system. Here, one observes that the processed goods emanating from food processing companies such as Tiger Brands, Pioneer Foods, Unilever and the like are procured at the (domestic) consumer markets node. According to Greenberg (2017) the (domestic) consumer markets node is comprised of various and varied stakeholders such as Institutional stakeholders, Food services, Wholesalers & bulk markets, as well as Wholesale & retail to mention but a few. These (domestic) consumer markets stakeholders are the conduit through which consumers purchase processed goods.

Today's consumer demands are more differentiated, dynamic and more complex than ever before (Grunert, 2003). Customers demand better quality products, and expect reduced prices as well as high levels of service (Nguegan & Mafini, 2017). Yet these changes in consumer demand patterns provide the food processing sector with both opportunities and threats (Santos, 2010; Grunert, 2003). However most critically, these changes bring new opportunities for organisations to add value through innovation and product differentiation (Santos, 2010); which can lead to brand equity, higher margins, strong consumer preferences and less price competition to mention but a few (Grunert, 2003). To successfully capitalise on these aforementioned opportunities, certain competencies are required within an organisation's business strategy arsenal; which many organisations in the food processing industry only possess in limited capacity (Grunert, 2003).

The proliferation and pervasive nature of information and communication technologies means that organisations are better able to apply effective techniques to sustain their

business strategies (Noor *et al*, 2013). The food processing sector is facing the issue of demand amplification due to information mismatch; as a result the food supply chain elements remain loosely linked, and they require more transparent and integrated models (Singhal *et al*., 2011). According to Noor *et al* (2013), Nel & Badenhorst-Weiss (2010) and Nguegan & Mafini (2017), supply chain management has a firm connection with operational competencies of organisations' capabilities to deliver on their promise, eliminate costs, design products and execute logistics services; all of which are supply chain elements. One must bear in mind that supply chain flows are triggered by end customer demand for the product, which therefore necessitates organisations to have greater understanding of market requirements (Nel & Badenhorst-Weiss, 2010) in order to ensure that the aforementioned supply chain elements are executed accordingly.

2.3.2 Food processing companies in SA: tackling supply (agricultural) and demand (consumer) challenges.

There is an increase in the value of, and demand for a flexible supply chain that responds swiftly to varying customer demands and unique market requirements (Gunasekaran *et al*., 2008). In order to achieve this flexibility extensive supplier involvement, as well as accurate and timely product demand information are vital so as to link customer information with the manufacturing activities of the organisation (Gunasekaran *et al*., 2008). Within the South African context, food processing companies must respond to both the challenges presented from the supply side (agricultural challenges) as well as those presented from the demand side (consumer demands); yet challenges presented from the former and the latter overlap inexorably. From the supply side, South African agricultural challenges such as food insecurity, smallholder systems and land tenure all result in diminished crop yields, which affects food processing companies utilising those crops for production to satisfy consumer demand (Sikora *et al,* 2020). From the demand side, the ever-changing needs of the South African consumer challenge food processing companies to better align their product offering and quantities (Sikora *et al,* 2020); (Tatoglu *et al*., 2016). From both the supply and demand perspectives accurate and timely information is paramount. It is therefore reasonable to expect that farmers (suppliers) can supply information

relating to possible crop shortages timely so as to afford food processing companies time to effect necessary supply changes; and from the consumer side information on product demand makes for a more responsive and accurate product offering from food processing companies. Effective information flows within and across organisations are thus vital for the managing of supply chains because supply chain management operations cannot be possible without effective information systems management (Tatoglu *et al*., 2016). Hence, ineffective information systems are major impediments to effective supply chain management (Tatoglu *et al*., 2016).

2.4 Supply Chain Information Flow.

The objective of supply chain management is to provide a flow of accurate, reliable, timely and high-quality information that will allow suppliers to provide an uninterrupted and precisely timed flow of materials to customers (Sentia *et al*., 2013). Hull, (2002) asserts that timely and accurate information must flow among the supply chain links in a coordinated fashion as it eliminates distortions. Supply chain information flows are bi-directional (Sweeney, 2006) and the flows of materials as well as finances are usually activated by an associated information flow (Sweeney, 2006). In that sense, information flow serves as the bonding agent between material and financial flow (Sentia *et al*., 2013).

In order to thrive and compete in today's global economy; the manufacturing sector needs to progressively create, share, and assimilate up-to-date and appropriate supply chain information and market-related knowledge (Lotfi *et al*., 2013). The supply chain Information acquired enables companies to make better decisions in their operations as information flow provides resources for decision-making and it consistently keeps all components of the supply chain updated (Sentia *et al*., 2013). This leads to lower supply chain costs and more effective utilisation of resources (Baihaqi & Beaumont, 2006). Ultimately this allows companies to respond swiftly to varying customers' demands (Baihaqi & Beaumont, 2006).

According to Sentia *et al.,* (2013*)* Supply chain value adding activities such as order fulfilment, capacity status, inventory status, product and process design changes and demand are often triggered by information flow. It is worth mentioning that information

sharing can result in supply chain efficiency increase by smoothing production and reducing inventories (Kumar & Pugazhendhi, 2012). This is especially true when the bullwhip effect arises from asymmetric information, which is to say that the information is distorted in supply chain; in this instance each individual organisation will tend to make locally optimal decisions (Sentia *et al*., 2013). Additionally, information sharing among participants in a supply chain results in mutually competitive advantages in cost reduction and customer value improvement (Simatupang & Sridharan, 2001). Therefore, implementing an effective supply chain requires a continuous flow of accurate information (Sentia *et al*., 2013).

2.4.1 Supply chain information flow: agricultural sector & food processing companies.

According to Csoto (2010) the critical role that information plays in the modern world is just as important in agriculture. This is because in order for agriculture to reap the benefits of success the industry needs to gain, process, use, and evaluate a large amount of information on issues such as climate change, markets, new methods etc. “Farmers are working in an information-intensive environment and numerous studies have shown that information and communication technologies (ICT) can play a vital role in realising benefits with more effective information management in the farm level (Csoto, 2010). The Food and Agricultural Organisation of the United Nations (2017) asserts that the adoption and integration of ICT’s improves service delivery, saves resources, reduces information and transaction costs, generates new revenue streams; to mention but a few benefits. Furthermore, downstream nodes in the agro-food system such as agricultural product buyers (food processing companies), retailers and wholesalers (e.g., supermarkets) engage (with each other) in the food supply chain through ICT’s. Within this interconnected realm of the agro-food system technology is utilised to provide information on various aspects of farming to numerous stakeholders who have a vested interest in the operational and regulatory developments in the industry.

2.4.2 Supply Chain Information Flow Risks.

According to Sentia *et al* (2013, p404) “information risk can be defined as the probability of loss arising because of incorrect, incomplete, or illegal access to information.” Within the agro-food system information flows upstream and downstream. When centering the food processing (manufacturing) node in the agro-food system, upstream information flow occurs between the food processing (manufacturing) node and primary production node (agriculture), and downstream information flow occurs between the food processing (manufacturing) node and consumer markets node (Greenberg, 2017). Upstream information flow risks involve incorrect or incomplete access to agricultural information as it pertains to the supply of crops or raw goods to food processing companies. In the Southern African context where challenges faced by smallholder farmers centre around food insecurity as a result of unpredictable weather as one example, a lack of ICT-based tools that provide early warning information on climate related fluctuations means that smallholder farmers cannot provide correct or complete information to food processing companies on crop yields (FAO, 2017). Similarly, downstream information flow risks involve incorrect or incomplete access to consumer demand information as it pertains to the supply of processed consumer goods by food processing companies to consumer markets (through wholesalers, retailers etc.)

2.4.2.1 Supply Chain information flow risks: the bullwhip effect.

‘Under the aforementioned definition, *“the bullwhip effect, that is the distortion and amplification of demand information as it moves up the supply chain, can be categorised as one of the risk factors in information risk”* (Sentia *et al*., 2013, p404).

The bullwhip effect occurs when variations in customer demand causes larger variations in orders placed upstream (Lampret & Potočan, 2014). Aprile & Garavelli, (2007) emphasized that the bullwhip effect leads to supply chain inefficiencies. This describes how a lack of transparency, inaccurate information and a mismatch between production and real time supply chain information results in poor customer service, unrealised profits, high inventory levels and increasing lost sales. The bullwhip effect signifies a lack of synchronisation among the various supply chain participants

(Buchmeister *et al*., 2008). Yet more detrimentally, the bullwhip effect all but guarantees that an organisation does not meet its supply chain goals.

Lampret & Potočan, (2014) listed the causes of the bullwhip effect as the following:

Table 1: Barriers in cooperation/causes of the Bullwhip Effect.

Table 1: Barriers in cooperation/causes of the bullwhip effect

BARRIERS IN COOPERATION	CAUSES OF THE BULLWHIP EFFECT		
Barriers due to different initiatives	Local optimization of functions or partners in the chain	Inconsistent initiative of sales staff	
Barriers in information processing	The demand bases on the orders and not on the actual demand	Denied access to full information	
Operative barriers	Ordering in bundles	Long delivery times	Speculative ordering
Pricing barriers	Quantity discounts tied to the amount of a single order	Short-term pricing promotions	
Organizational barriers	Lack of trust	Bad relations between partners	Lack of learning from mistakes

Sources: Lampret & Potočan, 2014.

Based on the aforementioned, it would seem in an organisation's best interest to eliminate the bullwhip effect. However, a key challenge that organisations face when attempting to eradicate the bullwhip effect is that there are often many reasons for its existence that are frequently unnoticeable (Lampret & Potočan, 2014). For example one of the most important reasons for the increase in variability of orders is that information on the actual final customer demands are no longer available for higher chains (Lampret & Potočan, 2014). According to Sentia *et al., (2013)* there are risk factors in information sharing too which include; price fluctuation, inaccuracies of supplier data, network system and machine problems, shipment and delivery inaccuracies, changes in ordering contracts, inaccuracies in past demand data, uncertainties in product supply from both internal and external stakeholders, late

payments, natural disasters, uncertainties in demand and inaccuracies in demand data. In the depicted figure 2 below Paik & Bagchi (2007) found that delays in both the delivery of materials and the timely sharing of information would be the possible causes of the bullwhip effect. However, reducing delays in the lead time defers the amplification of demand information and operational costs would be significantly reduced. Demand as it pertains to customer requests represents a series of orders that are coming from the downstream of the supply chain; but incomplete information can tempt a higher chain in the supply chain into excessive reaction regarding variations in the amount of orders received.This results in an excessive increase of an order to the next chain in the supply chain (Lampret & Potočan, 2014).

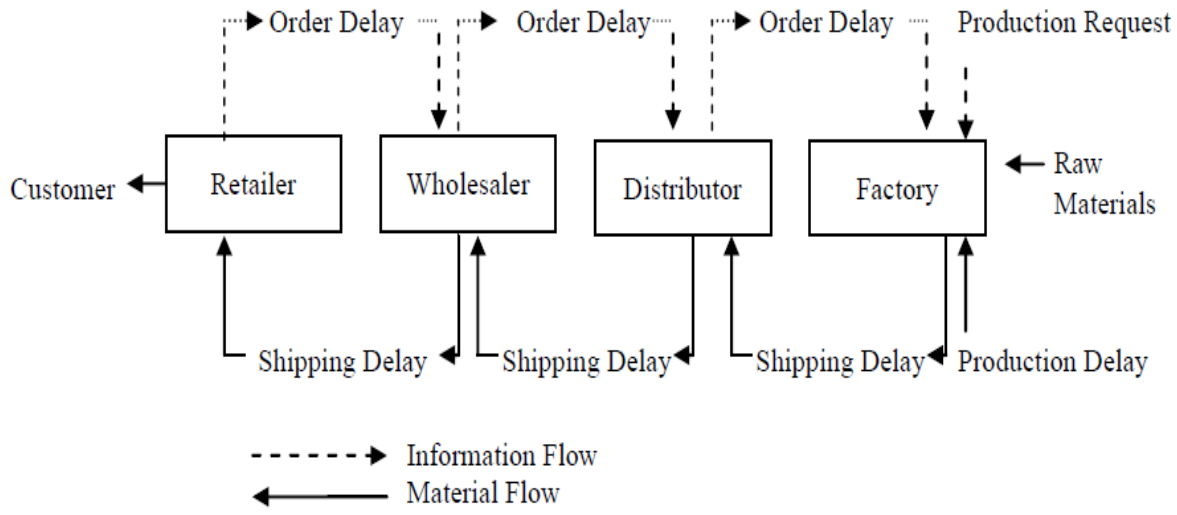


Figure 2: Structure and flows of the beer distribution game [Paik & Bagchi, 2007].

2.4.2.2 Supply Chain Information Flow risks: ICT's in agriculture.

Another factor in information flow risk is the lack of rapid adoption of ICT's amongst farmers, particularly smallholder farmers. According to Csoto (2010) despite the demonstrable benefits of ICT diffusion in the agricultural sector; which include but not limited to timelier and more comprehensive information, accessing new types of information, and easy exchange of information, "ICT take-up in agriculture remains low." The visible profit is possibly the biggest hindrance or promoter of ICT uptake in the agricultural sector as well as the weighing up of realisable benefits in relation to resources required in achieving those benefits. Given the already mentioned

strenuous challenges faced by smallholder farmers in South(ern) Africa as far as unequitable access to basic resources such as water and land tenure related resources; accessing ICT resources for smallholder farmers is yet one more challenge added onto an already constraining list of challenges. Despite this however, sizeable swathes of the agricultural sector do indeed operate with ICT assisted tools. A potential source of problem with agricultural IT management systems currently being utilised is interoperability, which is the 'transferring of information between systems," wherein in the agricultural sector there is a lack thereof (Csoto, 2010)." Thus, given that ICT tools in the agricultural sector either have selective uptake, or lack of interoperability within existing IT systems, information flow between agricultural sector and the food processing (manufacturing) industry may encounter incorrect and or incomplete information, thereby increasing the probability of loss for the latter.

2.5 Supply Chain Risk Management.

According to Ferry *&* Poindexter (2016) the interconnectedness that communication technologies have resulted in is at once advantageous and threat-exposing; however, the latter can be mitigated by means of Supply Chain Risk Management. "Supply Chain Risk Management (SCRM) is a systematic process for managing supply chain risk by identifying susceptibilities, vulnerabilities and threats throughout the supply chain and developing mitigating strategies to combat those threats, whether presented by the supplier, the product and its sub-components or the supply chain" (Ferry *&* Poindexter 2016, p 20). Senna *et al* (2020) reasons that the concept of Supply Chain Risk Management is applied across various disciplines and sectors; such as the food industry, electronics industry and healthcare industry to mention but a few. However, despite this SCRM essentially has four component parts: identification (critical components & functions, supply chain threats, vulnerabilities & risks), assessment (of susceptibility to risks/threats etc. and impact of those risks), mitigation (strategy development in response) (Ferry *&* Poindexter 2016), while the fourth component part Ferry *&* Poindexter (2016) contends is the continual assessment of supply chain threats and risks at each life cycle stage.

2.5.1 Risk management: mitigation for specific threats with policy, procedure and compliance.

According to Kaplan & Mikes (2012, p1) although many resources have been funnelled into understanding and implementing risk management by organisations, there is an apparent trend in which risk management is handled as a compliance issue which can be addressed by "drawing up lots of rules and making sure that all employees follow them." Rules in and of themselves are not a bad thing of course, indeed they do go some ways in mitigating potentially harmful risks; however, the nature of the risk calls for specific risk management approach. To this end, first and foremost an organisation must understand the qualitative differences in the various kinds of risks it faces when establishing an effective risk management system.

In accordance with the aforementioned proposition Kaplan & Mikes (2012) suggests three categories of the types of risks that organisations could face. Category 1 are Preventable risks; these are risks that emanate internally or from within the organisation. These risks can be controlled and should be 'eliminated or avoided'. An example of this category of risk would be the "risks from employees' and managers' unauthorized, illegal, unethical, incorrect, or inappropriate actions and the risks from breakdowns in routine operational processes (Kaplan & Mikes 2012, p 2). Monitoring operational processes and steering employee behaviour towards compliance is the best way to manage this risk category. Category 2 are Strategy risks; these are risks that an organisation willingly takes on as a result of the industry or sector the organisation operates in. This type of risk is linked with the level of returns the organisation stands to reap, in that the higher the assumed risk the higher the returns. The best way to manage this kind of risk is by implementing a probability reduction risk management system, that reduces the probability of the assumed risk from occurring. Category 3 are External risks; which are those risks that are beyond an organisation's control given that they stem from the external environment, such as natural disasters. Since prevention of this category of risk is unlikely, risk impact identification and mitigation is the most suitable risk management strategy for this category.

2.5.2 Management of supply chain Information flow risk.

Supply chain risk management is not only about identifying and mitigating against risks linked to natural disasters and other huge events. The various risks associated with supply chain risk management include changes in information technology system, rapid growth, demand and supply fluctuations, contaminated and counterfeit products as well as changes to supplier base (Sentia *et al*., 2013). Information risk can be perceived as a contributing factor to supply chain risks (Sentia *et al*., 2013). “Information risk management is the management of information risks in the supply chain through coordination or collaboration among the supply chain partners so as to ensure profitability and continuity’’ (Faisal *et al*., 2007, p4). ‘’There is a collection of processes that collectively ensure that information risks are adequately reduced to an acceptable level’’ (Sentia *et al*., 2013, p406).

Faisal *et al*., (2007) developed a model, (figure 3) for information risk mitigation in a supply chain. The model depicts twelve interacting variables based on their driving and dependence power towards information risk mitigation.

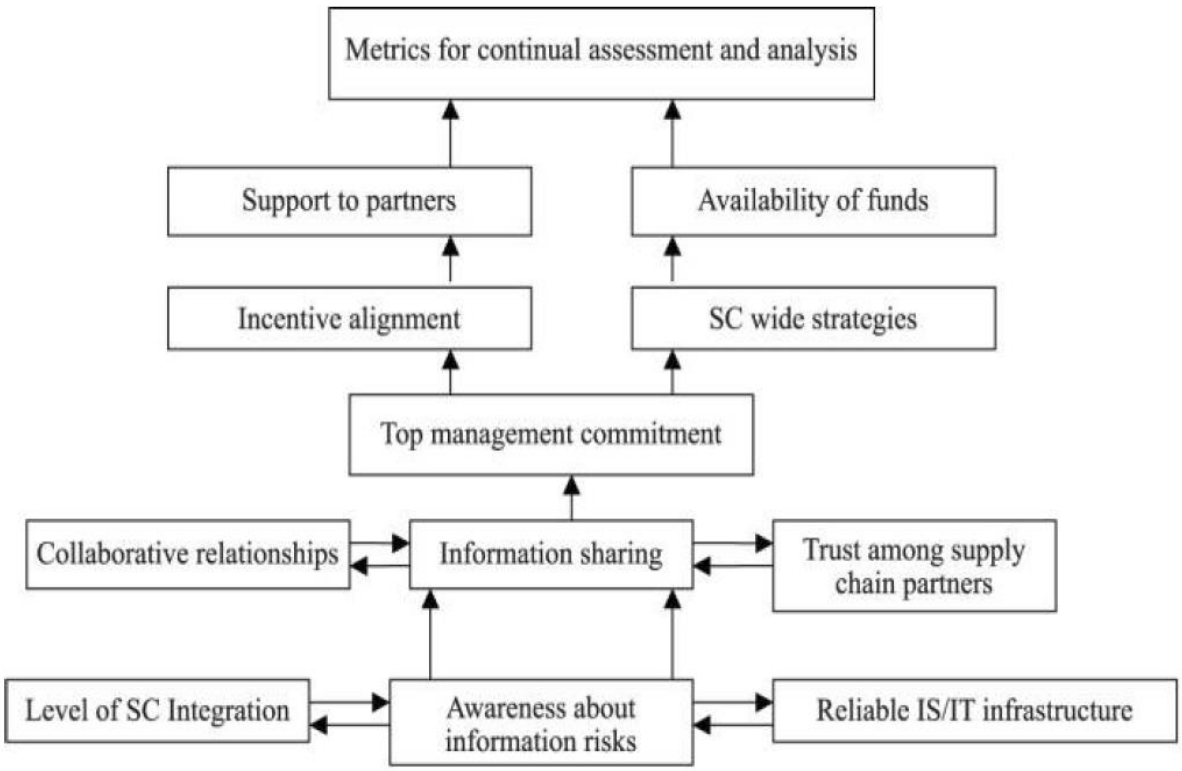


Figure 3: Interpretive Structural Modelling (ISM) based model for information risk mitigation in a supply chain [Faisal et al., 2007].

As illustrated in Figure 3, the four component parts of Supply Chain Risk Management are at play as they systematically connect through top management in order to mitigate information risk in the supply chain. The Identification component comes in the form of awareness about information flow risks, an awareness facilitated by reliable IT infrastructure and an integrated supply chain. The Assessment component as to where information risks may lie is enabled through information sharing. According to Simatupang & Sridharan, (2004) information sharing aims to disseminate and capture timely and relevant information that allows decision makers to plan and control supply chain operations. Therefore, effective information sharing enables information risk mitigation (Faisal *et al*., 2007). Furthermore, the transparency of the information being shared guarantees enhanced mutual trust and commitment to the delivery of services to service providers and consumers in a supply chain (Hua & Notland, 2016; Akkermans *et al*., 2004). However, sharing of information requires trust among supply chain partners and collaborative relationships. This is echoed by Faisal *et al*. (2007) that mitigation of information risks requires mutual efforts from partners in a supply chain. In order to reduce information risks in a supply chain, mutual trust in long-term relationships and the confidentiality of information among supply chain participants are essential (Faisal *et al*., 2007). Once assessment of risk susceptibility has been established, mitigation (third component part) by means of strategy development and implementation (across the supply chain) is enabled by top management's commitment to the process. Finally, continual assessment and analysing of information risks is the component part completes the information risk mitigation process.

2.5.3 Managerial risk perception and decision making.

It is supply chain employees who are responsible for understanding and processing risk levels/factors and for making and taking actions on recommendations (Duhadway *et al*, 2018). They can be caught off guard but are the ones who must respond to supply chain disruptions (Duhadway *et al*, 2018). Supply chain managers also face short term financial incentives to underestimate risks, which can lead to greater costs over the long run (Duhadway *et al*, 2018). Managers strive to find ways to understand how different internal and external factors influence risk, how to judge and interpret

the available evidence on the possibility of loss, and how to take individual actions to manage risks (Tse *et al*, 2018).

As emphasized by Sunjka & Emwanu (2015) and Faisal *et al*. (2007), through skills, knowledge, experience and daily activities, managers are able to identify, scan, and assimilate information from the external supply chain environment as well as the company's internal environment to make sensible decisions. This information is translated by the personal characteristics of managers – the way in which managers view phenomena influences the information received and applied – into risk management practices (Sunjka & Emwanu, 2015). Tse *et al*, (2018) pointed out that individual perceptions of risk often influence risk related supply chain management decisions, yet it is human nature to react more strongly to signals they can observe than to the environment.

Duhadway *et al*, (2018) emphasised that organisational communication regarding risk often influences decisions made by supply chain managers who compensate for changes in organisational risk. While decision makers compensate in response to communicated risk, their perceived overall levels of risk having done so are positively related to levels of communicated risk. In other words, as communicated risk increases or decreases, the effect of such communication might persist, even after adjusting decisions to accommodate different levels (Duhadway *et al*, 2018).

A number of risk management frameworks (e.g., SCRM Framework) have been proposed and employed in different areas. These frameworks lay the foundation and groundwork for managers to collect available data to analyse risk. Such frameworks enable managers to gather knowledge intellectually, to properly judge their experience and to assess the current situation, so as to enter into the most appropriate decisions (Tse *et al*, 2018).

Above all there are various qualities that management requires in order to ensure effective supply chain risk management, but the most pivotal among all is commitment to the process, for this ensures all other qualities can be carried out (Faisal *et al* 2007). Without commitment collaborative relationships amongst the supply chain stakeholders are not assured and thus reliable information is not guaranteed. Without commitment, decision-making is rendered ineffectual, for what effective decisions can

be carried out with unreliable information? Without commitment, management cannot offer the requisite support to supply chain stakeholders, as and when it is required.

2.5.4 Top management commitment and support.

As echoed by Wong *et al*, (2012) SCM requires managerial commitment to achieve customer responsiveness and collaboration breakthrough. To achieve the highest level of supply chain success, top management support, broad-based functional support, channel support, and infrastructure/governance support are essential (Wong *et al*, 2012). As a means to align supply chain strategy and business processes, it is crucial for top management to offer requisite support to internal communication department by constantly being available, serving as a communication model, and expecting other managers in the organisation to emulate and develop into strong communicators (Wong *et al*, 2012) Alignment often entails two-way communication between management and employees (Wong *et al*, 2012). That being so, top management must listen to employees because leaders who listen are more likely to enable change (Wong *et al*, 2012).

Top management support can also be demonstrated through participation in employees' daily operations and decision-making processes (Wong *et al*, 2012). Management participation comprises two dimensions – involvement and influence (Wong *et al*, 2012). Goal setting, environment scanning, evaluation of the internal capabilities, generation of strategic alternative, strategic selection and supply chain activities are areas where organisations are often looking for senior management involvement and thus has a strong positive influence on the success of internal and external alignment (Wong *et al*, 2012). As managerial influence is critical for aligning conflicting objectives and interests, functional support could be demonstrated by involving middle management in the planning process (Wong *et al*, 2012). As a consequence, management may show visible support and involvement by taking part in important supply chain decision-making activities (Wong *et al*, 2012).

The most obvious way to show management support is by giving resources and funding to collaborative efforts, which demonstrates total commitment from top

management (Wong *et al*, 2012). Recognizing the significance of SCM is another aspect of top management support because a company that does not discuss supply chain issues in the boardroom will be more internally focused and less customer focused (Wong *et al*, 2012). Customer alignment requires top management commitment, urgency, ambition, and embracement of SCM (Wong *et al*, 2012). Understanding the supply chain will enable you to decide what is necessary to achieve shareholder and customer alignment (Wong *et al*, 2012).

2.5.5 Supply Chain information flow risk mitigation tools:

The appropriate tools are essential in the process of information risk management within the supply chain. More than merely tools, the following ensure that threats to information flow in the supply chain are timely mitigated or eradicated altogether.

2.5.5.1 IT infrastructure.

A reliable IT infrastructure eliminates many information risks in the supply chain. One of the information risks that can be mitigated for example is system breakdown, another is inadequate IT systems such as is the case in the agricultural sector where IT uptake is slow at best or non-existent at worst (Csoto, 2010).. However, establishing a reliable IT infrastructure in the supply chain becomes impossible without the necessary funds, so under these circumstances the role of top management becomes increasingly important (Faisal *et al*., 2007). There are two important constructs in IT infrastructure (Wu & Angelis, 2007). The first one is consistency of data; which should facilitate process integration comprising information flow by identifying key organisations to achieve information sharing. The other construct is cross-functional application integration; which supports the management of supply chain related processes and fulfils the ability to interface with supply chain applications among participants in real-time (Wu & Angelis, 2007). Information Technology is a very powerful tool which can combine the two elements of big data analytics and machine learning together. These two elements – data analytics and machine learning – are able to uncover alarming information about the business which could contribute to supply chain risk (TechTarget, 2017).

2.5.5.2 Process Automation: Expanding Possibilities.

Over the last few decades, new technologies that exist to meet an organisation's needs have been gaining ground globally and by extension in South African food processing companies. However, many organisations seem slow in adapting to and become more compatible with these new tools in terms of their applications and effects (Jain, 2019). Although modern technologies have allowed organisations the ability to process and analyse large amount of data; leaders across an organisation's departments – given that all information in the organisation must be aligned with the supply chain information flow, need to acknowledge the exponential growth of these technological resources (Jain, 2019), and then build their organisations' ability to harness more data than ever before. Indeed, Rozados & Tjahjono (2014) emphasise that supply chains generate large amount of data at every stage along the process, which they rely on. Therefore, they are inexorably bound to benefit from Artificial Intelligence (AI) and Robotics Automation. Furthermore, Robotics Automation has the potential to release human beings from strenuous and extremely time-consuming data processes, reduce variability, and improve quality control by eliminating errors (Jain, 2019).

Since Robotic Process Automation (RPA) has only just recently begun to emerge in supply chain operations, many organisations are embarking on the journey towards including robotics automations in their supply chains, in order to make the organisations more efficient and leaner (Jain, 2019). RPA enables organisations to seamlessly configure software robots to automate routine and repetitive task across applications and systems that human beings were previously required to perform. In an organisation, RPA could be placed alongside existing IT architecture without the need for complex systems integration (Jain, 2019).

The diagram below (Fig.4) by Jain (2019), depicts over 100 people who are involved in linking the creation and reviewing of plans, and implementing changes to the plans where risks have been identified in the supply chain. Without their involvement, problems arise, which can have enormous consequences on the organisation itself as well as other stakeholders across the supply chain. It is apparent that robotics is a gateway to making the aforementioned process better in the sense that it creates end-to- end visibility, control and automation throughout all supply chain processes such

as demand management, customer relations management, among others. This results in the elimination of errors associated with human intervention, more timely and accurate information, and increased trust between different stages of the supply chains.

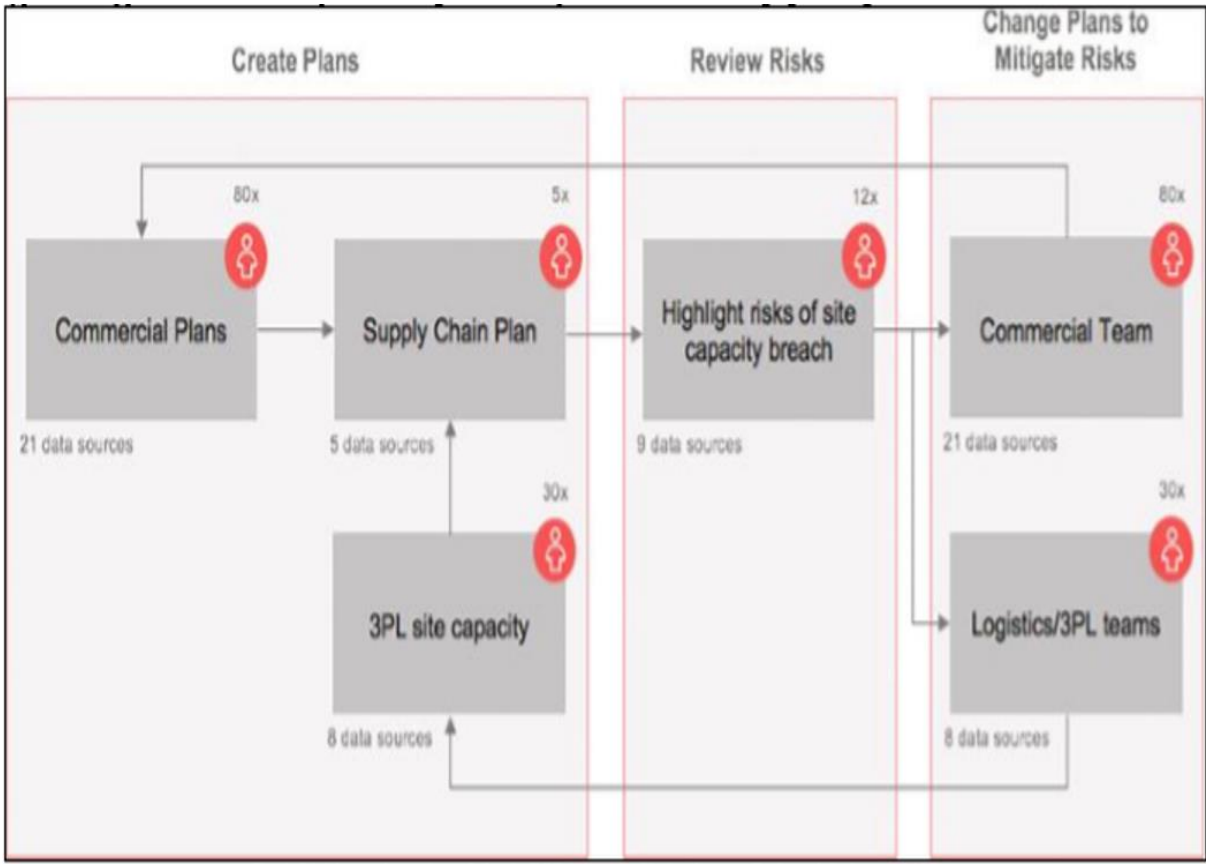


Figure 4: Linking and creation of plan in RRPA Supply Chain [Jain, 2019].

2.5.5.3 Collaborative relationships.

Collaborative relationships are critical in that they allow supply chain partners to mutually gain a rigorous understanding of future demand, set realistic plans to fulfil that demand and coordinate activities to do so in the most effective way (Smith *et al*., 2007). Faisal *et al*., (2007) found that support given to partners in collaborative relationships is facilitated by incentive alignment, this refers to the extent that supply chain partners equally share benefits, risks and costs. Advances in IT have made integrating of supply chain information flow feasible, placing IT as a key driver of supply chain collaboration (Smith *et al*., 2007). Once the information – consumer related

information from the demand side and supplier related information from the production side – within a supply chain has been mapped and diagrammed, the information can then be individually analysed and improved (Chibba & Rundquist, 2004). Information flow circuits which contribute to the bullwhip effect can also be identified and metrics developed for each of the circuits (Chibba & Rundquist, 2004). Therefore, issues such as uncertainties in demand or inaccuracies in demand data for example would be improved.

Sentia *et al*., (2013) developed a supply chain information flow risk management model based on a make-to-order production system. The model illustrates the mitigation activities, categories of information sharing, and the information risk factors. The model focusses on the three fundamental supply chain processes which are; source, make, and deliver; and it also captures the information risk issues (Sentia *et al*., 2013).

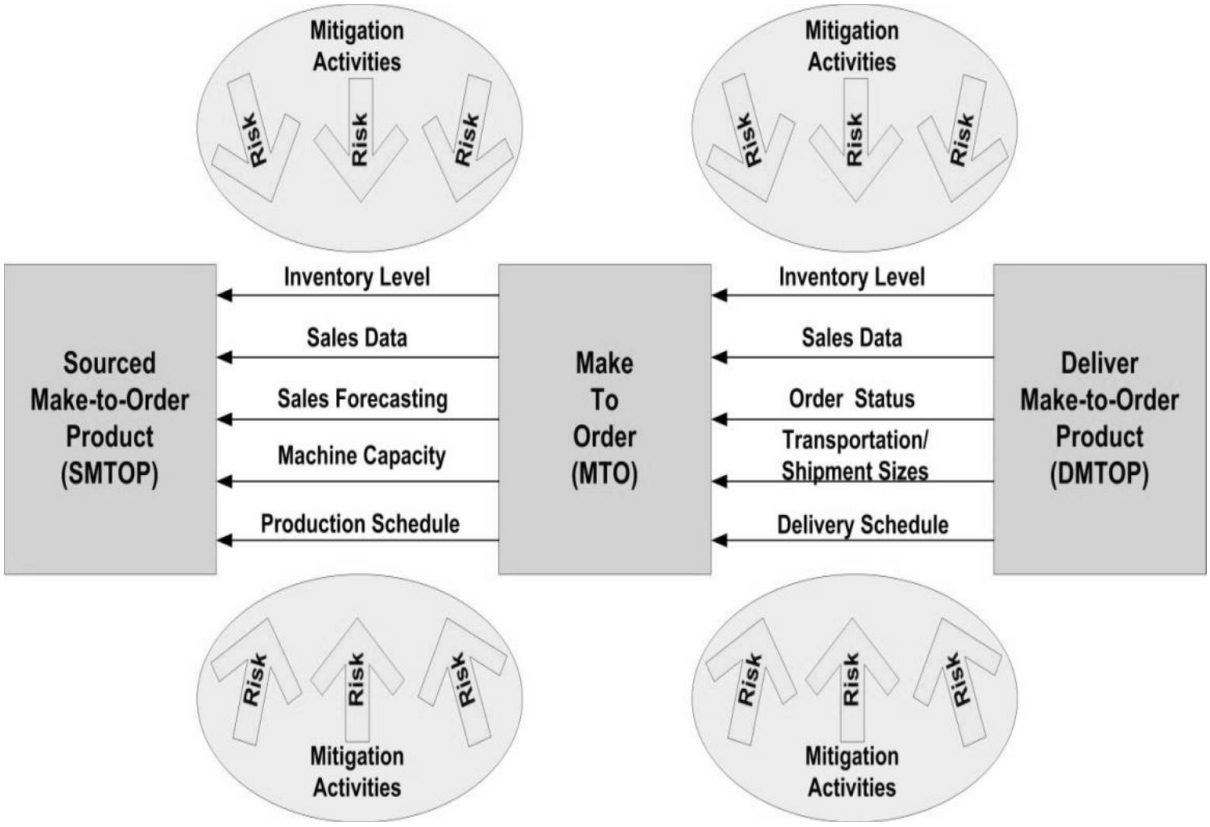
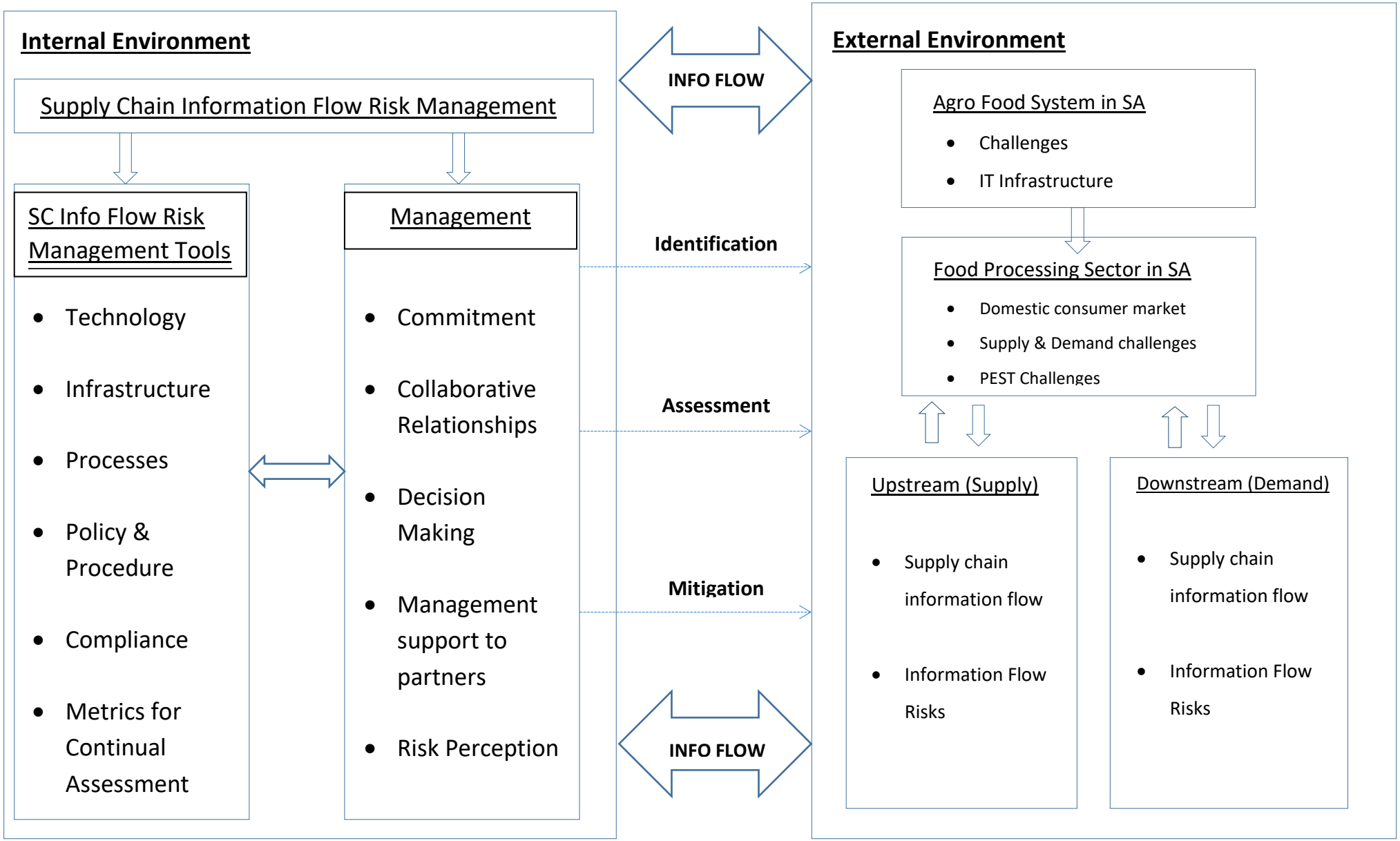


Figure 5: Supply Chain Information Risk Management Model in Make-to-Order [Sentia et al., 2013:406].

From the model given in figure 5, information is shared from Deliver-Make-to-Order Product (DMTOP), to Make-to-Order (MTO); and also from Make-to-Order (MTO) to Source Make-to-Order Product (SMTOP) (Sentia *et al*., 2013). Additional details are provided in Appendix 1 and Appendix 2.

2.6 Preliminary Conceptual Framework.

Having reviewed the literature, a conceptual framework for this study is proposed in figure 6 below. This conceptual framework was used as a guide to realise the purpose of this study. A conceptual framework is a setup of interlinked concepts that together provide a comprehensive understanding of a study phenomenon (Jabareen, 2009). According to Imenda (2014), a conceptual framework is used to synthesize existing views from the literature for a given situation, and it can emanate from both theoretical and empirical findings.



SC is Supply Chain; Info is Information

Figure 6: Preliminary Conceptual Framework Adapted from the Literature Review.

Drawing from the preceding literature review, this preliminary conceptual framework clearly draws a distinction between the external and internal environments in the supply chain as they pertain to the information flow, the attendant risks associated therein, as well as the resultant management of said risks. Indeed, Kaplan *et al* (2012) states that there are three categories within which risk can occur in the organisational context, namely; Preventable risks (internal), Strategy risks (internal), and external risks. These three categories of risk manifest themselves either in the internal or external realm of the organisation.

The external environment of the supply chain, as illustrated in the preliminary conceptual framework drawing (figure 6), is organised such that each respective system within the supply chain (external stakeholders/partners) is related to the preceding system. While the system represented by the 'Food Processing Sector in SA' graphic in the conceptual framework drawing is the supply chain context upon which this study is based, it is indeed connected to the preceding system represented by the 'Agro Food System in SA' graphic. As Greenberg (2017) asserts that the information flow risks in the supply chain of the South African food processing sector cannot be separated from the challenges within the broader South African agro-food system. So it is that the agricultural challenges that present themselves in the Southern African region, such as lack of access to resources by smallholder farms and climate unpredictability, can impact on supply of raw goods to the food processing companies in South Africa (FAO *et al*, 2018).

In the preliminary conceptual framework drawing, it is demonstrated that the food processing sector in South Africa – as it pertains to the servicing of the domestic consumer market – encounters supply (agricultural) and demand (consumer channels i.e. retailers, wholesalers etc.) challenges. This is noted by Mercer, (2011) and Nguegan & Mafini (2017), that some of the factors that contribute to the challenges faced by the food processing sector in South Africa include; information flow due to incompatibility of technological systems and technology development due to lack of investment in technology, market access in terms of inability to penetrate the market; to mention but a few. The former relates largely to upstream or the supply side (lack of technological uptake in smallholder farms) and the latter relates to downstream or the demand side. From the supply side, information flow between suppliers (agricultural entities/ primary production) and food processing companies is a two- way phenomenon, and technology aides this transaction. Tatoglu *et al*. (2016) argues that information systems are essential for effective information flows across organisations (supply chain stakeholders), so as to manage

supply chains. Thus, technological challenges in the agricultural sector create information flow risks in the supply chain of food processing companies in SA. From the demand side, Singhal *et al*. (2011) posits that the demand amplification that the food processing sector is facing is due to information mismatch. This too represents information flow risk within the supply chain of food processing companies in South Africa.

The internal environment, as depicted in the preliminary conceptual framework, represents the internal supply chain system of an organisation that belongs to the food processing industry. It is within the internal environment that information flow must be well managed in the supply chain. This is emphasised by Sentia *et al.* (2013) in outlining that the aim of supply chain management is to provide, "a flow of accurate, reliable, timely and high-quality information…" The information flow is two-way, moving between the internal and external environments. As such the information flow risks emerge and present themselves both internally (inside the organisation) and externally (external organisational stakeholders). The risk management of the information flow in the food processing industry thus necessitates interventions that mitigate Category 1: Preventable Risks (organisational or internal risks) and Category 3: External Risks as established by (Kaplan *et al,* 2012). The management of supply chain information flow risks is done from the internal environment side and follows a four-step process; despite the conceptual framework drawing depicting three arrows to represent the first three steps, the fourth step (continuous assessment) is not depicted as it technically creates an on-going application of the first three steps. The first component in the SCRM process being identification of information flow risks, the second component being assessment of the identified risk and the third component being mitigation of information flow risks.

The management of information flow in the supply chain along with its attendant risks both internally and externally requires two aspects; the active involvement and stewardship of the organisation's top management (Faisal *et al.* 2007) as well as tools that enables the management of SC information flow risks. Of all the attributes that set the good management apart; commitment may be the most important (Faisal *et al* 2007). Without commitment the vision needed for the success of the supply chain may not emerge. Only the committed management can dedicate resources and realign rewards and measures that are needed to make supply chain risk management an organisation wide priority. The supply chain management's risk perception is cultivated and maintained by the three components in the SCRM process; identification, mitigation and assessment; as seen in the conceptual framework drawing. Managers use their skills, knowledge and experience

to scan and assimilate information from both the internal environment and external environment to identify any potential risk factors that can affect the business in any way and for sensible decision making (Sunjka & Emwanu, 2015) and (Faisal *et al*, 2007).

The aforementioned management qualities work in tandem with the supply chain information flow risk management tools, as depicted in the preliminary conceptual drawing. Fundamental among the tools is IT infrastructure, as Csoto, (2010) points out that a reliable IT infrastructure eliminates many information risks in the supply chain. This is true for internal IT systems as well as IT systems in the external environment where system compatibility and reliability are paramount for information flow in the supply chain. But given that supply chains produce massive sums of data at every stage in the supply chain process, organisations can benefit from the automating of supply chain processes by way of Artificial Intelligence (AI) and Robotics Automation (Rozados & Tjahjono 2014). Policies and Procedures are essential in ensuring compliance amongst internal staff, with the view of managing supply chain information flow risks. Indeed, Kaplan *et al.* (2012) argues that having a set of rules in place in the organisation contributes to the mitigation of potentially harmful risks; given that the specific risk encountered calls for setting up of policies to be complied with. Metrics for continual assessment and analysis ensure that risk management practises are continuously applying the three SCRM processes of identification, assessment/analysis and mitigation (response, monitoring and controlling) of risks (Pimchangthong & Boonjing, 2017) and applying the fourth component being the cyclical process.

Chapter 3: Research Methodology and design.

3.1 Introduction.

According to Ahmed *et al* (2016) methodology is defined in many ways by various authors; however, there are three common factors to be found in many definitions of methodology; the first is how the research process is approached, the second is theoretical assumptions upon which research is based, and lastly the methods or tools to be utilised. As such, "methodology thus refers to the interrelationship that exists between theory, method, data and the phenomena under investigation" (Ahmed *et al* 2016). The theory for this research study has already been established in the literature review, and the phenomena under investigation have been coalesced into the research objectives. Therefore, the methods to be used in this research study must satisfy the aforementioned research objectives, given the theoretical foundation laid out in the literature review.

3.2 Research methodology steps.

This research study is concerned with uncovering the risk management strategies utilised by food processing companies in South Africa in managing supply chain information flow risks. To this end, the research objectives examine and analyse the contributing factors from the external environment (supply and demand stakeholders) as well as how management of supply chain information flow risks through top management stewardship, impacts food processing companies. So, the study centres on management of information flow risk, which is inherently a subjective process. Vasvari (2015) echoes this when he states that the relationship that individuals (and by extension organisations) have with risk is influenced by various subjective aspects, not least of which the risk perceptions held by those assessing risk. Indeed, this study, through the conceptual framework, has outlined that risk identification, assessment, and mitigation are all within the purview of top management in food processing companies in South Africa. It is within this subjective milieu that the researcher of this study pursues his inquiry. The researcher will attempt to interpret the meaning brought by respondents in the natural setting of the phenomena being studied, so as to fulfil the research objectives (Creswell, 2014).

3.3 Qualitative Research.

A qualitative research approach was adopted to carry out this study. This approach is appropriate to fulfil the research objectives because according to Creswell (2016) “Qualitative research is a situated activity that locates the observer (researcher) in the world. It consists of a set of interpretative, material practises that make the world visible.” It is the (interpretive) experiences of management in food processing companies as it pertains to supply chain information flow risk that must be made visible. Kumar, (2014) states that a qualitative research approach seeks to describe the perceptions and experiences of the participants rather than quantify or measure those perceptions and experiences.

3.3.1 Qualitative research design.

This study utilised qualitative research design. According to Bellamy *et al*, (2016, p671) qualitative research draws on the strengths of one or more qualitative approaches. The aim is to draw out participants’ ideas about things that are ‘outside themselves; rather than focussing on their inner feelings the research seeks to understand a phenomenon, a process, or the perspectives of participants. Sampling is designed to obtain a broad range of opinions about events and experiences and data collection includes interviews, questionnaires or surveys; thematic analysis is often used to analyse data.” This research design is well suited for this study because the phenomena being researched requires the perspectives of participants (supply chain managers in food processing companies) so as to know the risk management strategies employed by Food Processing Companies in South Africa in order to manage risks in supply chain information flow. Furthermore, through interviewing participants (supply chain managers in food processing companies) that the extent to which agricultural challenges in South Africa contribute to information flow risk in the supply chain of food processing companies in SA can be established, the ways in which the diverse distribution landscape of ‘corporate’ and ‘traditional’ wholesalers/retailers impact on information flow can be analysed, and the impact of risk management on the supply chain information flow of food processing companies in South Africa can be determined.

3.4 Creating a template for analysis.

As mentioned above, this research study has already established key objectives to be fulfilled in order to answer the research question posed. The literature review undertaken in this

research study has so far revealed interconnectedness among various elements fundamental to food processing companies in South Africa and information flow risk management within their supply chains. The preliminary conceptual framework systematically lays out the interlinked relationships various concepts have with one another, and it is these concepts and their relationship to one another that must be considered in order to meet the objectives of the research study. Given an already existing preliminary conceptual framework; a-priori themes will be established prior to data collection and analysis, thus creating a template for collecting data from participants and subsequent analysing of the data collected. According to Brooks *et al.* (2015, p203) "template analysis allows the researcher to define some themes in advance of the analysis process, referred to as 'a priori' themes. This is usually because a research project has started with the assumption that certain aspects of the phenomena under investigation should be focused on."

3.4.1 A priori themes.

It bears mentioning that the preliminary a priori themes identified for this study at this stage of the research project are as stated only preliminary. As Brooks *et al* (2015) reminds us that it is vital to acknowledge that a priori themes ought to always be viewed as tentative. Brooks *et al* (2015, p203) continues to assert that, "a priori themes are as equally subject to redefinition or removal as any other theme, should they prove ineffective in characterising the data."

There are four preliminaries a priori themes that are identified for this research study. The four themes are drawn from the preliminary conceptual framework, which schematically represents the interconnected relationship that exists between various elements as they pertain to the food processing industry in South Africa. The attendant information flow risks between, relevant stakeholders; and the management of the said information flow risks within the supply chain. It is worth noting that the four preliminary themes serve as a template in the pursuit of realising the research study's objectives, which is to say that the following a priori themes have been selected specifically with the aim of addressing and meeting the research objectives set out. More on this specific a priori themes is given below.

1) Supply partners and information flow risks.

The theme of supply partners emerges when assessing the external environment of a food processing company's supply chain. As demonstrated in the preliminary conceptual

framework the supply partners are those from whom food processing companies receive the requisite raw material to produce the consumer goods sold to consumers. So, the supply partners within the context of food processing companies involve the agricultural industry in all its various manifestations, i.e. small holder farms, commercial farms etc. As has been established in the literature review and indicated in the preliminary conceptual framework, the agricultural industry in South Africa encounters various challenges, which include but are not limited to IT infrastructure that is either incompatible with that of food processing companies' supply chain or lack of suitable IT systems to mention but a few problems (Nguegan & Mafini, 2017). But what might these challenges (IT infrastructure and indeed other agricultural industry related challenges) look like specifically when observed through the experience of food processing companies in South Africa? What might be the information flow risks that arise due to these challenges, if any? So, within this theme there arise theory and interview questions regarding the impact of supply partners' challenges on the supply chain information flow of food processing companies in South Africa. This theme will help address the first objective, but it is only in the results and discussion that it will it be clear whether the theme has been adequately addressed.

2) Demand partners and information flow risk.

Similar to the theme of 'supply partners'', the demand partners theme is drawn from the supply chain of the food processing industry's external environment. However, this theme is concerned with the relationship between the food processing company's supply chain and consumers (from the wholesalers and retailers all the way down to the final consumer of a food processing company's products) and how information flow risks may arise here. According to Singhal *et al*. (2011) some of the problems that are encountered in the supply chain, such as demand amplification, are due to information mismatch. Yet, what is the cause of this information mismatch within the supply chain of food processing companies in South Africa, if they even exist at all? Do the experiences of managers in the supply chain in food processing companies involve information flow risks as they relate to their various demand partners, be it retailers or wholesalers? If so, what is the impact that retailers and wholesalers have on the supply chain information flow in food processing companies? Within this theme there arise theory and interview questions regarding the impact of demand partners' challenges on the supply chain information flow of food processing companies in South Africa. This theme will help address the second objective, but it is only in the results and discussion that it will it be clear whether the theme has been adequately addressed.

3) Information flow risk and management in the supply chain.

The questions that arise regarding the stakeholders in the external environment (supply and demand partners) of the supply chain in food processing companies in South Africa can most adequately be addressed by the top management in the aforementioned supply chain. As established in the literature review and indicated in the preliminary conceptual framework the internal environment – and more specifically management within this environment – is the place where supply chain information flow risk is managed. Since information flow is a two-way process, with information being disseminated (or lack thereof in some instances) between the external and internal environments, ensuring that this information is accurate and reliable is the responsibility of the supply chain management (Sentia *et al.* 2013). In this instance that supply chain management would be that of food processing companies in South Africa. This theme brings to the fore (for scrutiny)) a host of pertinent elements as they pertain to the qualities required of the supply chain management in managing information flow risk. Still more salient is the matter of how supply chain management in South African food processing companies manage information flow risk, and whether this risk management is externally or internally (or both) focused. Within this theme there arise theory and interview questions regarding the impact of risk management challenges on the supply chain information flow of food processing companies in South Africa. This theme will help address the third objective, but it is only in the results and discussion that it will it be clear whether the theme has been adequately addressed.

4) Information flow risk management tools.

This theme is closely linked to the “management in the supply chain” theme, because as is illustrated in the preliminary conceptual framework one is tied to the other. The question of how information flow risks are managed in the supply chain of food processing companies in South Africa can be addressed here. The various ‘tools’ listed in the conceptual framework all have their own background story, and indeed it is necessary to understand what the experience of supply chain management is regarding not just these, but other risk management tools utilised in aid of managing information flow risk in the supply chain. Within this theme there arise theory and interview questions regarding the impact of risk management tools challenges on the supply chain information flow of food processing companies in South Africa. This theme helps address the third, fourth and fifth objectives.

3.5 Sampling.

Sampling is defined as the process of choosing specific data sources where data is collected with the purpose of addressing the objectives of the study (Gentles *et al*, 2015).

The target participants for this study were supply chain professionals from various large food processing companies based in Gauteng. From the aforementioned ten food categories in the literature review; a minimum of one semi-structured interview was conducted with each participant regardless of whether the participants represented one or several food categories in their respective companies. This took into consideration information in the literature review which indicates that the level of concentration by food sector underestimates the extent of concentration, such that one company can be involved across several food groups (The South African Food Processing Industry, 2011). Gauteng was chosen over other provinces in the country as it is the economic hub of South Africa, accounting for over 34.8% of the Gross Domestic Product (GDP) of South Africa (South African Government, 2018; Nguegan, 2017). Indeed, various Food Processing Companies are based in Gauteng, and an internet search was utilised to identify the Food Processing Companies available around the region (Nguegan, 2017).

The participants were selected based on the Homogenous Sampling Method. This method focuses on participants who share similar characteristics or qualities, and the extent to which those similarities relate to the research topic (Etikan *et al*., 2016). Only qualified and experienced supply chain executives were interviewed. Since these executives share similar characteristics (skills and experience) they are best positioned to serve the objectives of this study. Participants considered were those that held either a professional or formal qualification in any supply chain related field, and had garnered a minimum of two years' work experience in a supply chain environment. These were the key and necessary requirements prior to a participant signing a consent form.

These requirements were to ensure that the highest quality information was obtained during the interviews. The sample size for this study was determined by following the concept of data saturation. Data saturation point is reached when the collection of new data does not reveal new information. That is the point where the researcher discontinues new data collection, the research objectives have been achieved, and a sample size is thus determined (Creswell, 2014).

3.6 Data Collection and Analysis Procedures.

3.6.1 Researcher as the key implementer of the instrument.

Data were collected independently by the researcher through conducting interviews with participants without relying on instruments or questionnaires formulated by other researchers (Creswell, 2014).

3.6.2 Semi-structured interviews.

For data collection, both telephonic and face to face semi-structured interviews were conducted; transcripts and interview recordings were stored in Google Cloud. Alsaawi, (2014) notes that a semi-structured interview promotes the extraction of rich in-depth information. Furthermore, semi-structured interviews allow the interviewer (researcher) to modify the pre-set questions, and the interviewee (participant) is able to elaborate further since questions are open-ended (Alsaawi, 2014).

3.6.3 Design of Interview Questions.

Questionnaires were developed such that they related to the objectives of the study and/or issue being researched. To this end, the CRQ-TQ-IQ pyramid model was used to develop interview questions (Wengraf, 2001). Where CRQ stands for Critical Research Question, TQ stands for Theory Questions, and IQ stands for Interview Questions (Wengraf, 2001). “In the CRQ-TQ-IQ Model, the author mentions that the design of interview questions and questionnaire should found out the purpose of the research (RP) at first, and based on the research purpose set the Critical Research Questions, then find the suitable theory to solve the Critical Research Question, and finally put out questions based on the theory’’ (Zhonglv & Wei, 2014). See preliminary questions formulated in the following figure.

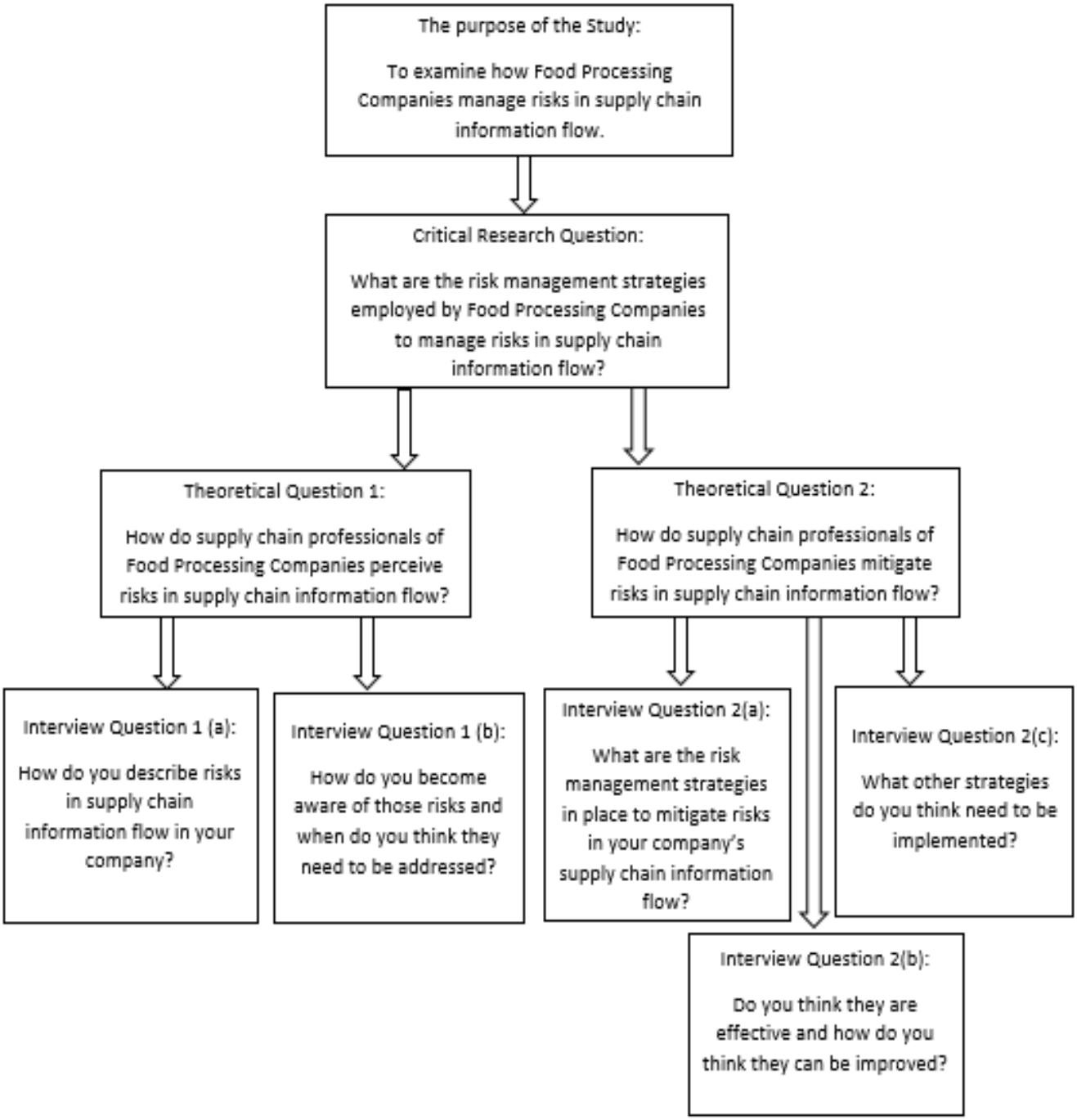


Figure 7: Preliminary Interview Questions developed by author based on Wengraf, (2001).

While the CRQ and TQ's are developed in the theory-language of the field of study, which is the conceptual framework; the IQ's are developed based on the interviewee's language, which is more colloquial (Wengraf, 2001).

3.7. Analysis Procedures: Thematic Analysis.

The study used thematic analysis to investigate risk management in supply chain information flow and analyse the influence of risk management on the supply chain information flow of South African food processing companies. Thematic analysis is a qualitative data analysis method that involves searching across a data collection to locate, analyse, and report on repeating patterns (Braun & Clarke 2012). It is a data description approach, but it also requires interpretation in the processes of selecting codes and generating themes. Thematic analysis is distinguished by its ability to be employed within a wide range of theoretical and epistemological frameworks, as well as to be applied to a wide range of study topics, designs, and sample sizes. The principles of thematic analysis, such as how to code data, search for and refine themes, and report findings, apply to a variety of other qualitative methodologies (Watling & Lingard 2012, Taylor, Sims & Haines, 2012).

As a result, the study concentrated on the thematic analysis methodology described by Braun and Clarke (2006), which has become the most generally used method of thematic analysis in the qualitative literature (Clarke & Braun 2017). It is crucial to note that Clarke and Braun's thematic analysis is intended to be a recursive, rather than linear, process in which succeeding steps may prompt the researcher to return to prior steps in light of fresh data or newly emerging themes that warrant additional exploration. The analytical process consists of five steps, which are as follows:

3.7.1 Data Familiarization.

The initial step in theme analysis is to become acquainted with the complete data set, which requires regular and active reading of the material (Braun & Clarke 2006). While it may be tempting to start coding data and searching for themes right away, familiarizing yourself with the whole data set first will provide a crucial orientation to the raw data and will serve as the foundation for all subsequent processes. Because the study relied on interviews as its primary data source, transcription was used, and it also serves as a good approach to become acquainted with the data.

3.7.2 Generating Codes.

Coding assists in the organization of data at a granular, precise level, which includes making notes on prospective data items of interest, queries, linkages between data items, and other preliminary thoughts. This stage of work develops codes rather than themes. A code should be well-defined and delimited enough so that it does not overlap with other codes and fits logically within a wider coding framework or coding template (also known as coding handbook) that leads the coding process by outlining and specifying the codes to be applied (Nowell et al. 2017). The researcher might begin the process of developing an audit trail to support the reliability of a researcher's interpretations and analysis by recording how codes originated from observations and thoughts (Nowell et al. 2017). After defining the coding framework or template, researchers apply the same codes to the full data set by labeling data extracts with relevant codes and noting any potential patterns or relationships between items that may inform further theme creation (Braun & Clarke 2006). After coding the whole data set, the researcher can collate the data by code in preparation for step 3: theme search.

3.7.3 Searching for Themes.

The third phase entails reviewing the coded and aggregated data extracts for potential themes of greater importance (Braun & Clarke 2006). According to Braun and Clarke (2012), if your entire analysis is viewed as a building, individual codes are the bricks and tile, while themes are the walls and roof. The process of topic identification, as well as the construction of the walls and roof, is basically an active and interpretative one, See appendix 5. Themes do not emerge from the data by themselves (Varpio et al. 2017); rather, themes are produced by the researcher by examining, combining, comparing, and even graphically mapping how codes connect to one another. In inductive analysis, researchers extract themes explicitly from coded data, so the themes revealed are more directly related to the original data and representative of the complete data set (Braun & Clarke 2006), as is the case in this study.

Important themes will reveal substantial relationships between data items and answer crucial parts of research questions, but the researcher will not know which themes will be maintained, rejected, or otherwise modified in the final analysis until the themes are reviewed in step 4.

3.7.4 Reviewing Themes.

Step 4 was characterized by Braun and Clarke (2006) as a two-level analytical method. The researcher looks at coded data provided within each theme in the first level of analysis to guarantee correct fit. The researcher goes over all relevant codes and data extracts under each theme and asks if each theme has enough supported data. Is the data given consistent in its support of that theme? Are certain topics too broad or diverse? Data within each theme should be sufficiently common and coherent, and data within themes should be unique enough to deserve separation (Braun & Clarke 2006). Data extracts can now be re-sorted, and themes changed to better reflect and represent coded data. When the researcher is certain that the revised thematic map appropriately covers all of the coded data to be included in the final analysis, the first level of analysis is complete (Braun & Clarke 2006).

Level two asks the same questions about the themes in connection to the complete data set. In this stage, the researcher determines whether particular themes fit properly within the data set and whether the thematic map accurately and adequately depicts the overall body of data (Braun & Clarke 2006). Thematic maps should clearly show how themes interact with one another and how they express the topic or construct of interest. To complete this work, the researcher re-reads the full data set to reassess themes and re-code for additional data that falls under the newly established or updated themes in this phase, then revises the thematic map accordingly (Braun & Clarke 2006).

While this iterative process could theoretically go on indefinitely, King (2004) and Braun and Clarke (2006) suggested that revisions should stop once all data items that appear relevant to the study question have been incorporated into the coding scheme, themes are coherent, and further refinements are not yielding significant changes.

3.7.5 Defining Themes.

Step 5 involves the researcher producing a definition and narrative description of each topic, explaining why it is essential to the broader study question (Braun & Clarke 2006). The names of the topics that will be included in the final report are scrutinized to verify that they are concise and properly descriptive (Braun & Clarke 2006). The researcher then zeroes in on the most important aspect of each theme and which aspects of the data set it covers, developing a cohesive narrative of how and why the coded data within each theme provide unique insights, contribute to the overall understanding of larger questions, and interact with

other themes (Braun & Clarke 2006). While answering these questions, the researcher seeks areas of overlap between themes, identifies emergent sub-themes (which can be used to provide more detailed accounts of themes as well as to describe hierarchies within the data), and clearly defines the scope of what each theme entails or includes (Braun & Clarke 2006). This is a good opportunity to choose data extracts to include in the final report that illustrate significant elements of themes and to develop narratives around them that provide context to explain their value to the larger story that each theme tells (Braun & Clarke 2012).

3.8 Criteria for validity and reliability in qualitative research.

For qualitative research, the quality of a study is determined by its trustworthiness and authenticity; and trustworthiness in qualitative inquiry is determined by the following criteria which are comparable to validity and reliability: credibility, transferability, dependability, and confirmability (Kumar, 2014). An audit trail was applied to establish credibility, transferability, dependability and confirmability of this study (Creswell & Miller, 2000). According to Anney (2014), an audit trail is a process where a researcher accounts for all the activities and decisions made during the research process in order to validate how the data were collected, recorded and analysed. In addition, as a requirement to fulfil the trustworthiness criteria a detailed descriptions of participants backgrounds are provided; research processes and study contexts are as well distinctly defined, together with the discussion guide and analysis process so that those who seek to transfer the study findings can judge transferability (Nowell *et al*, 2017). The confirmability and credibility of this study is well rooted in checking the preliminary findings and interpretations against the raw data (Nowell *et al*, 2017). Authenticity was fulfilled by appreciating different opinions, judgements and ensuring all viewpoints are taken into account and represented in the study analysis (Johnson *et al*, 2016).

3.9 Ethical Clearance.

To ensure the study would be conducted in an ethically accountable and responsible manner; Ethical Clearance was applied through the Wits University's Human Research Ethics Committee (HREC) and Ethical Clearance #H19/04/12 was obtained from the Committee.

Consent forms were sent to participants prior to any verbal interviews being conducted. According to Kumar, (2014) it is unethical to conduct research without participants' informed consent, and the informed consent process met the following criteria: the consent was

voluntary, enough information was provided for sensible decisions to be made, and the capability of participants to provide consent was also taken into consideration (Kumar, 2014).

Information collected from the participants was treated confidentially and anonymously. It is unethical to not protect the anonymity and confidentiality of the information collected from the research participants (Kumar, 2014).

Chapter 4: Data Analysis and results.

4.1 Introduction.

This section gives a detailed analysis of the qualitative interviews that were conducted to examine, risk management in supply chain information flow, the extent to which agricultural challenges, diverse distribution landscape of cooperate and traditional wholesalers contribute to information risks, analyse the impact of risk management on the supply chain information flow of food processing companies in South Africa. Firstly, it gives detailed information about the sample, respondents and the areas of interest, the types of products manufactured and the geographical origins of the companies. The companies interviewed included locally based, international companies and international companies with local operations. Secondly, it gives a definition of information flow risks according to the supply chain of food processing companies. Lastly is assess the impact of risk management on the supply chain information flow of food processing companies.

From interview data gathered, codes, sub-themes and themes were generated as described in preceding section. The working is given in appendix 3, appendix 4, appendix 5, appendix 6, appendix 7 and appendix 8.

4.2 Sample Description.

The study leveraged the knowledge, experiences and expertise of six respondents all working in the South African food processing industry. The respondents worked in managerial positions across the operations planning and supply chain management area in the processed food and beverages industry. They were selected from five major companies which have both a national and international footprint.

The respondents worked in four main roles across the processed food and beverages operations and supply chain management area as shown in Figure 8 below:

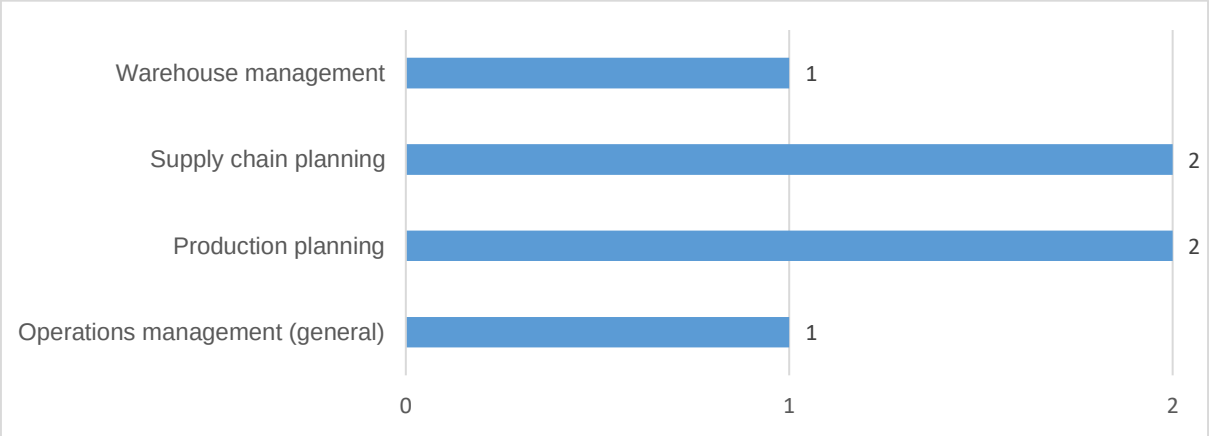


Figure 8: Respondents' work areas.

One respondent was from warehouse management, two from supply chain management, one from production planning and another one from general operations management in the processed foods and beverages industry.

4.3 Types of products manufactured in respondents' companies.

The respondents were drawn from companies that could be categorised into three distinct groups – in terms of the general types of products they manufactured.

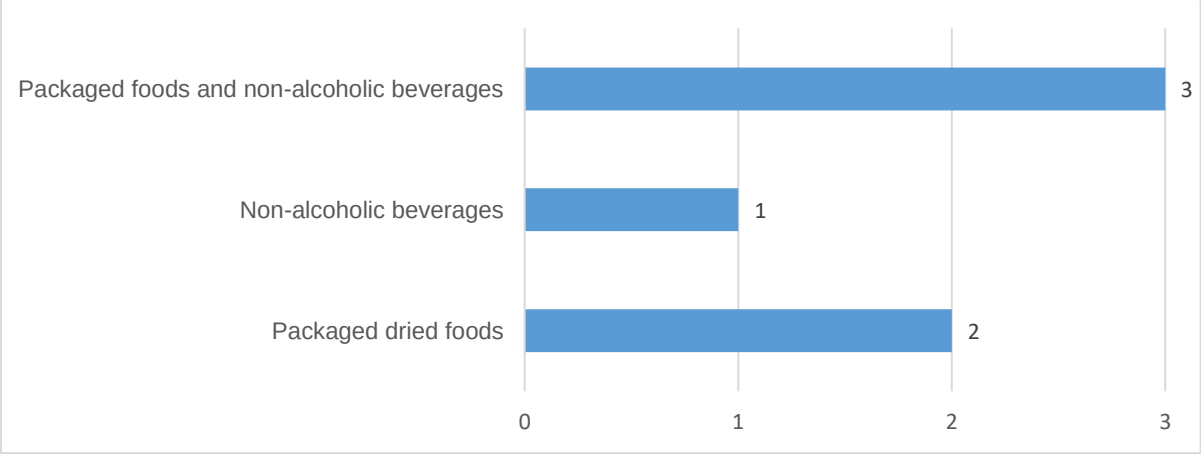


Figure 9: Major products produced by the companies represented in the sample.

Out of the six respondents, three were from companies that manufactured both packed processed foods and non-alcoholic beverages. One respondent was from a company specialising in the production and distribution of non-alcoholic beverages and two were from companies manufacturing packaged dry foods.

The study also drew respondents from companies that had different geographical origins classifying the companies into three categories, namely: South African companies with local operations, South African companies that also had international operations and international companies that operated in South Africa. Figure 10 below highlights this.

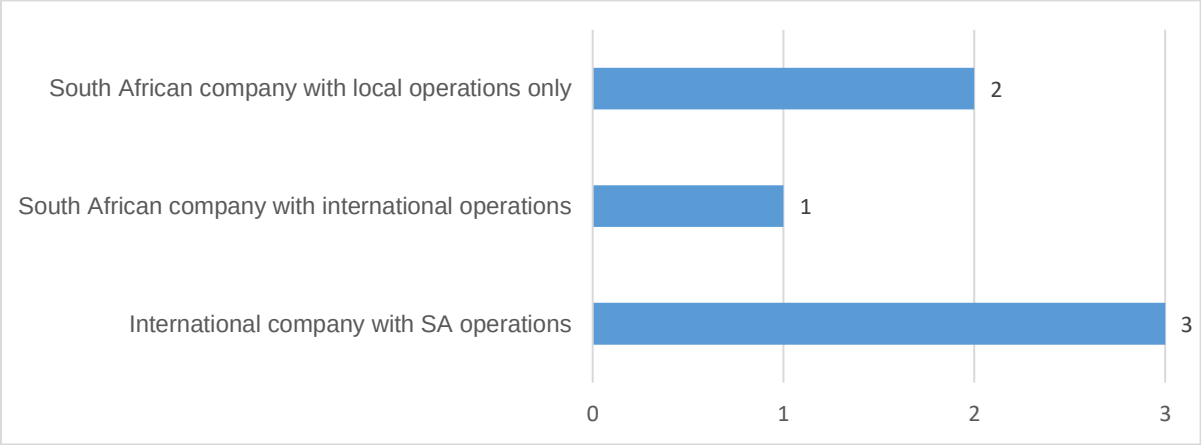


Figure 10: Company classification by geographical origins.

Two companies were headquartered and operated in South Africa only. One of the companies originated in South Africa but also had international operations and three were international companies with branches in South Africa. Thus five of the respondents were from companies whose information flow processes cut across international borders.

Table 2 below summarises these respondents' general profiles and further links them to their organisations.

Table 2: Summary of respondent profiles.

Respondent pseudonym	Gender	Work area	Organisation Description
P 1	Male	Regional operations management	Non-alcoholic Beverage manufacturing entity with operations in South Africa and other parts of the world
P 2	Male	Master Planner (Snacks and Treats)	A South African processed and packaged, long-life goods company whose products include packaged cereal, spaghetti, tomato sauces
P 3	Female	Supply chain planning	A processed and packaged foods company with operations in SA and North America
P 4	Male	Regional supply planning	An international dairy, dairy substitutes and snack company with operations in South Africa
P 5	Male	Production planning - exports	A South African processed and packaged, long-life goods company whose products include packaged cereal, spaghetti, tomato sauces
P 6	Male	Warehouse management	A South African processed and packaged, long-life goods company whose products include shelf beverages, biscuits, snacks, teas

The study, therefore, drew its data from a sample of persons directly involved in food and beverage processing operations. They also came from companies with diverse profiles including some with international operations. In the researcher's view, this diversity of

company backgrounds widens the scope and perspective of findings giving deeper and richer meaning to the study.

4.4 Interview question: Definition of risk in a company's supply chain information flow.

The interview process had a direct question that required the respondents to define risk in a company's supply chain information flow from their companies' perspectives. This question was important because it revealed the respondents' general information flow risk perspective; and such a perspective was expected to help an understanding of their views and experiences on information flow risk.

Table 3: Respondents' definitions of information flow risks.

Respondent	Respondent view/definition
P1	The potential flow of unreliable, incorrect or inadequate information across the production value chain; threats of wrongful publication of internal information
P2	Foreseen and unforeseen adverse possibilities with "the greatest risks are those which are unseen"
P3	Loss or leaks in supply chain information as well as the movement of erroneous information across the supply chain
P4	Scenarios where "information is not transmitted accurately and timely that will result in delay and that create problems in your supply chain"
P5	Information losses to unauthorized parties including through leaks and non-procedural disclosures of confidential information
P6	"I think the definition will be the same because the definition will be the probability or the threat of damage, injury, liability, loss or any other negative occurrence that is caused by internal or external vulnerability and that might be avoided through preventive actions"

P1 and P4 conceptualised information flow risk in relation to losses in information reliability due to inadequacy and accuracy issues. P4 added that delays in information transmission also fell under this risk. P3 and P5 looked at this risk in relation to data and information losses to unauthorised parties with P3 also noting the information reliability in their definition. The remaining respondents, P2 and P6 chose to define information flow risk in general terms as probabilities of adverse occurrences. The first four definitions highlighted information flow risks as the possibility of losses in reliability, integrity and timeliness of information.

4.5. Interview question: characteristics of information quality.

The respondents further revealed the core characteristics of information quality whose absence or presence could also be used to define information flow risks in supply chains.

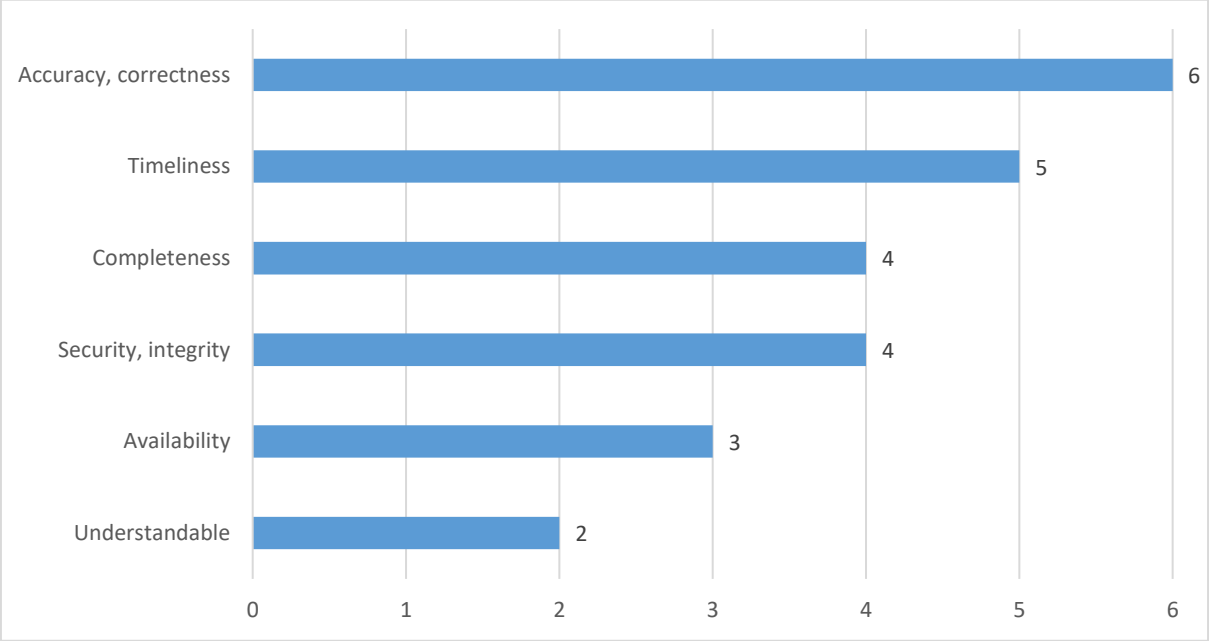


Figure 11: Characteristics of information quality.

The respondents believed that accuracy and correctness, timeliness and completeness were the basic qualities of effective information flow. Information flow was also compromised by the loss of information security and integrity (when it passes to unauthorized parties) by its non-availability and when it is not understandable to those it was passed onto.

4.6 Interview question: types of risks associated with information flow.

The respondents highlighted various types of risks that existed in their companies and by extension their supply chains. In the interview process, there were discussions that information flow risks often triggered chains of events that included the manifestation of several types of risks.

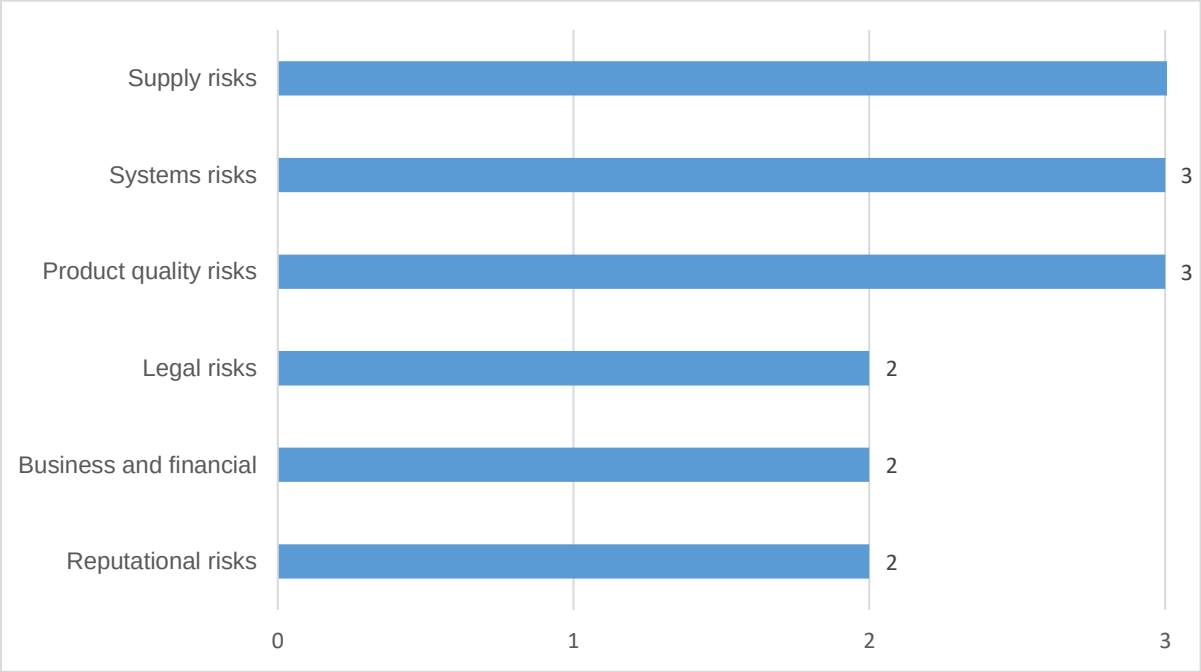


Figure 12: Types of risks associated with information flows.

Only three respondents linked information flow risks to supply risks. These were risks in the delayed, curtailed or erroneous supply of required goods from suppliers to the company, or from the company to its customers. Systems risks involving breaches and disruptions to information access, use, distribution, and storage technologies were considered a major contributor to information flow risks. For instance, system downtimes affected the flow of supply information along supply chains while breaches violated the trust and integrity users had in the same systems. Breaches were mostly discussed in line with losses of confidential market data that could be abused against both the companies and their customers. Such losses were a function of poor security protocols. Legal risks were threats of lawsuits that emanated from losses and abuses of confidential data. As P3 elaborated once information is shared *"wrongly with the wrong customers…it became a whole legal issue."* This was regardless of whether this was an error or an intentional loss. The probability of losing a good market reputation also referred to as reputational risk or *"reputational damage"* is described as a potential risk that also flows when information is lost or abused by P1 and P5. This also emanated from losing the reputation of being a reliable supply chain entity. P2 and P5 described how poor information flows, which is another manifestation of information flow risks as can culminate into product quality risks. In P5's experiences, information flow issues resulted in delays in moving goods of varying perishability across supply chains. For low-shelf-life goods, these delays affected the quality level they have as they get on store shelves.

In P2's experiences, quality is compromised when wrong information affects the quality component of the product and also results in a "*quality delay"* – or poor service.

4.6.1 Risks grouped according to common errors.

The above risks were also looked at from an itemised view of common errors they were associated with. From the dataset, common information flow errors experienced by the interviewees within food processing supply chains were also extracted. These errors were: sending wrong information to suppliers, customers or internal departments; Receiving wrong information from suppliers, customers or internal departments; Losing internal or customer/supplier information through IS breaches or error; delaying information and sending or receiving inadequate, incomplete or incorrect information. These process-related errors are categorised in Figure 13 below:

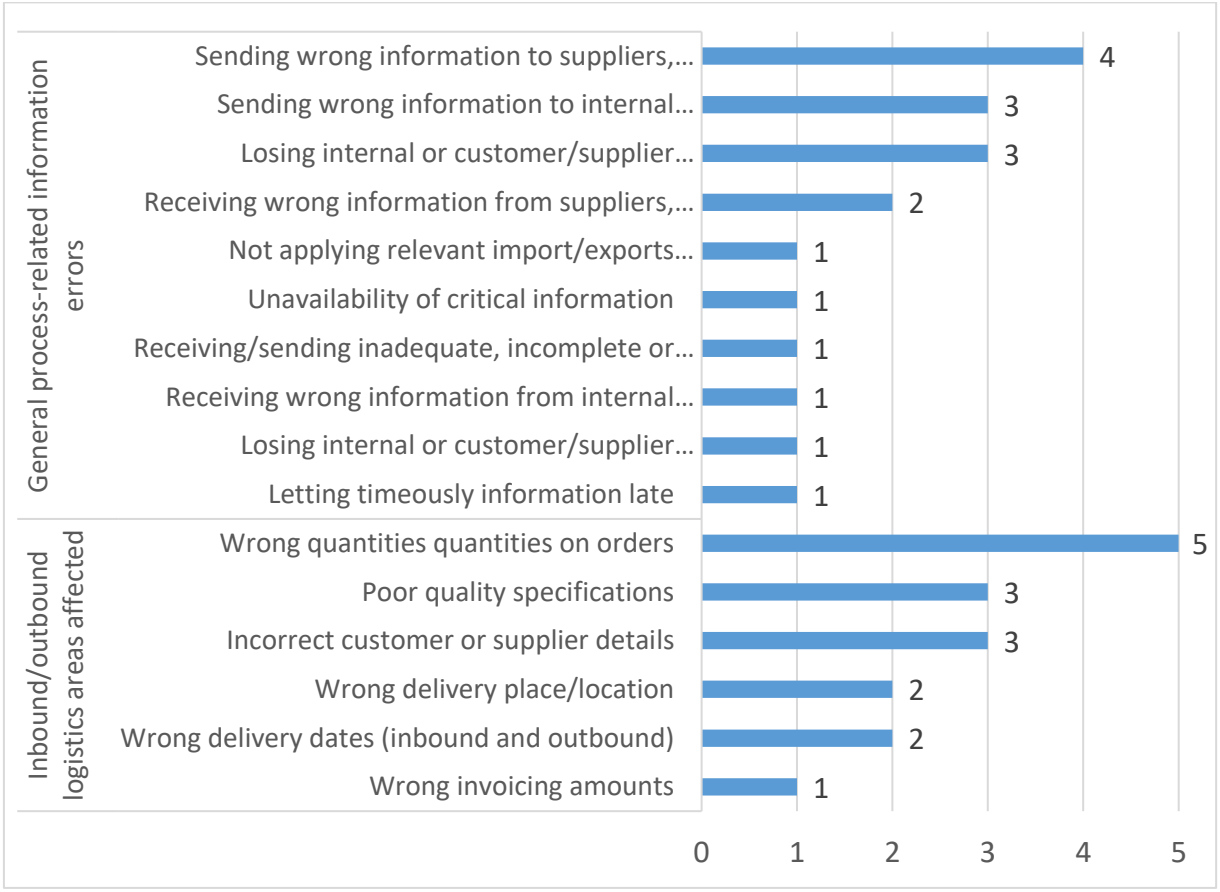


Figure 13: Supply chain information flow errors and immediate outcomes.

The immediate consequences of these errors as extracted from the dataset as a whole were: wrong invoicing amounts; wrong delivery dates (inbound and outbound); wrong delivery place/location; incorrect customer or supplier details; incorrect product and/or quality specifications and incorrect order quantities. These errors were mostly discussed as the drivers of supply chain risks which manifested themselves as more consequential operational and strategic challenges.

4.7 Interview question: How risks manifest themselves in the supply chain

In their responses to questions, the respondents mentioned and talked about the effects of poor information flow risk management – in other words how these risks manifested themselves in organizations or supply chains.

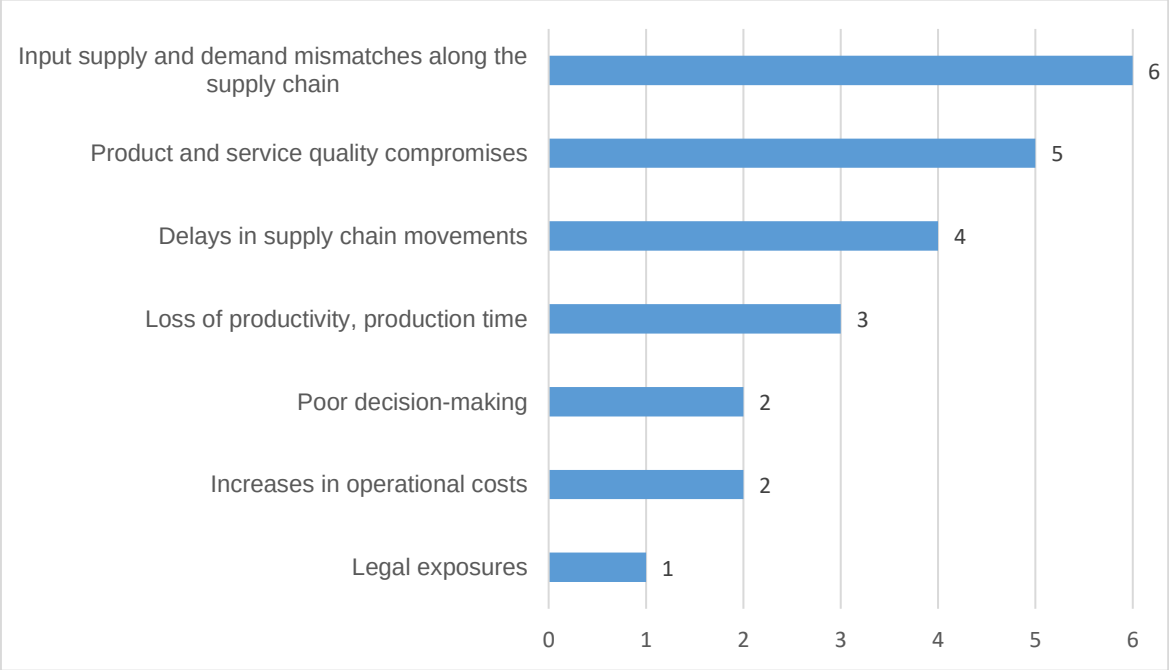


Figure 14: How risks manifest themselves in the supply chain.

As shown in the above chart all the respondents shared a common observation that information flow risks manifested themselves as supply and demand mismatches along the supply chain. This applied to both finished goods to the next supply chain level and raw materials. Additionally, poorly managed information flows result in product quality compromises. For example, P1 mentioned that highly sensitive product specifications needed to pass through the various stages of the supply chain but the challenge was for this information to pass through accurately all the time. P5 also mentioned that *"sometimes we*

miss production because we're missing information", an experience also shared by P2 and P3. Delays in supply chain movements were highlighted as a manifestation of the same risk. P1 and P6 also mentioned how information flow risks along the supply chain adversely affected the quality of decision-making with P1 stating that *"with wrong information (they) are not able to make good ideas."*

4.8 Interview question: Awareness of information flow risks that need addressing.

The interview process collected data on the point at which the respondents believed that there was an information risk that needed to be managed. The question – *How do you generally become aware of these risks and when do you think they need to be addressed* – was designed to start discussions on the information flow risk identification process that respondents used in their respective organizations. Table 4 summarizes their responses:

Table 4: Awareness of risks that need addressing.

Respondent	Respondent view/experience
P1	Proactive risk assessment as per contingency plan
P2	Data due diligence
P3	No particular experiences
P4	"I think generally when there is a break in the link, delays are when we become aware of the risk ok which will mean that we are not necessarily proactive."
P5	At the point of occurrence " immediately, if you find that there's been a compromise"
P6	At risk assessments - actual incident awareness is when it is reported

According to P1 proactive risk assessment as guided by the company's contingency plan enabled the identification of risks that needed to be managed before they manifested into occurrences. The particular respondent saw their approach as highly effective stating that

"*we do have a business contingency plan and we can mitigate any kind of risk that comes our way."* In P2's organisation, operational systems due diligence enabled the identification of risk areas that needed attention and this was also a proactive approach that did not wait for any problems to occur before being activated. P4 admitted that their organization often became aware of risks after they had manifested into adverse occurrences. They mostly took a reactive approach. P5's risk management system was described as neither proactive nor reactive but more or less as real-time detection. The company had systems that identified compromises in information flows as they occurred and P6's company had a proactive risk identification risk through risks assessments and a reactive one when risks are reported.

4.9 Interview question: Risk severity and the likelihood of occurrence.

To further understand the nature of information flow risks, data were collected on their prevalence as well as their severity based on past experiences. Table 5 shows respondents' input to the question - *How severe is the impact of risk and how likely are they to occur?*

Table 5: Risk severity and prevalence.

Respondent	Respondent view/experience	Severity	Frequency
P1			
P2	"It's very, very severe, that's why we had to take a lot of time and attention"	Very high	Low
P3	"well they're not, they do occur but they don't like occur--- it's not like an everyday issue"	It depends	Low
P5	"Well so like, as I said the risk can be between medium to high; so it depends as well uh what type… But if let's say somebody breaks into our systems and they're able to steal information, I mean that's an unlikely event, but if it could happen then obviously the impact is quite high, ja, it's quite severe."	It depends	Low

P6	"The severity in measurement the risk is high because you need a team that will be able to concentrate on what the customer the is saying so I can say its high the risk is high because that is something that is happening in every month or daily processes"	High	High

The data shows different severity and frequency of occurrence depending n the types of exposures and the risk environment.

In P2's experiences, there was a low information flow risk in their company. However, when it occurred, it was severe and this motivated the company to invest much time in its management despite its low frequency. P3 and P5 highlighted that the frequency of occurrence based on past observations was low but its severity depended on the situation. Lastly, P6 talked about information flow risks at their company as mostly affecting client services, for example through delays, wrong quality and quantity of products. Because it affected the very essence of what their organization existed for its severity was high. It also occurred quite frequently with P6 attributing it to the fact that their operations were *"more dependent on the network"* and greatly intertwined with other value chain players whom they did not have control over. Most risks were therefore passed along this network.

4.10 Interview question: Major information flow risk factors in selected food companies.

The respondents discussed various factors affecting information flow risks in their respective companies. Eight broad categories of factors came out and these are shown in Figure 15 below:

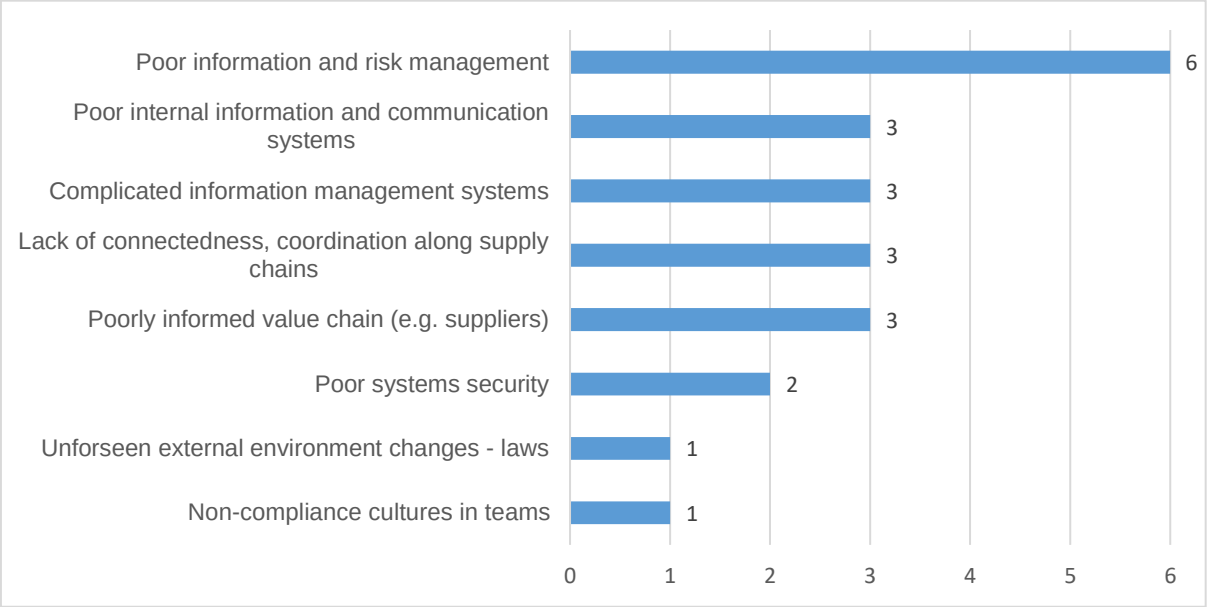


Figure 15: Major information flow risk factors in selected food companies.

The general perspective was that poor information and risk management was an underlying cause of such a problem, albeit P4 believing that unforeseen external environmental factors can derail existing, well-managed risk and information systems. P3, P4 and P6 saw poor internal and information and communication systems as a major factor behind information flow risks. The Information systems in question related to ICTs that were used in information management and also supported the flow of such information across internal units. Poor internal communication involved the transmission of unreliable information as well as the non-availability or inadequacies of data and information that might be required as an input into the next stage of production.

The selected food processing firms heavily relied on operations and management information systems for daily work processing as widely discussed by P2, P5 and P6. These systems were fashioned to enhance efficiency however sometimes proved to be too complicated for users. This created a risk of errors that included security breaches. Some of the systems, however, came with poor security systems that exposed the to violations by internal and external parties. P1, P2 and P6 saw poor external coordination among supply chain entities that are otherwise supposed to be connected in terms of information sharing as a causative factor of information flow risks. In P2's view, the efficiency with which information passed from supplier to manufacturer and from manufacturer to the customer faced a *"big risk because you see supply chain we work in silos."* Silos cause bottlenecks that included demand and supply mismatches in raw materials and finished goods that often-had negative cost and

revenue implications for parties involved. While companies could implement information flow risk management measures, the threat that some employees would simply not comply with them generally lingered in organisations as observed by P2 who stated that *"Non-compliance is a very big thing, especially when you speak of a factory environment."* Such prominent cultures were thus a contributor to information flow risks.

4.11 Interview question: The role of management in information flow risk management.

Data on the observed and experienced roles of management teams in the management of information flow risk was also collected. This was to assess how managers in the respective companies responded to the information flow external and internal risk environment. With all the respondents being in managerial positions, they were able to draw on both their experiences and perspectives. Figure 16 summarizes their responses. These responses were coded into four major roles: managing and facilitating internal cohesion, communication facilitation, risk management action implementation and internal compliance management.

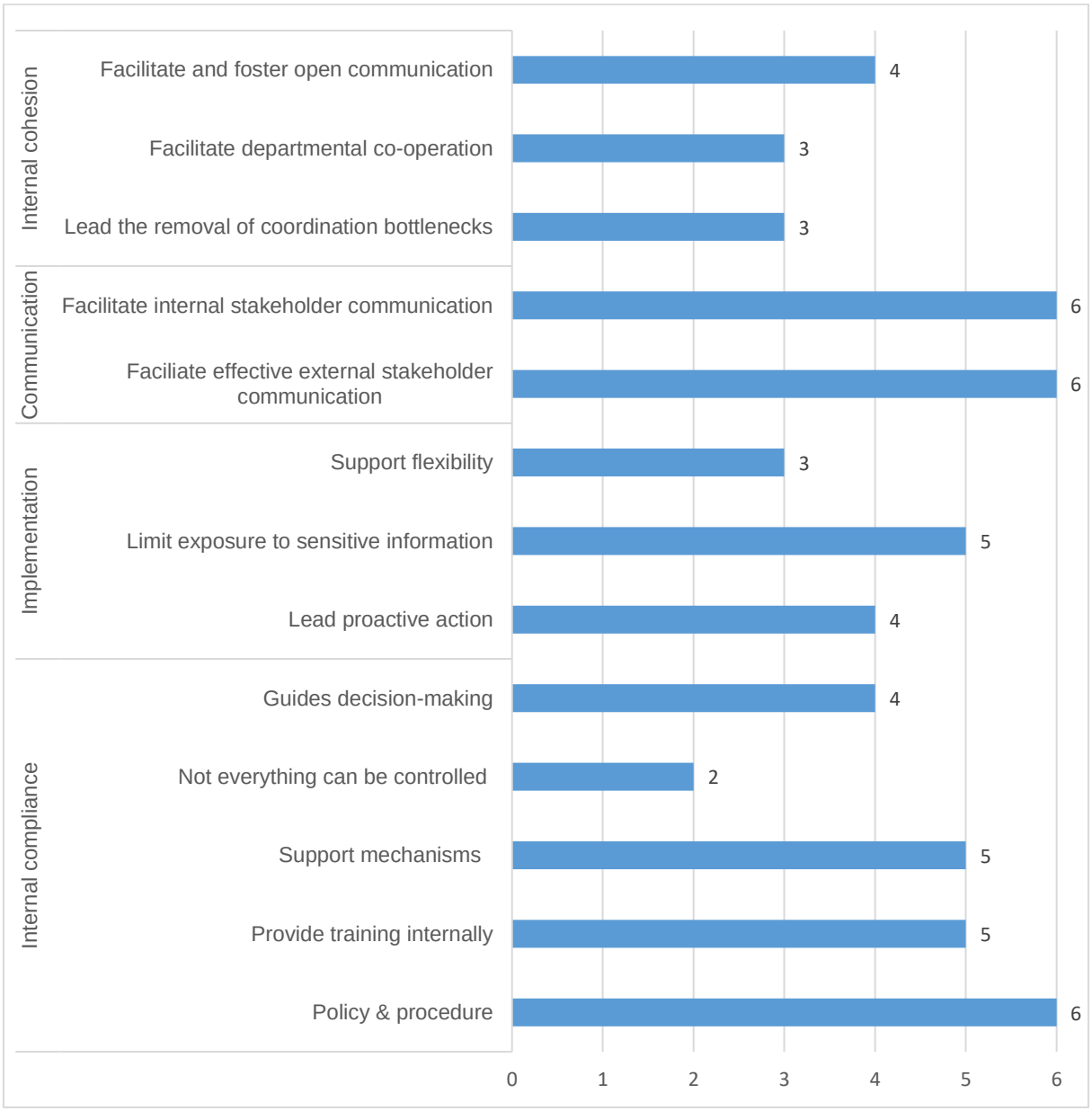


Figure 16: The role of management in information flow risk management.

In their internal cohesion facilitation role, managers were responsible for fostering interdepartmental cooperation. As highlighted "*siloed*" operations were risk factors that resulted in department's taking unilateral actions that affected others without consultation and in an uncoordinated way. The networked nature of production entities demanded coordinated risk management and this, in turn, required internal cohesion as experienced by P1 and P6 managers were therefore important in removing any barriers and hindrances to coordinated information flow that may exist in policies, strategies and cultures.

4.12 Interview question: Advantages of deliberate information flow risk management.

The respondents also discussed the organizational advantages of information flow risk management. These were grouped in Figure 17. These were not mutually exclusive.

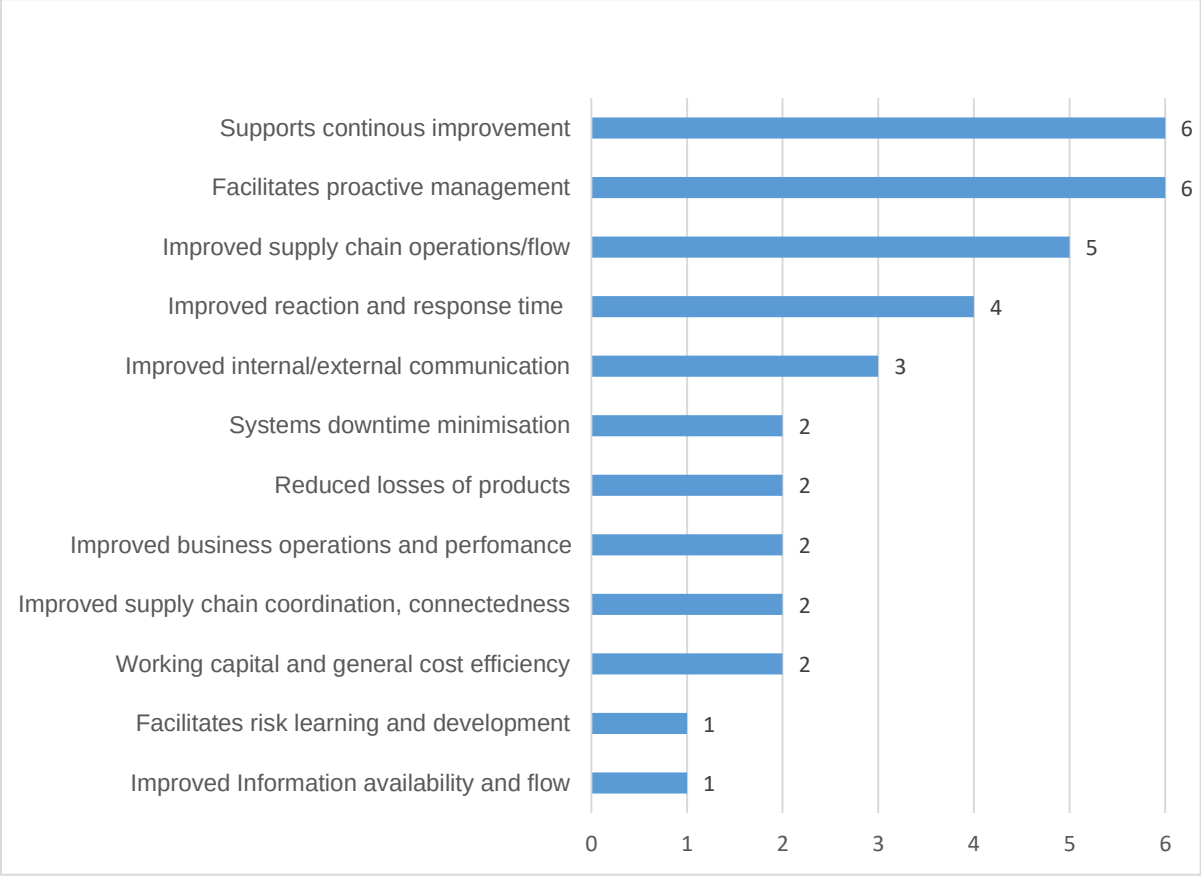


Figure 17: Advantages of deliberate information flow risk management.

There was a commonly shared view that information flow risk management facilitated proactive risk management and this contributed to low occurrences and in case severity of risk. This view was also held by P3 and P4 who had earlier indicated that their companies were mostly reactive rather than proactive to risk. The process also improved the general process and product flows across external and internal supply chains. Specifically, with risk management, facilitated communication and coordination of activities noting the bullwhip effect where *"whatever happens upstream will affect whatever happens downstream" (*P1). Effective information flow risk management considers effects on the supply chain as interconnected and plans in advances for disruptions along the whole chain as further explained by P6. Information flow risk management also improved the response times to risks even when proactive strategies fail to mitigate such risks. In P4's view, some risks simply escaped any internal management processes can fail to mitigate, for instance, rapid external

changes to supply chain regulations and protocol. Under such conditions, the ability to quickly respond is considered critical in reducing the effects of such risks on a company.

Information flow risk management also came with other advantages including improved business operations and performance (P2, P6); reduced losses of products (P4, P6); systems downtime minimization (P5, P6) and improved Information availability and flow (P2). P2 Also believed that once a risk manifests itself and is efficiently addressed this creates learning opportunities to manage it – *"So advantages is that it gets resolved and it doesn't happen again because people learn from their mistakes."* Thus, P2 effective information flow risk management, even in its reactive form facilitated risk learning and development.

4.13 Interview question: The importance of continuous improvement in risk management.

In their discussions on the advantages of risk management, the respondents explicitly and implicitly talked about the importance of continuous improvement in information flow risk management. This referred to the various systems, processes and procedures that their companies put in place to manage and contain risks. Further probing on continuous improvement revealed that the respondents associated it with seven core benefits which are shown in Figure 18 below.

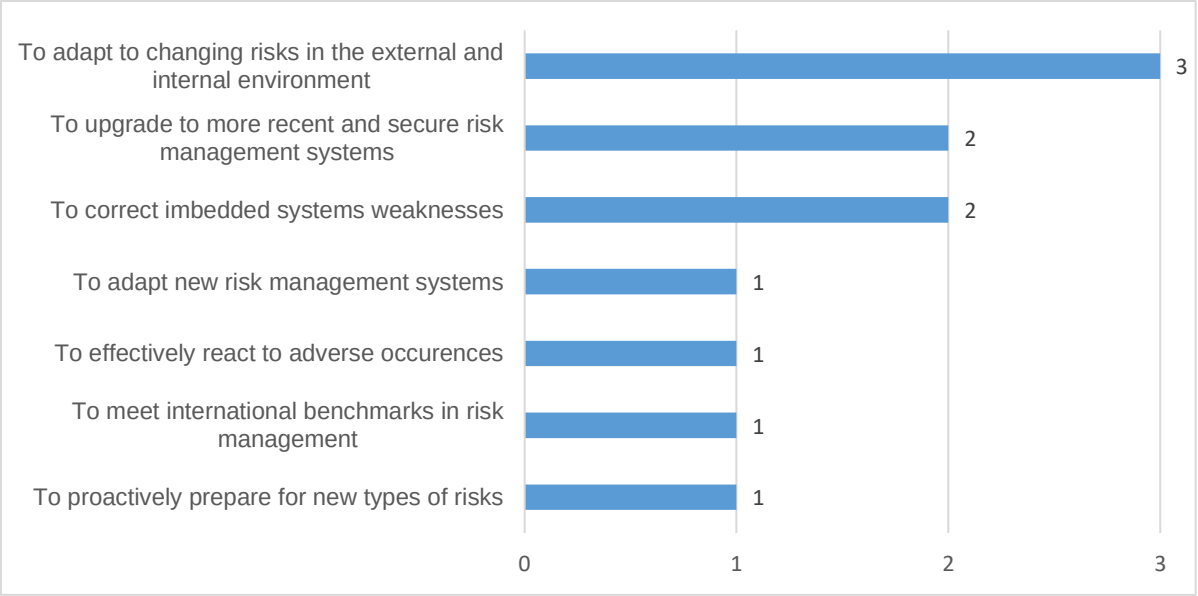


Figure 18: The importance of continuous improvement in risk management.

According to the respondents, continuous improvement facilitated risk identification capacities in the selected food processing companies. P1 believed that risk management systems were tied to business and market opportunities, and both needed companies to timeously adapt to change. Continuous improvement was part and parcel of adapting to new risks that came as the business environment changed. Companies did not have a choice but to continuously improve and as P1 put it: *"if you remain stagnant you are dead, you are out of the business"* (P1). Related to this, P3 believed that *"to improve their KPIs"* which were usually not perfect companies needed to continuously improve their risk management processes. From P2's perspective, continuous improvement in information flow risk management was a result of the inbuilt imperfections that every system came with. Even with the most articulate design by experts and professionals, *"no system is perfect"* (P1). In addition to perfective corrections that are required in risk management systems, P1 further asserted that the risk environment is dynamic and tends to gain more complexity with time. Like P1, P2, therefore, saw a perpetual need for change in the risk management processes. Also, with information flow risk management being highly dependent on management information systems, the upgrading and evolution of such systems also demanded companies to get the latest available versions, and this too was considered part and parcel of continuous improvement. A new system like integrated *"vendor management systems"* mentioned by P4 that linked supplier and customer systems facilitating seamless transaction processing and information flows and the need to adapt these systems-related continuous improvement needs. As part of an international portfolio, P3 believed that their organization was required to continuously improve to meet global risk management standards.

4.14 Interview question: Effectiveness of information flow risk management strategies.

Respondents were requested to give a general rate of the effectiveness of the risk management strategies that their companies had in place. Alongside this general rating, they also had to give the main indicators they used to make it. Four of the respondents responded and their views are summarized in Table 6 below:

Table 6: Effectiveness of information flow risk management strategies.

Respondent	Respondent view/experience	Indicator
P2	very effectively	audit reports
P3	they are effective	positive KPIs
P4	most of our strategies are effective	positive KPIs
P5	it's very effective	no recorded IS/ICT breaches

The respondents generally believed that the various risk management strategies, including those that were mostly reactive rather than proactive, were effective in information flow risk management. P2 believed that positive audit reports were an indication of effective information flow risk management processes while P3 and P4 saw positive or improving KPIs on risks as indicators of this effectiveness. In P5's view, not having experienced adverse information systems breaches was an indication of effective risk management within their company.

4.15 Interview question: Tools and systems for managing risks.

The respondents either mentioned or explicitly discussed tools used in risk management and these were mostly digital information systems. Information on these systems was considered necessary as their strengths and weaknesses were expected to affect information flow risk management. Additionally, the respondents widely referred to the use of systems in their risk management endeavors and this necessitated an identification of these. These tools are listed in Table 7 below.

Table 7: Tools and systems for managing risks.

Tools/Respondents	P1	P2	P3	P4	P5	P6
Enterprise Resources Planning systems (e.g. SAP)		x	x	X		
Advanced Planning and Optimization tools				X		

Tools/Respondents	P1	P2	P3	P4	P5	P6
Business Intelligence Software or Systems (e.g. Microsoft BIS)				X		x
Vendor management systems				X		
Databases		x				
Management and operations information systems	x	x				
Manual tools	x					x
General office tools (spreadsheets)	x			X		x

ERPs were discussed as part of the tools that were used in information flow risk management by P2, P3 and P4. P4 also mentioned the use of advanced planning and optimization (APOs) tools and vendor management systems. The latter was used to link supplier and customer supply chain transactions. P4 and P6 mentioned business intelligence software (BIS) as assisting in the processing and transmission of information as well as in supporting supply chain decision-making in general. P2 mentioned database management systems, specifically Oracle as well as other management information systems that were not specified. General office tools and spreadsheets were used in information flow processes while manual systems were also used – “so we still are very much dependant on spreadsheets and manual manipulation of data and information” (P1).

4.16 Interview question: Overall information flow risk management.

From the dataset, information on how risk was managed was collected and it was possible to categorize information flow risk management into four facets: strategies, policies and procedures, systems and assessment, monitoring and evaluation. Figure 19 below:

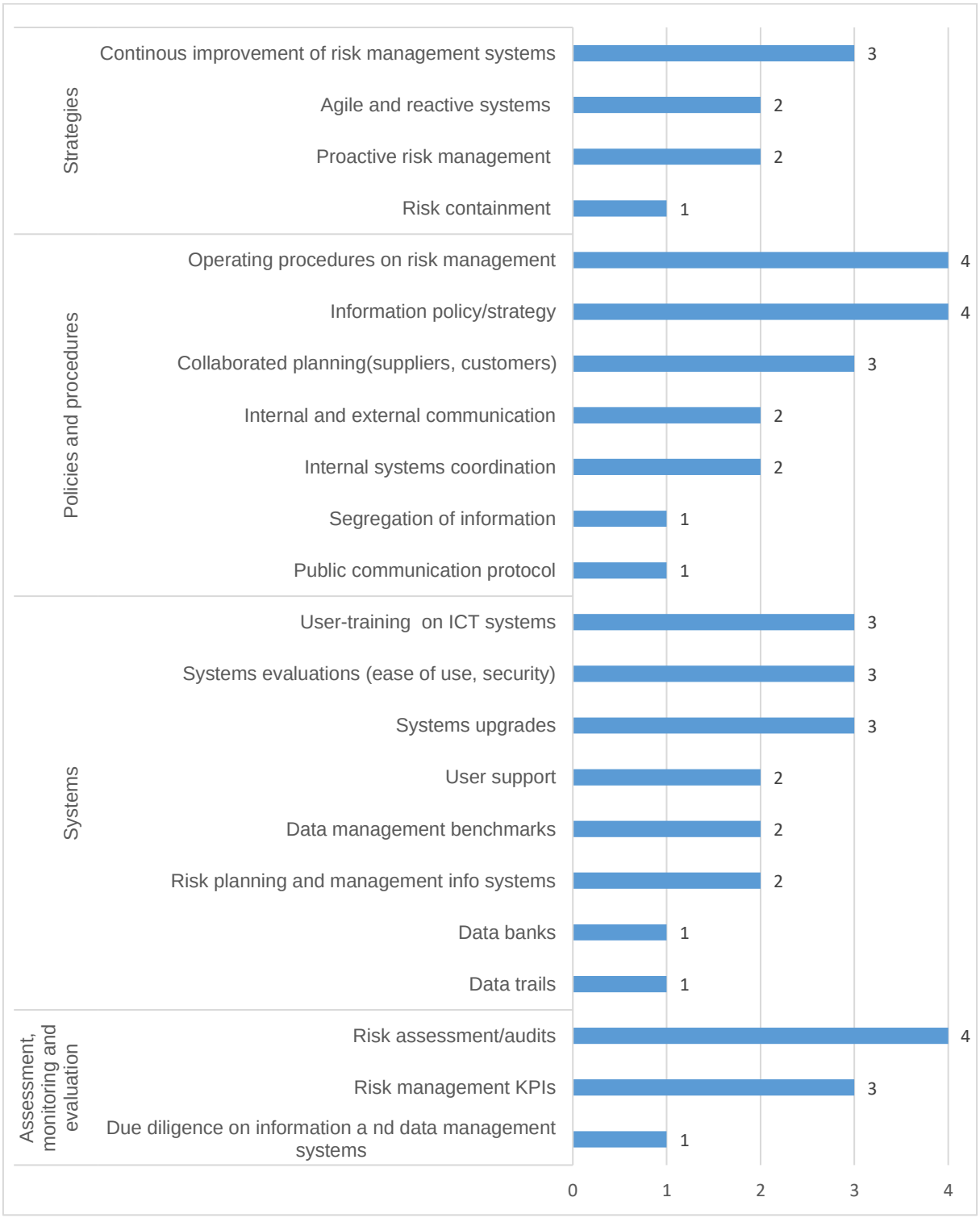


Figure 19: Overall information flow risk management.

Common strategies to manage risks were continuous improvement, building agile reactive systems, proactive risk management systems and risk containment. Policies and procedures supporting risk strategies were public communication protocols; segregation of information, buffering, information policies, operating procedures on risk management, internal systems

coordination, internal and external communication processes and collaborated planning (suppliers, customers).

The selected companies relied mostly on ICT systems to manage information flow albeit some manual elements existed. The respondents highlighted important systems management issues and processes that included: the use of data trails and data banks to assess and back-up information respectively; making use of risk and general information management systems and setting data management benchmarks. The systems aspect of risk management also included offering user support on information systems; facilitating systems upgrades, carrying out systems evaluations (for example on ease of use, and security) and providing user training on ICT systems.

Another aspect that came out was that of risk assessment, monitoring and evaluation. This was mostly discussed in relation to methods and processes that were used to assess risk management. These were risk assessments and audits, the use of risk management key performance indicators (KPI) and due diligence on information and data management.

4.17 Conclusion.

The section defined information flow risks as the possibilities of losses in reliability, integrity and timeliness of information. The respondents further highlighted the core characteristics of information quality whose absence or presence could also be used to define information flow risks in supply chains. It was observed that information flow risks manifested themselves as supply and demand mismatches along the supply chain. Management roles that include controlling and facilitating internal cohesion, facilitation of communication, risk management action implementation, and internal compliance management were seen as very critical risk considerations. The companies indicated that they had proactive risk identification through risk assessments and a reactive unit when risks are reported and these mitigate against information loss to food processing companies. The results generally show that the various risk management strategies, reactive and or than proactive, were effective in information flow risk management.

Chapter 5: Discussion of Findings.

5.1 Introduction.

The discussion of findings is presented in four distinct parts, which correspond to four of the five research objectives that have been set out. Information is drawn from the results as they emerged across the various interview questions and interpreted with respect to a specific research objective. This is because insights into the research objectives are gleaned from all responses to the interview questions as applicable to a specific objectives.

5.2 Sample description.

From the sample and profile of participants, it can be said that the results of the study are reliable to infer conclusions on the extent to which agricultural challenges, diverse distribution landscape of cooperate and traditional wholesalers contribute to information risks and the impact of risk management on the supply chain information flow of food processing companies in South Africa. This is based on the premise that the sampled interviewees had a wide spectrum of experience from both local and international supply chain information risk practices (Table 2).

5.3 Discussion of findings addressing the first objective.

The first research objective namely, “Examine the extent to which agricultural challenges in South Africa contribute to information flow risk in the supply chain of food processing companies in SA”, deals with the agricultural industry as supply side.. The literature review revealed that indeed; food processing companies in Southern Africa do receive raw materials from the agricultural industry such as smallholder farms. As Greenberg (2017) asserted that, the information flow risks in the supply chain of the South African food processing sector cannot be separated from the challenges within the broader South African agro-food system. Therefore, the agricultural challenges that present themselves in the Southern African region; such as lack of access to resources by smallholder farms and climate unpredictability, can impact on supply of raw goods to the food processing companies in South Africa (FAO *et al*, 2018). Yet the research results reveal that while supply partners do have an impact on information flow risk in the supply chain; that impact does not precisely mirror the agricultural challenges as laid out in the literature review. Which is to say that types of information

(including misinformation) shared and communication challenges, as it relates to the supplier, has more of an impact on information risk flow in the supply chain; rather than the aforementioned agricultural challenges.

5.3.1 Types of risks associated with information flow (supply side perspective).

The interview question “types of risks associated with information flow” reveals that all respondents linked information flow risks to supply (side) risks; including the delayed, curtailed or erroneous supply of required goods from suppliers to the company. Far more problematic and a cause of worry for the respondents as pertains supply side information flow risk are common information flow errors experienced by the interviewees within food processing supply chains. Figure 13 clearly indicates that sending and receiving incorrect information from suppliers count as general process-related information errors. These errors were mostly discussed as the drivers of supply chain risks, which manifested themselves as more consequential operational and strategic challenges. Incorrect information from suppliers is viewed as a risk to the supply chain by two participants. Yet this misinformation as it relates to the supplier appears to be a two way street, because four of the six participants insist that an ill-informed supplier (resulting from lack of information from the company) is equally problematic and as a result proves to be an information flow risk to the supply chain. Which is to say that suppliers must both, supply correct information to the supply chain and also receive the correct information from the supply chain (and other sources) in order for the supply chain to be able to make good decisions. The challenges that may hinder the supplier from achieving this are related to technology, insofar as agricultural suppliers having access to the necessary technologies, as well as the linking of supplier ICT’s with that of the supply chain. This is an agricultural challenge clearly articulated by Nguegan & Mafini (2017) when they stated the limitations posed by the lack of access and adoption of IT infrastructure in the agricultural industry. However, the extent to which this supplier challenge affects information flow risk in food processing companies in SA does not appear to be too wide spread as yet to warrant immediate intervention.

5.3.2 Misinformation to and from supplier and its impact on consumer.

The second supply side related issue that emerged in analysing this supplier related research objective is how misinformation from the supplier to the supply chain or vice versa impacts

on the consumer. The concern here appears to be that miscommunication or rather the movement of incorrect information between the supplier and the supply chain will inevitably impact the consumer. This is clearly articulated by participant two 2 in the following statement, “So just an example; packaging quality right, when you do an RSP or RSQ for a supplier, you have your defined specifications, down to the micron’s rights. Now what the supplier turns up in respect to what you actually wanted to procure might differ, and that in itself is a risk if the wrong packaging is brought to market.” The two identified ways that this problem poses a risk is that food processing companies in SA may end up producing and distributing inferior product quality to the consumer, as well as disrupt product availability to market. These two problems are flagged by two of the six participants, further adding to the notion that supplier challenges minimally impact on the supply chain information flow risk of food processing companies in South Africa.

5.3.3 How risks manifest themselves in the supply chain.

When looking at the question, “how risks manifest themselves in the supply chain”, figure 14 illustrates that, there are three responses to this questions that have the highest respondent agreement. Furthermore, these three responses also happen to be supply side related issues. Input supply and demand mismatches along the supply chain is one of the three responses (with all six respondents citing this as a manifestation of supply chain risk). Product and service quality compromises is another of the three responses (with five respondents citing this as a manifestation of supply chain risk). Lastly, delay in supply chain movements is the last of the three responses (with four respondents citing this as a manifestation of supply chain risk). All of the aforementioned three responses have at the centre of them supplier related information flow disruptions. This is because poor information management compromises product quality, P5 said, "Sometimes we miss production because we lack information," echoing P2 and P3. Delays in supply chain movements are another concern. P1 and P6 also emphasized how information flow risks along the supply chain affected decision-making implying that the major routes in which the South African food and beverage processing industry mainly face is supply and demand mismatches along the supply chains.

Overall, supplier side related information flow risks ultimately lead to supply chain disruption. Any disruptions on the supplier side, for example mismatched information from or to the supplier, will disrupt the entire supply chain operation. The bullwhip effect is sometimes triggered under such circumstances: Participant 1: “...bullwhip effect is so powerful because

whatever happens upstream will affect whatever happens downstream, whatever happens in between will affect both ways because it create a bottleneck in between…" Therefore, it is this ripple effect that is created as a result of supplier related disruptions, that ultimately runs the risk of an organization losing revenue.

The data analyzed did not directly mirror the literature review data on the agricultural challenges impacting on information flow risks of the supply chain. This is because the myriad agricultural challenges of the South/Southern African agricultural sector identified in the literature review are hardly recognized by respondents as contributing to information flow risk in the supply chain.; However, agricultural challenges insofar as they pertain to types of risks associated with information flow, mismatched information to and from the supplier, manifestation of risk in the supply chain, as well as supply chain disruption; these supplier related challenges do indeed contribute to information flow risk in the supply chain of selected food processing companies in SA.

5.4 Discussion of findings addressing the second objective.

The second research objective namely "Analyse the ways in which the diverse distribution landscape of 'corporate' and 'traditional' wholesalers/retailers impact on information flow and attendant risks in the supply chain of food processing companies in SA", deals with demand partners in the supply chain of food processing companies in South Africa and the ways in which they impact on the supply chain's information flow risk. As established earlier in the literature review the demand partners in the supply chain of SA food processing companies are wide ranging; from retailers to wholesalers, but they are all considered 'consumers' of the products procured from food processing companies; as the product is ultimately procured with the main goal of consumption.

5.4.1 Definition of risk in a company's supply chain information flow.

Before delving into the ways consumers/demand partners impact on information flow risks in the supply chain, it would be prudent to establish first what respondent's defined as risk in a company's supply chain information flow. From the interviews, 67% of the respondents (P1 to P4) had a deeper understanding of supply chain information flow risks as their definition captured the possibilities of losses on information quality (that is, accuracy, correctness, timeliness). The definition provided by the respondents was in line with that of Sentia *et al*

(2013, p404) who stated that “information risk can be defined as the probability of loss arising because of incorrect, incomplete, or illegal access to information.” The major information flow risks in the food and beverage processing supply chains include supply risks, system risks and product quality risks which are mostly as a result of sending wrong information to suppliers, customers, and/or internal departments; incorrect order quantities; and losing internal or customer/supplier information through IS breaches or error. The major drivers for these supply chain information risks as indicated by the results are input supply and demand mismatches along the supply chain; product and service quality compromises; delays in supply chain movements. These disruptions are as a result of compromised information quality that occurs when passing through information as stated by P5 response that *“sometimes we miss production because we’re missing information”*.

5.4.2 Types of risks associated with information flow (demand side perspective).

The interview question “types of risks associated with information flow”, revealed not only the supply chain’s information flow risks but the impact these have on the supply chain’s demand partners. The data presented in figure 12, can be categorised into three ways in which the risks identified impact on demand partners namely technology (systems risks and legal risks), customer communication (product quality risks and reputational risks), and processes and procedure (business and financial risk).

Systems risks (which also include breaches and disruptions to customer information access such as the loss of confidential market data), which invariably give rise to legal risks are both risks which speak to the impact of technology on demand partners. Participant 1 perfectly captures the critical role that technology plays in the relationship between the supply chain and demand partners, “...remember technology is the heart we make decisions because of technology, technology enhances us to have information right here right now…” Indeed, the importance of technology in the supply chain is identified by 4 of the 6 participants as being central to ensuring the flow of reliable information, the consolidation of information from various sources, and 3 of the 6 participants also went on to identify elimination of mistakes through manual labour as being enabled by technology. Akkermans *et al*, (2003) advised that greater customer demand whichever rapidly changes; will result in quicker and more comprehensive exchanges of information among all players in the chain. What is more, technology will include not just improved ERP systems but specifically, improved IT tools which incorporate the various stakeholders into the supply chain. Therefore the right

technology, applied in line with demand partner requirements can reduce attendant systems risks and by extension the associated legal risks, with the opposite also being true.

Better customer communication can be seen as an advantage of improved technological systems and tools, and it certainly is seen to be a beneficial factor amongst 4 of the 6 research participants interviewed. The impact of technology on supply chain information flow where customers (demand side) are concerned seems to hinge on whether accurate information is supplied or not, whether access into customer systems can be gained, and the visibility of customer needs. For example, participant 4 suggests that if a supply chain has access to a customer's information they can replenish stock without the organisation (customer) placing the order; "If we have the customers information for example let's say we have Samsung's information of how much…what is their stock levels, their selling rate etc. or we have their warehouse information so we know that when Samsung stock reaches 20 days cover we replenish them instead of someone from Samsung placing an order." As a result of this the product quality risk is minimized given that the supply chain operates from a position of being informed on the customer's exact needs. From that an organization's reputation is not placed at risk as reputational risk arises in instances where customer needs are routinely not met, as one example.

Business and financial risks are closely tied with the organisation's operational efficiencies, and following established processes and procedure speaks to operational efficiency. Following established processes and procedures are what internal staff within the supply chain organisation seem to be engaged in when dealing with the supply chain's demand/customer side. This is echoed by participant 6 when he says, "planning department will consolidate those orders per route and then once consolidated planning department will create the delivery numbers each customer will have delivery number depending on their order so sales will create the order number on the system of the customer and then sales will then capture the quantity of the customer and filter that through to planning by the system not telephonically it will be done on the system so planning will check the order number and the route the route that are on the system then capture…" There is a clear and established way of dealing with customers and their orders, and in order to ensure better customer service and enable better planning, supply chain processes and procedures must be adhered to.

There are three aforementioned three ways in which the risks identified impact on demand partners (and vice versa in that demand partners can give rise to or minimise these risks); namely technology (systems risks and legal risks), customer communication (product quality risks and reputational risks), and processes and procedure (business and financial risk).

Under this research objective, these may not deal specifically with the diverse distribution landscape of corporate and traditional customers (wholesalers and retailers) but they do address the three important ways in which supply chain customers (demand side) in general impact on information flow and attendant risks in the supply chain of food processing companies in SA. Technology (by way of the system risk it engenders) is the biggest impact factor, as attested to by 3 of the 6 research participants interviewed because it enables the flow of reliable information between the supply chain and customers, it consolidates information that comes from various sources for better coherence and it eliminates mistakes from manual labour. By extension information risks as they pertain to unreliable information, incoherent information, and mistakes brought on through human error are avoided. Better customer communication (by way of the product quality risk it engenders) is closely linked to implementation of supply chain and customer IT systems that speak to each other. Again, with 3 out of 6 research participants advocating for the importance of this; this clearly has a substantial impact on information flow in the supply chain; as the information flow risks brought on by inaccurate information, lack of access to customer systems, and not knowing what customer needs are; are mitigated. And while the third factor of processes and procedure (by way of the business and financial risk it engenders) may only have 2 out of 6 research participants identifying it as impacting information flow in the supply chain, its impact is noteworthy in that it enables operational efficiencies in the supply chain.

5.5 Discussion of findings addressing the third objective.

The third research objective namely “assess how food processing companies in South Africa manage risk in the supply chain information flow”, delves into the inner workings of the supply chain in food processing companies in South Africa. While the two preceding objectives were more outwardly focused, in that suppliers (supply side) and customers (demand side) are both external stakeholders in the supply chain; this objective assesses the role that the internal environment plays in managing information flow risk in the supply chain. But first, it is essential to first establish the severity and likelihood of occurrence said risks.

5.5.1 Severity and likelihood of information flow risk occurrence.

In order to fully visualize the nature of information flow risks, it was crucial to ask the interview question, “what is the severity and likelihood of info flow risk occurrence?” The occurrence of

information flow risk is low, which may explain why the P5 respondent stated that their organization's identification process utilized the spot-on approach and why some organizations prefer the reactive approach. Regarding severity, it was observed that despite the modest frequency with which information risk occurs, its effects are extremely severe. One of the responses (P1) indicated that there was a minimal risk of information flow in their organization, but that when it did occur, it was severe. As a result, the company invested a significant amount of effort in information flow risk management despite its low frequency. The intensity of information flow risk is dependent on the exposure types, scenario, and risk environment. In some circumstances, information flow risk has a negative impact on customer services via delays and erroneous product quantity and quality. The respondents mentioned a variety of risk issues associated with information flow in their individual organizations. Poor information and risk management was the primary factor affecting information flow risk, followed by inadequate internal information and communication systems, complex information management systems, a lack of connectivity and coordination along supply chains, and a poorly informed value chain. Although P4 expected that unanticipated external environmental factors may derail existing, well-managed risk and information systems, this was not the case.

Considering the organizations' substantial reliance on operations and management information systems for daily operations, these systems were designed to improve efficiency, but users occasionally found them to be overly difficult. This raises a risk of errors, including security breaches, which endangers the information flow. Information flow risks were thought to be brought on by a lack of external coordination between entities in the supply chain that are otherwise expected to share information. Participants noted, for instance, that the efficiency of information transfer between supplier, manufacturer, and consumer is distorted due to their operation in silos. Silos result in bottlenecks including demand and supply mismatches, which can have negative cost and income repercussions for all parties involved. Despite the fact that businesses might develop information flow risk management procedures, the possibility that certain employees would ignore them persisted. Intriguingly, participant P2 noted, *"Noncompliance is a major issue, particularly when speaking of an industrial environment."* Therefore, such significant cultures contributed to information flow risks.

5.5.2 Identification processes for supply chain information risks.

To comprehend the mechanisms through which information risk is communicated inside an organization, the participants were asked about the identification processes for supply chain information risks. Based on the interviews, it was determined that the most common technique to risk identification is proactive, as it permits problem identification prior to its occurrence. This is backed by P2's statement, which claimed that *"they perform operational systems due diligence, which enabled the identification of risk areas requiring attention,"* and is consistent with P1. However, there are times when organizations take a reactive position when the risks have already expressed themselves in negative events. An interesting exception was P5, who indicated that their organization's approach to risk detection is not proactive nor reactive, but rather a "spot on" strategy that identifies information flow breaches as they occur.

Essentially, the concept of risk assessment uses the score for the likelihood of the occurrence of risk, the impact of the risk, and the method of identification that organisations have at their disposal to reduce the risk impact (Faizal & Palaniappan, 2014). This is consistent with the idea that risk identification is the most undefined process step and can therefore benefit to the greatest possible extent from the integration of lessons learned and continuous improvement efforts (Kern *et al*, 2012).

5.5.3 Role of management and three factors for managing information flow risk.

A pivotal player in the managing of information flow risk in the supply chain seems to be the role that management plays. The first critical role that management must play is maintaining communication, not only with internal stakeholders (employees expected to adhere to internal compliance) but also external ones (suppliers and customers). This seems to be one of the most critical, as all 6 of the research participants interviewed indicated that management must maintain communication with both internal stakeholders and external ones. The second critical role that management must play is that of taking action, and 5 of the 6 research participants interviewed cited this. This of course is not confined to taking action when risk arises, but far more importantly is taking pro-active action or rather being pro-active, while only 4 of the 6 research participants interviewed deemed this to be essential; it is important because as participant 2 stated, “the management and senior leaders basically roll out the vision and the mission statement,” from which aforementioned policies and procedures for internal compliance are birthed. Yet in taking action management needs to be responsive and

flexible in not only their dealings and communication with internal and external stakeholders, but also in how they implement and sustain certain programs, processes and the like in managing information flow risk. An important way in which management can manage information flow risk particularly, is by limiting exposure to sensitive information. Whether this information is flowing from within the organization to external stakeholders, or from external stakeholders (suppliers and customers) into the supply chain, or even with internal information circulating within the organization; management; through processes, systems and procedures; must ensure that only authorized individuals and departments have access to sensitive information.

5.5.3.1 Information flow management factor 1: Internal compliance.

Internal compliance is one of the three major factors identified by research participants interviewed as being essential in the managing of information flow risk in the supply chain. All 6 of the research participants cite internal compliance as a major factor in ensuring the management of information flow risk, and this is expressed rather aptly by participant 1 when he says, “we’ve got processes that we put in place to ensure that our operations, our procedures are complying to our standard to mitigate any risk that will come and cause us any harm.” Here it appears that policy and procedure anchors internal compliance, and indeed all 6 research participants interviewed indicate that policy and procedure must be adhered to internally in order to ensure compliance is attained internally. The reason that putting policies and procedures in place is important, is because 4 of the 6 research participants interviewed agree that policies and procedures govern decision-making, which is to say that when internal members of the supply chain comply with the policies and procedures in place, then the supply chain is able to make decisions that are beneficial for the supply chain. However internal members of the supply chain must be provided with the necessary training internally and support mechanisms in order to ensure that they do indeed follow policies and procedures, and ultimately are complying. Incidentally, 5 of the 6 research participants interviewed expressed that both these factors are important in ensuring internal compliance, as is evidenced in this statement by participant 5; “…obviously training is provided especially for people who have just joined the organisation. We provide training and tell you all sorts of uh let’s say when it comes to computing like that you should be aware of and should familiarise yourself; so, the pub forms part of your own body, make sure that you’re made aware of any of these things so that when they occur you’re able to act promptly and inefficiently when it comes to that.” Yet even with policies and procedures being put in

place in order to guide decision-making, and the provision of internal training and support mechanisms; 2 out of 6 of the research participants interviewed accept that not everything can be controlled, or rather, as participant 4 put it, “there are things beyond our control.” But at the very least, internal compliance ensures that the things that the supply chain is able to control are indeed controlled effectively and thus managing risk factors.

5.5.3.2 Information flow management factor 2: Internal cohesion and co-operation.

While management must limit access to and flow of information of a sensitive nature internally (and externally, to be sure); they must break down any silos within the organization as well as barriers to communication internally and foster inter-departmental co-operation so as to maintain internal cohesion. 4 of the 6 research participants mention that internal cohesion is important in managing information flow risk; and one understands why this is deemed important when considering this statement from participant 2, “so basically if I am not paired to my procurement stakeholders or if I am not paired with my R&D stakeholders or my logistics stakeholders, right let’s say we’re doing a ... project, if there’s a missing piece of the puzzle, then there’s a great risk of delays, delayed to market executions and delays, quality delays etc. you know. It’s more of an information flow and more of a stagnant of that information flow. Therefore, these are risks that can be mitigated.

5.5.3.3 Information flow management factor 3: Putting systems in place.

The management (and mitigation) of these information flow risks can be achieved through putting systems in place, and with no exceptions, all 6 research participants interviewed indicate the great importance of this. Putting systems in place acts more as a toolbox from which management can apply various tools in order to address specific information flow risks within the supply chain. One of the tools that can be used is the monitoring of the internal environment (as well as constantly scanning the external environment) so as to ensure that the systems that have been put in place are indeed working, that policies and procedures are being followed (so as to maintain internal compliance), as well as making sure that the lines of communication remain open. Indeed, participant 2 states that “it is middle management’s job to implement and monitor…” systematic programs in place. One of the ways to monitor systems in the supply chain is by implementing system key performance indicators or KPI’s which ensures that the systems put in place are indeed effective. Effective systems and

system implementation is vital because all 6 of the research participants interviewed acknowledge that it allows the supply chain to always know what is going on; participant 1 says, "…we know exactly what's going on and what we need to put in place in order to be able to contain any particular risk…" All of the aforementioned information flow risk management tools (KPI, monitoring, ensuring systems are effective and always knowing what's going on) allow the supply chain management to continuously assess risk and all 6 of the research participants interviewed agree that this is an important tool in information flow risk management, because as participant 1 attests; "…we are able to contain that particular information or risk and also the key thing that we do in each of our processes we got risk assessment that we do and put in place before we can be able to…each and every process let's say for example payment of our suppliers, payment of our people, payment of any other services there are some processes in place risk assessment that has been done to make sure that these processes are going to be sorted out."

5.6. Discussion of findings addressing the fourth objective.

Once the contributing factors to information flow risks in the supply chain (from the supply side, demand side and within the organisation) and the mechanisms (information flow risk management) have been put in place (spearheaded by the supply chain management and sustained through systems and internal compliance); the impact of risk management on the supply chain information flow can be assessed. There are four main ways – identified through the research interviews – that risk management impacts on the information flow of food processing companies in South Africa, and these are the improvement of internal processes, the improvement of internal systems, fostering improved collaboration, and continuous improvement.

5.6.1 Improvement of internal processes.

All 6 of the research participants attest that internal processes and internal systems are improved as a result of risk management, and to this participant 1 says, "our processes are so clear that we are well defined we know who to talk to, we know how to operate to our people, we know how to engage, we know the processes to follow and we are able to mitigate whatever risk that we are being faced with." It would seem that having processes in place leads to improved communication with both internal and external stakeholders. While internal

processes improve stakeholder relations, internal systems improve the operational side of the supply chain, as it renders the supply chain more efficient and minimizes problems. Participant 5 says this about the impact that risk management has on the supply chain; “the sooner you address it you minimise the impact that’s being done on productivity hours. But the disadvantages of not addressing it on time as I said is you lose a whole lot of productive time; which means that you’ll not be able to meet deadlines.”

5.6.2 Improved collaboration and continuous improvement.

Collaboration and continuous improvement are two other factors that result from managing the information flow risk in the supply chain; with most research participants agreeing to this for the former and all 6 participants agreeing to this for the latter. When an organization’s processes are firmly in place and are indeed being followed internally, the supply chain is able to better plan in terms of how much supply is required in relation to the demand coming through, and this in turn improves stakeholder relations. Continuous improvement implies a constant and consistent monitoring of the supply chain’s systems and processes to ensure that risk identification happens timeously so that risk containment is implemented. Participant 6 aptly describes this aspect of continuous improvement when he says, “...you have to be able to check and look for those things and when you identify them you have to make sure that you report them on a continuous basis because you try to reduce the cost on your side… the risk become high especially when you going to take care or you going to look or check what is happening inside if you blink the eye just for the second you can find a lot of things damaged or a loss of a huge amount of money.” The participant touches on yet another crucial aspect of continuous improvement which is the avoiding of production loss and costs, so crucial is this aspect of continuous improvement that all 6 of the research participants interviewed mentioned this being a vital and positive impact of risk management on the supply chain. The reduction of work interruptions is another positive impact of continuous improvement on the supply chain information flow, with most interview participants citing it as such. While only 3 of the 6 research participants interviewed agree that continuous improvement renders the supply chain more agile, the negative implications of not having an agile supply chain are perfectly captured in this statement by participant 5, “…the disadvantages of not addressing it on time as I said is you lose a whole lot of productive time; which means that you’ll not be able to meet deadlines, and it means that decisions will not be able to be made, you are not being--- you won’t make decisions any faster...”

5.6.3 Advantages of deliberate information flow risk management.

Due to the fact that all of the respondents held managerial roles, they were able to draw on both their experiences and perspectives. In their function as facilitators of internal cohesiveness, managers were responsible for promoting interdepartmental cooperation which in turn reduces supply chain information flow risks. As a result of increased "siloed" operations, departments took unilateral measures that affected others without consultation and in an uncoordinated manner. The interconnected nature of producing entities necessitated coordinated risk management, which in turn necessitated internal cohesion. As experienced by P1 and P6, managers were crucial in removing any obstacles and impediments to coordinated information flow that may exist in policies, strategies, and cultures.

The organizational benefits of information flow risk management did not contradict one another. It was widely held that information flow risk management facilitated proactive risk management and contributed to low occurrences and case severity associated with risk. Risk management, facilitated communication, and activity coordination in light of the bullwhip effect, in which *"what happens upstream will affect what happens downstream"* as stated by P1.

Effective information flow risk management recognizes the interconnectedness of supply chain effects and plans in advance for interruptions along the whole supply chain. Even when proactive techniques fail to limit risks, information flow risk management improves response times. For instance, in order to mitigate the effects of information flow risks resulting from rapid external changes to supply chain norms and procedure, a corporation must be able to adapt rapidly.

Other benefits of information flow risk management include enhanced corporate operations and performance, fewer product losses, reduced system downtime, and improved information availability and flow. When a risk develops and is effectively managed, it generates learning opportunities for managing it. As a result, even in its reactive form, effective information flow risk management encouraged risk learning and development.

5.6.4 Effectiveness of information flow risk management.

The respondents discussed the significance of ongoing improvement in information flow risk management, both directly and implicitly. This was in reference to the different systems, methods, and procedures that companies implemented to control and contain risks. Further investigation into continuous improvement found that it facilitated risk identification capabilities in the selected food manufacturing industries. Adaptation to the changing business environment necessitated a commitment to continuous development. Companies had no choice but to pursue constant improvement because, as P1 stated, "if you remain stationary you are dead, you are out of business". In a similar vein, P3 argued that "to improve their KPIs," which were typically imperfect, businesses needed to continuously enhance their risk management methods.

Moreover, constant development in information flow risk management was necessitated by the inherent flaws in every system. Even with the most precise design by pros and experts, "no system is flawless." In addition to the need for corrective adjustments in risk management systems, it is essential to recognize that the risk environment is dynamic and tends to increase in complexity over time. As a result, P1 and P2 perceived that the risk management processes required constant modification. In addition, information flow risk management's reliance on management information systems necessitated businesses acquire the most recent versions of these systems; this was also regarded as an integral aspect of continuous improvement.

A new system like integrated *"vendor management systems"* that linked supplier and customer systems facilitating seamless transaction processing and information flows and the need to adapt these systems-related continuous improvement needs. To support this, P3 perception was that organizations are required to continuously improve to meet global risk management standards.

Respondents were instructed to provide an overall rating of the risk management strategies' efficacy. The majority of respondents agreed that the various risk management strategies, even those that were predominantly reactive as opposed to proactive, were effective for managing information input risk. Positive audit reports, increasing risk KPIs, and the absence of detrimental information system breaches were indicators of well-managed information flow risk systems.

According to Hyland *et al*, (2003) it is generally recognised that in today's complex and tumultuous business environment – internally and externally – organisations need to develop capabilities that allow them to be both versatile and agile, all while incorporating new product

and process technologies that allow for the establishing and leveraging of good practices in supply chains. This versatility and agility demand that organisations improve their productivity, leverage synergies insofar as working together with stakeholders in order to achieve a common goal, as well as learn in all aspects of their operation (Hyland *et al*, 2003).

Metrics for continuous assessment and analysis ensure that risk management practices continuously apply the three (fourth component is the cyclical process) SCRM processes to identify, analyse and mitigate (react, monitor and control) risks (Pimchangthong & Boonjing, 2017). The findings also highlight advancements in computing and risk technology, as well as new breakthroughs in new technologies that exploit cloud computing, analytics, mobile applications, big data, enterprise resource planning, and governance risk. Compliance plays a critical role in risk management in the information flow of the supply chain. According to Sweeny (2006), supply chain partners can use common data by utilizing technology such as the Internet, Electronic Data Interchange (EDI), and Enterprise Resource Planning (ERP) systems. As a result, organizations can operate on the basis of actual demand rather than the skewed product demand information that arises when orders are relayed in an extended chain. Such technological developments offer risk managers and those inside or outside the organization involved in improving existing risk management systems a greater ability to improve risk management efficiency.

5.6.5 Tools for info flow risk management in the supply chain.

The interview adopted a different approach to examine the impact of risk management on the supply chain information flow. This was achieved through examining the risk management instruments, the majority of which are digital information systems. This helps to identify the strengths and drawbacks of these techniques as they pertain to the risk management of information flow. Enterprise Resource Planning (ERP) and general office tools (spreadsheets) followed by manual tools; management and operations information systems; and Business Intelligence Software or Systems (BIS) were the agreed-upon tools (e.g., Microsoft BIS). These tools proved to be the most effective in the food and beverage industry for addressing information flow concerns in the supply chain. However, other technologies, such as advanced planning and optimization tools, vendor management systems, and databases, can be implemented.

ERP was seen as the most effective technique for information flow risk management due to the fact that deploying ERP software helps organisations stay ahead of the competition by

eliminating the danger of making costly business errors that could put the organization behind the pack. An ERP platform removes repetitive operations and drastically decreases the need to manually enter information, which not only increases user productivity but also minimizes the potential of erroneous data, which could lead to costly business mistakes. Nobody desires to manage a business in which each department operates independently. Collaboration between departments is an essential and frequently necessary aspect of business, especially given that business tasks sometimes involve more than one department. APICS Report, (2016) revealed that to reduce risk in supply chain partners need to work together to build trust, in other words there must be collaboration. Lack of confidence between companies can lead to a vortex of risk whereby risk rises, and trust corrodes.

Collaborative relationships allow supply chain partners to mutually gain a rigorous understanding of future demand, set realistic plans to fulfil that demand, and coordinate activities to that end in the most effective way (Smith et al., 2007). Supply chain partners must collaborate in planning, forecasting and replenishment in order to ensure that their information flows are always reliable, accessible and occur in real time (Ulhaq et al, (2016).

With consolidated and consistent data entered into the ERP system, there is no reason why departments cannot work together, share information, and collaborate as needed which then reduces supply chain information flow risks. Visibility into supplier and customer metrics, as well as into organisations data systems such as an ERP system increases the ability to monitor potentially risk laden events (Faizal & Palaniappan, 2014).

Sweeny, (2006) pointed out that technologies such as ERP, EDI and the Internet enable supply chain partners to use common data. This enhances agility in the supply chain, since businesses should operate on the basis of ' real demand' and not on the distorted and noisy picture arising as orders are transmitted in an extended chain from one point to another (Sweeney, 2006).

Risk management information was categorized into strategies, policies and procedures, systems and assessment, and monitoring and evaluation. Risk management strategies include continuous improvement, agile, reactive systems, proactive risk management, and risk containment. Risk strategies were supported by public communication protocols, information segregation, buffering, information policies, risk management operating procedures, internal systems coordination, internal and external communication processes, and collaborative planning.

The companies used ICT systems to control information flow, with some manual parts. Using data trails and data banks to review and back up information, using risk and general information management systems, and defining data management benchmarks were essential systems management concerns and processes. Risk management's systems part included user assistance, system upgrades, system evaluations, and ICT user training. Risk assessment, monitoring, and evaluation were also examined in relation to risk management approaches and processes. Risk assessments and audits, risk management KPI, and information and data management due diligence.

Effective information flows within and across organisations are thus vital for the managing of supply chains because supply chain management operations cannot be possible without effective information systems management (Tatoglu *et al*., 2016). Hence ineffective information systems are major impediments to effective supply chain management (Tatoglu *et al*., 2016).

The results revealed that policies and procedures, specifically information policy and/or strategy, and operational procedures on risk management were the most prevalent forms of risk management, followed by assessment, monitoring, and evaluation, with particular emphasis on risk assessments/audits.

Given the overall results obtained in this study, it is appropriate to investigate whether there are any significant changes on the preliminary literature conceptual framework (Figure 6) from the presented results and make necessary modifications. Hence, the following section presents the modified conceptual framework.

5.7 Modified Conceptual Framework.

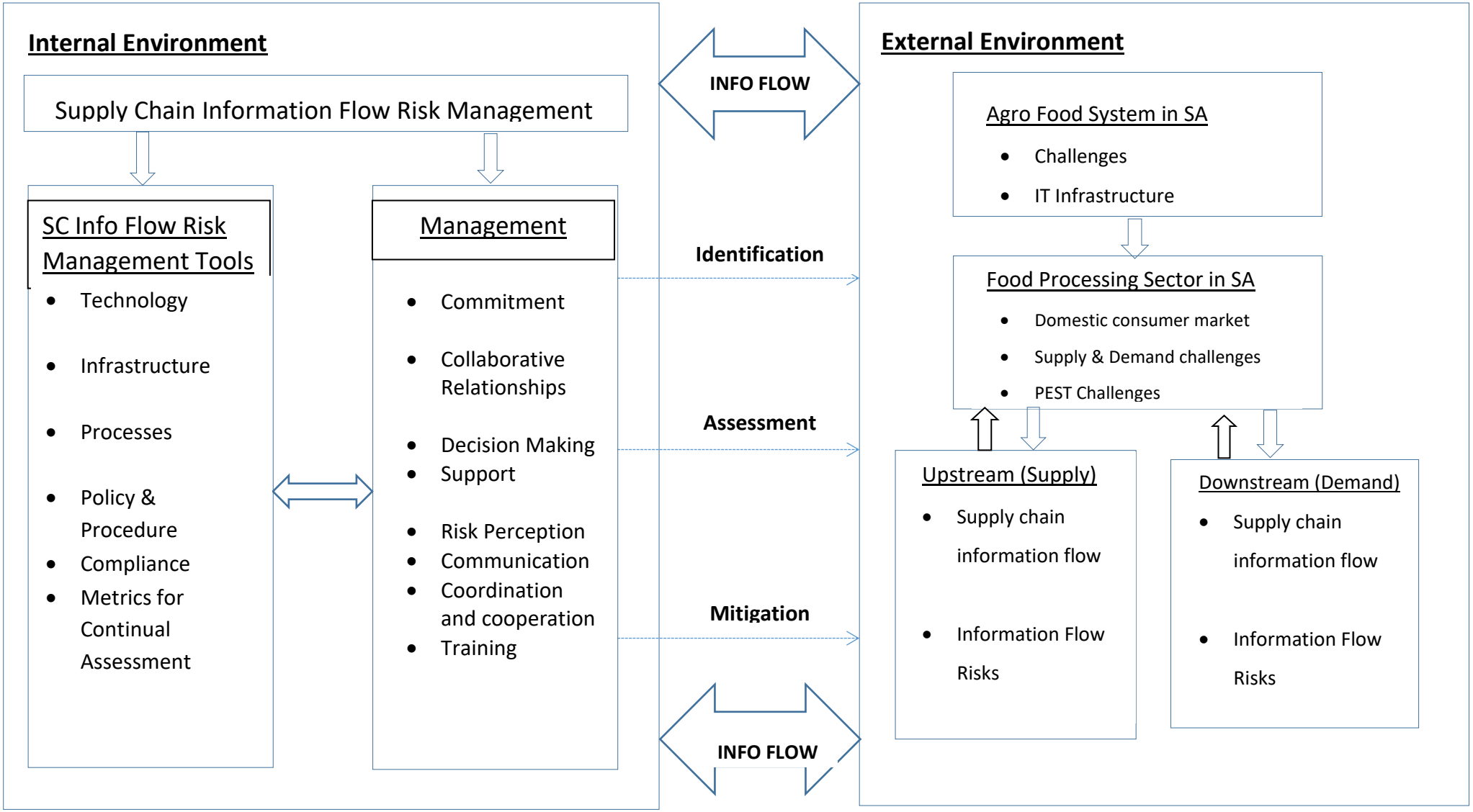


Figure 20: Modified Conceptual Framework from the results.

The Figure 20 above shows the modified conceptual framework for this study after incorporating the feedback from the interviews conducted and the literature review. It shows both the internal and external environment. The frame resembles the initial structure as proposed in the preliminary model with a few changes which are highlighted under the two categories internal environment and external environment below.

Internal environment.

The major change from the proposed framework is the internal environment on supply chain information flow risk management. The new dimensions include communication, training, coordination and cooperation. The other dimensions from the literature like commitment, collaborative relationships, decision-making, and support and risk perceptions remained relevant in the framework as stated in the literature.

Duhadway *et al*, (2018) emphasised that organisational communication regarding risk often influences decisions made by supply chain managers who compensate for changes in organisational risk. While decision makers compensate in response to communicated risk, their perceived overall levels of risk having done so are positively related to levels of communicated risk. In other words, as communicated risk increases or decreases, the effect of such communication might persist, even after adjusting decisions to accommodate different levels (Duhadway *et al*, 2018).

As a means to align supply chain strategy and business processes, it is crucial for top management to offer requisite support to internal communication department by constantly being available, serving as a communication model, and expecting other managers in the organisation to emulate and develop into strong communicators (Wong et al, 2012) Alignment often entails two-way communication between management and employees (Wong et al, 2012). That being so, top management must listen to employees because leaders who listen are more likely to enable change (Wong et al, 2012).

Another critical role that management must play is that of taking action. This of course is not confined to taking action when risk arises, but far more importantly is taking pro-active action or rather being pro-active. Yet in taking action, management needs to be

responsive and flexible in not only their dealings and communication with internal and external stakeholders, but also in how they implement and sustain certain programs, processes and the like in managing information flow risk. While management must limit access to and flow of information of a sensitive nature internally (and externally, to be sure); they must break down any silos within the organization as well as barriers to communication internally and foster inter-departmental co-operation so as to maintain internal cohesion. Most critically, internal members of the supply chain must be provided with the necessary training internally and support mechanisms in order to ensure that they do indeed follow policies and procedures, and ultimately are complying.

From the Supply Chain Information Flow Risk Management Tools, the results managed to identify the actual Supply chain information flow risk management tools that includes technology. Technology included ERP, advanced planning and optimisation tools, business intelligent systems, vendor management system, databases, management and operations information system and general office tools. The research findings emphasised the importance of technology in supply chain information flow risk management which is in accordance with Tatoglu *et al*. (2016) and Faizal and Palaniappan, (2014) who emphasised the importance of technology in supply chain management since it promotes coordination and cooperation within departments. The framework also includes infrastructure, processes, compliance, policies and procedures as some of the tools. Compliance and metric for continual assessment were also integral part of Supply Chain Info Flow Risk Management Tools.

External environment.

From the research findings, the external environment framework did not change given that the issues revolved around the same challenges raised in the literature review. As Greenberg (2017) asserts that the information flow risks in the supply chain of the South African food processing sector cannot be separated from the challenges within the broader South African agro-food system. The agricultural challenges such as lack of access to resources by smallholder farms and climate unpredictability, can impact on supply of raw goods to the food processing companies (FAO *et al*, 2018). Mercer,

(2011) and Nguegan & Mafini (2017), noted that some of the factors that contribute to the challenges faced by the food processing sector in South Africa include; information flow due to incompatibility of technological systems and technology development due to lack of investment in technology, market access in terms of inability to penetrate the market; to mention but a few.

Information flow between suppliers (agricultural entities/ primary production) and food processing companies is a two-way relationship, and technology aides this relationship. Information systems are essential for effective information flows across organisations (supply chain stakeholders), so as to manage supply chains (Tatoglu *et al*., 2016). Thus, technological challenges in the agricultural sector create information flow risks in the supply chain of food processing companies in South Africa. Additionally, Singhal *et al*. (2011) posits that the demand amplification that the food processing sector is facing is due to information mismatch. This external factor as highlighted in Figure 16 represents information flow risk within the supply chain of food processing companies in South Africa.

Conclusively, the major changes from the proposed conceptual framework (Figure 6) was on internal environment with the inclusion of communication, training; coordination and cooperation whilst the external environment remained the same.

5.8 Conclusion of discussion.

Based on the findings, it was determined that, while every company faces business risk factors that affect its competitiveness, business risk factors that pose a particular risk to the flow of information in the supply chain for food processing companies in South Africa are closely linked to the supply side in terms of agricultural challenges faced by South African farmers as well as attendant difficulties arising from the demand side where 'corporate' and 'traditional' wholesalers/retailers are concerned.

Most importantly, findings revealed, that the management of information flow in the supply chain along with its attendant risks both internally (organisational internal environment) and externally (made up of suppliers and customers); requires two aspects; the active involvement and stewardship of the organisation's top management (Faisal *et al.* 2007) as well as tools that enables the management of SC information flow risks.

The findings support those of Singh & Singh (2019) who found that management decision-making has a variety of implications in organizations, ranging from reducing risk, building up business risk resilience and enhancing operational efficiency.

Frigo & Anderson, (2011) caution however, that If risk assessment and management processes are not incorporated and owned by management as an inherent element of business processes, the risk management process will quickly lose control and will not contribute to or serve its intended function. These clearly correlate with practitioners (P1, Male, Operations Manager; P2, Male, Master Planner and P3, Female, Supply Chain Analyst) who insinuated that management lays out its strategy and mission, guides/oversees the process, and ensures that their subordinates are following the process and paying attention to the achievability of the organisation's objectives.

The findings echoed that commitment is the most important management quality among all the different qualities that management needs to ensure effective risk management in the information flow of the supply chain. Without commitment collaborative relationships amongst the supply chain stakeholders are not assured and thus reliable information is not guaranteed. Without commitment, decision-making becomes ineffective, and management is unable to provide supply chain stakeholders with the support they need when and where it is needed.

The results seem to recognize that it is not enough for management to simply put in place policies, processes and procedures, it must also ensure compliance by internal stakeholders in the supply chain. This implies providing general guidance regarding an organization's mission and clarifying and reinforcing the standards expected of employees regarding risk mitigation in the supply chain information flow.

Through the repetitive rounds of analysis, the researcher has identified the four most important components of risk management in supply chain information flow, which are; identification of information flow risks, assessment of identified risk, mitigation of identified risks and continuous assessment. Metrics for continuous assessment and analysis ensure that risk management practices continuously apply the three (fourth component is the cyclical process) SCRM processes to identify, assess/analyze and mitigate (react, monitor and control) risks (Pimchangthong & Boonjing, 2017) .

The findings also highlight advancements in computing and risk technology, as well as new breakthroughs in new technologies that exploit cloud computing, analytics, mobile applications, big data, enterprise resource planning, and governance risk. Compliance plays a critical role in risk management in the information flow of the supply chain. According to Sweeny (2006), supply chain partners can use common data by utilizing technology such as the Internet, Electronic Data Interchange (EDI), and Enterprise Resource Planning (ERP) systems. As a result, organizations can operate on the basis of actual demand rather than the skewed product demand information that arises when orders are relayed in an extended chain. Such technological developments offer risk managers and those inside or outside the organization involved in improving existing risk management systems a greater ability to improve risk management efficiency.

Chapter 6: Conclusion.

6.1 Introduction.

The preceding chapters focused on outlining the background of the study, problem identification, review of applicable and a presentation of the results followed by discussion of the research findings. This chapter concludes the study and makes recommendations.

6.2 Contextualising the research study.

This study set out to investigate information flow risk factors and the mitigation strategies employed by Food Processing Companies in South Africa in order to better understand how information flow risk is managed within the food processing industry in South Africa. To accomplish this goal, a qualitative research approach was adopted to carry out this study. As per research design it is an appropriate approach since the aim is to obtain the (interpretive) experiences of management in food processing companies as it pertains to supply chain information flow risk that must be made visible. Six interviews were conducted from various individuals who have vast knowledge and experience in the food and beverage industry and have worked with companies that have both national and international footprints in the industry.

From the findings, information flow risk was defined as the possibilities of losses in reliability, integrity and timeliness of information. The respondents further highlighted the core characteristics of information quality whose absence or presence could also be used to define information flow risks in supply chains. It was observed that information flow risks manifested themselves as supply and demand mismatches along the supply chain. The companies indicated that they had proactive risk identification through risk assessments and a reactive unit when risks are reported and these mitigate against information loss to food processing companies. The results generally show that the various risk management strategies, reactive and proactive, were effective in information flow risk management.

6.3. Answering the research question by addressing objectives.

To help answer the study question, the following objectives were addressed below:

Objective 1: Examine the extent to which agricultural challenges in South Africa contribute to information flow risk in the supply chain of food processing companies in SA.

The research results revealed that while supply partners do have an impact on information flow risk in the supply chain that impact does not precisely mirror the agricultural challenges as laid out in the literature review. This is because none of the respondents explicitly discussed challenges in the agricultural industry – that is the supply side – as directly affecting the supply chain, but rather that inadequate information flow and misinformation to and or from the supply side disrupts the supply chain. Nevertheless, there are other ways that the supply side impacts the information flow in the supply chain, which include the following:

A poorly informed supplier is problematic and proves to be an information flow risk for the supply chain. Which is to say that suppliers must both, supply correct information from the supply chain (and other sources) in order for the supply chain to be able to make good decisions. Of course, the challenges that may hinder the supplier from achieving this are related to technology, insofar as agricultural suppliers having access to the necessary technologies, as well as the linking of suppliers' ICT's with that of the supply chain. Another way is where supplier affects consumer – The concern here seems to be that miscommunication, or rather the exchange of incorrect information, between the supplier and the supply chain will inevitably have an impact on the consumer which may result in poor product quality sent to the consumer and invariably this will affect the organisation's reputation. Yet another way is by supply chain disruption - Any disruptions on the supplier side, for example too much stock or too little stock, will disrupt the entire supply chain operation, the bullwhip effect is sometimes triggered under such circumstances. And it is this ripple effect that is

created as a result of supplier related disruptions and the supply chain ultimately runs the risk of losing revenue as a result.

Objective 2: Analyse the ways in which the diverse distribution landscape of 'corporate' and 'traditional' wholesalers/retailers impact on information flow and attendant risks in the supply chain of food processing companies in SA.

The impact of technology on the flow of information in the supply chain when it comes to customers (demand side) seems to depend on whether accurate information is provided or not, whether access to the customer system can be obtained and how visible customer needs are.

As the study results show, there are several risks that the supply chain is exposed to, namely systems risks, legal risks, product quality risks, reputational risks, business risks and financial risks. The ways that demand partners (consumer) impact on the information flow of the supply chain is through technology, customer communication and processes and procedures. Demand partners can give rise to or minimise these risks in that: technology gives rise to or minimises systems risks and legal risks, customer communication gives rise to or minimises product quality risks and reputational risks, and processes and procedure give rise to or minimise business and financial risk.

The results indicate that because technology enables the correct and efficient flow of information which leads to correctly processing and delivering of consumer goods, if demand side does not have the right technology that allows the right information to flow to and from the supply chain or vice versa, then this results in system errors (risks) such as incorrect order quantities and consequently opens up the supply chain to legal risks from the consumer. Customer communication ensures that product quality is met to the customer's needs and specification. Without this, there is a risk of the supply chain's reputation being adversely affected due to routinely not meeting customer needs as a result of lack of communication. Processes and procedures in the supply chain enables supply chain efficiency, and this efficiency benefits the customer because it results in timely delivery of goods and related services.

Objective 3: Assess how Food Processing Companies in South Africa manage risk in supply chain information flow.

This objective is more outwardly focused; and in addressing it, it was necessary to first establish the likelihood of information flow risks occurring in the supply chain. Surprisingly, the results showed that the likelihood of information flow risk occurring is low. So, it would seem that food processing companies in South Africa do not have much to manage as far as information flow risks are concerned based on this finding. Nonetheless, there is low risk probability which still needs to be managed. The risks that occur are managed through internal compliance, identification of supply chain flow risks and an activate involvement of management in managing supply chain information flow risk.

Internal compliance is an important factor in ensuring information flow risk management. This is because organizations substantially rely on operations and management information systems for daily operations; yet these are routinely ignored by internal staff.

To enable internal compliance organisations put in place policies and procedures, and the reason why establishing policies and procedures is important is because policies and procedures govern decision making, i.e. when internal members of the supply chain comply with the policies and procedures in place, then the supply chain is able to make decisions that are beneficial for the supply chain. However, internal members of the supply chain must be provided with the necessary training internally and support mechanisms to ensure that they actually follow, and ultimately comply with, the policies and procedures.

Identification of supply chain information flow risks is crucial in managing risks even before they emerge. Based on the interviews, it seems the most common technique to risk identification is being proactive.

The role of the organisation's management in managing supply chain information flow risk appears to be highly regarded by most respondents. Management does this by maintaining communication with internal as well external stakeholders, taking pro-

active action in managing the flow of information within the supply chain and limiting exposure to sensitive information. Organisational management is also responsible for ensuring internal compliance, fostering internal cohesion and co-operation, as well as putting systems in place in order to address specific information flow risks within the supply chain.

Objective 4: Determine the impact of risk management on the supply chain information flow of food processing companies in South Africa.

From the findings of the study, there are four main ways that risk management impacts on the information flow of food processing companies in South Africa, and these are the improvement of internal processes, the improvement of internal systems, fostering improved collaboration, and continuous improvement.

It would seem that having processes in place leads to improved communication with both internal and external stakeholders. While internal processes improve stakeholder relations, internal systems improve the operational side of the supply chain, as it renders the supply chain more efficient and minimises problems. Having improved internal systems such as Enterprise Resource Planning (ERP) tool is more efficient in addressing information flow risk in supply chains. This is so mainly because ERP platform removes repetitive operations and drastically decreases the need to manually enter information, which not only increases user productivity but also minimizes the potential of erroneous data, which could lead to costly business mistakes.

Collaboration and continuous improvement are two other factors that results from managing the information flow risk in the supply chain; When an organisation's processes are firmly in place and indeed being followed internally, the supply chain is able to better plan in terms of how much supply is required in relation to the demand coming through, and this in turn improves stakeholder. Continuous improvement implies a constant and consistent monitoring of the supply chain's systems and processes to ensure that risk identification happens timely so that risk containment is implemented. Another crucial aspect of continuous improvement is the avoiding of

production loss and costs. The reduction of work interruption is another positive impact of continuous improvement on the supply chain information flow.

Thus, based on the fulfilled objectives above, the research question can be answered. Risk management strategies employed by food processing companies in South Africa appear to target both the internal and external environment of the supply chain. From an external perspective there is the demand side and the supply side; both of which have an impact on information flow risk in the supply chain. On the supply side, since the impact has been established to be communication centred, in that lack of adequate and correct information flowing both to and from the supplier has the potential to give rise to information flow risks which result in issues such as disruptions in the supply chain, here improved communication systems are key. On the demand side, meeting consumer needs appears to be central in strategies to address information flow risks. This includes improving technology, customer communication and processes and procedures so as to minimise risks such as systems risks, legal risks, product quality risks, reputational risks, business risks and financial risks.

From the internal perspective, strategies employed in the internal environment by companies in the food processing industry in order to managed information flow risk can be categorised into two interconnected parts namely, the role that organisational management plays and supply chain risk management application. With the former, the organisation's management is seen as the leader or rather at the forefront of putting in place requisite policies and procedures so as to ensure internal compliance amongst staff. Management does this by maintaining communication with internal stakeholders, taking pro-active action in managing the flow of information within the supply chain and limiting exposure to sensitive information. Organisational management is also responsible for ensuring internal compliance, fostering internal cohesion and co-operation. From the application of supply chain risk management side; this means putting in place appropriate internal processes, the improvement of internal systems, fostering improved collaboration, and continuous improvement.

6.4 Recommendations.

Following the conclusion of the study, the following policy recommendations are proposed:

1. Invest in Risk Management Instruments.

The Food processing industry of South Africa needs to investment in the latest and best risk management instruments such as the ERP which has the ability to improve the competitiveness of an organisation, collaboration between departments, and forecasting, among other factors. This will assist in removing and/or reducing supply chain information flow risk.

2. Encourage a proactive and reactive approach.

Organisations in the food processing industry need to be both proactive and reactive as a contingency plan to address any challenges emanating from information flow risk. Being proactive anticipates for the worst and enables prompt and effective preparation to address impending risk. While a reactive response ensures organisations move swiftly in addressing information flow risks in real time. This will reduce the severe effects of the supply chain information risk in the event that one occurs.

3. Synergy.

There is need to promote synergy between supplier and manufacturer and manufacturer and customer so as to reduce the information flow risks that arise due to information inaccuracy.

4. Educational Campaigns.

Due to the low frequency of supply chain information flow risk occurrence, most organisations might see this as a myth. Therefore there is a need for educational campaigns to educate managers; executives and employees regarding the unexpected and unplanned information risk occurrences; as well as how these hinder the operation of the business. Hence there is a need to be always prepared and to have a contingency plan in place.

6.5 Avenues for Future Research.

The current study investigated the role of risk management in supply chain information risk with particular attention to the food processing industry. There is room for future studies to investigate further in this realm of study, while taking into consideration the differences between various sectors in the food processing industry of South Africa. Moreover, future studies can conduct a comparative investigation on whether the same strategies are being adopted in various industries or if the strategies implemented to mitigate information flow risk vary within the industry under investigation in this study.

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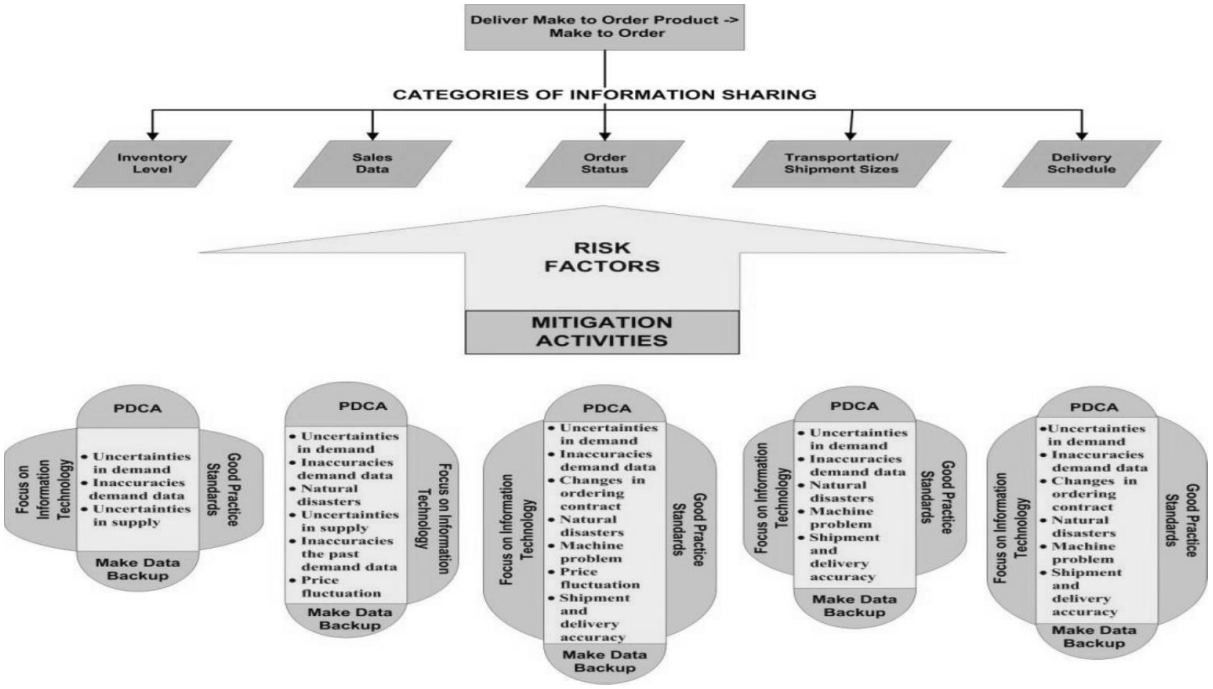
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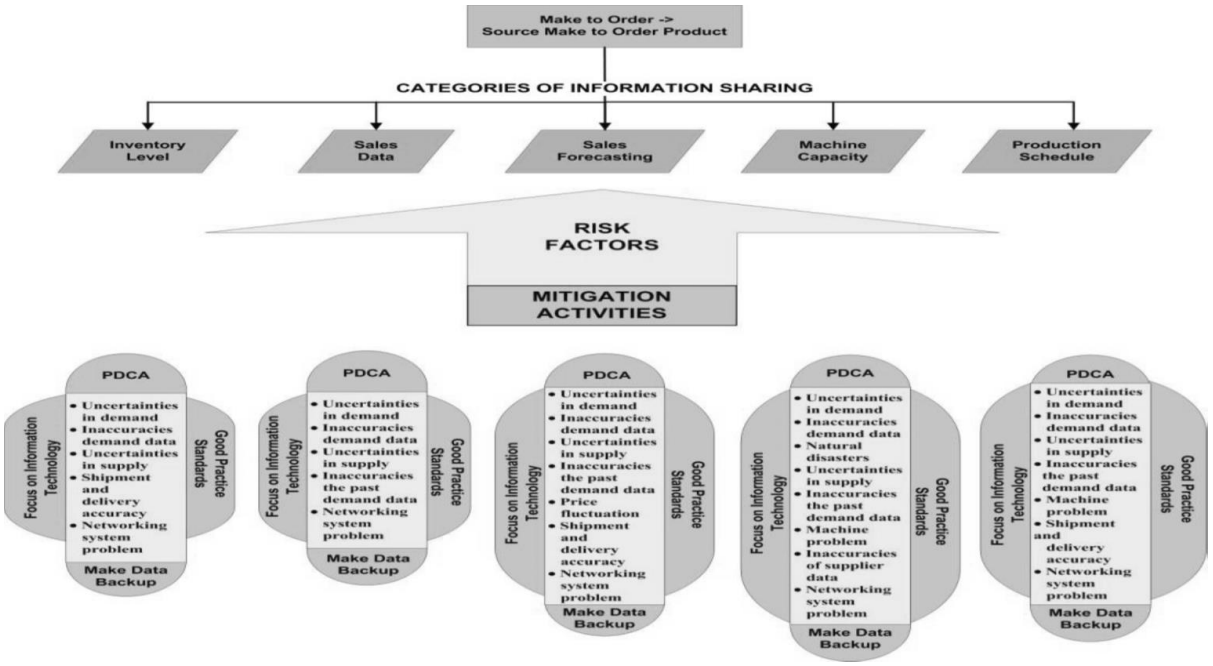
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8. Appendices.

Appendix 1: Information-Risk-Mitigation Model DMTOP to MTO [Sentia *et al*., 2013:408].



Appendix 2: Information-Risk-Mitigation Model MTO to SMTOP [Sentia et al., 2013:409.



Appendix 3: HREC Ethics Clearance Certificate.

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Matlhoko

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H19/04/12**
PROJECT TITLE	Risk management in supply chain information flow: A study of selected food processing companies in South Africa
INVESTIGATOR(S)	Mr O Matlhoko
SCHOOL/DEPARTMENT	Mechanical, Industrial and Aeronautical Engineering/
DATE CONSIDERED	26 April 2019
DECISION OF THE COMMITTEE	Approved Permission letters required before data collection can commence
EXPIRY DATE	17 July 2022

DATE 18 July 2019 **CHAIRPERSON** J. Knight
(Professor J Knight)

cc: Supervisor : Dr B Emwanu

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University. Unreported changes to the application may invalidate the clearance given by the HREC (Non-Medical)

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to completion of a yearly progress report.**

Signature

18/07/2019
Date

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

].

Appendix 4: Themes/Respondents.

Table 8: Advantages/Respondents.

Advantages/Respondents	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**
Improved Information availability and flow		x				
Facilitates risk learning and development			x			
Working capital and general cost efficiency		x		x		
Improved supply chain coordination, connectedness		x				x
Improved business operations and performance		x				x
Reduced losses of products				x		x
Systems downtime minimization					x	x
Improved internal/external communication			x	x		x
Improved reaction and response time			x	x	x	x
Improved supply chain operations/flow	x	x		x	x	x
Facilitates proactive management	x	x	x	x	x	x
Supports continuous improvement	x	x	x	x	x	x

Table 9: Types of risks/Respondents.

Types of risks/Respondents	**P 1**	**P 2**	**P 3**	**P 4**	**P 5**	**P 6**
Reputational risks	x				x	
Business and financial	x					x
Legal risks			x		x	
Product quality risks		x	x			

Systems risks	x	x			x	
Supply risks	x	x	x	x	x	x

Table 10: Advantages/Respondents.

Advantages/Respondents	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**
Improved Information availability and flow		x				
Facilitates risk learning and development			x			
Working capital and general cost efficiency		x		x		
Improved supply chain coordination, connectedness		x				x
Improved business operations and perfomance		x				x
Reduced losses of products				x		x
Systems downtime minimisation					x	x
Improved internal/external communication			x	x		x
Improved reaction and response time			x	x	x	x
Improved supply chain operations/flow	x	x		x	x	x
Facilitates proactive management	x	x	x	x	x	x
Ripple/domino effects	x		x			

Table 11: Tools/Respondents.

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Tools/Respondents	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**
Enterprise Resources Planning systems (e.g. SAP)			x	x		

Tools/Respondents	P1	P2	P3	P4	P5	P6
Advanced Planning and Optimization tools				x		
Business Intelligence Software (e.g. Microsoft BIS)				x		x
Vendor management systems				x		
Management and operations information systems	x	x				
Manual tools	x					x
General office tools (spreadsheets)	x			x		x

Table 12: Strategies/Respondents.

Strategies/Respondents	*P1*	*P2*	*P3*	*P4*	*P5*	*P6*
Due diligence on information and data management systems		x				
Risk management KPIs		x	x	x		
Risk assessment/audits			x	x	x	x
Data trails		x				
Data banks		x				
Risk training				x		
Risk planning and management info systems			x	x		x
Data management benchmarks		x				
User support		x	x			
Systems upgrades		x			x	x
Systems evaluations (ease of use, security)		x			x	x

User-training on ICT systems		x	x		x	
Public communication protocol	x					
Segregation of customer accounts management			x			
Buffering				x		
Information policy/strategy	x	x		x	x	
Operating procedures on risk management		X	X	x	X	
Internal systems coordination		x				x
Internal and external communication			x	x		x
Collaborated planning(suppliers, customers)	x	x		x		x
Risk containment	x					
Proactive risk management	x					x
Agile and reactive systems				x	x	
Continous improvement of risk management systems	x				x	x

Table 13: Manifestations/Respondents.

Manifestations/Respondents	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**
Legal exposures			x			
Increases in operational costs		x			x	
Poor decision-making	x					x
Loss of productivity, production time		x	x		x	
Delays in supply chain movements		x	x	x		x
Product and service quality compromises	x	x		x	x	x

Input supply and demand mismatches along the supply chain	x	x	x	x	x	x

Table 14: Factors/Respondents.

Factors/Respondents	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**
Non-compliance cultures in teams		x				
Unforeseen external environment changes - laws				x		
Poor systems security			x		x	
Poorly informed value chain (e.g., suppliers)	x				x	x
Lack of connectedness, coordination along supply chains	x	x				x
Complicated information management systems		x			x	x
Poor internal information and communication systems			x	x		x
Poor information and risk management	x	x	x	x	x	x

Table 15: Risk containment/Respondents.

Risk containment/Respondents	*P1*	*P2*	*P3*	*P4*	*P5*	*P6*
Business contingency plan	x					
Risk management capacity and abilities	x					
Agility to immediately adjust to external shocks and changes				x		

Table 16: Risk management philosophies/Respondents.

Risk management philosophies/Respondents	*P1*	*P2*	*P3*	*P4*	*P5*	*P6*
Knowledge of internal environment	x					
Collaboration capacities with value chain players	x					

Appendix 5: Theme generation.

Definition of risk in a company's supply chain information flow

The interview process had a direct question that demanded the respondents to define risk in a company's supply chain information flow from their companies' perspectives. This question was important. This question was an important indicator of the respondents' general information flow risk perspective and such a perspective was expected to help an understanding of their views and experiences on information flow risk.

Table 17: Respondents' definitions of information flow risks

...1: Themes were generated in response to specific questions e.g the THEME: ***Definition of risk in a company's supply chain information flow*** was generated in response to the question: ***How do you define risk in your company's supply chain information flow? (note there were different questions among other candidates these too guided the themes)***

How do you define risk in your company's supply chain information flow?

Risk is anything that have got a potential of causing harm to our business, be it a financial loss, be it a reputational damage, be it a human capital damage, its risk for us. And now it comes in various forms either in where we got processes that we put in place to ensure that our operations, our procedures are complying to our standard to mitigate any risk that will come and cause us any harm, For example on the information flow there's a information policy that we've got, we got a policy that will describe and define in case of a particular issue there are different levels that one need to follow before they can communicate to let's say for example outside people...so its just one element there are many others but in this case for example if there's issues that are related to the media there's one specific allocated person who can talk to the media...if there's anything that is happening in the business there's some levels of people designated to have that kind of information flow and communication because the key thing is to have one information that is very accurate, is reliable and not going to cause any harm to the business and to a company as a whole so in a nutshell we take risk very serious in terms of information flow and how we do things and operations. There was a time were

.

Respondent	Respondent view/definition
P1	The potential flow of unreliable, incorrect or inadequate information across the production value chain; threats of wrongful publication of internal information

- ***2. Themes were generated in response to research objectives – where applicable, e.g. THEME Tools and systems for managing risks***

RESPONDS to objective- Assess how selected Food Processing Companies in South Africa manage risk in supply chain information flow.

Appendix 6: Interview Transcript Example (Screenshot).

M: → Okay,·they're·having·a·meeting;·I·have·to·change·to·another·one·ne.¶

[Brief·silence]¶

M: → Hello?¶

R: → Hi.¶

M: → ·How·severe·is·the·impact·and·how·likely·are·they·to·occur.¶

R: → Uh,·is·there·a·ste----well·they're·not,·they·do·occur·but·they·don't·like·occur----it's·not·like·an·everyday·issue·where·now----otherwise·we·won't·have·any·production·happening,·or·we·won't·have·business·as·normal.·It·does·occur·but·I·wouldn't·say·it's·things·that·uh·affect·our·day·to·day·operations.·In·terms·of·everyday,·we're·facing·the·same·issue.¶

M: → Okay,·so,·eh·question·number·three;·how·do·you·generally·become·aware·of·these·risks·and·when·do·you·think·they·need·to·be·addressed?¶

R: → [Brief·silence]·is·that·the·risks·that·I·mentioned·in·question·one?¶

M: → Ja,·question·one·and·question----ja,·question·one.¶

R: → What·is·the·question·again?¶

M: → How·do·you·generally·become·aware·of·these·risks·and·when·do·you·feel·they·need·to·be·addressed?¶

R: → They·need·to·be·addressed·all·the·time·because·you----because·you----if·you·mistakenly·share·eh·confidential·information,·that·alone·is·a·problem·because·then·it·means·you've·broken·the·contract,·you've·breached·the·contract.·So·personally·I·haven't·come·across·a·situation·where·there·was·a·risk·or·there·was·a·disciplinary·hearing·because·somebody·shared·information·wrongly·with·the·wrong·customers·and·uh,·ja,·and·it·became·a·whole·legal·issue.¶

M: → Okay,·so·risk·related·to·maybe·the·day·to·day·activities·like·eh,·eh·receiving·the·information·about·orders·or·maybe·about·eh·[brief·silence]·ja,·about·orders·eh,·receiving·the·incomplete·information·about·the·orders.¶

R: → Ja,·so·the·risk·like·I·said,·the·risk·would·be·that·then·uhm,·it·affects·the·output·of·us·being·able·to·deliver·to·customers,·because·if·we·are·missing·information·and·we·are·unable·to·produce,·that·is·gonna·have·a·problem·in·terms·of·risk·delivery.¶

M: → So·but·I·think,·uh----okay,·okay·but·eh----are·you·alerted·by·your·KPI's·or·any·red·flags?¶

R: → Ja,·there's·KPI's,·we've·got·KPI's·that·we·measure,·and·even----that·even·applies·to·compliance·to·schedule·in·terms·of·how·much·or----ja,·how·much·we·produce·per·day.·Now·

Appendix 7: Development from codes extracted from raw data to preliminary themes and then to final themes.

DEVELOPMENT FROM CODES EXTRACTED FROM RAW DATA TO PRELIMINARY THEMES AND THEN TO FINAL THEMES

Codes from raw data	Participant mentions						Frequency	Themes development step1	Themes development step2
Strategies	*P1*	*P2*	*P3*	*P4*	*P5*	*P6*			
Due diligence on information a nd data management systems		x					1	Assessment, monitoring and evaluation	Risk strategies
Risk management KPIs		x	x	x			3	Assessment, monitoring and evaluation	Risk strategies
Risk assessment/audits			x	x	x	x	4	Assessment, monitoring and evaluation	Risk strategies
Data trails		x					1	ICT systems	Risk strategies
Data banks		x					1	ICT systems	Risk strategies
Risk training				x			1	ICT systems	Risk strategies
Risk planning and management info systems			x	x		x	2	ICT systems	Risk strategies
Data management benchmarks		x					2	ICT systems	Risk strategies
User support		x	x				2	ICT systems	Risk strategies
Systems upgrades		x			x	x	3	ICT systems	Risk strategies
Systems evaluations (ease of use, security)		x			x	x	3	ICT systems	Risk strategies
User-training on ICT systems		x	x		x		3	ICT systems	Risk strategies
Public communication protocol	x						1	Policies and procedures	Risk strategies
Segregation of customer accounts management			x				1	Policies and procedures	Risk strategies
Buffering				x			1	Policies and procedures on all risk managem	Risk strategies
Information policy/strategy	x	x		x	x		4	Policies and procedures	Risk strategies
Operating procedures on risk management		X	X	x	X		4	Policies and procedures	Risk strategies
Internal systems coordination		x				x	2	Stakeholder engagement	Risk strategies
Internal and external communication			x	x		x	2	Stakeholder engagement	Risk strategies
Collaborated planning(suppliers, customers)	x	x		x		x	3	Stakeholder engagement	Risk strategies
Risk containment	x						1	Strategies	Risk strategies
Proactive risk management	x					x	2	Strategies	Risk strategies
Agile and reactive systems				x	x		2	Strategies	Risk strategies
Continous improvement of risk management systems	x				x	x	3	Strategies	Risk strategies
Manifestations	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**			Risk manifestations
Legal exposures			x				1	P3	Risk manifestations
Increases in operational costs		x			x		2		Risk manifestations
Poor decision-making	x					x	2	P2	Risk manifestations
Loss of productivity, production time		x	x		x		3		Risk manifestations
Delays in supply chain movements		x	x	x		x	4	market misinformation eg. Product labelling (p2)	Risk manifestations
Product and service quality compromises	x	x		x	x	x	5	bottlenecks (p2)	Risk manifestations
Input supply and demand mismatches along the supply chain	x	x	x	x	x	x	6	But the way the mine is currently operating, I'm overusing	Risk manifestations
									Risk factors
Factors/Respondent	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**			Risk factors
Non-compliance cultures in teams		x					1		Risk factors
Unforseen external environment changes - laws				x			1		Risk factors
Poor systems security			x		x		2		Risk factors
Poorly informed value chain (e.g. suppliers)	x				x	x	3	unauthorised person communicating company positi	Risk factors
Lack of connectedness, coordination along supply chains	x	x				x	3	silos (p2)	Risk factors
Complicated information management systems		x			x	x	3	*More time is spent on converting the data than analysing*	Risk factors
Poor internal information and communication systems			x	x		x	3	inadequate, unavailable	Risk factors
Poor information and risk management	x	x	x	x	x	x	6		Risk factors
Risk containment									
Business contingency plan	x								Risk containment
Risk management capacity and abilities	x								Risk containment
Agility to immediately adjust to external shocks and changes				x					Risk containment
Risk management philosophies									
Knowledge of internal environment	x								Risk management
Collaboration capacities with value chain players	x							suppliers and customers	Risk management

Risk concerns

P1	Reputational damage through bad publicity form wrong/inaccurate information or poor containment of in	Risk concerns
P1	nanifestatsions across the supply chain	Risk concerns
P1	:omes a risk, how it is managed, how it manifests	Risk concerns
P2	:ks the most adverse	Risk concerns
P3	:onfidentiality especially perating to customer data	Risk concerns
P4	rt regulations - in Kenya + supply cahin risks emanating from one por more players failing to fulfil agreed terms and expectati	Risk concerns
P5	ses to unathorised parties	Risk concerns
P6	M is info dependant from indound losigistics, operations, outboud logitstics	Risk concerns

Types of risks/Respondent	P1	P2	P3	P4	P5	P6				
Reputational risks	x				x		2	Reputational risks	2	Tyoes of ristks
Business and financial	x					x	2	Business and financial	2	Tyoes of ristks
Legal risks			x		x		2	Legal risks	2	Tyoes of ristks
Product quality risks		x	x				2	Product quality risks	3	Tyoes of ristks
Systems risks	x	x			x		3	Systems risks	3	Tyoes of ristks
Supply risks	x	x	x	x	x	x	2	Supply risks	6	Tyoes of ristks

Advantages/Respondent	P1	P2	P3	P4	P5	P6		
Improved Information availability and flow		x					1	Advantages
Facilitates risk learning and development			x				1	Advantages
Working capital and general cost efficiency		x		x			2	Advantages
Improved supply chain coordination, connectedness		x				x	2	Advantages
Improved business operations and perfomance		x				x	2	Advantages
Reduced losses of products				x		x	2	Advantages
Systems downtime minimisation					x	x	2	Advantages
Improved internal/external communication			x	x		x	3	Advantages
Improved reaction and response time			x	x	x	x	4	Advantages
Improved supply chain operations/flow	x	x		x	x	x	5	Advantages
Facilitates proactive management	x	x	x	x	x	x	6	Advantages

Tools/Respondents	P1	P2	P3	P4	P5	P6	
Enterprise Resources Planning systems (e.g. SAP)			x	x			Tools
Advanced Planning and Optimization tools				x			Tools
Business Intelligence Software or Systems (e.g. Microsoft BIS)				x		x	Tools
Vendor management systems				x			Tools
Management and operations information systems	x	x					Tools
Manual tools	x					x	Tools
General office tools (spreadsheets)	x			x		x	Tools

Quality of information

Understandable	2	Quality of information
Availability	3	Quality of information
Security, integrity	4	Quality of information
Completeness	4	Quality of information
Timeliness	5	Quality of information
Accuracy, correctness	6	Quality of information

Respondent	Respondent view/definition
P1	Potential flow of unreliable, incorrect or inadequate information across the production value chain; threats of wrongful publiciation of internal information
P2	Foreseen and unforseen adverse possibilities with "the greatest risk are those which are unseen"
P3	Loss or leaks in supply cahin information as well as the movement of erroneour information across the supply chain
P4	Scenarios where "information is not transmitted accurately and timely that will result in delay and that create problems in your supply chain"
P5	Information losses to unathourised parties including through leaks and non-procedural discolures of confidential information
P6	"business I think the definition will be the same because the definition will be the probability or the threat of damage, injury, liability, loss or any other negative occurrence that is caused by internal or external vulnerability and that might be avoided through preventive actions"

Respondent	Respondent view/experience
P1	Proactive risk assessment as per contingency plan
P2	Data due diligence
P3	No particular experiences
P4	I think generally when there is a break in the link, delays is when we become aware of the risk ok that will mean that we not necessarily pro-active.
P5	At the point of occurrence " immediately; if you find that there's been a compromise"
P6	At risk assessments - actuial inciden awareness is when it is reported

Respondent	Respondent view/experience
P1	
P2	The existence of manual data systems; large volumes of information; multiple complicated information systems each with own weaknesses
P3	
P4	
P5	Network disruptions; systems challenges
P6	Poor technical specification/communitation

Respondent	Respondent view/experience	Severity	Probability
P1			
P2	It's very, very severe, that's why we had to take a lot of time and attention	Very high	Low
P3	well they're not, they do occur but they don't like occur--- it's not like an everyday issue	Depends	Low
P4			
P5	Well so like, as I said the risk can be between medium to high; so it depends as well uh what type of--- . But if let's say somebody breaks into our systems and they're able to steal information, I mean that's an unlikely event, but if it could happen then obviously the impact is quite high, ja, it's quite severe.	It depends	Low
P6	The severity in measurement the risk is high because you need a team that will be able concentrate on what the customer he is saying so I can say its high the risk is high because that is something that is happening in every month or a daily processes	High	High

	Management roles	
	Policy & procedure	6
	Provide training internally	5
Internal compliance	Support mechanisms	5
	Not everything can be controlled	2
	Guides decision-making	4
	Lead proactive action	4
Implementation	Limit exposure to sensitive informat	5
	Support flexibility	3
	Faciliate effective external stakehol	6
Communication	Facilitate internal stakeholder comn	6
	Lead the removal of coordination bc	3
Internal cohesion	Facilitate departmental co-operatior	3
	Facilitate and foster open communi	4

CONTINUOUS IMPROVEMENT	6
Risk identification	6
Risk containment	2
Reduce work interruptions	5
Supply chain is more agile	3
Avoid production loss & costs	6

	KPI	4
	Always know what's going on	6
Monitoring and evaluation systems	Monitoring	5
	Risk assessment	6
	Ensure systems are effective	5

	Improves orgnaisational planning	3
	Improves stakeholder relations	4
	Improved KPI	4
INTERNAL SYSTEMS	Improves internal and external com	5
	Minimisation of problems	5
	Better organisational efficiency	6
	Supports/facilitates continous impr	6
CONTINUOUS IMPROVEMENT		

Codes & Sub-codes

INCORRECT INFO FROM SUPPLIERS	2
Ill-informed supplier	1
Bad decision-making	1
SUPPLY AFFECTS CONSUMER	2
Inferior product quality	2
Product availability	2
SUPPLY CHAIN DISRUPTION	2
Ripple effect	2
Loss of revenue	2

Respondent	Respondent view/experience	Indicator
P1		
P2	very effectively	audit reports
P3	they are effective	positive KPIs
P4	most of our strategies are effective	positive KPIs
P5	it's very effective	no recorded IS/ICT breaches
P6		

Importance of continuous improvement in risk management

To proactively prepare for new types of risks	1
To meet international benchmarks in risk management	1
To effectively react to adverse occurences	1
To adapt new risk management systems	1
To correct imbedded systems weaknesses	2
To upgrade to more recent and secure risk management system:	2
To adapt to changing risks in the external and internal environme	3

Common risk incidents given as examples

Sending wrong information to suppliers, customers
Sending wrong information to internal departments
Receiving wrong information from suppliers, customers
Receiving wrong information from internal departments
Losing internal or customer/supplier information through IS breaches
Losing internal or customer/supplier information through error
Letting timeosu information late
Receiving/sending inadequate, incomplete or incorrect information
Unavailability of critical information

Inbound/outbound logistics areas affected	Quantities orders	5
	Quality specifications	3
	Delivery dates (inbound and outbound)	2
	Delivery place/location	2
	Customer or supplier details	3
	Invoicing amounts	1
	Applicable import/exports regulation	1
Common types of errors	Sending wrong information to suppliers, c	4
	Sending wrong information to internal dep	3
	Receiving wrong information from supplie	2
	Receiving wrong information from interna	1
	Losing internal or customer/supplier infor	3
	Losing internal or customer/supplier infor	1
	Letting timeosu information late	1
	Receiving/sending inadequate, incomplet	1
	Unavailability of critical information	1

Appendix 8: Interview Questionnaire.

Introduction.

Thank you for taking time to participate in this research. My name is Otshepeng Eddison Matlhoko I am a Master of Science student in Industrial Engineering at the University of the Witwatersrand, Johannesburg. The purpose of this study is to examine how Food Processing Companies in South Africa manage risk pertaining to Supply Chain Information Flow and develop a conceptual framework in which risk management in Supply Chain Information Flow will be grounded on.

Our interview will take up to 60 minutes and to keep the conversation flowing and to avoid any delays audio recording device will be used. All terms mentioned in the Participants Information Sheet and Consent Form will be adhered to.

Background Questions.

Can you tell me about your position at (Organization)?

How long have you been in this position and in this industry?

Tell me more about your role and responsibilities?

Open Ended Interview Questions.

1. How do you define risk in your company's supply chain information flow from the perspective of:
    - Information Policy/Information Security Policy?
    - Procedures/Processes?
    - Please provide examples of those risks or some scenarios?

2. How severe is their impact and how likely are they to occur?

3. How do you generally become aware of these risks and when do you think they need to be addressed?

    - Are you alerted by KPI's (e.g Costs, Targets) or any Red flags?
    - Please tell me more about these?

4. What are the advantages of addressing these issues and challenges in your business? And what are the disadvantages of not addressing them?

    - Please provide examples or some scenarios?

5. What are the risk management strategies do you employ to mitigate these risks in the business?

-How do you assess and analyse information flow risk in your supply chain?

-What are the roles and responsibilities of top management in ensuring information flow risk is mitigated in your supply chain e.g Funding, Training, Business Strategy, Outsource service

-Please tell me more about your information technology (IT) (e.g ERP, Vendor Management System, SAP) and how it enable risk management and mitigation in your supply chain information flow?

- How do you ensure compliance with information policies and procedures? (e.g. Set deadlines for each policies and procedures to be acknowledged, make them easily accessible

e, measure the understanding for example interviews or one on one sessions, determine the best format and meet divisional leader's to ensure policies are feasible for individuals)

6. How effective is your company in managing these risks?

-Please can you tell more about how you measure these? e.g KPI's

7. Are there any improvement initiatives or alternative strategies you think need to be implemented and why?

-e.g. adoption of new technology**,** system**s** and standard operating procedures or development, amendment and review of information policies?

-Please tell me more about these?

Conclusion.

Thank you once again for taking time to make a contribution to this study. I'm a very impressed that the Interview was very informative and will positively impact the outcomes of this study.

Thank you.