Profile of Traceability Systems in the South African Fish Supply Chain

By

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DECLARATION

I, Nozipho Sweetness Puwana, declare that the dissertation, which I hereby submit for the degree MSc (Agric) Agricultural Economics at the University of Pretoria, is my own work and has not been submitted for a degree at any other tertiary institution.

SIGNATURE……. DATE: FEBRUARY 2023

DEDICATION

This Master's degree is dedicated to my daughter, Likhanye Puwana, and to everyone who believed in my academic career: for their words of encouragement, willingness to support me through the journey, and endless love.

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"*Commit to the Lord whatever you do, and he will establish your plans*".

Proverbs 16:3

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ABSTRACT

Supply chain is the interconnection of all the functions that start from manufacturing or raw material into the finished product. The purpose of a supply chain is to safeguard people who are responsible for a specific stage and ensure who is in charge of each stage of the chain and communication between the players.

The South African seafood industry consists of a complex set of supply chains that bring products from production and harvesting to consumption. Because of the complexity of the supply chains, consistency in identifying product origin is difficult. Incidences and allegations of illegal fish harvesting, and the mislabelling of fish products have become increasingly noticeable in recent years.

For this reason, the purpose of this research is to study the traceability status of fish supply chains in South Africa. The research objectives are to: (I) investigate the status of traceability within fish supply chains in South African, (II) Describe the current traceability system to protect consumers from food safety issues, (III) Identify what impacts upon traceability implementation in the supply chain, (IV) Determine what perceptions actors have in the chain towards the current traceability systems.

This study used qualitative methodology to investigate the current state of traceability systems within fish supply chains in South African. The study was conducted in two provinces: Gauteng and Western Cape. The main concentration was on fish processors (Sea Harvest and Irvin & Johnson), Sea Harvest factory shops, logistics chains, and South African retailers. South African fish supply chains were used to draw a random sample of 40 participants. The data was obtained from interviews, using a questionnaire. SPSS and Excel were used to process and analyse the data. Descriptive statis tics were used to examine the nature and scope of the current traceability system in the companies, as well as the challenges that exist within fish supply chains in South Africa.

The results attained by the study show that 72% of participants were of the opinion that the current traceability system of South African fish supply chains is satisfactorily developed. Furthermore, 75% of participants were of the opinion that the quality of traceability technology within fish and fishery products supply chains in South Africa matches the expectations. Among the participants, 75% were of the opinion that the quality of the traceability system implemented in South Africa fish supply chains matches the expectations. After an increase in food safety incidents and food scandals, many efforts were undertaken to implement proper information technology and to improve the quality of the traceability system. Participants were of the opinion that an advanced traceability system enhances overall supply chain performance, and furthermore elevates information quality and reliability throughout the supply chain.

The industry is faced with the following challenges: Companies are, in some cases, unwilling to invest in a traceability system that needs continuous investment. The innovation used to implement traceability system is expensive, particularly for medium and small-scale companies. There is still a lack of skilled labours. Considering the abovementioned findings, the research recommendations are as follows: training services and skills development should be provided to traceability users; information sharing is essential among supply chain stakeholders “compatibility in data collection and communication technologies and integration of systems at different levels and regions”.

Keywords: Traceability, Traceability System, Supply Chain, fish

CONTENTS

FIGURES

TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

AFRA	Agriculture, Food & Rural Affairs
BRC	British Retail Consortium
FAIS	Food Safety Authority of Ireland
HACCP	Hazard Analysis & Critical Control Point
I&J	Irvin & Johnson
ISO	International Organization for Standardization
JDSA	Jeffers, Danielson, Sonn & Aylward
IUU	Illegal, unreported, and underreported
MSC	Marine Stewardship Council
PIF	Product Information Form
SAP	Systems, Applications and Products
SKU	Stock Keeping Unit
SPSS	Statistical Package for the Social Science
USDA	United States Department of Agriculture
WOR	World Ocean Review

CHAPTER 1
INTRODUCTION

1.1 Background

Deliberate mislabelling of fish was first identified in South Africa in 2009, exposing the lack of coherent or explicit naming and labelling policies (Barendse & Francis, 2015). Food scandal, whereas is not a new phenomenon has come under a spotlight in recent years. Outrage against the food industry followed after the 2013 horsemeat scandal in parts of Europe, when foods advertised as beef were found to contain undisclosed horsemeat, by as much as 100% of the meat substance (Brown, 2013). A number of products also contained mislabelled meats, such as pork (Meikle & McDonald, 2013). The issue was revealed on the 15th of January 2013, when British and Irish beef burgers were reported to contain horse DNA (Telegraph Reporters, 2013). A similar study that was conducted by Robert Hanner together with Sven Becker, Natalia and Dirk Steinke in 2011 discovered that DNA based approaches have demonstrated that between 60 and 94% of fishes labelled as red snapper Lutjanus campechanus for sale in the USA were mislabeled. The scandals revealed a lack of traceability of food within supply chains. "*Traceability is the ability to access any or all information relating to that which is under consideration, throughout its entire life cycle, by means of recorded identifications*" (Borit & Olsen, 2012).

In South Africa, the occurrence of food-borne listeriosis was a widespread scandal of Listeria monocytogenes food poisoning caused by contaminated processed meats produced by Enterprise Foods, a subsidiary of Tiger Brands, in Polokwane, from 2017 to 2018. During the outbreak, there were 1,060 confirmed cases of listeriosis and approximately 216 deaths (de Wet, 2018). On the 4th of March 2018, Health Minister Aaron Motsoaledi stated that "*the disease was tracked to the Enterprise prepared meats production in Polokwane Environment samples from the factory were found to contain the bacterium Listeria monocytogenes strain*" (Heiberg, 2018). "*A positive case of Listeria was also experienced in a Rainbow Chicken manufacturing factory in the province of the Free State"* (Petersen, 2018). Food-borne scandals comprise a potential concern for many different foods, including seafood. This is a result of increases in global importing and exporting of seafood that has affected many countries across global food supply chains (Lyons, 2018). Recent reviews have shown that the seafood chain is particularly venerable to fraud, particularly in mislabelling (Reilly,

2018). Khaksar *et al*. (2015) stated that "*Mislabelling is the inaccurate identification of a product in which the label lists ingredients or components that are not actually included within the product" (JDSA, 2018)*

According to Helyar *et al*. (2014), previous studies done in seafood traceability indicate that Europe is the leading continent, with a rate of 32% of mislabelling in the seafood industry, and the players identified as carrying out the most mislabelling were small retailers and suppliers of convenience food. Helyar *et al*., (2014) further found through genetic identification that Atlantic cod samples were mislabelled as Pacific Cod, and M. aegle finus were misidentified as G. morhua. Lucid approaches to the naming and labelling of fish in South Africa are arguably an aftermath of the recognition of the intentional mislabelling of fish was first noticed and publicised in 2009. In 2015, research by the international criminal police organisation, Europol, ascertained that the fish trades, worldwide, "*were among the highest risk categories for food fraud*" (Thomas, 2013). The same was found in 2013, with a European Commission report that identified fish as constituting second category for food fraud (Reilly, 2018). Incidences and allegations of the mislabelling of fish products and illegal fish harvesting have become increasingly noticeable.

The mislabelling of fish species has risen as a worldwide problem (Khaksar *et al*., 2015). *"Mislabelling of a food product can occur when a food products label does not accurately reflect its ingredients*" (Quantum Food Solution, 2021). This has resulted in the exposure of consumers to fraudulent produce (Ene, 2013). Mislabelling and fraud also occur within licensed fisheries (Marko *et al*., 2011). According to Reilly (2018), a 2016 study, which was done in 55 countries, revealed that 20 percent of all the fish products in retail were mislabelled. Mislabelling is expanding as new and inadequately managed fisheries develop, resulting in traders being unable to trace product origin or to confirm a product is the real species being sold (Holmyard, 2012). The mislabelling of fish results in opportunities for illegal fishing business and makes it easy to 'launder' illegal fish products.

The seafood industry is confronted with the challenge of illegal fishing, which is a violation of food regulations and worldwide requirements (Reilly, 2018). There is an increase in illegal fishing that leads to food insecurity (Kastern *et al*., 2014; Sterling & Chiasson, 2014). "*Unreported fishing refers to fishing activities, which have not been reported to whom must they be reported*" (WOR, 2013). While illegal fishing primarily results in food insecurity and

overfishing, it can also lead to significant risk of food fraud, where low-quality products are labelled as high-quality products for sale to gain illicit profit.

There is an increase in low-quality seafood products and unhealthy fish stock coming to the markets (Kastern *et al*., 2014). The increase of low-quality seafood products in the supply chain can adversely affect fair practice in trade (Sterling & Chiasson, 2014; Ene, 2013). Increases of low-quality seafood products are the result of mislabelled and substituted species. "*Species substitution happens where low-valued or less-desired fish species are exchanged for more expensive species, for example fraudulently marketing of wild catch species as farmed salmon*" (Reilly, 2018). This is because, there are some key nutritional differences between wild and farmed salmon wild salmon, wild salmon gets the edge for having fewer calories and less in protein. Traceability systems assist in the elimination and processing of low-quality fish products (Aung & Chang, 2014).

Derrick and Dillon (2004) defined traceability as the process of tracing and identifying all stages of production processing, as well as the unique distribution of a product unit. A traceability system captures all data, as well as processing and desired information, related to the components of the product in all the steps of the chain of production (Ene, 2013). "*The purpose of a traceability system is to gather all the necessary information linked in the processing of the product along the supply chain*" (Dabbene & Gay, 2011). Traceability is a safe method used in supplying food that is safe and a way of connecting consumers and producers (Regattieri *et al*., 2007).

In incidents regarding threats to food safety, traceability systems help in allowing the identification of hazardous material (van Rensburg 2007). Such information is important when the industry is facing a food safety crisis and is used in managing the resulting product recall actions (Dabbene & Gay, 2011). "*Food traceability is an instrument for improving food safety and to give reliable information to consumers regarding their food"* (Hall, 2010). Traceability in food assists in the identification of food products by individual identification and by group identification (Ene, 2013). A key requirement for securing sustainable fisheries is the ability to trace the movement of seafood from boat to plate and having an effective traceability system in place will secure and safeguard the seafood industry and promote legal seafood. "*Traceability is important as it gives the capacity to fully trace a product from the retail location back to its place of origin and makes information available about all*

movements of the product" (Holmyard, 2012). Boecker *et al*., (2013) argue that investing in the improvement of traceability systems in the supply chain can potentially reduce the costs of monitoring activities, from raw material suppliers to retailers and processors. Another benefit of accurate traceability systems would be to help to reduce the cost of gathering information (Hobbs, 2004).

There are several important benefits of implementing traceability systems, including cost reduction in a case of the recall of unsafe food. The market benefits from the improved trust in the supply chain and the improvement of processes that assure safe and healthy raw materials (Chen *et al*., 2015). Good traceability systems will eliminate mislabelling in the supply chain. Traceability systems are essential because they provide the understanding and knowledge of where a product is from (Miller *et al*., 2012). Sufficient seafood traceability systems provide reliable information in the supply chain about the origin, catch, and product movement along the chain. Traceability systems make it easy to monitor fair trade (Kastern *et al*., 2014). Without formal traceability systems and the full knowledge of how seafood was harvested and its origin, illegal fishing practices and unsustainability could be easily facilitated (Bizcommunity, 2018).

"In the absence of effective traceability systems and transparency of information along the value chain, it is difficult to successfully eliminate illegal seafood products" (Borit & Olsen, 2016). Businesses are not able to who a responsible supplier is during outbreaks or scandals (Bizcommunity, 2018). Moreover, an effective traceability system assists in obtaining reliable information for monitoring trade challenges by providing information about the origin of the species and catch to consumers, seafood companies and government (Kastern *et al*., 2014). Traceability systems are essential for the seafood industry because they help businesses to reduce risks in the chain, such as the mislabelling of products, the inability to identify hazard sources, and the exposure of consumers to fraud perpetration. Moreover, they promote long-term profitability by providing reliable information to management, which helps in making decisions about market penetration and increasing brand equity (Gooch & Sterling, 2013).

However, regardless of the benefits of a traceability system in place, "*traceability is often seen as an inconveniencing investment that does not add much value to profit"* and competitiveness (Verdenius, 2006). Verdenius (2006) further states that this perception has

resulted in the slow introduction of traceability systems in the food industry. The cost of traceability is determined by the size of the company, the extent of technology adoption by the company, its types of products, production procedures, and the complexity and structure of the supply chain, as well as the quality of information needed to be stored (Asioli *et al*., 2011). It can be costly to implement a traceability system (Dessureault, 2019).

1.2 Problem Statement

At present, there are limited studies that have been done on traceability in the fish supply chain in South Africa. Available studies carried out are on the requirements and benefits of the traceability system (Andre, 2018; Mai *et al*., 2010). Research that has been done on traceability systems in South Africa include, traceability systems at the retail level of the fresh vegetable supply chain (Mugadza, 2014), traceability systems within the sheep meat supply chain (Van der Merwe, 2013), voluntary traceability systems in the beef supply chain (Calitz, 2016), blockchain food supply chain traceability transparency (Kanjere,2021) and automated traceability in fruit export chains in South Africa (Fourie, Evans & Olivier, 2007).

The lack of traceability systems in the fish supply chain is one the reasons that consumers are exposed to fraudulent produce through the mislabelling seafood products, the inability to identify disease outbreaks and the sources of these hazards (Ene, 2013). *"Deliberate mislabelling of fish was first detected in South Africa in 2009, exposing the lack of coherent or explicit naming and labelling policies"* (Barendse & Francis, 2015). "*Previous to this, an incident had occurred in February 2002 in the Gauteng Province, where two children died from botulism poisoning after consuming the contents of a tin of canned pilchards in tomato sauce*" (Department of Health, 2004). The incident revealed several shortcomings of the traceability system in fish supply chains, such as the deliberate mislabelling of seafood with the intention of deceiving consumers and inadequacy in food quality. South Africa is not unique when it comes to traceability problems in fish supply chains. Research conducted by Helyar *et al*. (2014) showed that Europe had a 32% mislabelling rate in its seafood industry, with most of the culprits being small retailers and convenience food outlets. According to a 2016 report by Reilly (2018), "*based on more than 200 published studies from 55 countries, 20 percent of all fish in the retail and catering sector was mislabelled and were found to be mislabelled*".

Some of the problems that motivate the use of traceability systems within the seafood sector include an increase in the mislabelling of seafood products, an increase in illegal fishing, requirements of traceability regulations, and commitment to supply chain sustainability and food safety (Lewis & Boyle, 2017). Traceability assists in the reduction of illegal fishing because seafood companies are "*able to track the origin of their products to make sure that species and attributes of the products meet the fishing policies"* (Fish Wise, 2018). To meet traceability regulations, which work as a factor that forces food processors to implement traceability systems (Skees *et al*., 2001). "*The role of traceability in sustainable supply chain management related to food quality and safety issues*" (Zhang & Kraisintu, 2011).

1.3 Purpose of the Study

As a consequence of identifying the challenges and advantages of implementing a traceability system. This research attempts to facilitate improved supply chain management to improve the implementation of systems that are effective in identifying product information, as well as in keeping product records. Moreover, findings from the study will play a pivotal role in informing South Africa's traceability system policy. The study will make recommendations for its effective implementation, and suggestions have been identified for addressing the problems such as factors contributing to traceability system implementation.

1.4 Objectives

The study seeks to understand traceability systems in the South African fish supply chain. The research question is addressed through the general and specific objectives of the study. The general objective is the overarching theme of the study, and the specific objectives are the representation of the general objective.

1.4.1 General Objective

The main objective of the research is to profile traceability systems in the South African fish supply chain and to develop a theoretical and comprehensive framework through the current traceability systems used in the South African fish supply chains.

1.4.2 Specific Objectives

The specific objectives of this study are:

1.4.2.1 To examine the current traceability systems in South African fish supply chains.

1.4.2.2 To identify challenges in the existing traceability systems in the South African fish supply chains.

1.4.2.3 To develop possible methods for the implementation of an effective traceability system in the South African fish supply chains.

1.5 Research Hypotheses

H1: A number of South African fish supply chains do not have a traceability system in place.

H2: Companies that are more capital intensive tend to have traceability system in place.

H3: The implementation of a traceability system is determined by a combination of factors, such as availability of capital, advancement in technology, and skilled labour.

1.6 Significance of the Study

A traceability system permits the efficient identification and elimination of risks and problems, thereby allowing for the delivery of safe products of certified quality throughout the chain (Aung & Chang, 2014). Traceability gives suppliers and consumers the confidence that the products being bought are legal and safe. Similarly, traceability enables businesses to ascertain the source of all inputs at all stages in the chain (Muntean & Radu, 2007). The protection of the brands and reputations of businesses depends on a good traceability system (Opara, 2003). Therefore, traceability systems ensure that food businesses are able to provide information, including origin, about the products on their premises. "*Given the above, the importance of applying an appropriate system of traceability in the supply chain is to identify all the parties in the supply chain, as well as the products' physical flow and information about the flow of products"* (Porto *et al*., 2011).

1.7 Social Benefit

This study endeavours to provide a partial explanation of the slow gain of traceability in the industry, while it aims to add value to marketing strategies. The study is, in addition, motivated by food safety regulations. The adoption of a traceability system helps to eliminate risks related to unsafe food (Boecker *et al*., 2013). The consequences of the risks associated are reputational damage, financial damages, likely penalties, loss of trade, and loss of capital brand name. Good traceability systems eliminate chances of mislabelling. The benefits of a traceability system to firms also include safety and quality assurance. Companies with a good traceability system are less vulnerable to public food health problems (Souza-Monteiro & Caswell 2004). This study aims to provide policymakers with information regarding the benefits of implementing a traceability system.

1.8 Academic benefit

"*There is a dearth of research on the implementation of traceability systems in the fish supply chain in South Africa, and control over the integrity of the chain remains limited*". "*The implementation of traceability systems could be challenging because of the lack of a common theoretical framework*" (Karlsen *et al.,* 2013). In order for companies to implement a traceability system, many aspects need to be considered, including the cost of implementing the system, the required levels of traceability of different products, and the suitability of manual or electronic tracking methods for the product. According to Karlsen *et al*. (2013), without this information, it is challenging for companies to consider implementing a traceability system. The literature review will help to know the "*area that need to be studied that include the depth of traceability with the inter organization collaboration shall help to attain the supply chain tracking and tracing" (*Dabbene, Gay & Tortia, 2014).

1.9 Outline of the Study

The study is divided into seven chapters. Chapter 2 is the literature review, which provides an overview of the seafood industry, the current state of traceability system in seafood industry and, the traceability challenges that exist in the industry. Chapter 3 gives an overview of the fish supply chains in South Africa and the regulations that regulate the industry. Chapter 4 presents the methodology of the study and describes the study area and methodological

approaches used. Chapter 5 presents the result and findings regarding the status of traceability systems of fish and fishery products in the South African supply chain. Chapter 6 sets out analyses regarding the actors in the supply chain. Chapter 7 sets out the discussion, conclusion, and recommendation arising from this study.

CHAPTER 2
TRACEABILITY SYSTEMS IN SOUTH AFRICAN SEAFOOD SUPPLY CHAINS

2.1 Introduction

The purpose of this chapter is to review the literature on traceability systems for fish within South African supply chains. Currently, South Africa does not have legislation in place to enforce the implementation of traceability systems. However, a traceability system is becoming fundamental for each business in the food industry (Coleman, 2015). This chapter will discuss various definitions of traceability, as well as theories that emphasise the types of traceability systems, and the necessity for implementing traceability. Furthermore, the chapter will cover benefits as well costs, labelling and the requirements for implementation, as well as strategies for implementation that include mock traceability trials and mock product recalls. Lastly, the chapter examines traceability research that has been conducted in South Africa regarding quality assurance systems and traceability technologies in the seafood industry. Food safety is a fundamental requirement for all food businesses within the food supply chain to ensure that the food produced is safe.

2.2 Food Safety

"*The lack of traceability systems is one of the reasons why consumers are exposed to fraudulent produce*" (Ene, 2013). In California, 634 people were infected by salmonella in chicken produced by Forster Farms, with the salmonella subsequently affecting 29 states, and the company initiated a voluntary recall of all Foster Farms branded chicken products (Marcin, 2018). According to the same report, 907 people were infected by salmonella in cucumbers imported from Mexico. More than 200 people were hospitalised as a result of the outbreak.

2.3 Overview of traceability

Borit and Olsen (2016) "*defined traceability as the ability to access any or all information related to that consideration, throughout its entire life cycle by means of recorded*

identification." In the same way, Ene (2013) referred to "*traceability as the ability to identify a food product according to when and where it came from"*, and where it was sent to, by using electronic or paper records. Similarly, Derrick and Dillon (2004) proposed traceability as representing the process of tracing and identifying "*all stages of production processing and uniquely distribution of a product unit*." Borit and Olsen (2016) stated that traceability systems permit traceability through paper-based or computer-based systems. Traceability is the facility of tracing history and location through using recorded information to identify a product (van Rijswijk & Frewer, 2008).

According to Regattieri *et al*. (2007), traceability is a safe method used in supplying food that is safe and provides a way of connecting consumers and producers. Traceability systems help in allowing the identification of hazardous materials (Van, 2004). The information is important when the industry is confronted with a food safety crisis, and it is then used to manage product recall (Dabbene & Gay, 2011). Moreover, traceability is currently a requirement in agriculture, and it is essential in all developing countries (Dabbene & Gay, 2011). Good traceability systems help in the eliminating the supply of low-quality food products (Aung & Chang, 2014). The uniform of traceability safeguards the agreements of recognising the product within the parties.

2.4 Types of traceability systems

Although there are several types of traceability, only two types will be discussed in this study, namely, external and internal traceability systems. An external traceability system identifies a product by "*information that an operation receives from the supplier and provides this to consumers"* (Food Standards Agency, 2021). *External* traceability represents the traceability that links product information a firm provides or receives to other supply chain members. External traceability includes identification by number and batch, which can be done by labelling a product. This is all about tracing a product backwards and forwards. Internal traceability represents the recordkeeping about a product within an operation, a company and production facility.

Internal traceability relates information "*about raw materials and processes to the final product*", and this process assists an enterprise to relate and distinguish the raw materials with the final products (Information Technology, 2017). In the processing of a product and

packing, the processed product needs to have its unique product identity (Vernede *et al*., 2003). Internal traceability deals with providing an assurance that all the ingredients recorded in the process have been identified for each specific product produced by the firm. The importance of internal traceability relates the data about raw materials and processes to the final product before it is delivered. Internal traceability is aimed at productivity improvement and cost reduction within a production unit such as fish plant. This type of record keeping is already required throughout the seafood industry as it is essential for keeping track of inventory.

2.5 The scope of a traceability system

"*The scope of a traceability system involves locating a product through all the stages that involve its manufacturing, processing, and distribution – from production to consumption*" (Traceability Solutions, 2021). Scope of traceability refers to the process of tracing a product backward and forward within a supply chain. There are three traceability dimensions, namely depth, precision, and breadth of traceability (Calitz, 2016; Van der Merwe, 2013).

2.5.1 Breadth

"*Breadth is the amount of information that a traceability system can record"* (Calitz, 2016). Similarly, the Citrus Growers Association (2020) has defined 'breadth' as the "*amount of information collected by the system that is linked to a certain product*". Consider an example of a slice of fish. At times, a fish product can come from any number of fish catchers from fishing areas. There are few customers who would be interested in the details of this information, provided that the fish is safe for consumption. The breadth category in many systems of traceability exclude these attributes and ensure that only the important information is available as to how that fish is safe for consumption.

2.5.2 Depth

Depth of traceability refers on how deep the traceable unit is tracked and how accurately (Narsimhalu *et al*., 2015). Traceability depth reflects how the system tracks the appropriate information, backwards and forwards (Citrus Growers Association, 2020). For example, a traceability system of fish from the sea to the marketplace.

2.5.3 Precision

Golan *et al*., (2003) stated that "*the precision of a traceability system indicates the degree of assurance that the tracing system provides in identifying a certain product's movement". "A precise traceability system is able to identify a pack on pallet as part of particular consignment in a warehouse*". While traceability that is more precise is able to identify a particular packet on a pallet in a warehouse, traceability that is less precise will only be able to identify the location of a batch (Citrus Growers Association, 2020). Adopting a system of traceability that allows for a high level of tracing and tracking is becoming an important aspect of food manufacturing.

2.6 Necessity and Functions of Traceability

"*Traceability is necessary for a business to be able to track the movement of several products along supply chain stages, starting from the manufacturing of the product, to processing stages, and to the final stage of market distribution*" (Sweet Technology, 2018). With traceability, it is possible to locate a product at any stage of the food chain, within that supply chain. "The recent outbreak of listeriosis in South Africa, according to the World Health Organization, was the largest ever recorded, globally, and this not only highlights the importance of quality control in the food manufacturing process, but also emphasises why traceability throughout the food supply chain is critically important" (Food Focus 2018).

2.6.1 Improved brand reputation

Traceability is important for creating transparency in that it allows brands to build trust with their customers. When customers are able to trust a brand, they feel loyal to it and would like to share it with others. Traceability also enhances the value of a brand. Consumers look up to the brands with trust and consider their products as reliable (Kumar, 2019). A traceability system supports decisions that impact upon brand reputation. After the horsemeat scandals in 2013, the Findus products brand dropped out from parts of the markets in the UK, the Republic of Ireland and in parts of the European Union. It takes a long period of time to build a brand reputation, and what has been built can be lost rapidly in only one major scandal (Wattanajantra 2019). Contaminated foods that cause sickness, sometimes resulting in death, will diminish consumer's confidence in those foods.

2.6.2 Increased consumer confidence

The lack of traceability systems could result in loss of consumer confidence. Food safety incidents have decreased food confidence and food trust among consumers. Nevertheless, globalisation has made tracking and tracing products origin more complex. "*Traceability allows the industry and regulators to maintain or rebuild trust with consumers into the safety and resilience of the food system*" (McEntire *et al.*, 2010). Taceability improves confidence and trust among consumers (van Rijswijk & Frewer, 2008). Consumer confidence and brand image are negatively affected in cases where a product is recalled due to potential contamination.

2.6.3 Reduced recall costs.

"*A recall is an action taken to remove from distribution, sale and consumption, food that may pose a health risk to consumers*" (Food Standards, 2021). In recent years, food recalls have increased, and that fact has contributed to the need to have traceability (Cropin, 2020). Product recalls can cost millions of rands per occurrence, and they comprise one of the biggest risks that manufacturers and distributors have to face (Pyke & Tang, 2010). "*A product recall is associated with two types of costs, namely indirect costs and direct costs. Direct costs include recall notifications, retrieving of the product, and loss on the recalled products*". Indirect costs are the result of loss in consumer confidence, which affects the demand for a company product and the company's stock price (Resende-Filho & Buhr, 2010). Traceability systems assist in facilitating faster and more precise product withdrawals and may mitigate the product recall costs for a company and the food risk to consumers. Traceability systems also reduce the possibility of a supplier with responsibility for product safety problems and show that the suppler complies with regulatory requirements (Fritz & Schiefer, 2009).

2.6.4 Supply Chain Management

Traceability improves the precise tracking of product movement, and also assists companies in improving supply chain efficiency (Debabrata & Albert, 2018). "*Traceability improves the agility of the response from the stakeholders when something goes wrong in the chain*"

(McEntire *et al*., 2010). *"Traceability provides greater visibility into a supply chain"*, which allows for a faster response if there is any product recall or outbreak (Norton, 2019). Traceability in companies' supply chains has become increasingly important with the advent of increasing calls for better transparency. According to Zhang & Kraisintu (2011), *"traceability could provide a hazard management tool, which offers the ability to respond to potential risks that might emerge within the food supply chain". Also, traceability* gives a mechanism for isolating contaminated products through product recalls, thereby preventing contaminated and unsafe food from reaching consumers (Zhang & Kraisintu, 2011).

2.6.5 Risk management and food safety

Traceability is a crucial tool for promoting food standards and regulations in food. A traceability system allows for quick response in verifying whether a product meets regulatory requirements "*in the case of a food safety event*" (Agrilinks, 2019). According to DiMase *et al*. (2016), the ability to effectively trace products is critical to understanding the risk involved. Currently, food supply chains are complex, with various partners with different roles in the chain. The significance of transparency in food production is still a challenge as food supply chains become more complex (Astill *et al*., 2019). "*Traceability is a risk management instrument which offers the possibility to reaction to potential risks that can arise in food and give the chance to food business operators to isolate the problem by withdraw or recalling and then prevent contaminated products from reaching consumers*" (Zhang & Kraisintu, 2011).

2.6.7 Transparency

Transparency and traceability are key tenets of integrity and trust. In the food sector, transparency has now become a watchword. Food regulations "require transparency from food companies that includes record sharing, supplier verification and product sharing along the supply chain" (Moore, 2016). Food chains need to regain consumer trust after the various food incident scandals that have occurred in the past (Wognum *et al*., 2011). There is an increase in the need for transparency because of increases in outbreaks of foodborne illnesses and the resulting increases in consumer demand for food safety and product risk management (Astill *et al*., 2019). Without effective traceability systems and transparency, it is difficult to eliminate illegal fish products and the mislabelling of food products. In the absence of

transparency, companies are unable to identify responsible suppliers during outbreaks of tainted food scandals (Bizcommunity, 2018). According to Veronneau and Roy (2009), traceability provides the ability to create transparency in the supply chain. A decrease in opacity leads to an increase in food authenticity. Difficult to monitor activities of processors. Food is considered authentic if the product corresponds to the original condition and the information on the label.

2.6.8 Quality assurance of products

Demands for assurances of food quality and food safety have been increasing recently (Hobbs, 2003). Quality assurance is a process implemented by companies for ensuring that set standards with respect to food are met. Traceability assists in monitoring product quality (Narsimhalu *et al*., 2015). Traceability is intended to determine if any food safety hazard is likely to occur in a processed fish product by means of examining biological and physical risks in "the raw material to processing, distribution and consumption of the final product".

2.6.8.1 Benefits of Quality Assurance system:

- It helps to remove a problem from the system and thereby improve the system (Manghani, 2011).
- It helps to achieve international quality recognition.
- It helps to highlight deficiencies.
- Provides an approach for continuous improvement.

With effective traceability systems in place, food processors are able to mitigate product recall problems, and to review existing products and processes to ensure the risks of tainted food outbreaks and product recalls occurring are reduced (Aung & Chang, 2014).

2.6.9 Product recall

According to Spink *et al*. (2019), a product recall is the process of recovering defective and unsafe products from customers, while providing customers with compensation. "*Hazard*

means a biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect" (Department of Health, 2004). A company conducts a product recall when it finds a faulty product. The primary reason for product recall is to recognise and remove affected products from the marketplace as fast as could be allowed (HACCP Mentor, 2016. Moreover, "*in the United States of America, the ability to trace a product is a requirement of the Bioterrorism Act of 2002"* (HACCP Mentor, 2016*).*

Having a recall plan, including piloting mock recalls, and using an electronic traceability system can assist in reducing the risks involved in a product recall. This is done because recall plans are not only helpful, but it is also a requirement of HACCP in the USA that mock recall processes must be in place. Recalls usual occur because of safety concerns over a manufacturing fault in a product that may harm consumers (Spink *et al.*, 2019). "*Having a good traceability system in place will assist food processors to improve food quality and reduce costs" (Sweet Technology, 2018).*

2.7 Costs and benefits for traceability systems in the fish chain

"*The purpose of determining the costs and benefits of fish traceability is to assess the impacts of implementing traceability*" (Lumsden & Stefansson, 2007). It is expensive to implement a traceability system. Hobbs (2006) has argued that "*the more precise traceability system is, the higher cost it will generate*". Traceability infrastructure is costly (Lumsden & Stefansson, 2007).

Table 2.1: Benefits and costs of traceability systems in fish supply chains

Benefits	**Costs**
• Finished products can be traced back. • Suppliers are able to react instantly to any product problems. • Reduces risk in the supply chain,	• It is expensive to maintain traceability system. • Financial investment on skills development of labor.

reduces recall cost and business loss. • Helps to enable identification of and outbreak or hazard source. • Reduces problems of mislabeling food. • Traceability promotes transparency and labelling and that food processors that meats food regulations.	• Financial constraints of implementing. • The lack of skilled workers affects the implementation of traceability. • "*The information needs to be stored form a longer period as the product moves along the supply chain which adds to the cost*" • "*There is an information cost that arises from obtaining information about the product, products prices and suppliers of the products*"

2.8 Labelling

Labelling comprises printed information that is bonded to the product for identification and gives detailed information about the product. A label contains information about the product on its packaging, including the origin of the product. The labelling of food products is an important tool as the label sets out information that conveys to consumers the characteristics of a product. According to a report by Carvalho *et al*. (2011), DNA barcoding of whole fish "sold in Brazilian markets under the common name surubin revealed incorrect labelling of approximately 80% of all samples analysed, with mislabelling being more pronounced within fillets rather than whole fish". An EC labelling requirement requires fish products to be labelled, indicating the area of the production site, the commercial designation of the species, and an indication if the fish is wild or farmed (Lupien, 2005). On 30 August 2018, the South African agency for food safety and quality recalled imported table eggs (King, 2018). Similarly, in July 2018, the South African department store, Woolworths, recalled frozen rice products, and this followed an incident of a worldwide product recall amid a listeria outbreak

in Europe. Importance of labelling in long supply chain help to define where a product was made. Labels have always been a fundamental element for the proper functioning of the supply chain to identify each player in the chain. Food labelling requirements are best suited to alleviating problems of asymmetric information.

2.9 Drivers of Implementation of Traceability System

"*There are many drivers of the implementation of a traceability system"* (Haleem *et al*., 2019). The adoption of a traceability system is driven by influences from different sources, including government legislation, and pressures from the customers' needs and consumers' demands.

2.9.1 Legislation

Continuous outbreaks have prompted other countries to impose regulations on food (Mugadza, 2014). "*Legislation is known to comprise one of the drivers for implementing traceability"* (Bosona & Gebresenbet, 2013). "*Regulations in many countries oblige food companies to have a traceability system in place*" (Haleem *et al*., 2019). Haleem et al., (2019), further stated that, the implementation of traceability is a regulator requirement. As a result, countries in the Europe Union enforce the implementation of a traceability system on food products (Duan *et al*., 2017). In South Africa, "*there is no legislation that directly requires food companies to conduct food recalls, and all food recalls conducted are initiated voluntarily, in the interest of public safety*" (Department of Health 2004), even though traceability is considered by many consumers as a tool for ensuring food safety.

2.9.2 Consumers

Consumers needs for quality and safe products constitute a major driver for the implementation of traceability. Consumers now demand clear labelling on food products and transparency (Haleem *et al*., 2019). This has resulted in greater pressure on food processors to have traceability systems in place. Consumers consider traceability as a support to food safety, and when something goes wrong in the supply chain, consumers expect traceability to be in place.

2.10 Mock Trials Programme

Because of the increase in food safety incidents, mock trials programmes should be regarded as compulsory by manufacturers that are concerned about food safety. Traceability is an important part of the manufacturing process and provides a convenient tool for quick responses for removing unsafe products from the supply chain during food recall incidents. Having a mock trials plan and traceability system in place eliminates food safety risks (Future of fish, 2020).

2.10.1 Mock traceability trials

The "*ability to follow the history, application, management, and area of an object through identified stages of production, processing, and distribution is referred to as mock traceability*". "*Movement can reveal the origin of the materials, the history of handling, or the distribution of the product*". Mock recall includes testing all procedures that relate to recalling the product from the marketplace (HACCP Mentor, 2016). The aim of a mock trial is to validate the traceability programme and differentiate where the product went. All food company operators have to comply with the 'one stage back, one forward' approach; for example, food processors need to know the companies that supplied products to and as well intermediaries need to be able to trace back the products.

2.11 Traceability advancement impact

"*The reliability and dependability of the traceability system largely rely on the level of accuracy, efficiency of the identification and authentication technologies"* (Zhang & Kraisintu, 2011). Keeping track of food as it travels from sea to shelf through food processing and packaging, warehouse storage, to distribution centres, and then across transportation routes until it arrives at markets and grocery stores, is a challenge. All the supply chain participants and consumers need to have access to particular data items of interest. Providing all the participants with access to data items of interest can be achieved by utilising automated identification technologies (Senk *et al*., 2013). The advantage of using advanced technologies is a resulting increase in accuracy in data and speed in gathering the data (Haleem *et al*., 2019).

2.12 Traceability technologies in seafood industry

According to Espineira and Santaclara (2016), the traceability of food products is becoming essential, as globalisation continues to increase the complexity of food chains, and because product recalls are costly. Using technology to enable traceability can provide extra advantages (Olsen, 2020). Traceability technology eliminates product recalls, because it provides information about the machines, component stations, shifts and operators, as well as the process steps involved before shipping the product. In addition, traceability technology systems have become important tools for producers to separate out quality, guarantee and safety issues, and reduce interruptions to production. "*The quality of a traceability system helps to track performance and trace a product and eliminates distortion of information*"(Olsen, 2020). Traceability software and technology tools help in the collection and management of information in order to improve product traceability, security and safety through the supply chain (Olsen, 2020). Technology enables information to be stored and easily retrieved whenever is needed. Traceability technology improves food safety control to respond quickly "*in the event of a threat to food safety*"(Agrilinks, 2019). There are several types of traceability technologies used in food industry, including by article number, barcode, internal and external number, item number, production number, and many more.

2.12.1 Article number

"*Article numbers are used in a numbering system to identify a specific retail product, manufactured by a specific company" (International article number, 2020). "The article number identifies a specific retail product type, a specific package configuration, and the specific product manufacturer*"(Laurer, 2019). An article number is in the form of a 13-digit barcode standard for identifying products. An article number uniquely identifies the manufacturer of the product (Laurer, 2019).

2.12.2 Barcode

A barcode encodes details about a product that includes the size and type of the product. Developments in barcode technology are important for meeting product traceability requirements. Barcode numbers are basic for traceability. Barcodes are used for tracing the products along a supply chain, and identify products, areas, and logistics units (Munro, 2014).

Barcodes are essential for eliminating the possibility of human error, such as the mislabelling of the product. Standardised barcodes ensure that the information is stored in a relayed manner.

2.12.3 Internal & external numbers

An internal number is sourced from the recordkeeping of a product within a company. It relates information such as the raw material used in the product, the procedures used to process the product, and to whom the product is supplied. On the other hand, an external number reflects traceable information between the companies that make up a supply chain. "*An external number permits the tracking of a product and the attributes of that item through the stages of the distribution chain, for example from boat or fish farm to table*" (Dipole, 2020).

2.12.4 Item & stock keeping unit number (SKU)

An SKU number is a code that is used to identify products and to assist in tracking stock by a retail business. It is given in different ways, and it is usually broken up into smaller numbers. Following an example, the initial two digits determine the function and next three digits determine the type of product. The item number is also referred to as a stock keeping unit number. An item number comprises a variety of identifications used by a manufacturer that allows unique product identification. An item identification number is used to identify the products that are in stock. Item numbers are used to link records together to form a list of materials used in the production of a product (Lindsey, 2019).

2.12.5 IQ retail system

An IQ retail system is used to assist in managing sales orders, points of sale and stock, and it allows food processors to accurately manage their stock and track orders. Furthermore, it assists in accurate stock management and risk management, and also allows food processors to monitor their stock without tedious administration processes (IQ Retail, 2020). An IQ retail system is contained in software that a company uses to provide business administration solutions for food products and to manage retail products.

2.12.6 Lot/Batch code

A lot code is a unique mix of letters or numbers by which a unit of a product can be traced and differentiated in the records of an operation: a lot code is used to identify a production lot. If a product is not lot coded, the whole year's production could be considered as one lot, and in the event of a product recall, all products may need to be removed. Having a lot of code enables a particular product to be identified, and in that case, only one lot of the product may be affected and would need to be recalled (Martz, 2018). A lot code identifies the date of production and the source of raw materials. Lot code great is the particular identifier assigned to all products in each production lot. It is a unique mix of letters or numbers, or letters and numbers, by which a unit of products can be traced and differentiate in the operation's records.

2.12.7 Production code

A production code is a type of code that is allocated by a food processor to products, and is normally between 9 and 10 digits long, depending on the length of the country code. A production code contains particulars regarding a product, for example it size and type, and the producer. When manufacturers produce a product, it is typically produced in batches. Each production code is assigned a unique series number that make it feasible for manufacturers to track precisely when a problem arose, and which products should be recalled (Huffman, 2011).

2.12.8 Distribution & vendor number

A distribution number is a type of number that a distributor uses to handle products and gives the breadth and "*the depth of distribution of the products, as well as the number of products in stock*". Various stores may carry different combinations of products, and the distribution numbers quantify the availability of products sold through retailers. "*A vendor number is allocated to a supplier in the supply chain that delivers goods and services to the distributor company*". A vendor number is a unique number issued to a company that supplies products (McFall, 2017).

2.12.9 Systems applications & products (SAP) Software

SAP Software is provided by a European global software company that was established in 1972 (Food Software, 2020). The software is used to track product information and is the requirement for food safety compliance. SAP software is used for managing business operations and is also used by companies to ensure food safety and to ensure that companies comply with food standards. SAP software functions are also used for warehouse management and inventory control. It offers visibility across the supply chain and assists a company to stay in compliance with the industry regulations (Food Software, 2020).

2.12.10 SYSPRO software

SYSPRO software facilitates food production, quality control, traceability of products, product recalls, and stock management. More specifically, SYSPRO assists food manufacturers to achieve regulatory compliance and production efficiency, and to ensure food safety. SYSPRO empowers food companies to manage transparency (SYSPRO, 2020) and to manage the traceability of their products. SYSPRO has a comprehensive stock management system that enables the serial tracking and traceability of product," *from the raw material, to manufacturing, to shipment and to the final product"* (SYSPRO, 2020).

2.13 Challenges in implementing traceability system.

Food manufacturers and suppliers are challenged by limited resources and labour in their need to continually improve traceability quality and maintain compliance with government regulations. Currently, there are several challenges to implementing proper traceability systems within fish supply chains, which include lack of capital resources, limited availability of technology advancement, limitations in research, and unskilled labour.

2.13.1 Capital resources.

The majority of supply chain companies have limited resources available for capital expenditure. Furthermore, traceability systems are often not integrated with retailers or suppliers, which would allow for cost sharing. The current tracking system is owned by the product distributor. "*Each player employs a unique traceability system to trace and track the*

product throughout the supply chain". "*The lack of a common system is attributable to a lack of funds and the difficulty in implementing it*" (Narsimhalu *et al*., 2015).

2.13.2 Technological advancement

The traceability system used currently is designed to monitor and manage the stock and generate internal reports. Supply chains without advanced traceability technology tracing and tracking of products are not efficient (Narsimhalu *et al*., 2015). The "*amount of time it takes to trace a product is affected by a lack of information at every point in the supply chain*" (Mugadza, 2014). Specialised technology can help to reduce the input of fraudulent information. *"Technology enables end-to-end traceability in the food supply chains*", and combined with multi-stakeholder collaboration, has the potential to fundamentally improve food systems (World Economic Forum, 2019).

2.13.3 Limitation in research

"*There is a lack of a common theoretical framework in this field, which makes it challenging for companies to implement a traceability system*" (Karlsen, 2013). According to Karlsen *et al*., (2013), this is because a company needs to consider the product cost, the various techniques to track a product, and the level of traceability needed for different products. If these aspects are not identified, it makes it challenging to implement traceability by companies.

2.13.4 Skilled labour

Skilled labour is scarce, and there are few people who are adequately trained in the relevant specialities. The lack of skilled people also negatively affects the implementation of traceability (Ruiz-Garcia and Lunadei, 2011). The South African markets are poorly equipped in resources. It the South African food industry wishes to compete effectively on a global scale, a practical and workable system of traceability must be introduced and adopted (Coleman, 2015).

2.14 Desired state of traceability system

More than ever before, it is necessary to have details about everything "*in the supply chain, from the sea to the consumer's plate: the status of the species, how the fish is caught, where the fish was caught, and the path it has travelled to reach the end customer*" (Kastern *et al*., 2014). This can be achieved with transparency and by providing sufficient information to track fish throughout the fish chain (Kastern *et al*., 2014). A seafood traceability system must record the details set out in Table 2.2 below.

Table 2.2: What Seafood traceability System must Record. Seafood traceability system stem must record, the fishing area, vessel, fish species, weight of the fish, grade of the fish, fish cut and ingredients that used in the preparation of the product (Hosch & Blaha, 2017)

	Explanation
Fishing Area	Fishing areas include some magnificent landscapes and attractive fishing harbours.
Vessel	A vessel can be a ship or a container for holding liquids
Species	Fish species refers to *"limbless cold-blooded vertebrate animal with gills and fins living wholly in water*."
Weight	*"Standard weight in fish is the expected weight at a given total length for a specific species of fish"*
Grade	Grade is the highest quality of the fish
Fish Cut	Fish Cut refers to cutting up bait fish
Processing (Ingredients)	'Ingredient' is a food that is used with other foods in the preparation of a particular product.
Yield	Yield is the amount of fish harvested
Sex	Sex for fish is a phenomenon used in sexual relationships
Maturity	Maturity of fish refers to when fish are fully matured
Logistic chain	Logistic chain refers to path of goods and information from origin to an end user fisherman to secure supply of fish

2.15 Studies in South Africa

The traceability of beef was studied by Calitz (2016), with a focus on establishing a globally recognised framework for beef traceability in South Africa. "*The results showed that a framework could be established, and that the establishment of the framework would allow all the participants to have access to the same benefits as the participants in countries with mandatory traceability".* Furthermore, the results showed that "*it is essential for countries and companies to adopt a globally acceptable traceability system to remain competitive in the global market*". Mugadza (2014) studied the traceability of a fresh vegetable supply. It was established by the research that there were major contributors to the implementation of traceability, including cost, liability, legislation, technology, and consumer awareness. However, it was noted that "*cost is the major constraint, as it affects the overall of implementation of traceability in the supply chain*".

Studies in South Africa have focused on traceability in Karoo lamb (Du Plessis & Du Rand 2012; van der Merwe, 2013), with regard to consumer perception, chain-wide traceability, and transparency. "*The results identified the influences on consumer decisions to purchase Karoo lamb as being quality, safety, traceability, origin of the product, and price*". A point highlighted was that traceability was identified as being the main driver for consumers to purchase Karoo lamb, because the lamb could be traced to its Karoo origin, regardless of the price. It was also concluded that "*the entire South African sheep meat supply chain could guarantee the origin of the product in case of Karoo lamb*".

Evans (2006) conducted a study on traceability in South African fruit chains. The study's goal was "*to determine the viability of effective information access and traceability in the South African fruit exports industry*". It was demonstrated that improved information access and traceability were then feasible for the South African fruit export industry. No studies have yet focused on traceability in the fish supply chains and on the challenges that exist in implementing a traceability system in the fish supply chains within South Africa.

2.16 Summary

The purpose of this chapter was to review the literature on traceability systems for fish within South African supply chains. Primarily, a definition of traceability was discussed. The chapter further explored the necessity for implementing a traceability system and it portrayed the importance of a traceability system. Information on the origin of a product is being requested more frequently than before. A series of frequent food outbreaks and scandals have resulted in increased demands for the implementation of traceability and tracking technologies in seafood industry (Olsen & Borit, 2013). The final discussion focused on the challenges that exist in successfully implementing a traceability system, as well as on studies that have been conducted on traceability in South Africa. Following the review of the literature on traceability, Chapter 3 provides an overview of regulations that regulates seafood industry and South African fish supply chains.

CHAPTER 3
SOUTH AFRICA FISH SUPPLY CHAIN

3.1 Introduction

The aim of this chapter is to provide background of regulations and policies that regulate the South African fish industry. According to Skees *et al*. (2001), government regulations constitute a factor that obliges food processors to have a traceability system in place. The chapter will cover an overview of the global fish industry and the South Africa fish industry, and the mandatory government regulations and policies that regulate the industry in South Africa. The chapter will further discuss case studies of two selected fish supply chains. Traceability of products throughout the supply chain is now an important mandatory aspect in global market for seafood products.

3.2 Overview of traceability in the global seafood industry

There has been a rise in the importance of trade measures for avoiding tainted or sub-standard seafood products from entering international markets (Halyar *et al*., 2014). This is because the fish chain is mainly vulnerable to fraud (Reilly, 2018). This is the case because fraud vulnerability results from openings for undesirable events resulting from weaknesses or flaws related to the system (Spink, Ortega, Chen & Wu, 2017). Reilly furthered stated that, *"Fish was identified as the third-highest risk category of foods with the potential for fraud*". According to Reilly (2018), a European Parliament report of 2013 "*identified fish as the second-highest category of food at risk of fraud"*. Research from the United States of America supports Reilly's assertion by indicating the size of fish fraud. In the United States, fish fraud is still a problem; in 2019, a study found that 21 percent of fish tested was mislabelled in grocery stores and restaurants (Schmidt, 2019).

"*Mislabelling has emerged as a serious problem in global markets for the fishery industry, which has resulted in the need for the development of traceability systems for species*" (Khaksar *et al*., 2015). *"Mislabelling occurs when a food product label does not accurately reflect the ingredients of the product*" (Quantum Food Solutions, 2021). Traceability allows brands to provide consumers with accurate information. Due to the rise in risks of food fraud, governments and food manufacturers have been developing their own tracing and tracking

systems. In the United States, a study using DNA barcode analyses revealed that 75 percent of fish products had been mislabelled (Marko *et al*., 2011). According to Hanner *et al*. (2011), a research study conducted in the retail sector in Canada revealed that 41 percent of fish was mislabelled. Another study in Europe examined frozen fish fillet that was retailed and labelled with an MSC certificate stating the fish to be MSC-guaranteed southern rock sole; however, DNA analysis identified the frozen fish fillet as the northern rock sole species (Holland, 2016). Some mislabelling is a result of poor traceability (Holland, 2016).

In the fishery industry, traceability information is used in connection with guaranteeing food safety, and to ensure that the materials and products originate from a source that meets food safety conditions (Goulding & Megapesca, 2016). Turkey has implemented an automatic identification system for their seafood (Andre, 2018). Other countries have fully adopted computerised systems to ensure continuous traceability; for example, in Morocco fish processors have adopted the use of computerised systems to reduce the use of paper records. The traceability unit is connected to the fishing vessel (Andre, 2018). In other countries, such as Argentina, the seafood traceability system is linked to a landing report, together with a sanitary certificate (Andre, 2018). In the seafood sector, the sharing of information about the product does not take place (Borit & Olsen, 2012). This lack of sharing of information has resulted in an opportunity for fraud and purposely mislabelling of the names of species, as the supply chain become more complex (Fish Wise, 2018). The key motives for regulating traceability is to improve efficiency "in the supply chain management, meet targets of food quality, reduce risk and liability in operations, comply with regulatory requirements, improve competitive advantages, and improve market access, as well to guarantee consumer confidence" (Jones *et al*., 2004; Aung & Chang, 2014).

3.3 Overview of existing traceability standards and regulations

This section will discuss current global traceability standards and regulations, which are adopted for making sure that only safe products make it into the market. Traceability is currently at the forefront of both government regulations and industry concerns, worldwide. As a result, several countries have adopted traceability standards and regulations (Charlebois *et al*., 2014). The regulations involve the implementation of a system for traceability and

labelling of foods. Global traceability regulations and standards help to enable consistent traceability throughout the supply chain.

3.3.1 Global Traceability Standards (GTS)

"*The Global Traceability Standard is provided to assist companies in the design and implementation of traceability systems*" (Global Standard 1, 2017). The Global Standard intends to provide key insights and knowledge to companies about the implementation of long-term traceability. Furthermore, it supports companies to identify and capture important information that is appropriate to their sector. The Global Standard is planned for the entire lifecycle of traceable products in the end-to-end supply chains. "*This Standard allows for the flow of information along the supply chain, which is important in the event of a tainted food outbreak and in the event of a product recall*" (Global Standard 1, 2017). "*The information includes details of raw materials, ingredients and intermediate products and components in the product" (GS1 Global Traceability Standard, 2017). The ability to follow global traceability standard improves quality control systems and reduces risks. Global scale ensures that ensures that standards that support traceability work for everyone.*

3.3.2 ISO 22005

"*ISO 22005 is a basic requirement for the implementation of a traceability system in the food sector and sets out principles that are required for that implementation" (PECB, 2021)*. It also applies to the feed and food chain in all stages of the implementation of the traceability system. The goal set by ISO 22005 is to determine the origin and components of a product. In 2009, ISO 22005 was adopted in China as a standard requirement for the implementation of traceability in the food chains. Following on, in 2010, "*guidelines for the implementation of the traceability system were published"* (Charlebois *et al*., 2014). The implementation of the ISO standard enables the identification of product batches according to raw material, processing and distribution records. "*In the event of the occurrence of unsafe food incidents, the traceability system will assist in the process of product recall and the removal of unsafe food products from the marketplace"* (Charlebois *et al*., 2014).

3.3.3 Regulation 1760/2000

The European Union introduced regulations on traceability in 2000, being Regulation (EC) 1760/2000, which has two fundamental goals. "*The first is to establish an effective system for the identification of products at the production stage. The second is to define a common European system for labelling in the food industry, at the marketing phase of the food chain*". This Regulation maximises transparency in the labelling of food products and obliges food manufacturers to label products with the specified information. "*The information would include the origin of the product, such as name of the country where the fish was caught*" (South African Government, 2012). The Regulation is essential for overcoming problems of mislabelling in food products.

3.3.4 Regulation 178/2002

In 2002, "*due to outbreaks that include foot and mouth disease, the European Union's General Food Law regulation 178/2002 came into force requiring compulsory traceability for food operators*" (FSAI, 2021). Regulation 178/2002 contains general traceability rules and has been put in place for the protection of consumers and traders. According to the Regulation, food must be traceable in all stages, from production to distribution. Food companies are required to keep records of the companies that supply their company with food ingredients. Each food product must have an identifiable supplier and customer. The information must be made available to enforcement officials, whenever required. Companies must keep reference records in their identifying system, for an example, by lot number, barcode and description of food.

3.3.5 Legislation 1224/2009

"*Legislation 1224/2009 requires that fisheries and aquaculture products must be traceable throughout production stages and distribution stages, starting from the fish catcher to the retailer*"(Charlebois *et al*., 2014). The legislation requires that all the products must comply with the requirements for labelling, such as unique number identification and supplier's address (Charlebois *et al*., 2014). This is important in the need for the transparency required for the detection of foodborne illnesses and the management of product risk, product quality and product recalls.

3.3.6 Regulation 104/2000

Regulation 104/2000 became effective in 2002, "*directing that all fishery products be labelled with commercial designations of all the species"*, which include catch area, production location, and production method (FAO, 2003). Regulation 104/2000 requires that all aquaculture products must be labelled according to the regulation, including shellfish, smoked fish, and frozen and chilled products, before the products are distributed to the retailer. The regulation requires that the above information must be provided at all "*the stages of the supply chain, which can be in the form of direct labelling or commercial documentation*" (Mendes *et al*, 2015). The regulation is there to assist in eliminating the high of risk of incidents of mislabelling in seafood products, as the seafood chain is particularly venerable to fraud, particularly mislabelling (Reilly, 2018).

3.3.7 Regulation 2065/2001

Regulation 2065/2001 contains rules on what information must be given to the consumer regarding food manufacturers and production methods, throughout the supply chain. "*This is an important regulatory aspect in food quality and safety, which provides assurance in being able to trace the product ingredients, processing of the product, and the manufacturer"*. Furthermore, it assists in determining the source of the outbreak in an incident of foodborne illness.

3.3.8 Regulation 01224/2009

Regulation 01224/2009 provides fisheries with control measures for the implementation of traceability. "*Companies need to know where an ingredient came from and where the product went to". The* regulation requires product information to be available throughout supply chain, including:

- Lot number
- Name of fishing vessel
- Food & Agriculture Organization species code
- Date of catch

- Date of supply
- Commercial designation
- Catch area & production method.
- Scientific name.
-

3.3.9 World Trade Organization (WTO)

"*The World Trade Organization was formed to support governments in imposing sanitary and phytosanitary measures to protect humans, Sanitary and phytosanitary measures set out the essential rules for food safety health standards*", and countries use these standards and guidelines to ensure their protection (World Trade Organization, 1998). The WTO allows and supports countries to set their own standards and plays an essential role in food safety by enabling countries to protect their citizens from unsafe food.

3.3.10 EC 1830/2003

This regulation provides for labelling and traceability in genetically modified food products, as well as transparency and traceability in all food products. Regulation 1830/2003 ensures that accurate information is made available to consumers and that labelling is verified. The regulation ensures that a traceability system is applied by manufacturers of food products.

3.4 South African Seafood Industry

South Africa is 30th among fishing nations worldwide, and it contributes 20% in the Western Cape to gross geography product (Sea Fish Report, 2019). An estimated 6 billion rand is contributed by the fishery industry to the economy, per annum, amounting to 1% of the GDP (Mkhize, 2020). The South African fishery trade contributes to government revenue, employment and incomes; as such, the industry is important for economic growth and the reduction of poverty (Sea Fish Report, 2019).

In the past, South Africa experienced food recall incidents and some of the incidents led to recall of food products on a national scale. In February 2002, two children died from botulism after the children consumed canned pilchards (Department of Health, 2004). The

incident exposed a lack of control system on food products. A traceability system is important because, in the incidents of food safety threats, it helps in allowing for the identification of hazardous material. The traceability information is important when the industry is confronted with a food safety crisis and is used to manage the product recall (Dabbene & Gay, 2011).

3.5 Regulations and policies that regulate the South African fish industry.

A worldwide rise in outbreaks of food contamination and numbers of food fraud scandals has increased consumer pressure on the government to ensure consumer protection through improved legislation (Lupien, 2005). “Regulations are a factor that forces manufacturing firms, particularly food manufacturing firms, to implement traceability (Skees *et al*., 2001)”. There is a low awareness of laws requiring traceability among fish traders in South Africa (Kastern *et al*., 2014). “In South Africa there is no single food law which can be referenced to determine traceability compliance with the law and for different food product” (Janus, 2017). The following are regulations that manage and govern the South African fish supply chains.

3.5.1 Traceability Operating Guidelines (T-SOP)

"*On 13 June 2007, the South African Department of Agriculture issued traceability operating guidelines (T-SOP) that are only applied to export food products*" (Mugadza, 2014). The Traceability Standard Operating Guidelines (T-SOP) were developed because of traceability requirements of the general food law regulation. Food laws and food safety measures require products to be traceable through all manufacturing steps.

3.5.2 Agricultural Products Standards Act (Act 119 of 1990)

"*The purpose of the South African Agricultural Products Standards Act, 119 of 1990, is to ensure compliance with food safety standards by conducting food safety audits on all registered food business operators and regulated food products destined for export"* (Government Gazette, 1990). The Act also addresses the classification of food products intended for sale in South Africa. The Act also promotes control over sales of certain local agricultural food products and over sales of imported agricultural products.

3.5.3 Foodstuffs, Cosmetics and Disinfectants Act, 54 of 1972

Act 54 of 1972, among other things, deals with Hazard Analysis and Good Manufacturing Practices and Critical Control Points (SA MoH - Government Gazette, 2004). The Act includes a list of potential hazard points that could cause harm, as well as the necessary controls. When conducting hazard control, it is critical to consider raw materials, manufacturing processes, distribution, and storage to create a "list of critical control points (CCP) to eliminate contamination and reduce food safety hazards". The Act is significant because it serves as a tool for verifying food safety.

3.5.4 HACCP – Hazard Analysis and Critical Control Points

HACCP is a globally recognised system for reducing the risk of hazards to food safety. Some of the risks "*associated with fish include, but are not limited to, parasites inherent in the ingredient, toxins (botulism, ciguatera, and histamine) found in fish, and risks introduced during processing procedures, such as temperature abuse and cross-contamination*". HACCP is a food safety system that identifies and controls potential hazards in the food production process (Pierson, 2012). HACCP identifies and controls hazards to ensure food safety. These include biological, chemical, and physical threats. HACCP can be used all the way from primary production to final consumption (Registrar Corp, 2020).

3.5.5 Consumer Protection Act, 68 of 2008

The Act encourages a fair, accessible, and long-term marketplace for consumer goods and services. The Act's goal is "*to establish national norms and standards for consumer protection*". The Act raises the bar for consumer information standards, and prohibits unfair marketing and business practices, encourages responsible consumer behaviour, and improves the quality of information received by consumers. In addition, "*the Act promotes a consistent legislative and enforcement system in relation to consumer transactions and agreements. The Act is one of the primary reasons for the existence of supply chain traceability systems*" (Government Gazette, 2009). This is done to ensure the disclosure of information and the elimination of deceptive and dishonest behaviour.

3.5.6 ISO 14000 (Environmental safety)

ISO 14001 is a globally recognised standard that specifies the requirements for an environmental management system, which assists businesses in identifying, managing, monitoring, and controlling environmental issues. ISO 14000 is the core set of standards that organisations use to design and implement an effective environmental management system.

3.5.7 ISO 22 000 (Food safety)

"The International Organization for Standardization developed ISO 22000, a global food safety standard" (Pierson, 2012). ISO 22000 assists businesses in reducing food risks and improving food safety performance.

3.5.8 Ingredient information file

An ingredient information file includes all the elements considered to be essential to consumers and their health, and "*contains all the most important information about the final product and the ingredients that the product is made from*". "*A food label is an important communication channel that gives consumers information about a product's composition and nutritional profile*" (Wingfield, 2016). This suggests that it is the duty of a manufacturer to ensure that the information displayed on its label is accurate, sufficient to guarantee the safety of the product, allows traceability, and permits tracing activities. The ingredients list provides important information that indicates the nature and quality of food.

3.5.9 Expiry date

"*The expiration date is the date up to which the food maintains its microbiological and physical stability, and the nutrient content declared on the label*" (Habib, 2012). An expiry date is a previously determined date, after which the product should no longer be used, and the date is set by operation of law or according to the anticipated shelf timeframe. The food information regulation explicitly states that food still on the shelf after the used by date is considered to be unsafe (Soethoudt *et al*., 2012). The product is unsafe after this date, as indicated by the labelling regulation. Food producers give dating to assist retailers to decide when food is at its best quality (Tardi, 2019).

3.5.10 Food Safety Initiative (FSI)

The Act "is administered by the Consumer Goods Council of South Africa and focuses on food safety, nutrition and regulations related to food. The Act has established the food safety audit system named Global Food Safety Initiative (GFSI), which is implemented by packing facilities. Global Food Safety Initiative offers certification and audits in food safety".

3.6 South African fish supply chain stakeholders.

This section discusses a general South African fish supply chain. Figure 3.1 below illustrates the stakeholders who are involved in fish supply chains. "*A supply chain network gives an understanding of the flow of information and products and enables companies to look at the overall movement of products and information" (Hinz, 2011). It* furthermore allows companies to understand the value in creating partnership and the value in working together to ensure that the best possible value is provided to the consumers. A supply chains network links companies together to serve the end-customer. The fish supply chain is complex and consist of four different stages, namely fish processors, logistics chain, retailers, and consumers. The supply chain is essential in assuring product safety.

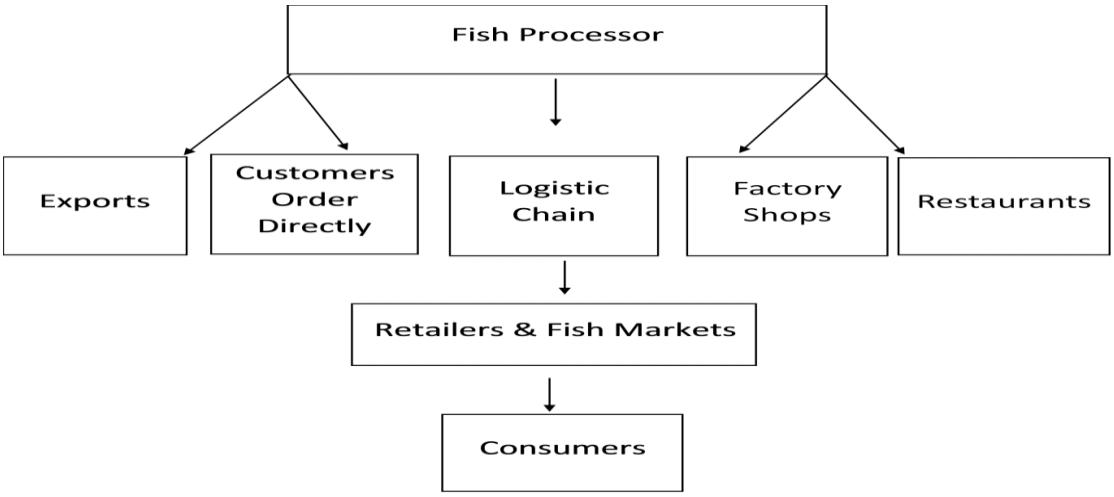

Figure 3.1: South African Fish Supply Chain Stakeholders

Note: Created from data collected

3.6.1 Actors within South African fish supply chains

The purpose of this sub-section is to gain a better understanding of the South African fish supply chain structure, and to ascertain the diversity of the different stages in the chain. The

flow of the supply chain begins with a fish processor and ends with an end-buyer that sells the product to a consumer. End-buyers include exporters, logistics chains, factory shops, retailers and restaurants.

3.6.2 Fish processors

Fish processors are the manufacturers of fish products. Fish processors can be divided into different categories: primary processors that deal with raw fish from the catch, and secondary processors that deal with the processing of the fish products. Fish processors distribute the products to intermediaries and grocery logistics chains. The fish processor processes fishery products, and keeps records of the fish catcher or supplier, of what products were produced from which raw materials, and of where the final product was sent to.

3.6.2.1 Sea Harvest

"*The Sea Harvest Group was established by a Spanish-owned organisation in 1964 at Saldanha Bay, on the Atlantic Coast of South Africa*" (Sea Harvest, 2018). Currently, Sea Harvest is the leading company of household brands in the fish category. The company's operations include value-added support services, such as quality control, logistics chains, and supply chain management. Sea Harvest has ten factory shops, and the "*factory shops are situated around the country including Saldanha Bay, Vredenburg, Piketberg, Sea Point, Paarl and Belville in the Western Cape*" (Sea Harvest, 2018). In recent times, factory shops have also been opened in Centurion, Brakpan, Xavier Boulevard, Silverton in Gauteng, and Rustenburg in the Northwest. Sea Harvest is a vertically integrated group and supplies products to logistics chain companies, which include Vector Logistics and Fisherman's Deli, products for export, and products to the local fish markets.

The purpose of choosing Sea Harvest as a case study is that it is the leading fishing company in South Africa and is also an international fishing company with operations in South Africa, Namibia, Mozambique, and Australia, selling and delivering its premium, sustainably sourced products to 22 countries around the world (Sea Harvest, 2017). Sea Harvest sell their products throughout South Africa to fishmongers, retailers, restaurants, food markets and general food markets. It is one of the largest vertically integrated producers of Cape Hake in South Africa, and its retail products are delivered to major general food store chains in South

Africa. Sea Harvest has long-standing relations and is a market-leading brand in South Africa with a good reputation, delivering to major retailers, worldwide food companies and buyers across the globe (Sea Harvest, 2017). For these above reasons, the Sea Harvest group was selected for a case study.

3.6.2.2 Irvin & Johnson Limited

Irvin & Johnson Limited was established in France in 1897 and currently operates in 28 countries. I&J is a leading fishing company and processor of high-quality chilled and frozen food, and for over 100 years, it has been a trusted brand in seafood. Irvin & Johnson is a vertically integrated South African company, with large investments in fishing, food processing and aquaculture. The company is one of the major fishing companies in the country (I&J sustainable Policy, 2014). The I&J fish processing factory is based in Woodstock, and its value-added processing factory is situated on Paarden Eiland, adjacent to the Cape Town harbour. I&J products are stored and distributed, both locally and internationally. Irvin & Johnson supplies its products to logistics chain companies that include Vector Logistics and Fisherman's Deli. I&J supplies products to the wholesalers, fish markets, restaurants, and to customers who order directly. The reason for choosing I&J as a case study is that it is one of the biggest fish processors in South Africa.

3.6.3 Logistic chains

A logistics chain is an important component of a supply chain. *"It encompasses the planning, transport, and management of goods and services, as well information about a product, from the origin to the point of consumption"*. Logistics help in transferring information along a supply chain and a logistics chain plays an important role in keeping the supply chain strong. "*A logistics chain implements and controls the flow and storage of products and services, and delivers finished products"* (Wins, 2018). The logistics chains involved in the supply chains of Sea Harvest and I&J, namely Vector Logistics and Fisherman's Deli, are responsible for the movement of products across the supply chains of the two companies.

3.6.3.1 Vector Logistics

Vector Logistics is a merchandising and supply chain partner, and serves two types of customers, food manufacturing and food service groups and national retailers. The main customers are I&J, Rainbow and Pieman's. However, Vector Logistics' supply services are not limited to its main customers, and it also serves other food manufacturing and food servicing companies, including Sea Harvest. Vector Logistics delivers 60 million cases per year to more than 67 000 customer drop points through a nationwide network that includes four plant-based cold stores and fourteen distribution sites (Vector, 2019). Vector Logistics' roles include sales management, shelf health management, merchandising, and distributing the products to retailers. Distribution centres for Vector Logistics have been established in South Africa, Namibia, and Botswana. Vector Logistics distributes products to retailers, wholesalers, restaurants and hotels (Vector, 2019).

3.6.3.2 Fisherman's Deli

Fisherman's Deli is a leading distributor and supply partner to both the food service and retail industries. It supplies a large variety of frozen and chilled produce, as well as grocery products, to customers across South Africa (Fisherman's Deli, 2023). The retail team of Fisherman's Deli consists of sales representatives, merchandisers and promoters. Fisherman's Deli distributes products to retailers, wholesalers, restaurants and hotels.

3.6.4 Factory shops

A factory shop is a manufacturer's own store that sells the company's products directly to the public. It is one of the important links in the supply of goods to customers. In some cases, also sell goods directly to the consumers if the quantity is large enough. Sea Harvest and Irvin & Johnson have factory shops that sell their finished products directly to consumers. The role of these factory shops is as an intermediary for the sale of finished products by Sea Harvest and Irvin & Johnson and includes locating buyers for Sea Harvest and Irvin & Johnson products.

3.6.5 Retailers

Retailers provide the final link in the supply chain between the manufacturer and a customer and provide an important link between producers and consumers. Retailer activity involves selling goods and services directly to customers (Goose, 2019). Retail is designed to display goods from the manufacturer and is the final stage in the marketing channels for products. Retailers are organised to sell Sea Harvest and Irvin & Johnson products in small quantities to the public for personal or household consumption. According to Veneto Promozione Scpa (2013), South Africa has five major retailers, being Shoprite/Checkers, Spar, Pick ‘n Pay, Woolworths, and Massmart, and, for the purpose of this study, only the top five retail groups will be discussed. The retailers that service Sea Harvest and Irvin & Johnson are Pick ‘n Pay, Checkers, Spar, Shoprite and Woolworths.

3.6.5.1 Shoprite / Checkers

Shoprite Checkers is the largest retail company in the country and operates more than 1 200 retail outlets and 270 franchises in 16 countries across Africa. Shoprite increased turnover by 14.4 percent and grew by 8.5 percent. "*Shoprite’s headquarters are in the Western Cape province of South Africa" (Melbmars, 2021).* Shoprite’s primary business is food retailing, with an objective to provide all communities in Africa with affordable food and to bring products and services to market that satisfy consumers in quality. Suppliers who provide food products to it are obliged to ensure that they meet requirements for food quality assurance. The food quality assurances relate to regulations for food standards and food safety and quality.

3.6.5.2 Pick ‘n Pay

"*Pick ‘n Pay is the second-biggest retail store chain in South Africa, and its retail outlets can be found in various regions of southern Africa, including Zimbabwe, Zambia, Lesotho, Namibia, Mozambique and Botswana" (Smith, 2020). "All the raw materials and ingredients used in the production of food products supplied to it are required to indicate expiry dates and full traceability of the origin must be shown" (Pick n Pay, 2022). "All Pick ‘n Pay food suppliers are required to meet the minimum food safety standards and undergo food safety*

audits" (Pick n Pay, 2022). The auditing process is conducted according to ISO 19011 and ISO 17021, published by the International Organization for Standardization.

3.6.5.3 Spar

Spar operates across 33 countries on five continents, and has roughly 12 000 stores, globally. The operates as a distributor and wholesaler of goods and services to Spar retail stores. Spar uses ISO 22000 to mitigate risks of food safety hazards. The Spar group also uses an Electronic Identification System, and the system records all product life cycles, facilitating the traceability of products, from source of origin to consumer. The system enables the group to capture product information quickly and accurately, "*including information about the place of product origin, and the information is stored in a record-keeping database*" (Spar, 2020).

3.6.5.4 Woolworths

Woolworths is a South African retail chain and is among the biggest retailers in the country (Woolworths Holdings Limited, 2023). In 2015, the South African customer index described Woolworths as the best store for consumer care (van Wyk, 2017). Woolworths sources the fish products it sells from South African fish processors. It uses modern technologies that incorporate a traceability system that includes stock keeping unit numbers, which are codes that are used to identify products and assist to track and trace stock for retail businesses. A stock keeping unit number incorporates information for the identification of a product-by-product colour, price, brand, size and manufacturer. All the products are traceable through the product distribution chain until the product is delivered to Woolworths' distribution centre, where the products go through an electronic checking system.

3.6.5.5 Massmart

Massmart Holding Limited is a South African company that owns local retailing brands, including Game and Makro. *"Massmart is the second-biggest distributor in Africa, and the largest retailer of general products and wholesaler of basic foods. The company operates 422*

retail stores in South Africa, and 12 in other Sub-Saharan countries" (Istanbul Africa Trade Company, 2018). The Massmart head offices are located in Sandton, Johannesburg.

3.6.6 Distribution of the fish products

Table 3.1 below summarises the distribution of fish products along the fish supply chains in South Africa. I&J distributes 10% of its products directly to the customers, while 60% of I&J fish products is distributed to its logistics chain. Furthermore, 10% is distributed to fish markets, 10% is distributed to the restaurants, and 10% is distributed to wholesalers. Sea Harvest does not distribute its products directly to the retailers, but rather distributes 60% to the logistics chains, and 20% is distributed to Sea Harvest factory shops that are based in Western Cape, Gauteng and Northwest provinces. Lastly, Sea Harvest exports 20% of its fish and fish products.

Table3.1: Distribution of the fish products

Distribution Channel	**Sea Harvest**	**I&J**	**Vector Logistic Chain**	**Fishman' Deli (logistics chain)**
Direct orders to Customers		10%		
Logistic Chains	60%	60%		
Exporters	20%			
Fish markets		10%		
Hotels			15%	
Restaurants		10%	10%	15%
Retail			50%	75%
Sea Harvest Factory shops	20%			
Wholesalers		10%	25%	10%
Total Distribution	**100%**	**100%**	**100%**	**100%**

The above table summarises the distribution of fish products along the fish supply chains in South Africa. Majority of products are distributed to logistic companies for ensuring the distribution of final product retailers. Above 80% of Sea Harvest products are distributed local and only 20% of the company's production is exported. On the other hand, I&J distribute local only.

3.7 Summary

There has been an increase in the importance of food regulation measures. Food regulations and policies have formed a major driver of the implementation of traceability practices across the food sector. This chapter provided the background of regulations and policies that regulate the South African fish industry. The chapter also contains case studies on two different fish supply chains. The criteria for selecting each supply chain were based on the relative leading and major fish processors in South Africa. It was found that, in South Africa, there is no food law which can be referred to in order to determine traceability compliance, and that the traceability standard operating guideline that exists is only applied to exported food products. In order to benefit from international trade, it is necessary for South African companies to have a traceability system in place.

CHAPTER 4
RESEARCH METHODOLOGY

4.1 Introduction

The aim of this study is to profile the traceability systems that are used in the fish supply chain in South Africa. This serves as a guide as to which methods were selected to profile the traceability systems used in the South African fish supply chains. In this chapter, the research design tools and settings are described in a way to give an overview of how the research was carried out. This chapter will also include a description of the areas in which the study has been conducted. The following instruments will be described: research design, study population, sampling strategies, data collection instruments, data analysis and the model used.

4.2 Research design

"*Qualitative research involves collection of narrative data in a natural setting to gain insights into phenomena of interest. The most common methods of data collection are observation, in-depth interviews and focus group discussion*" (Sutton & Austin, 2015) Qualitative research includes collecting verbal data that gives insights into the opinions of the research participant's experiences. Qualitative research is more subjective (Taylor & Littleton, 2006). On the other hand, quantitative research involves gathering information in numeric form that can be readily manipulated through statistical methods of data analysis. Qualitative research is different from qualitative research because it uses more structured instruments to collect data, while the results provide fewer details on behaviour, attitude, and motivation (Mhlongo, 2013).

For this study, a qualitative research design was used because the study aim was to explore how participants have experienced the traceability system of their companies. The study seeks to understand and interpret current traceability systems used within the South African fish supply chain. Qualitative research was a useful approach for this study as it allowed for a full exploration of participants' subjective understandings of the traceability systems used by their companies. "*Moreover, qualitative research gathers a variety of subjective ideas from the population of interest and makes sense of the ideas through examining patterns and*

themes. However, qualitative research has several strengths and has limitations" (Smith & Caddick, 2012). One of the limitations of using a qualitative approach is that the quality of the evidence found is reliant on the research.

4.3 Study population

The research was conducted in two provinces, the Western Cape and Gauteng. *"Western Cape province is the major costal fishing province in South Africa. South African seafood industry is dominated by the Western Cape, which accounts for more than 80% of domestic aquaculture produce*" (Cawthorn, 2007 & Witthuhn, 2011). The Western Cape has historically been the centre of the aquaculture and fishing industry (Marillier, 2016). Gauteng province was selected because it has the highest population, compared with other inland provinces, with a higher per capita income, and has a high rate of sales and consumption of commercial seafood (Schlemmer, 1998). There are 12.7 million of people in Gauteng, which is 24% of South African population, and 45% of the highest-income-earning households live in Gauteng.

The focus was placed on fish processors, factory shops, logistics chains and retailers. The fish processors studied are the Sea Harvest group and Irvin & Johnson. The factory shops sampled were the Sea Harvest factory shops based in Silverton, Centurion and Brakpan. However, Irvin & Johnson do not have factory shops. The logistics chains sampled were those of Vector Logistics and Fisherman's Deli. The Vector Logistics unit that was sampled is situated in Midstream, Johannesburg. The Fisherman's Deli warehouse that was sampled is also situated in Johannesburg, in North Riding. The retailers studied were Checkers, Pick 'n Pay, Shoprite, Spar, Game and Makro.

4.4 Sampling strategies

"*Sampling is the process of selecting a few respondents from a population of interest, so by studying the sample, we may fairly generalise our results back to the population from which they were chosen*" (Kumar, 2019). There are two types of sampling approaches that are used in social science research, namely probability sampling and non-probability sampling (Latham, 2007). The sampling method chosen for this study is probability sampling. "*The reason for using probability sampling is that, in probability sampling, all the elements in the*

population of interest have an equal opportunity of being included in the sample". On the other hand, in non-probability sampling, the elements are selected on basis of their availability instead of sampling from the entire population, and the disadvantage is that the sampling could be biased and inaccurate.

This research selected fish processors for study because processing is where the supply chain starts. Logistics chains were selected because logistics chains distribute the fish products to the retailers. Retailers are the final link in the supply chain, between the fish processor and customer. The sample consists of 40 respondents. The researcher decided to use the Sea Harvest and Irvin & Johnson fish processors because these two companies are among the top South African fish processors, and they would be a good source of participants. The data collection period took place from 19 June 2019 to 17 August 2019. The sampling strategy was used to study the current traceability system used in South African fish supply chain.

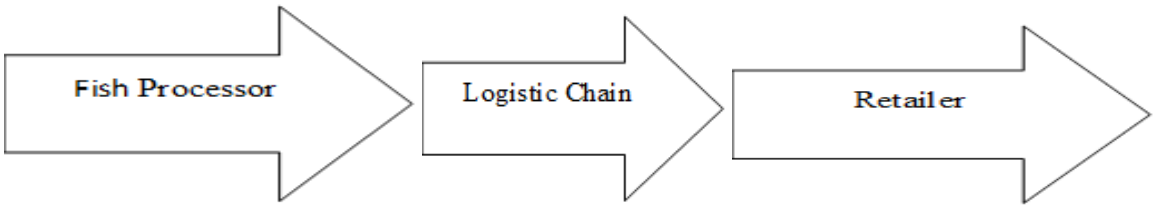

Figure 4.1: Data collection order

Table 4.1 below illustrates the respondents, together with the number of respondents. The respondents comprised 5 fish processor participants, 9 logistics chain participants, and 26 for retailer participants.

Table 4.1: Number of respondents

Respondents	**Number of respondents**
Fish Processor	5
Logistics Chain	9
Retail	26
Total	40

Table 4.2 below illustrates the sample participants per province. There were 2 fish processor participants in Gauteng and 3 in the Western Cape. There were 7 logistics chain participants in Gauteng and 2 in the Western Cape. There were 16 retail participants in Gauteng and 10 in the Western Cape.

Table 4.2: Sampled participants per province.

	Gauteng	**Western Cape**
Fish processor	2/5	3/5
Logistic chain	7/9	2/9
Retailer	16/26	10/26

A sampling size is dependent on the availability of participants, budget for traveling costs, and the availability of time. It was challenging to secure interview appointments with fish processors and logistics chain managers, and because of time limitations, only 5 fish processor participants were interviewed. Traveling between the Western Cape and Gauteng was costly because the harbours are far apart from each other and from the logistics chains' warehouses.

4.5 Data collection instruments

A data collection instrument is an important tool used to obtain sufficient information to meet a study's objectives (Fossey *et al*., 2002). An opening consent form was formulated (see Appendix 1), giving a brief explanation of the study and asking each potential participant to indicate his or her willingness to become participant in the study. Because of the nature of the study, and in order to obtain the appropriate information for answering research objectives, the study was open only to systems managers for the fish processors, warehouse system managers in the logistics chains, and product merchandisers and field marketers in retail.

Data was obtained through using interviewer-administered questionnaires in semi-structured interviews, (See Appendix 2), "which are useful and appropriate tools in qualitative research (Fossey *et al*., 2002; Holliday, 2004; Blanche *et al*., 2006). The interviews were appropriate

for in-depth and comprehensive information gathering, as qualitative research interviews aim to obtain participants' views of their experiences" (Rice & Ezzy, 1999). The questionnaires were interviewer-administered to minimise common errors and misinterpretations, as well as misunderstandings of questions. The administration of the questionnaires by the interviewer ensured that all the questions were clear to the respondents and that respondents did not skip difficult questions.

The questionnaire consisted of closed-ended and open-ended questions. The importance of open-ended questions is that they give respondents an opportunity to express their views freely. However, the disadvantage of open-ended questions is that the questions are narrowed to focus on the relevant issues and to allow ease of data analysis. In this study, the majority of the questions were set as closed-ended questions, for the purpose of obtaining as much information as possible without taking up too much of the time of the respondents. The duration of the interviews was set at twenty minutes. The questionnaire focuses mainly on the current traceability systems, and the effectiveness of the traceability systems in recording product information throughout all the stages of the handling of a product.

4.6 Data analysis

The aim of this section is to give an explanation of the methods used to analyse the data, where the aim is to profile the traceability systems used for fish products within South African chains. The data analysis techniques adopted give detailed coverage. The study collected descriptive data, as the study endeavours to investigate the status of the traceability systems used in South African fish supply chains. "Qualitative data analysis is a process of reviewing, synthesizing and interpreting data to describe and explain the phenomena being studied (Fossey *et al*., 2002)". "*This includes making sense of huge amounts of data by reducing the volume of raw information, followed by identifying significant patterns and building a logical chain of evidence"* (Wong, 2008). After the data collection process was completed, the data was captured and encoded in the form of a spreadsheet for data analysis. The interview transcripts were analysed by SPSS, a software package used for analysis, which may be done interactively or statically.

The data analysis techniques adopted for the hypothesised independent variables that could possibly impact upon the implementation decision of traceability systems" and the factors that influence the current state of traceability systems are summarised in Table 4.3 below

Table 4.3: Description variables and expected sign.

VARIABLE	DESCRIPTION	UNIT	EXPECTED SIGN	EXPLANATION
Dependent Variable				
Traceability	Traceability system in place	Dummy		
Independent Variables				
Capital	Amount of capital available to implement and maintain traceability in the company	Rand	+	Traceability system implementation and innovation is costly and needs capital investment in place.
Skilled Labour	If the company has IT experts.	Dummy	+	The traceability system requires skilled labour to do technical work.
Technology Advancement	If the company have advanced system in place.	Dummy	+	Technology advancement improves accuracy and efficiency of product identification.
Government regulations	If government put regulations for implementation of traceability system.	Dummy	+	Government regulatory requirements is a driver of traceability system implementation

4.7 Model

This study adopted Fisher's exact test, van der Merwe (2013) used Fisher's exact test to evaluate South African traceability systems in fish supply chain. Fisher's exact test is used to determine whether or not there is a significant association between two categorical variables. Fisher's exact test is applicable in two situations. The first one is when a sample is drawn from a population and two categorical variables are recorded for each element in the sample for example availability of regulations and policies in place can improve implementation of traceability system in the food industry. Fisher's exact test is more accurate than the chi-square or G-test of independence when the expected numbers are small. In a case when the total sample size is less than 1000 Fisher's exact test is used.

Fisher's exact test is used:

- when there are two nominal variables,
- for 2 by 2 tables,
- to determine whether or not there is a significant association between two categorical variables.

The formula for Fisher's exact test is represented as follows:

$\rho = ((a + b)! (c + d)! (a + c)! (b + d)! / a! b! c! d! N!$ ..... (1)

In this formular the 'a', 'b', 'c', and 'd' are individual frequencies of the 2X2 contingency.

ρ = P-value

a + b = population successes

a + c = sample size

a = sample successes

N = Total frequency

The Fisher Exact test uses this formula to obtain the probability of the combination of the frequencies that are actually obtained. It also involves the finding of the probability of every possible combination which indicates more evidence of association.

4.8 Reliability

Reliability is represented by a dependable and consistent account of data (Neuman & Kreuger, 2003). "*Validity refers to the degree to which the tool measures what it is intended to measure and the extent to which a concept is accurately measured in a study*" (Heale & Twycross, 2015). According to Neuman and Kreuger (2003), qualitative researchers aim to "*give a fair, honest and balanced account of social life from a viewpoint of someone who lives it every day*". This part of the study describes the validity and reliability of the research and the tools that were used to assess the status of traceability systems used in South African seafood supply chains. The analytical tools used consisted of descriptive and inferential statistics. Descriptive statistics summarize the characteristics of data set. Inferential statistics allow you to test a hypothesis or assess whether your data is generalizable to the broader population.

4.9 Summary

The purpose of this chapter was to give details of the analytical framework that was designed for answering the study objectives. The chapter described the approach used during the study, as well the method applied in collecting data. The analytic framework defined the traceability systems used within South African fish supply chains. This serves as a guide as to which methods were selected to profile the traceability systems used in the South African fish supply chains. The following chapter will present the analysis and findings of the study.

CHAPTER 5
ANALYSIS & FINDINGS REGARDING TRACEABILITY SYSTEM OF FISH IN SOUTH AFRICAN SUPPLY CHAINS

5.1 Introduction

This chapter presents the research findings and qualitative analyses of the collected data. The chapter will start with an overview of traceability systems that are adopted by the sampled fish supply chains. The chapter will proceed to review the perceptions of the participants about the current traceability systems, quality of traceability technology, access to quality traceability technology, and impacts of advancements in traceability. The chapter will further include the qualitative analyses using Fisher's exact test, components of what the current traceability systems record, and the quality assurance systems used within the sampled companies. The chapter will also be covering why the traceability systems are in place, the drivers for the implementation of a traceability system, the economics of traceability systems in fish supply chains, mock traceability trials conducted, and product recall incidents. Lastly, a chapter summary is set out.

5.2 An overview of traceability systems adopted by sampled fish supply chains

The study has shown that all the sampled fish supply chains have a basic traceability system in place. The participants indicated that they have traceability systems in place to follow food assurance standards and to follow the food safety regulations.

5.2.1 Implemented traceability systems in South African fish supply chains

The participants highlighted the point that the methods used for record keeping could be paper-based or electronic, depending on the company involved. The information needed to be kept for fish includes the name and address of the supplier, quantity of products, batch number, and the nature of fish supplied. The information needed to be kept by a retailer includes the producer's name, product name, quantity of products, pallet number, transporter's name, shipment number, and distributor's name and address. For packaging, the basic data includes details such as the type of fish product, the origin of the product, and the supplier's name. Different elements of traceability systems are used to create a history of the

journey of the product, and the information is used to compare it with the production planning system to ensure that no step is missed. Table 5.1 below illustrates the different types of traceability systems available in the South African fish supply chains.

Table 5.1: Traceability system implemented in South African fish supply chains

ELEMENTS OF TRACEABILITY SYSTEM	FUNCTION
Article Number	Article number is a numbering system used in identifying retail products received from a manufacturer.
Barcode	Barcodes contain details about a product that include the size and type of the product.
Internal Number	Internal traceability is the recordkeeping of a product within a company.
External Number	External traceability permits the tracking of a product and the attributes of that item through the stages of the distribution chain
Item Number	Item number is a number for identification used by manufacturer, which allows for product unique identification.
IQ Retail System	IQ retail system is used to assist in managing sales orders, points of sale and stock.
Lot Code	Lot Code is a unique mix of letters or numbers, by which a unit of product can be traced and differentiated in the operation's records.
Production Code	Production code contain particulars regarding a product, for example, the size, type, and producer.
Distribution Number	Distribution Number is the number the distributor uses to handle products.
SAP Software	SAP is used to plan and control financial, manufacturing, logistics and distribution activities.
SKU Number	SKU number is a code that is used to identify products and assist to track stock for retail businesses
SYSPRO Software	SYSPRO software facilitates in food production, quality control, traceability of products, product recalls and stock management.

Vendor Number	Vendor number is a number assigned to a supplier in the supply chain that delivers goods and services to the company.

The traceability system that is used the most in South African fish supply chains is the barcode system, followed by the production code system. Companies use different traceability systems across the supply chains, which is a challenge in information sharing. For this reason, the lack of continuous information sharing affects the monitoring of the product. From the data collected, it was found that the above traceability systems could capture the following information:

- Identification of incoming products, such as raw materials and ingredients, and their sources.

- Records on activities linked to product processing and storage.

- Product codes, which carry information that includes raw material and date of manufacturing. The code is used during events of hazards to food safety and quality, which is important because the product may have to be removed from the marketplace. If the product is not coded, the entire production may need to be removed.

- Date of production, which is the date when the product was manufactured; more precisely, it is the date when the batch of fish product was produced. Fish processors "provide dating to help consumers and retailers decide when food is of best quality". Date of production expresses both the day and month of production.

- Internal and external codes, which are both traceability codes that are used in South African fish supply chains. On fishing vessels, the fish processors record information related to the catch, processing place, and all internally generated batches.

5.3 Perceptions on the current state of traceability systems

A well-developed traceability system is a well-functioning system that can track and trace all the stages of production, from the raw material to the final product. It is a system that meets regulation requirements, and, in the event of a food safety outbreak, it can respond quickly (Agrilinks, 2019). "*In order to achieve a well-developed traceability system, various levels of verification are needed at all stages in the supply chain*". The system is said to be satisfactory when it can retain the important "information about the product and its components through all its production."

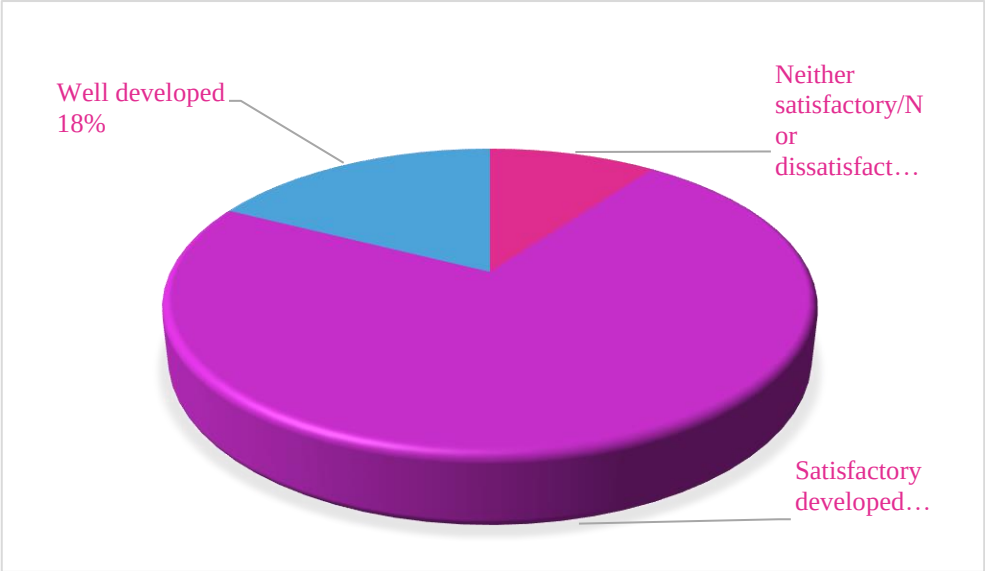

Figure 5.1: State of current traceability system of South African fish supply chains

- Figure 5.1 above shows that 72% of the current traceability systems in South African fish supply chains are regarded as being satisfactorily developed. The categorisation of 'satisfactorily developed traceability' means that the traceability is adequate but needs attention. The majority of the participants confirmed that the current traceability system is able to identify the origin of the product, manufacturing information, and the source of outbreaks and hazards. The companies use an item number that assists in identifying the origin of the product and the manufacturer of the product. The system allows the fish processor to provide proof of the origin of all their fish products. The system determines the location of the fishing harbour, manufacturing information and the physical address of the fish processor. The tools such as barcodes, SAP, SYSPRO,

SKU number, scan, records product codes, records manufacturing and distribution activities.

- It was found that 18% of the participants were of the opinion that South African fish supply chains are well developed. Well-developed traceability means that the traceability system meets the consumers' expectations, and more." *Traceability is said to be well developed based on the resources required to track and trace the supplier and buyer relationship*". The fish processors use production codes, which cover details of the area of the catch, the shipping of the product, and where and when the product was produced. Some fish processors also use lot codes to identify when and where the product was produced. All the products are marked early in the production process for quality control purposes. One fish processor advised that the company uses a 'nerve system' (as referred to in Section 5.5. below) at the harbour that shows all the stages related to the production of a product. Some logistics chains use the SAP software system at their warehouses to manage all product movements and stock in the warehouse.

- From the data gathered, 10% of the participants indicated that current the state of South African traceability systems is neither satisfactory nor dissatisfactory. A few participants revealed that they had not been with the company for long, and in their time had not encountered any complaints about the system, or any outbreaks or food hazards, and they had no idea if the system could identify the source of the product.

5.4 Quality of traceability technology

Figure 5.2 below shows that 75% of the participants were of the opinion that the quality of traceability technology in South African fish supply chains is in line with the expectations. When the traceability system matches with the expectations, it indicates that the system works well in tracking and tracing the product, and that the authorities could act quickly to identify a cause of a food hazard, isolate the source, and remove affected products from the supply chain.

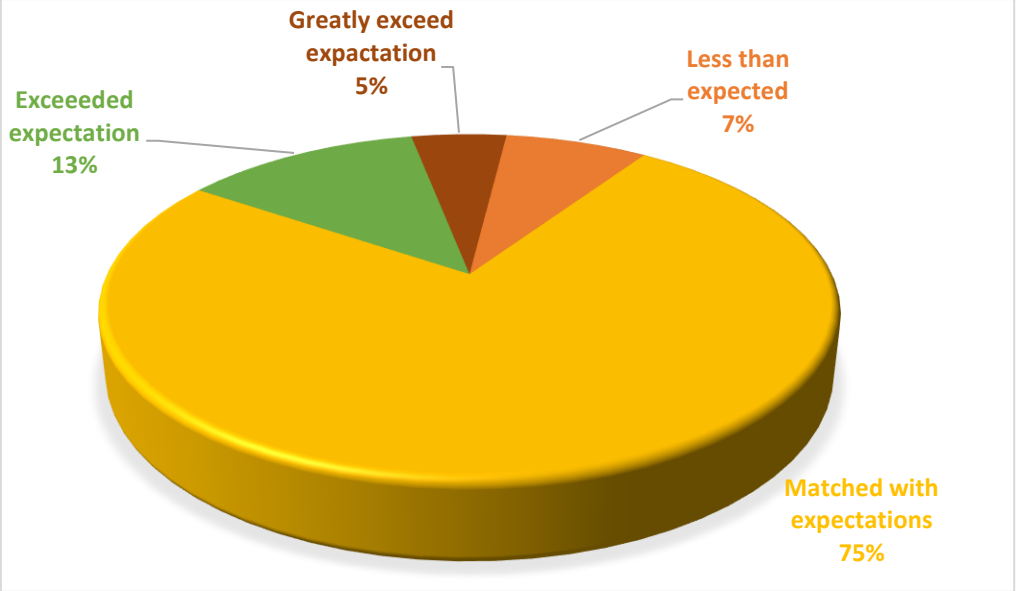

Figure 0.1: Quality of traceability technology within fish supply chains in South Africa

Figure 5.2 further indicates that:

- 13% of the participants believed that the quality of traceability technology exceeds the expectations in the industry. This is because a product can be traced back to the fish processor. The batch number and all the records are available, when needed, to query a product. The barcoding system allows supply chain stakeholders to identify the products.

- 7% of the participants were of the opinion that quality of the traceability technology is less than expected in the industry. When the traceability system is less than expected, the company cannot identify where a product had gone, and which products were affected.

- 5% of the participants believed that the quality of the traceability technology greatly exceeds expectations in the industry. The study shows a positive result that the quality of the traceability technology used does meet basic expectations.

5.5 Access to quality traceability technology

From the data gathered regarding access to quality traceability technology in fish industry, the results indicate that:

- 75% of the participants were of the opinion that access to quality traceability technology is satisfactory in the industry. Some of the actors in the South African fish supply chains have access to quality traceability technology. A 'nerve system' is one of these traceability technologies used, and the function of the system is to show all the stages related to the product production. There is also the IQ retail system that assists in managing sales orders, points of sale, and stock. The actors in the chains also use SAP software to manage the movement of products.

- 10% of the participants were of the opinion that the access to quality traceability technology in the industry is very satisfactory. Some of the retailers use SKU numbers to keep track of each product. This is because the traceability systems used can identify the product at any point in the supply chain.

- 8% of the participants were of the opinion that the access to quality traceability technology in the industry is fair. The traceability system chosen is dependent on a company's internal and external needs for traceability information.

- 7% of the participants were of the opinion that the access to quality traceability technology in the industry is poor. Although data revealed little evidence of this, this might be because not all the stakeholders in South African fish supply chains have access to the best traceability technologies.

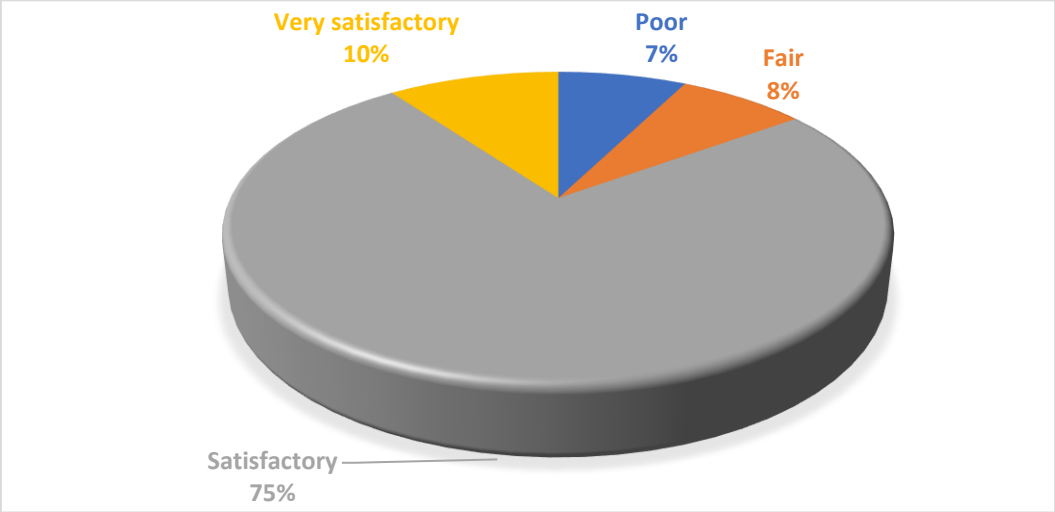

Figure 5.3: Access to quality traceability technology in seafood industry

5.6 Impact of advancement in traceability

This study aimed to find out how fish processors, logistic chains operators and retailers perceive the impact of advanced traceability. Advanced traceability is more reliable, increases the speed of production, and ensures that the end result of the product required initial outlined for the product. Figure 5.4 below indicates that advancements in traceability have impacts on the traceability capacity of a company, with 95% of the participants indicating that advanced technology does have an impact on traceability. On the other hand, 5% of the participants were neutral. From the results, it appears that the South African fish supply chain actors are fully aware of the contribution and impact of advanced traceability technology. However, South African fish supply chains use basic traceability systems. This is due to various reasons, such as not having the funds to implement advanced traceability systems, which are costly. Nevertheless, advancements in traceability technology are being developed to overcome food safety concerns.

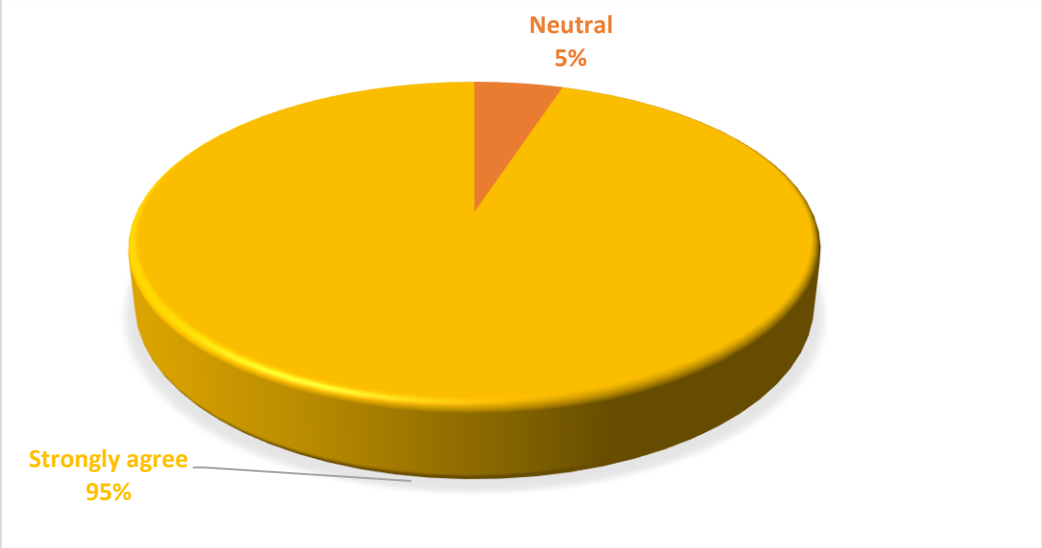

Figure 5.4: Traceability technology advancement impact

5.7 Fisher's exact test

The Fisher's exact test was performed to test the association between the variables of: access to quality traceability technology and quality of traceability technology available to the industry; access to quality traceability technology and state of current traceability implemented by the company; quality of traceability technology available to the industry and state of current traceability implemented by the company. Fisher's exact test is used to determine whether or not there is a significant association between two categorical variables. Fisher's exact test is applicable in two situations. The first one is when a sample is drawn from a population and two categorical variables are recorded for each element in the sample for example availability of regulations and policies in place can improve implementation of traceability system in the food industry. The hypotheses of the test are as follows:

H0: There is no association between Variable 1 and Variable 2

H1: Variable 1 and Variable 2 are not independent**.**

The results obtained from the Fisher's exact test and the rejection rules are presented below.

Access to quality traceability technology for your industry	Quality of traceability technology available to your industry				Total
	Exceeeded	Greatly e	Less than	Matched w	
Fair	0	0	0	3	3
Poor	0	0	3	0	3
Satisfactory	3	0	0	27	30
Very satisfactory	2	2	0	0	4
Total	5	2	3	30	40

Fisher's exact = 0.000

Figure 5.5: association between Variable 1 and Variable 2

In the test between access to quality traceability technology and the quality of traceability technology available to the industry, the p value is less than the conventional levels of significance 10%, 5% and 1%. Accordingly, the null hypothesis is rejected in favour of the alternative hypothesis. Therefore, the two variables show strong association. The conclusion was drawn that access to quality traceability technology is affected by the quality of traceability technology available to the industry. Therefore, this means that the adoption of quality traceability technology by the fish processors, logistics chain operators and retailers is determined by the availability of quality of traceability technology in the seafood industry.

Access to quality traceability technology for your industry	State of the current traceability system used by the company			Total
	Neither s	Satisfact	Well deve	
Fair	1	2	0	3
Poor	3	0	0	3
Satisfactory	0	27	3	30
Very satisfactory	0	0	4	4
Total	4	29	7	40

Fisher's exact = 0.000

Figure 5.6: association between Variable 2 and Variable 3

In the test between access to quality traceability technology and the state of current traceability implemented by the company, the p value is less than the conventional levels of

significance 10%, 5% and 1%. Accordingly, the null hypothesis is rejected in favour of the alternative hypothesis. Therefore, the two variables show strong association. The conclusion was drawn that access to quality traceability technology is affected by the state of the current traceability system used by the company. Therefore, the state of a company's traceability technology is affected by the access to quality traceability technology in the seafood industry.

Quality of traceability technology available to your industry	State of the current traceability system used by the company			
	Neither s	Satisfact	Well deve	Total
Exceeeded expectation	0	0	5	5
Greatly exceed expact	0	0	2	2
Less than expected	3	0	0	3
Matched with expectat	1	29	0	30
Total	4	29	7	40

Fisher's exact = 0.000

Figure 5.7: association between Variable 3 and Variable 4

In the test between the quality of traceability technology available to the industry and the state of current traceability implemented by the company, the p value is less than the conventional levels of significance 10%, 5% and 1%. Accordingly, the null hypothesis is rejected in favour of the alternative hypothesis. Therefore, the two variables show strong association. The conclusion was drawn that the state of the current traceability system used by the company is influenced by the quality of traceability technology available in the seafood industry.

From the results obtained, it can be concluded that the access to quality traceability technology implemented by the fish processors, logistics chain operators and retailers is influenced by the quality of traceability technology available in the industry. Furthermore, the state of the current traceability technology implemented by the company is influenced by the quality of the traceability technology available in the industry. The above conclusion is based on Fisher's exact test.

5.8 Components of what current traceability systems record.

A traceability system collects and records data throughout the production process. As the product moves from the manufacturer to the market actor, the traceability system records data points that track and trace the product. From the data gathered, the following results were obtained:

- Figure 5.8 shows that 78% of the current tractability systems record fishing areas. The systems record fishing location, gear used, and time of capture.

- Of the participants, 10% indicated that the traceability system records vessel and registration number.

- All the participants indicated that the current traceability system record the species caught. The fish processors ensure that species have unique names and can be identified.

- 53% of participants indicated that the current traceability system records product weight. “The weight of a fish is a way to measure the overall health of a fish by comparing its weight with the average weight of other fish of the same length and kind”.

- 53% of the participants indicated that the current traceability system records the grade of the product. During fish catches, fish are separated according to the fish categories that have reached the permitted market sizes.

- 18% of the participants indicated that the current traceability system records fish cuts and records the maturity levels of the fish.

- All the participants indicated that the current traceability systems record ingredients and yield of the product.

- None of the participants knew if the current traceability system records the sex of the fish caught.

- 45% of the participants indicated that the current traceability system records the logistics chain used for the product.

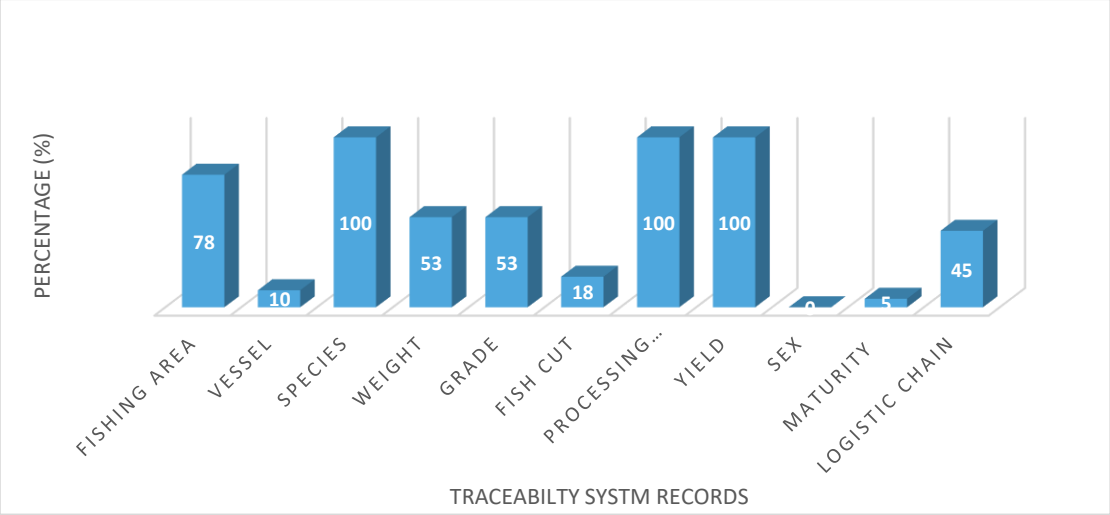

Figure 5.8: What current traceability system record in Seafood industry

5.9 Quality assurance systems

The participants were asked to provide details of the quality assurance systems used within their companies. Table 5.2 below illustrates the quality assurance systems in place in the South African fish supply chains.

Table 5.2 : Quality assurance systems in Seafood industry

QUALITY ASSURANCE SYSTEM	EXPLANATION	Fish Processor	Logistics Chain	Retailer
HACCP	HACCP eliminates food hazards and promote safety and quality assurance.	60% of fish processors indicated that they have HACCP quality assurance system in place.	None of the logistics chains has this quality assurance system in place.	None of the retailers has this quality assurance system in place.

GMP	GMP is the system used to ensure that products meet the quality standards.	80% of fish processors indicated that they have this quality assurance system in place.	None of the logistics chains has this quality assurance system in place.	None of the retailers has this quality assurance system in place.
ISO 14000 (Environment safety)	Environmental management system that exists to assist companies to comply with applicable laws, regulations and environmental requirements.	90% of fish processors indicated that they have this quality assurance system in place.	80% of the logistics chains have this quality assurance system in place.	80% of the retailers have this quality assurance system in place.
ISO 9000	This standard is used to trace the origin and location of a product.	80% of fish processors indicated that they have this quality assurance system in place.	60% of the logistics chains have this quality assurance system in place.	90% of the retailers have this quality assurance system in place.
ISO 22000 (Food safety).	The standard is applied at any stage in the supply chain for food safety management.	80% of fish processors indicated that they have this quality assurance system in place.	90% of the logistics chains have this quality assurance system in place.	80% of the retailers have this quality assurance system in place.
Ingredient Information File	The product information file	90% of fish processors	80% of the logistics chains	60% of the retailers have

	contains all the most important information about the finished product, ingredients, what the product is made from, its safety and value.	indicated that they have this quality assurance system in place.	have this quality assurance system in place.	this quality assurance system in place.
Expiry Date	The date a producer lists on a product to inform consumers of the last day that the product will be safe to consume.	All fish processors indicated that they have this quality assurance system in place.	All logistics chains indicated that they have this quality assurance system in place.	All retailers indicated that they have this quality assurance system in place.

5.10 Reasons for using a traceability system.

The participants were asked to provide reasons why fish processors, logistics chain operators and retailers would, in their opinion, implement traceability systems, as well their opinions as to why they think that fish processors, logistics chain operators and retailers would not implement traceability systems. The majority of the participants were of the opinion that traceability systems are used to identify products and to prevent business losses during incidents of product recalls. Table 5.3 below sets out a summary of the responses obtained.

Table 5.3: Reasons for having & not having a traceability system in place

Reasons for having traceability system in place	**Reasons for not having traceability system in place**
• Product recalls are a common occurrence in the food	• There are limited resources for implementing a traceability system,

industry. • The main reason for having a traceability system is to protect public health. • Traceability is essential for food safety operational effectiveness. • To be able to track the source of origin of the product to guarantee that species and qualities of the products meet the regulations. • Companies that lack an appropriate traceability system throughout the supply chain are at reputational risk. • Labelling is used as an efficient marketing means to attract customers.	and it is still a challenge for IT staff to implement comprehensive traceability systems. • Companies are in some cases unwilling to participate in a traceability system that will need continuous investments. • There is no profit benefit that has been well articulated as a result of putting resources into a traceability system. • The composition level of a traceability system influences the implementation of traceability system. • The innovation used to implement a traceability system can be costly, particularly for growing companies

All the participants indicated that there is traceability system in place at their firms and were of the opinion that having a traceability system in place is now a requirement in the seafood industry. The reasons for this are that:

- There is an increase in consumer awareness, and consumers now are becoming more conscious about the products they are consuming and demand a system to trace and track food.
- Retailers are demanding traceability system from their suppliers.

5.11 Drivers of Implementation of Traceability Systems

The participants were of the opinion that the key drivers for implementing a traceability system arise from the various requirements of the government, fish processors, logistic chains, retailers and consumers. Figure 5.6 below indicates that 5% of the participants were of the opinion that government regulatory requirements constitute a driver of traceability system implementation. The government demands that traceability systems be put in place before a fish processor considers supplying products to consumers. Government support and regulations were highlighted as being a driver for the implementation of traceability systems. This is in line with the study that done by Asioli, Boecker and Canavari in 2014, the results of which showed that the companies that receive support from government had implemented higher levels of traceability than the companies that did not receive that support.

The results of the present study also show that:

- 32% of participants were of the opinion that fish processors constitute drivers of traceability system implementation because they strive to ensure customer confidence in their products. Quality assurance contributes to traceability system implementation to give surety to the customers.

- Only 5% of participants were of the opinion that logistics chains are drivers of the implementation of traceability systems. However, in a logistics chain, it is a necessity to have a traceability system in place to trace each product back to the supplier in order to assure product origin, better supply chain management, and for ease of identification of products from suppliers. Therefore, it was concluded that logistics chains were drivers of traceability technology.

- 38% of the participants were of the opinion that retailers are drivers of the implementation of traceability systems. Retailers implement traceability systems to gain competitive advantages. For this reason, retailers were concluded to be drivers of the implementation of traceability systems.

- 20% of the participants were of the opinion that consumers are drivers of the implementation of traceability systems. Customers in the past were not conscious or thoughtful about the origin and suppliers of their food items; however, customers are

now more informed and educated and so demand systems that trace food. Traceability is driven by consumers' needs for safe, good-quality food products.

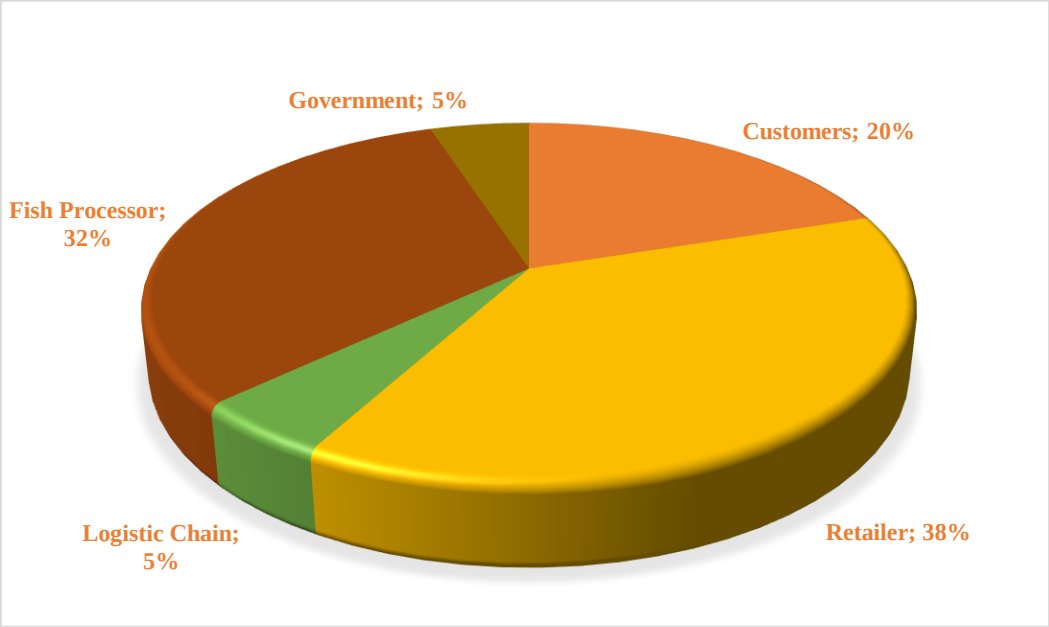

Figure 5.9: Drivers for implementation of traceability system in fish supply chains

5.12 The Economics of traceability systems in fish supply chains

The results revealed that 47% of the participants were of the opinion that fish processors carry most of the risk regarding the implementation of traceability systems. Participants and eliminated through strategic planning, other risks are not easy to identify at first. The risks include product recalls that usually follow after a product has reached the market. No company wants to deal with a product recall, because it affects the company's financial profile and the company's performance in the market. On the other hand, 75% of the participants were of the opinion that consumers benefit the most (see Figure 5.7 below) because a traceability system that is in place promotes food safety and food quality.

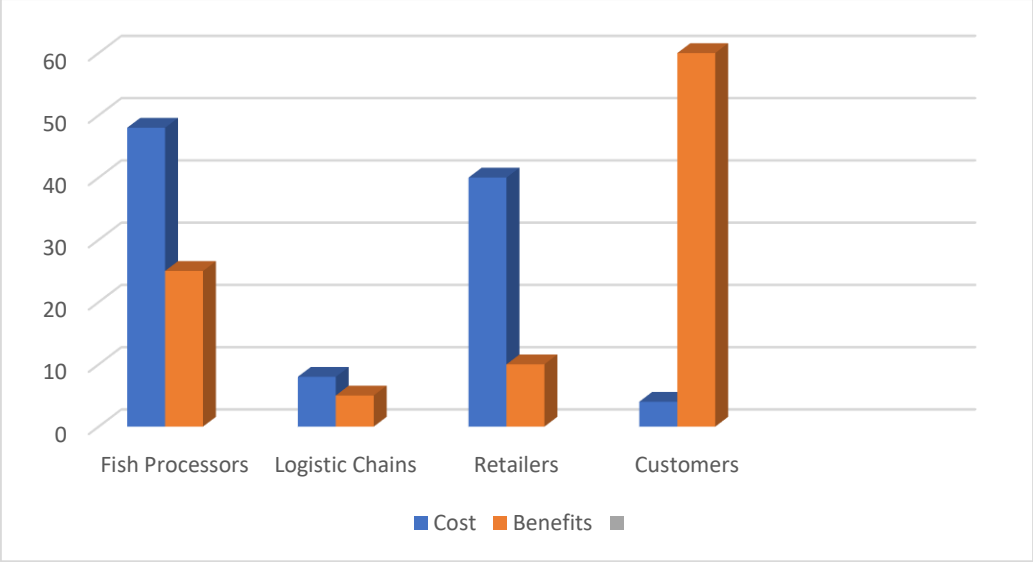

Figure 5.10: Who carries the Cost & Benefit for the implementation of traceability system

Table 5.4 below summarises the benefits and costs of traceability systems that were identified by the fish processors, logistics chains and retailer's participants. The benefits and costs of traceability systems identified by the participants are in line with the benefits and costs noted in the literature review in Chapter 2.

Table 5.4: Benefits & Costs of implementation of traceability system

Benefits of implementing a traceability system	**Cost of implementing a traceability system**
• Traceability system reduces recall costs and business loss. • Reduces mislabeling food problems. • Helps to reduce illegal fishing. • Helps to enable identifying an outbreak or hazard source. • Promotes sustainability in fisheries.	• It is expensive to maintain a traceability system. • Financial investment in skills development of labour. Financial constraints of implementation.

• Increases food security. • Traceability system reduces risk in the supply chain. • Traceability system helps to overcome low quality in seafood products and unhealthy fish stock. • Eliminates the exposure of consumers to fraudulent products	

5.13 Mock traceability trials

The participants stated that one of the reasons to hold mock trials is that product recalls present a serious threat to a company's profitability. Fish processors conduct mock trials on a quarterly and semi-annual basis. It was revealed that few companies conduct regular mock trials, and this is because there is no regulation in place that requires this practice. Having plans in place and conducting mock recalls do help to reduce the risk. Of the participants, 70% indicated that they do not practise mock traceability trials and participants indicated that they do practise mock trials and conduct mock backward traceability tests.

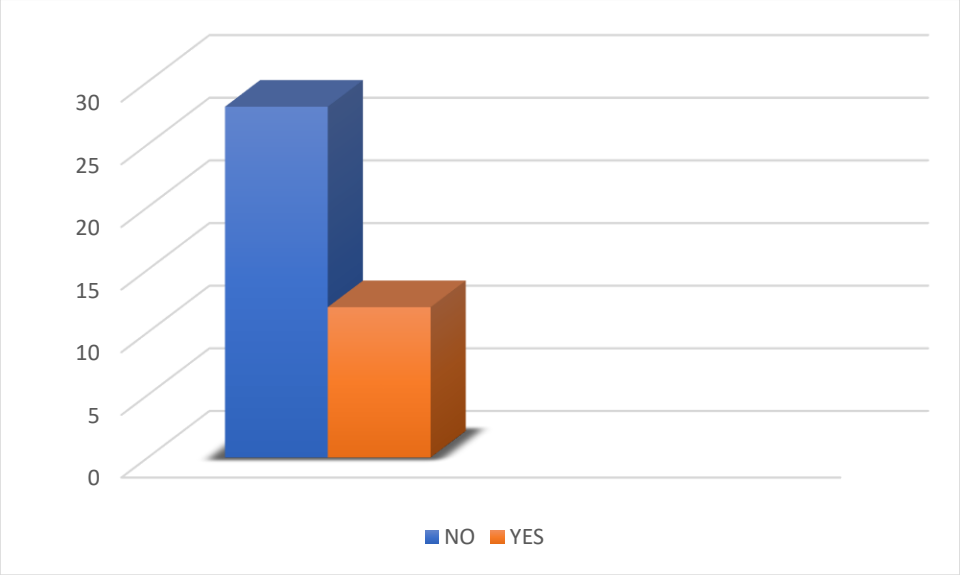

Figure 5.11: Mock traceability in Fish supply chains

5.14 Product recall Incidents

The participants highlighted the point that traceability systems enable the actors to achieve efficient recalls at the chain level, and proactive monitoring quality along the supply chain. The systems can indicate timely warnings of possible product problems, and can contribute in the search for the cause of product recalls. There were 8% recalls associated with product safety events and 10% recalls related with non-food safety.

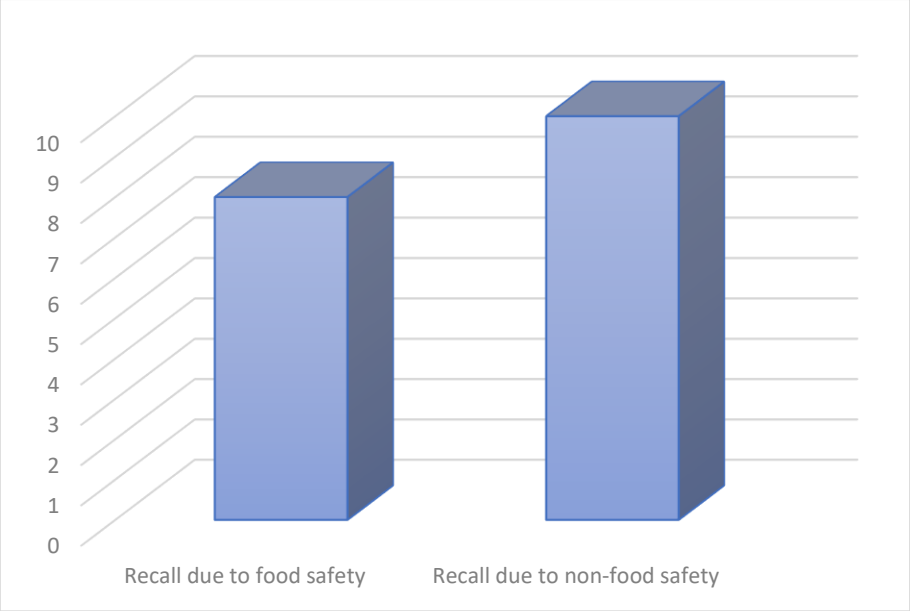

Figure 5.9: Product recall incidents

5.14.1 Causes of incidents of product recall

From the data gathered, product recall incidents were attributed to the following causes:

- Health problem complaints
- Improper packaging and mislabelling of products.
- Short lengths of shelf-life time.
- Expiry dates on the packaging not matching with the expiry date on the products inside the packaging.
- Barcodes that were not visible.

5.14.2 Resolutions to incidents of product recall

- All the products with the same production code as that which a customer had laid a compliant about were removed from the shelves.
- Products were taken back to the fish processor concerned.

5.15 Summary

Two South African fish supply chains were assessed in this study. The aim was to gain an understanding of, and provide knowledge about, the nature and scope of the current traceability systems, and the challenges that exist in those traceability systems. Using semi-structure interviews with 40 individuals, the research revealed that the current traceability system used in South African fish supply chains is satisfactorily developed. However, it was also revealed that the industry is faced with the challenges that the innovation used to implement traceability system can be costly, particularly for growing companies, and that, even when the system is implemented, it is expensive to maintain the traceability system. It is a challenge to fund investments in the skills development of labour. Chapter 6 will discuss the descriptive results of traceability systems, as implemented at each stage in the supply chain.

CHAPTER 6
ANALYSIS PER ACTOR IN THE SUPPLY CHAIN

6.1 Introduction

There is a traceability system in place in South African fish supply chains. According to the findings of the study, the majority of South African fish supply chains have basic traceability systems in place that allow the other players in the chain and consumers to at least know the origin of a product. This chapter aims at presenting the results, per actor. During the research, it was decided to divide all the sample participants in the supply chains into three different groups. This was done to gain a better understanding of the types of traceability system used and ascertain why specific actors have a particular system in place. The first section below presents the types of elements and mechanisms of traceability systems implemented in the South African fish supply chain. The second section provides results regarding the challenges that exist in the current traceability systems.

6.2 Types of elements and mechanisms of traceability systems implemented in the South African Fish Supply Chain

6.2.1 Traceability systems implemented by fish processors.

There are different types of traceability elements that are implemented by fish processors. However, the tracking and tracing of the products within the chains are expected to remain traceable, regardless of the type of traceability system used. When looking at the elements of the traceability systems implemented by fish processors, the following results were found:

- 80% of fish processors had a production code traceability system in place.
- 50% fish processors had a lot number traceability system in place.
- 60% of the participants indicated that they had an internal and external number traceability system in place.
- 65% of those indicated that they had SAP software traceability system in place.
- All of the participants revealed that they had a barcode traceability system in place.

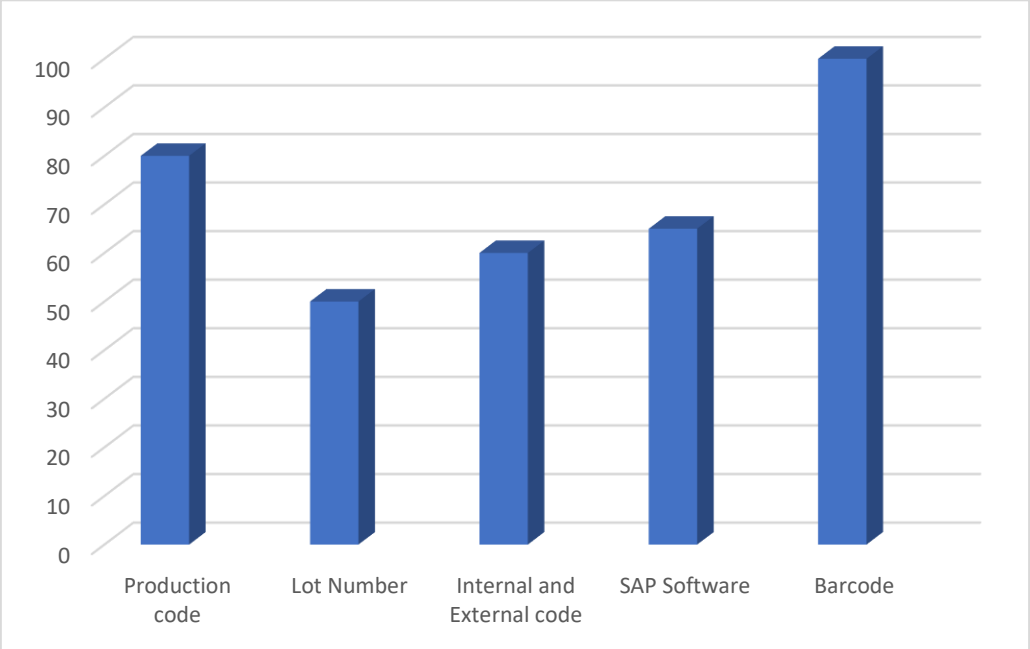

Figure 6.1: Traceability systems implemented by fish processors from the data collected.

The above-mentioned systems are expected to be able to identify the history and source of food products, and to manage the inventory. The results showed that the traceability systems mentioned in the above Figure could identify the following information:

- Manufacture name
- The raw material used.
- The production code and production date
- The shipment of the product.

In conclusion, traceability system implemented by fish processors from data collected can trace back the primary source of the product.

6.2.2 Traceability systems implemented by logistics chains.

Figure 6.2 below illustrates the types of the different traceability systems used by the logistics chain operators. It was noted that logistics chains are likely to have software-based traceability systems in place. Generally, the view is that these software systems can trace a product back to the processor. Of the participants, 70% stated that they use production codes.

About 60% of the participants indicated that they use article numbers and SAP software traceability systems. Of the participants, 50% indicated that they had the SYSPRO software traceability system in place.

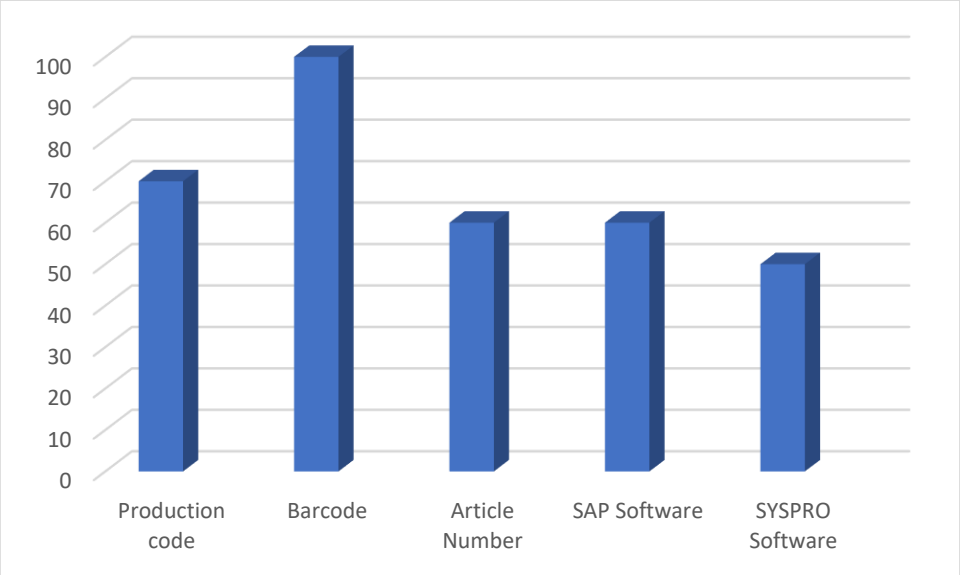

Figure 6.2: Traceability systems implemented by Logistic chains.

In conclusion, South African logistic chains use software systems. The systems can trace a product back to the processor.

6.2.3 Traceability systems implemented by Retailers.

Figure 6.3 below indicates the types of traceability systems used by South African retailers. The retailer respondents indicated that their most-used system is the barcode system, and the following results were ascertained:

- All of the participants stated that they had a barcode traceability system in place.
- 80% of the participants were of the opinion that retailers use item numbers.
- 60% of the participants were of the opinion that retailers use production numbers.
- 38% of the participants were of the opinion that retailers use lot numbers.

- 25% of the participants were opinion that retailers use SKU numbers.

- Lastly, 20% of the retailers use vendor numbers and the IQ retail system.

From the opinions of the participants majority of retailers use item numbers as a form of traceability. Item numbers are mostly used because they identify the history of a product, from the mix of raw material used to the delivery of the final product. About 60% of the participants indicated that they use production numbers to identify products and for ease of identification of a product during food recall incidents. Only 38% of the participants were of the opinion that retailers use lot numbers as a traceability system. Few of the participants were of the opinion that retailers use SKU numbers, vendor numbers and the IQ retail system.

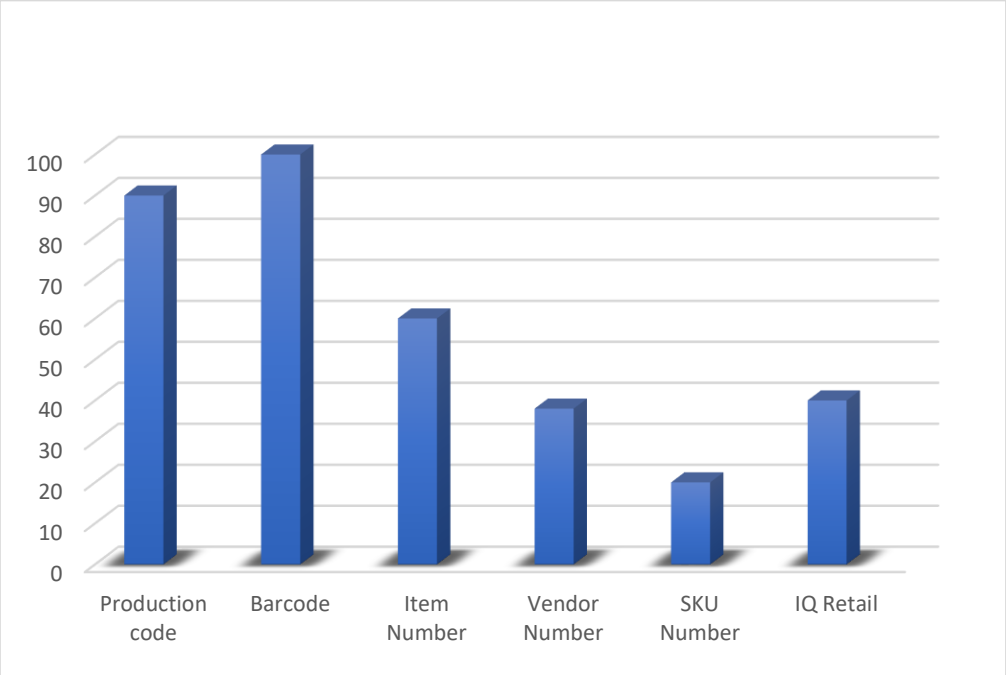

Figure 6.3: Traceability systems implemented by Retailers

6.3 Challenges in the existing traceability systems

The following subsection considers the challenges that exist in the current traceability systems used in the supply chains. It is important to identify these challenges to gain a clear understanding of the state of the current traceability systems in use. A clear understanding will be drawn from each segment in the chain. The challenges differ greatly along the supply chain, depending on the stage and company involved. The causes of the challenges in the

existing traceability systems relate to type technology available, financial availability are associated with greater challenges that exists.

6.3.1 Perception on the current state of traceability systems used by the company.

As shown in Figure 6.4 below, 60% of the participants were of the opinion that the current state of their implemented traceability systems is well developed. It was stated that this is due to several reasons. For food processors, the best way to protect their brands' reputations is to prevent having a crisis in the first place. Fish processors have well-developed traceability systems in place to prevent problems arising, such as contaminated food entering the supply chain, and to ensure that their products are safe for distribution. On the data collected of the participants, 40% were of the opinion that the traceability system of fish processors is satisfactory developed. About 70% of the participants were of the opinion that traceability systems are currently used to manage stock and to ensure food safety. This is because the traceability system used by fish processors can track a product, from production to consumption.

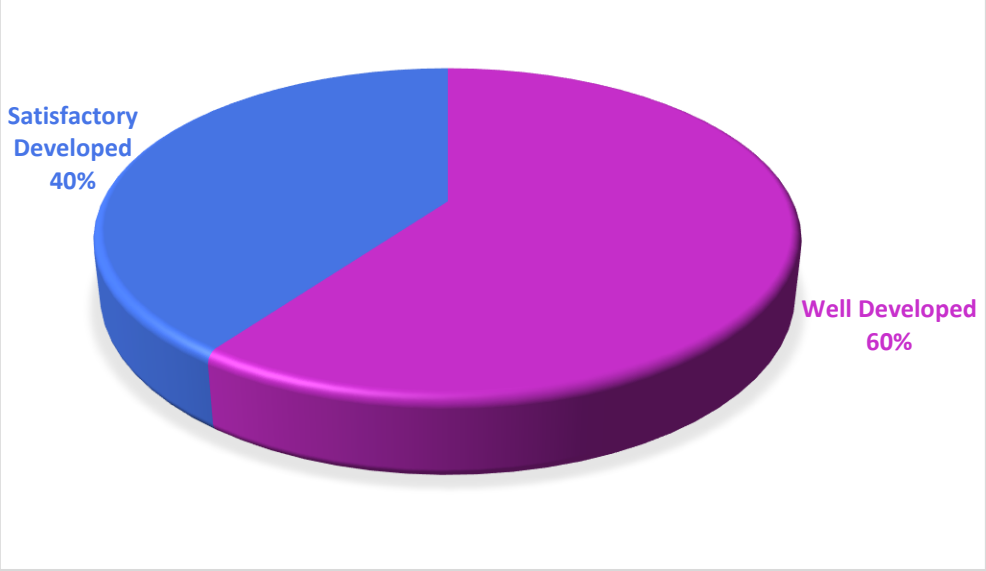

Figure 6.4: Current State of Traceability System implemented by Fish Processor

On the other hand, when looking at the logistics chains, the following results were found regarding the state of their traceability systems:

- 30% of the traceability systems used by the logistic chains are well developed. “A common opinion among the participants is that traceability systems are currently mostly used for management of inventory purposes by logic chains”.

- 70% of the traceability systems used by the logistics chains are satisfactorily developed. The point was highlighted that logistics chains have a traceability system in place because it is a requirement for being able to sell products to the retailers.

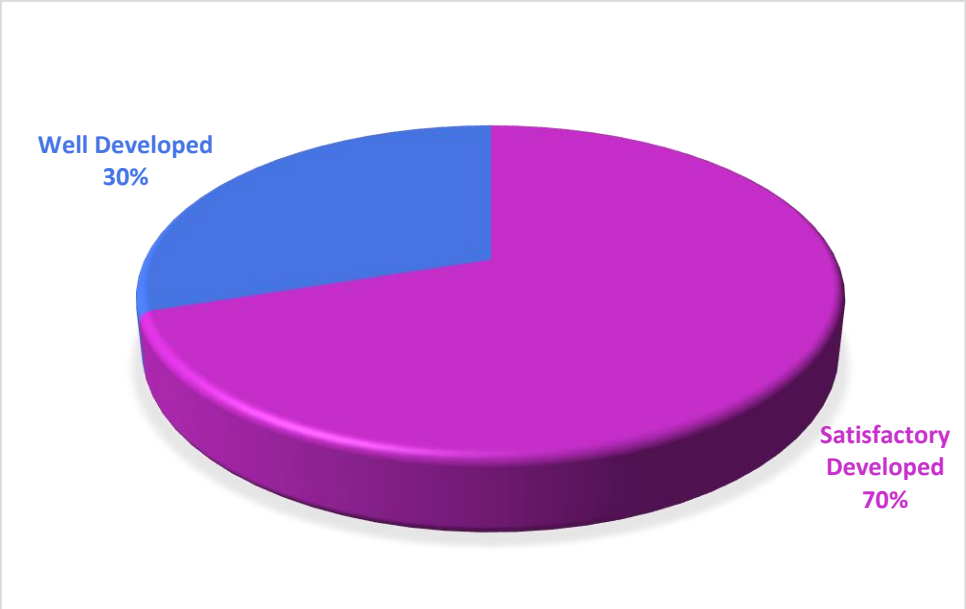

Figure 6.5: Current State of Traceability System implemented by Logistic Chains

When looking at the state of the traceability systems implemented by retailers, the following results were found:

- 15% of the participants were of the opinion that the state of the traceability systems used by the retailers was neither satisfactory nor unsatisfactory. The inherent challenges of the current traceability systems are attributable to poor digital literacy.

- 85% of the participants were of the opinion that the state of the traceability systems used by the retailers is satisfactorily developed.

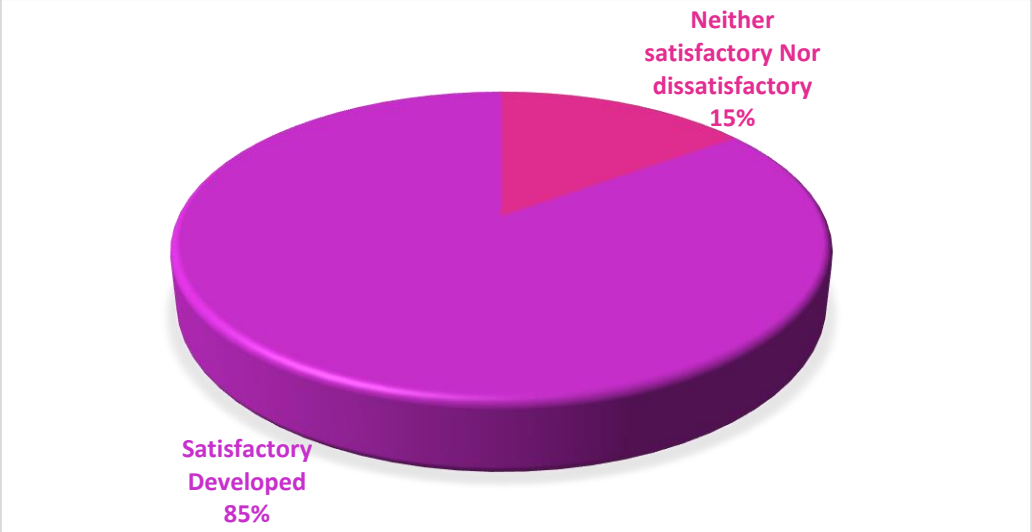

Figure 6.6: Current State of Traceability System implemented by Logistic Chains

6.3.2 Quality of traceability technology

Figure 6.7 below shows that about 80% of participants were of the opinion that the quality of the traceability technology available for South African fish processors exceeded expectations. The possible reasons for this could be that, while there is no single solution for managing food safety and brand reputation during food crisis incidents, the quality of traceability technology available is important. High-profile product recalls in the past have knocked consumer confidence as a result of accidental food contamination. The point was highlighted that companies throughout the supply chain need to have quality traceability technology in place for better crisis management procedures.

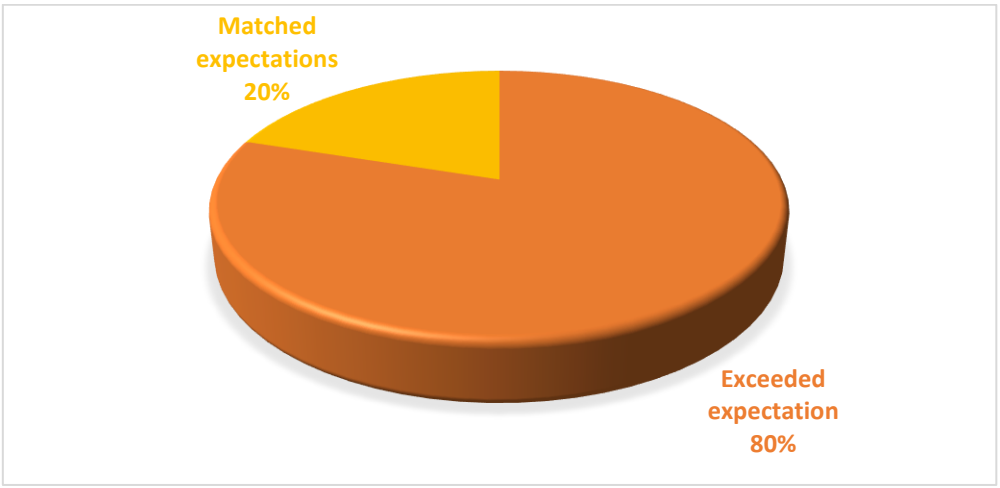

Figure 6.7: Quality of Traceability Technology of the fish processors

Among the participants, 70% were of the opinion that the quality of the traceability systems used matched the expectations. After a series of food scandals and incidents, many efforts have been undertaken to implement proper information technology systems and to improve the quality of the traceability systems. Of the participants, 20% were of the opinion that the quality of the traceability system used exceeded expectations, and 10% were of the opinion that the quality of the traceability system used greatly exceeded expectations.

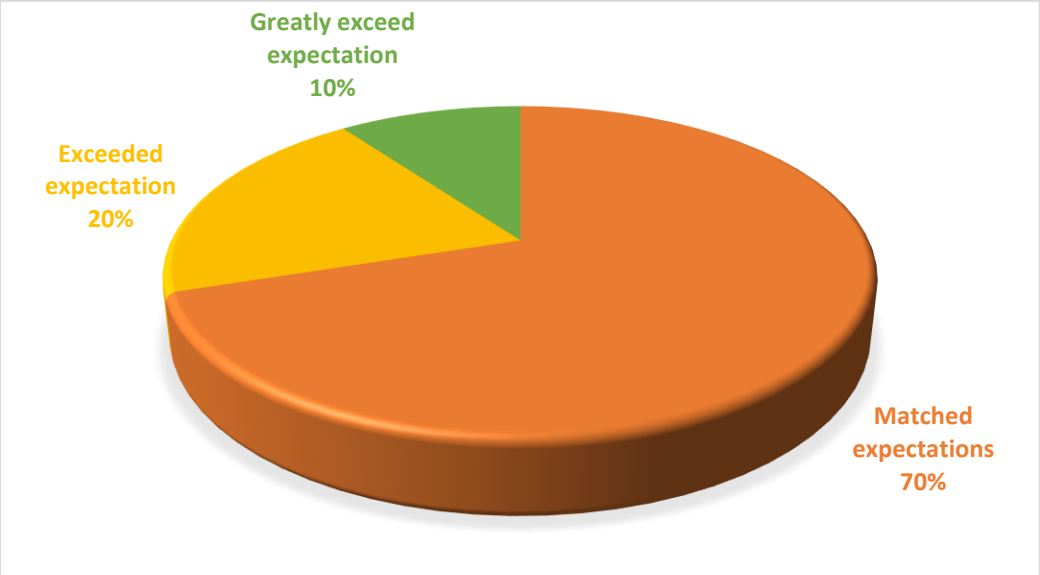

Figure 6.8: Quality of Traceability Technology of Logistic Chains

A generally held opinion is that consumers' growing concerns around food health are helping to influence the quality of traceability technology used in the retail industry. It was also ascertained that consumers are willing to spend more on a product if it comes from a transparent brand. Of the participants, 80% were of the opinion that the quality of the traceability system used matched the expectations, while 20% were of the opinion that the quality of the traceability system used was less than expected.

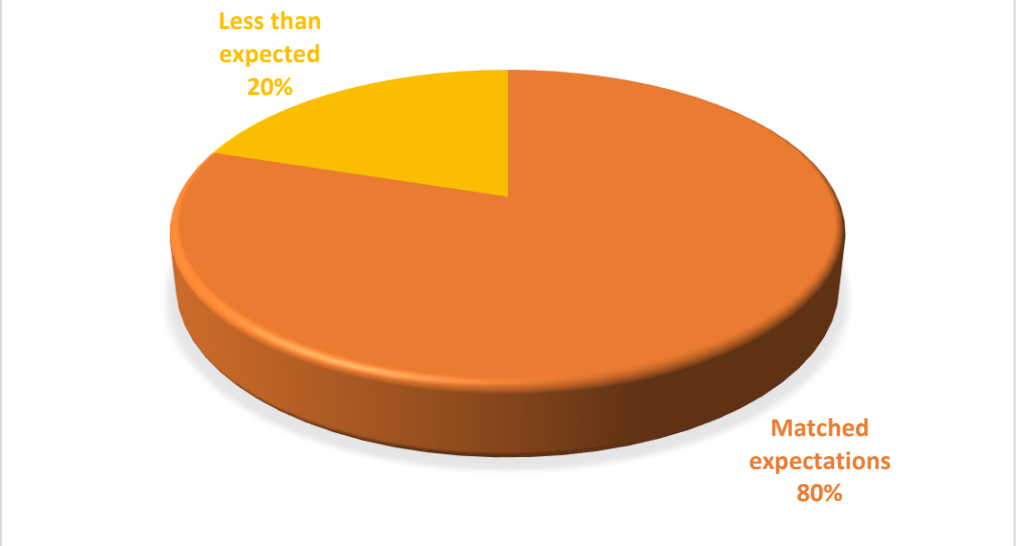

Figure 6.9: Quality of Traceability Technology of Retailers

6.3.3 Perceptions of the participants regarding the impact of advanced traceability

Figure 6.10 below presents the perceptions of the participants on the impact of advanced traceability on fish processors. Participants were of the opinion that an advanced traceability system enhances the overall performance of a supply chain, and also elevates the quality and reliability of relevant information throughout the supply chain. They stated that an advanced traceability system allows a company to track backwards the inputs purchased and final products forwards through the supply chain. A growing number of companies are looking for an efficient and reliable way to track a product. "*The application of traceability is able to go beyond food safety and stock management. Another perception in relation to advanced traceability technology adoption regards the availability of skilled workers in the industry*". The lack of skilled workers in advanced traceability technology seems to be one of the constraints. The participants were asked to provide their views, based on their perceptions, whether advancement in traceability technology would impact positively on the traceability systems used in their companies. A common opinion of 80% strongly agreed. This is because participants were of the view that a well-developed traceability system could create competitive advantages. The remaining 20% were neutral in their opinions.

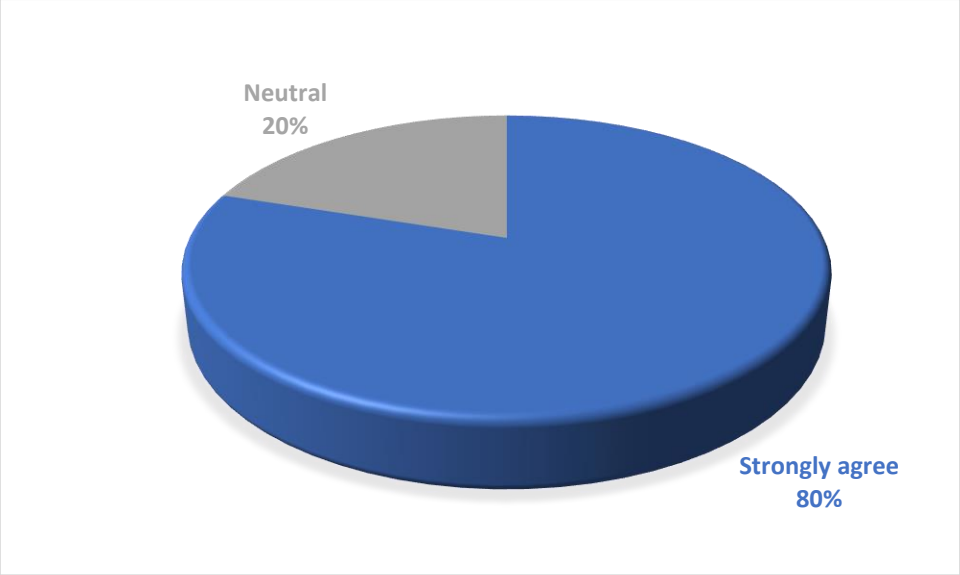

Figure 6.10: Fish Processor's Perception on the Impact of Technology Advancement

Regarding the logistics chain, 45% of the participants strongly agreed and 55% slightly agreed. The participants highlighted the point that a traceability system can prove compliance by a supplier with the standards and regulations and can also verify the origin of a product.

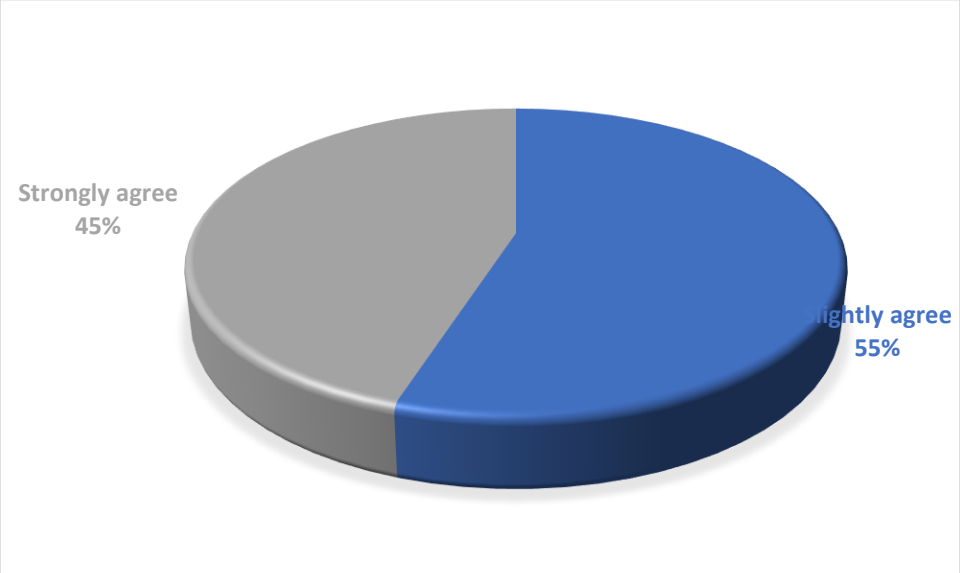

Figure 6.11: Logistic Chain's Perception on the Impact of Technology Advancement

It is shown in Figure 6.12 below that 65% the participants strongly agreed. Participants were of the opinion that a traceability system often requires the use of advanced technological and record-keeping capacities. Among the participants, a general view was that, as consumers become more aware of food safety issues, the actors along the supply chain must be equipped

with the ability to meet the consumers' expanding demands. Of the participants, 20% slightly agreed.

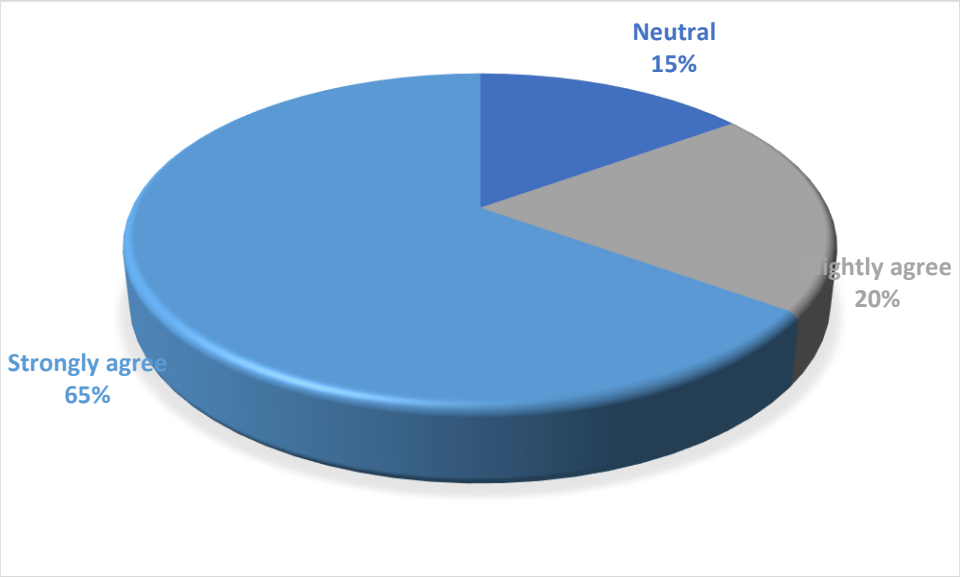

Figure 6.12: Retail's Perception on the Impact of Technology Advancement

6.4 Mock traceability trials by sampled participants

The participants highlighted the point that, long before a recall and contamination incident occur, it is important for the company to have a crisis plan in place. When a company waits until a crisis occurs, it allows itself little time for formulating a strategy, and the company is forced to simply react, rather than take well-planned actions. A crisis plan is thus of benefit to the company's brand. Recalls can impact negatively on a company's reputation and can lead to multibillion-rand losses. Traceability can provide an effective risk-mitigation strategy when a recall occurs; however, there are practices that can be used to prevent a recall from occurring. This is because some recalls happen due to operational mistakes. Therefore, fish processors need to "ensure that their traceability efforts are up to the highest standard in order to protect brand image in the market". From the data gathered, 40% of the participants conduct mock trials, while 60% of the participants do not conduct mock trials. It was revealed that, in most cases, a company is often willing to devote its human resources and capital to the production of new product development but would pay less attention to the possibility of a product crisis arising.

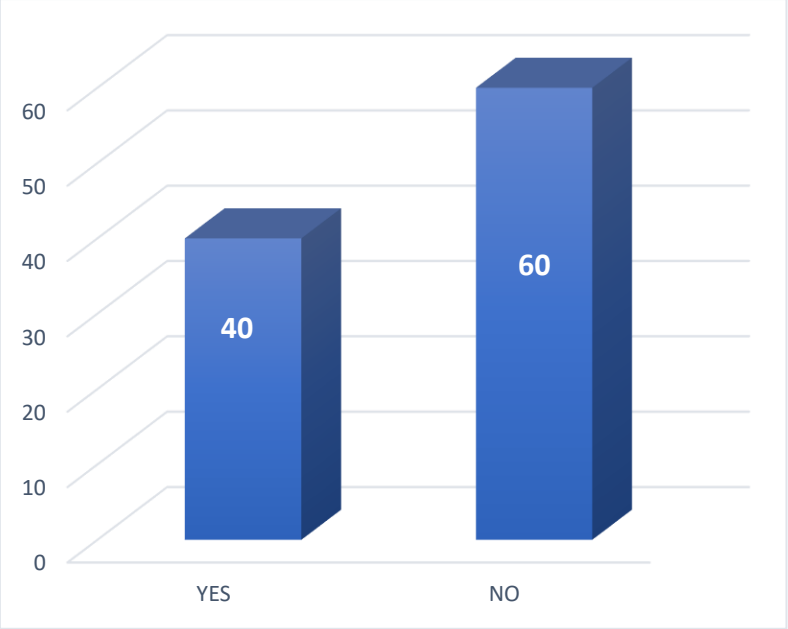

Figure 6.13: Mock Trials Exercise by the Fish Processors

The results shown in Figure 6.14 below indicate that 65% of logistic chains exercise mock trials, while 35% do not exercise mock trials. It was found that some of the logistic chains still lack knowledge on conducting mock trial exercises.

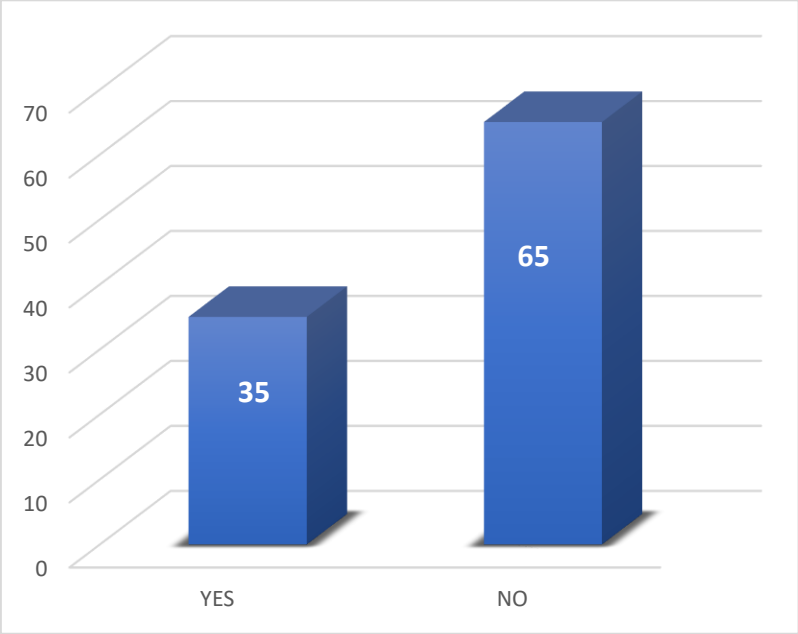

Figure 6.14: Mock Trials Exercises by the Logistics Chains

From the data gathered, the following conclusions were made in terms of the mock trials exercises:

- It is evident that the majority of retailers do not conduct mock trials, and about 81% of the retailors do not conduct mock trials.

- Only 19% of retailer participants stated that they had conducted mock trials.

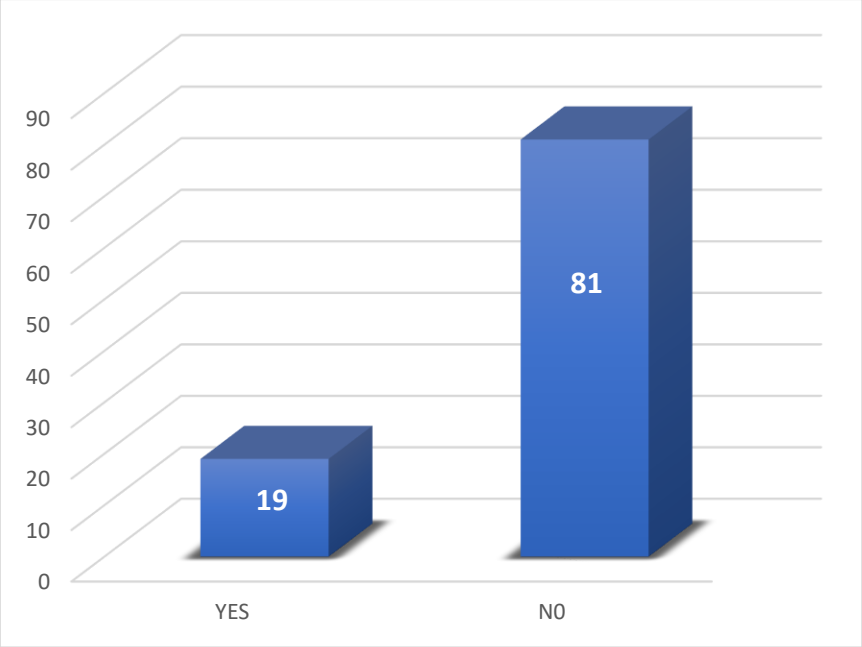

Figure 6.15: Mock Trials Exercised by the Retailers

6.5 Summary

To summarise the findings referred to in Chapters 5 and 6, it can be stated there is a traceability system in place in South African fish supply chains. According to the findings of the study, the majority of South African fish supply chains have basic traceability systems in place that allow the other players in the chain and consumers to at least know the origin of a product. What was discovered to be a concern was that only participants in management positions understood the functions of various types of traceability system and the reasons for having traceability systems in place. A solid strategic management is essential in order to produce food safe products that meet the consumer demand for high quality food. Strategic management implementation can improve food safety in the supply chain and prevent food fraud. Workshops and training sessions for retail merchandisers would help them to understand the functions of various types of traceability systems and the importance of implementing traceability systems. Chapter 7 will set out a summary and give recommendations.

CHAPTER 7
SUMMARY, CONCLUSION AND RECOMMENDATION

7.1 Introduction

As a consequence of identifying the challenges and advantages of implementing a traceability system. This research seeks to understand traceability systems in the South African fish supply chain. Food fraud has in recent years become much more of a concern among consumers. Traceability ensures that food processors deliver only safe and quality products to consumers. A traceability system is a risk management instrument that can be used whenever a food safety hazard becomes a concern. The aim of this research was to assess the current traceability system implemented in the South African fish supply chain. The research showed that there is traceability system in place in the South African fish supply chain. The hypotheses that were tested identified the factors that influence the implementation of a traceability system.

7.2 Research Objectives

Traceability systems are essential to have in the food industry because traceability systems help businesses to reduce risk in the supply chain, while they also serve to promote long-term profitability by providing reliable information to management that helps them in making decisions about market penetration and increasing brand equity. There are several important benefits for implementing traceability systems, which include cost saving in the case of an unsafe food recall. Market benefits by improving trust in the supply chain and process improvement by giving an assurance that safe and healthy raw materials are being used. Furthermore, traceability systems permit the efficient identification and elimination of risk threats to the delivery of quality and safe products throughout the supply chain. Moreover, a traceability system helps in the identification and removal of illegal activities within the supply chain.

7.2.1.1 The primary objective of this study was to investigate the current traceability systems used in the South African fish supply chains and their effectiveness in identifying product information and keeping product records.

7.2.1.2 The objective of the study was to develop a theoretically and comprehensive framework through evaluating the nature of the current traceability systems used in the South African fish supply chains and their effectiveness in identifying product information and keeping product records.

7.2.2 **Research specific objectives studied.**

7.2.2.1 To examine the current traceability systems in South African fish supply chains.

7.2.2.2 To identify challenges in the existing traceability systems in the South African fish supply chains.

7.2.2.3 To develop possible methods for the implementation of an effective traceability systems in the South African fish supply chains.

7.2 Conclusion

Traceability provides a safe method to use in supplying food that is safe and also provides a way of connecting consumers and producers. In past years, South African consumers were not conscious or thoughtful about their seafood suppliers, management experts and the sustainability of seafood industry. This led to a situation where seafood species were not being sold with transparency to consumers, and there were no guidelines for purchasing seafood of choice because of insufficient available information about the species.

This research was conducted in two provinces, the Western Cape and Gauteng. The focus was placed on the fish processors, logistics chains, and retailers. The sample consisted of 40 respondents. Of the sampled respondents, 5 participants were fish processors, 9 participants were in logistics chains, and 26 participants were retailers. The results regarding the first study objective revealed that the current traceability systems implemented in South African supply chains were being used to generate internal reports for product monitoring and managing the stock. The traceability systems as used have more effective internal tracing and tracking in the supply chain.

During the research, Fisher's exact test was used to test the study hypotheses regarding the variables that have an influence on the implementation of a traceability system. Companies with greater capital endowments are more likely to invest in a traceability system. Companies with skilled labour are more likely to adopt a traceability system. Technology advancement improves the accuracy and efficiency of product identification.

Companies use different traceability systems across the supply chains, which is a challenge for information sharing. The lack of continuous information sharing affects the monitoring of product quality. The study further revealed regarding the second objective that the industry is faced with the challenges that the innovations used to implement traceability systems can be costly, particularly for small- and medium-scale companies, and that, even when the system is implemented, it is expensive to maintain the traceability system. Furthermore, sourcing financial investment required for skills development for labour is a challenge.

7.3 Recommendation

7.3.1 **Information sharing** -it is essential to the success of a traceability system. There are key elements to the success of traceability, which include training sessions for traceability system users, skills development on how to operate traceability systems, and compatibility between data collection and communication technologies, and in the integration of systems at different levels and regions.

7.3.2 **Common System -** the use of a common system throughout the supply chain could assist in achieving higher levels of traceability, but it is also critical to consider the various contributing factors required for this implementation to take place.

7.3.3 **Government** - the implementation of a traceability system must be linked to a cost-benefit analysis and the identification of a key participant to push these requirements throughout the supply chain. Traceability systems in China are distinguished by a strong government push and financial support; South Africa could follow suit. All the study interviewees emphasised the importance of policy, guidance, laws, regulations, and standards.

7.3.4 **Consumers** - Consumer pressure, combined with regulatory provisions requiring standardised seafood labelling and more detailed information on imported seafood, will result in improved traceability being attained.

7.3.5 **Asymmetric information –** it is often a major problem in food supply chains, it can result to market failure, lack of information on food quality, price and safety. Therefore, proper traceability where documentation regarding a certain product is needed, in this case of a seafood product, sharing of information from the fish catch through fish processor, logistic chain, retailer right up to the point of consumption. The implementation of such systems might include labelling to try and overcome the information asymmetric information.

7.3.6 **Blockchain** - in the supply chain industry block chain can track the movement of products as products change hands. This allows greater transparency and accountability and reduce the risk of fraud. The implication of using blockchain it is hard to correct a mistake or make any necessary adjustments once the data is recorded.

7.3.7 **Food fraud** – it involves deliberate and intentional substitution, addition, tempering or misrepresentation of food, such includes food ingredients, packaging, mislabeling statements made about the product for economic gain, with the research fundings there is no evidence that there is any opacity and food authenticity within South African seafood supply chain.

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Appendix 1: Consent Form

CONSENT TO PARTICIPATE IN THE RESEARCH STUDY

"You are invited to participate in a research project entitled **Profiling traceability system of fish and fishery products with in South African supply chain** designed to attain a better understanding of the status of traceability systems used in fish supply chains in South Africa and their effectiveness in identifying product information and keeping product records". The study is being conducted by **Nozipho Puwana** from university of Pretoria. This research is being conducted as part of the thesis/dissertation for Master of Science in agricultural Economic.

This survey is comprised of 12 pages, the questionnaire should take about 20 minutes to complete, and it comprises of closed and open questions. Your responses will be kept private, and no physical or emotional distress or danger will be exposed as a result of them. "There are no known dangers associated with this research. If you opt not to participate in this research study or withdraw, there will be no penalty or loss of rewards. You may contact if you have any queries about the study".

- Dr Danie Jordaan,
- Email: danie.jordaan@up.ac.za , & Contact number +27 (0)83 785 2857
- Dr Melissa van der Merwe
- Email: melissa.vandermerwe@up.ac.za, & Contact number +27 (0)12 420 3248

Signature……Date ……

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Appendix 2: Interview schedule

Department of Agricultural Economics, Extension and Rural Development

Faculty of Natural and Agricultural Science

University of Pretoria

South Africa

"TRACEABILITY IN THE FISH AND FISHERY PRODUCTS SUPPLY CHAIN"

Participant's Number	
Date of Interview	

Dear Participant

The study's goal is to find out how well traceability systems are working in the South African fish supply chain. "It should take about 20 minutes to complete the questionnaire, which includes both open-ended and closed-ended questions. The information collected in this questionnaire will be kept in strict confidence. Completion of the questionnaire is voluntary, and you are free to withdraw at any time you choose".

Thank you for taking the time to fill out this questionnaire.

SECTION A: PARTICIPANT INFORMATION

Title	
Name	
Company	
Position in Company	
Phone Number	
Email Address	

SECTION B: NATURE AND SCOPE OF CURRENT TRACEABILITY SYSTEM IN THE COMPANY.

"Traceability is the process of tracing and identifying all stages of production processing and uniquely distribution of a product unit" (Derrick & Dillon, 2004). Traceability systems keep records according to the nature of product, production processing practice, consumer specification and regulatory requirements. The importance of traceability system helps in identification of hazardous material.

TRACEABILITY QUESTIONS

Q1.

Is there a traceability system in place at the company?	YES	NO

Q2. If **YES**, when was the current traceability system implemented?

Q3. Please indicate if the current traceability system records any of the following:

Fishing Area	
Vessel	
Species	

Weight	
Grade	
Fish Cut	
Processing (Ingredients)	
Yield	
Sex	
Maturity	
Logistic chain	
Others, please specify	

Q4. What percentage of total fish entering the company have certificate identification of fish farmer/ fish catcher?

IDENTIFICATION OF ORIGIN	**SHARE (%)**
Identification marks	
Unidentified	
TOTAL	**100**

Q5.

Does the company make use of the farmer's/ catchers of fish certificate identification?	YES	NO

Q6. If NO, please specify why the company is not making use of it.

Q7. How does the company keep track of its products (paper-based, barcoding or modern technology)? Please specify what system is used and elaborate a bit about the system. (**You can select more than one option).**

TRACEABILITY SYSTEM	EXPLANATION
Paper-Base traceability system.	
Barcoding traceability system. (E.g., Barcoding & scanners).	
Modern technology traceability system. (E.g., RFID tags, computer linked equipment, integrated IT systems)	
Others, please specify	

Q8. Please indicate the sales distribution of the fish product from your company. "Identify the main outlets, as well as the percentage of total fish processed and distributed that goes to each of the main outlets". [**NB: NOT FOR RETAILERS**]

DISTRIBUTION CHANNEL	**SHARE (%)**
Wholesalers (Ocean Best Trading, Skye Seafood unlimited)	
Exporters	
Retailers (E.g., Woolworths, Pick 'n Pay, Checkers etc.)	
Fish markets	
Restaurants	

(E.g., Ocean Basket, Fish & chips)	
Hotels (Protea, Table Bay hotel etc.)	
Other, please specify	
TOTAL	**100**

Q9. Please indicate the proportion of farmed fish versus wild-caught fish.

ORIGINAL	**SHARE (%)**
Farmed	
Wild-caught	
Unknown	
TOTAL	**100**

Q10. Which quality assurance system(s) does the company have in place? (E.g. HAS/ HACCP)?

HACCP	
Others, please specify	

Q11. How is the company engagement in product testing for safety hazards in food in terms of the requirements to follow "Fish HACCP plans that are required by Montana rule ARM 37.110.101 (1) (x)/21 CFR 123.6."?

AUDITING QUESTIONS

Q12. (NB: RETAILER, PLEASE SKIP THE QUESTION)

Does the firm conduct "MOCK FORWARD traceability trials? In other words, do you conduct spot checks to ensure that the traceability system in place is working properly?"	YES	NO

Q13. "If **YES,** please specify whether this was done voluntarily, for auditing purposes, or for other reasons".

Voluntary	Internal Audit	External Audit	Other: Please specify

Q14. If **YES**, how often, please specify by ticking one of the boxes below.

Routinely Three times a year	Routinely twice a year	Routinely once a year	Occasionally

Q15.

"Is it the company's intention to improve FORWARD traceability?"	YES	NO

Q16. "**If YES,** please specify the type of improvements, why they are needed, and when they will be implemented."

Q17. (NB: FISH CATCHERS PLEASE SKIP THE QUESTION)

Does the company conduct MOCK BACKWARD traceability tests? "In other words, do you conduct "spot checks" to ensure that the traceability system in place is working properly"?	YES	NO

Q18. "If **YES**, please specify if this was voluntary, for auditing purposes or other purposes"?

Voluntary	Internal Audit	External Audit	Other: Please specify

Q19. If **YES,** how often, please specify by ticking one of the boxes below.

Routinely > Three times a year	Routinely twice a year	Routinely once a year	

Q20

Is it the company's intention to improve BACKWAR traceability?	YES	NO

Q21 "If **YES**, please describe the type of improvements. why they are needed, and when they will be implemented".

Q22

"Has the company ever had a product recalled due to food safety issues in the last three years?"	YES	NO

Q23. "If you answered **YES**, please describe the food safety issue and how it was resolved".

Q24.

"Has the company ever had a product recall due to other (non-food safety) issues in the last three years?"	YES	NO

Q25. If you answered **YES**, please describe the other (non-food safety) issue and how it was resolved.

IMPLEMENTATION QUESTIONS

Q26. "Who, in your opinion, bears the cost of implementing a traceability system in place"?

I
II
III
IV
V

Q27. Please state **BENEFITS** traceability implementation.

Q28. Who, in your opinion, stands to gain from the implementation of such traceability systems?

I
II
III
IV

V

Q29. What, in your opinion, are the "reasons **FOR HAVING** traceability systems in place"?

Q30. What, in your opinion, are the "reasons **FOR NOT HAVING** traceability systems in place"?

Q31. Do you believe that in future companies will not avoid having traceability system in place?

Strongly agree	
Agree	
Neutral	
Disagree	
Strongly disagree	

Q32. If **YES**, who do you believe will be the driving forces behind the implementation of traceability systems?

SECTION C: CHALLENGES IN THE EXISTING TRACEABILITY SYSTEM

CHALLENGES QUESTIONS

Q33. How is the state of the current traceability system used by the company?

Very poorly developed	
Poorly developed	
Neither satisfactory	
Nor dissatisfactory	
Satisfactory developed	
Well-developed	

Q34. How is the quality of traceability technology available to your industry?

Much less than expected	
Less than expected	
Matched expectations	
Exceeded expectation	
Greatly exceed expectation	

Q35. How is the access to quality traceability technology for your industry?

Very poor	
Poor	
Fair	
Satisfactory	
Very Satisfactory	

Q36. Based on your perception, would traceability technology advancement impact traceability of your company?

Strongly disagree	
Disagree	
Neutral	
Slightly agree	
Strongly agree	

Q37. Please give a brief explanation**,** is the current traceability system able to identify outbreak or hazard source?

38. What is your opinion regarding management tool to improve traceability system? [Management tool in the case refer to company systems/ methodologies that can be used to help in upgrading the traceability system]

THANK YOU