*Master Thesis in Food Quality Management*


*Final report*

# Understanding Technological and Managerial Factors contributing on the Performance of Traceability Systems in the Fish Supply Chain, the case study of Tanzania

**John Thomas Mgonja**
**Reg. 720328-569090**

Thesis: Product Design and Quality Management: PDQ-80430
Internship: Product Design and Quality Management: PDQ- 70421

**Period: September 2006-August 2007**

**Supervisors:**
**Dr. Ir. Pieternel Luning**
**Dr. Ir. Jack G.A.J. Van der Vorst**

# Preface

At last I am happy to present the last version of my thesis project. It took me almost one year to come to this point. This report describes the work done (thesis and internship) in four different fish processing companies in Tanzania. The motive force behind this thesis was the two food incidents occurred in Tanzania between 1997 and 1999 where European Union (EU) imposed a ban on importing Nile Perch fish harvested from Lake Victoria. I am very grateful to many people who enthusiastically shared their experience and views with me; they actually gave this research its practical relevance, and kept reminding me of the significance of my research to the fish processing industry.

My first and foremost appreciations goes to the Netherlands Organization for International Cooperation in Higher Education (NUFFIC) for granting me a scholarship to pursue my MSc. studies in Food Quality Management at Wageningen University and Research Centre for a period of two years starting from 2005 to 2007.

Secondly, I would like to express my heartfelt thanks to my supervisors Dr. Ir. Pieternel Luning and Dr. Ir. Jack Van der Vorst who guided me through all stages of this project. They actually gave me a lot of advice, critical evaluations and support. Their contribution on this work is highly appreciated.

I would also like to extend my sincere gratitude to the management of: Sea Products ltd in Tanga, Nile Perch ltd in Mwanza, Tanzania Fish Processors in Mwanza and Vick Fish ltd in Mwanza for letting me do my internship in their companies.

I would also like to thank my classmates Emilie Jordi and Nidasanametla Pantulu who were also doing their thesis on traceability systems. Your encouragement and opinions are highly appreciated especially when the going got tough.

It is indeed difficult to thank everybody who contributed to this work. However, I would like to give special thanks to the following people for their moral and material support: Anangisye Emmanuel Mwakapila, Alan Aligawesa, Dunstan Mkundi, Willium Mndolwa, Joseph Mpepo, Donald Gramaphon, Msalale Athumani Lipindu, Damas Masologo, Ester Elisaria,Nyangabo Musika, Gabriel Volpato and Maria Tsamou.

Lastly but not least, I would like to extend my sincere gratitude to my family especially my mother, Leonara Reuben for the encouragement and moral support provided to me during the entire period of my study far away from home. I dearly missed you, May the almighty God bless you.

John Thomas Mgonja
Wageningen, the Netherlands. July, 2007

# Executive summary

This thesis starts with two examples of food incidents in Tanzania giving the reader the first insight into how track and tracing systems can be useful both in terms of protecting consumer's health and in terms of economical repercussions when it is well designed and executed.

To ensure the ongoing safety of food along the supply chain, traceability must be built into every step of the process. Traceability systems help companies minimize the production and distribution of unsafe or poor quality products, which in turn minimizes the potential for negative publicity, liability and recalls. The better and more precise the tracing system, the faster you can identify and resolve food safety or quality problems. This is best accomplished through a well designed and executed T&T system. A T&T System that takes into account of the contextual factors during design and execution will ultimately promote the availability of accurate and real-time information to all nodes of the supply chain, from raw materials and component suppliers, to manufacturers, distributors, transportation providers and consumers.

The first chapter of this project gives general introduction to the problem and then description of the reasons compelled me to carry out this project (motivation for the study). Chapter two deals with literature review. In this chapter, various models dealing with traceability systems directly or indirectly are fully explored and evaluated on the basis of their validity, reliability and relevance to the study. Chapter three deals with development of the research model, the research model is developed as a result of various models explored in chapter two including IMAQE-Food model developed by Van der Spiegel and co-authors (2003), and traceability system parameters model developed by Kousta (2006). This chapter also deals with development of different indicators which have been used to operationalise the research model. Chapter four is about methodology of the study. Chapter five is discussing the results of the study obtained after the analysis. The result of this analysis is identification of bottlenecks. Chapter six is about assessment of different solutions of the identified bottlenecks. Chapter seven is about general evaluation of the project including conclusions and recommendations.

The research conducted in this thesis may be useful to many organisations/companies. It may assist them to understand various factors which are influencing the design and execution of the traceability system and thereby improve the performance of their traceability systems.

# Table of contents

## List of Figures

## List of Tables

# Chapter 1
# Background information

## 1.1 General Introduction to the problem

Over the past decades, quality assurance has become a cornerstone of food safety policy in the food industry. Much focus has been on integral quality management systems. These systems include all steps in the food production chain such as supply of raw material, food manufacturing, packaging, transportation & logistics, research & development, maintenance of production equipment, training and education of staff (Beulens *et al* 2003). The need for QA systems is not a discussion anymore due to several crises occurred in the last decade (like BSE, dioxin crises, foot and mouth disease). Requirements set by consumers and government are basic driving forces beyond QA systems to guarantee safe foods with quality attributes that comply with consumer (customer) demands. In anticipation to this situation many new QA systems have been developed in the last decade like BRC, SQF, and Eurep-GAP etc. Most of these QA systems basically consist of aspects of the Good Practice codes and/or ISO 9000 family guidelines and/or HACCP principles. However, despite of the presence of various QA systems, there are still problems in the proper execution of these systems, and it is often not known how effective these systems are and what are the major bottlenecks for QA system performance (Luning and Marcelis, 2006).

Systems that are linked to quality assurance (such as T&T system) attain a lot of attention in food industry and agribusiness. Tracking and tracing is a hot topic nowadays in food supply chains because of the new ISO 22000 (based on HACCP principles) and EC 178/2002. The EC 178/2002 concerning General Food Law requires each stage in the supply chain to have access on demand to its upstream and downstream trading partners. The regulation seeks to ensure that at each stage of food production, processing and movement through the supply chain steps are taken to maintain safety of the products intended for human consumption, at its highest quality. However, currently the ability to trace consignments of food through the supply chain, in a consistent manner, does not exist. Local arrangements have been implemented in some elements of the sector that aim to achieve limited traceability, but this is fragmented, uncoordinated and inconsistent in approach (Tracefish, 2001).

## 1.2 Problem Feeling and motivation for the study

Fish industries today provide the world's population with a very significant fraction of their nutritional needs (Abila, 2002). Fish makes an important nutritional contribution to the diet, providing proteins, fatty acids (such as long-chain n-3 polyunsaturated fatty acids - LC n-3 PUFAs) and certain vitamins and minerals. Consumption of fish is beneficial to cardiovascular health and may also benefit development of the unborn child (FSA, 2005). However, in order to protect health of consumers, ever-stricter health standards are enforced on these products by putting high demands on the quality of the raw material as well as processed materials.

Between 1997 and 1999 Tanzania has had two cases of food-borne hazards, which had great consequences to the economy of the country. All cases involved European Union (EU) ban on imports of fish, the *Nile perch*, harvested from Lake Victoria, which is jointly shared between Kenya, Tanzania and Uganda. In 1997 there was an outbreak of cholera (microbiological hazard) around Lake Victoria and the EU imposed a ban on all the fish export from the Lake to the EU market. Tanzania requested WHO to carry out risk analysis, which concluded that fish from the Lake did not pose the risk of cholera outbreak in Europe (FAO/WHO, 2002)

In 1999, The EU imposed another ban on all imports of fish harvested from the Lake. The hazard addressed in this case was chemicals arising from suspected misuse of pesticides in Lake Victoria. The ban required the countries around the Lake to demonstrate beyond any doubt that fish from that Lake did not contain pesticides residues above tolerable levels (FAO/WHO, 2002)

Timely response to emerging or suspected hazards is very important if the extent of dangers as well as economic losses has to be minimized. Organization's/Country's un-preparedness can cause a lot of human sufferings due to inability to timely resolve the problem. In this case, availability of the right system such as track and tracing systems, expertise and infrastructure in the country would have greatly minimized the human sufferings and colossal economic losses incurred by the country as a result of the ban [1]

However, currently there are no specific requirements on the traceability system in fish processing industries. Therefore, it is difficult to assess performance of such systems since every manufacturing company may have its own way of doing it. Although the EU regulation 178/2002 which imposed traceability on all foods destined for human consumption is clear about the need to establish a path of information across food supply chains but this regulation does not stipulate specifically how to go about. For instance it does not specify; unit of tracing, time period for which information should be stored, what types of information should be made available to the competent authority, how quickly should the information be made available to the authorities, where and how this information should be captured stored and communicated and about system requirements and characteristics (Diogo *et al*., 2006). The regulation therefore, may be regarded just as a steppingstone for future legislation on food safety.

It is from such a background that this thesis project is going to focus on the identification of various technological and managerial factors that may contribute on the performance of track and tracing systems (traceability) along the fish chain. A case study from Tanzania

## 1.3 Problem definition

As it has been mentioned in the problem feeling, the current legislation (General Food Law Regulation, 178/2002/EC) does not clearly state the specific requirements for the traceability system to be used in fish processing. The fact that there are no specific traceability system requirements make trading partners to focus on their own way of designing and implementing such a system. The regulation 2065/2001 of EU on the other hand, specifies the kind of information required for traceability systems in fish industries. However, this regulation does not also clearly state how this information will be captured, stored and communicated in the traceability system. This situation leads to a huge spread in the traceability system performances and also makes it difficult to assess performance levels of such systems for various sectors in the supply chain.

## 1.4 General Research objective

The objective of this study is to gain an insight on the traceability systems performance in fish industries in Tanzania by investigating the major bottlenecks on the designing and execution of such systems under the given complexity conditions of the contextual factors, with the intention of developing scenarios for improvement and thereby contributing to improvement of food safety through such systems.

[1] http://www.fao.org/DOCREP/MEETING/004/AB522E.HTM

# Chapter 2
# Theory Analysis and Model Introduction

In this chapter, theoretical and empirical models regarding traceability systems are presented and the problem situation is analysed by using the techno-managerial approach. The starting point of this thesis is from the previous work of Kousta (2006), a former FQM student, who developed a research model on Traceability system parameters.

## 2.1 The Techno-Managerial (TM) Concept

Food quality management is of major importance in the agri-food sector due to an increasing number of requirements set by various stakeholders (e.g. consumer, legislator, competitors). Therefore, food producers pay much attention to management of food quality by implementation of quality assurance (QA) systems such as GMP (Good Manufacturing Practice), HACCP (Hazard Analysis Critical Control Points), ISO (International Organisation for Standardization) and BRC (British Retail Consortium). (Van der Spiegel and Luning, 2005)

However, Many of the problems in realising food quality deal with decision making towards quality management activities like taking corrective actions in time, executing procedures, and rejection or accepting of products (Motarjemi and Kaferstein, 1999; Vela and Fernandez, 2003; Walker *et al*., 2003 in Van der Spiegel and Luning, 2005). Track and tracing systems to a large extent fall under this paradigm of decision making since designing and execution of such a system depends on the decision made by the management of a particular organisation.

Relations between food quality, human behaviour and food behaviour have been recently proposed in a food quality management concept (Luning and Marcelis, 2006). This concept advocates that food quality management issues require a techno-managerial approach i.e. both theories from technological and managerial sciences have to be used in an integrated way. A techno-managerial approach in food quality management requires insight in how food behaviour interacts in decision making processes and how human dynamics under certain administrative conditions (training, Working conditions and procedures, etc.) affect decision making processes as well. Basing on the above insight, the detailed food quality relationship can be shown as follows:

Food quality = f (food behaviour (FB), human behaviour (HB), where by
Food behaviour (FB) = f (food dynamics, technological conditions), and
Human behaviour (HB) = f (human dynamics, administrative conditions)

In this relationship it is assumed that food quality is dependent on both dynamic properties of the food product as related to applied technological conditions and dynamic properties of people as related to applied administrative conditions and that both systems are interdependent. Food quality management issues (of which track and tracing is part of it) always deal with both food and human systems, which are both complex. Therefore this study will make use of the techno-managerial (TM) approach as proposed by (Luning and Marcelis, 2006) in the analysis.

## 2.2 The Meaning of Traceability (Track and Tracing) Systems

There exist many definitions of traceability: According to ISO 9000:2000, traceability is defined as the ability to trace the history, application or location of the product that is under consideration. In terms of products, it relates to the origin of materials and parts, the processing history, and the distribution of the product after delivery. In other words traceability means the ability to trace and follow the food through all stages of production and distribution (Tall, 2001). Two types of traceability can be identified: internal and chain traceability. Internal traceability is within one company and relates to data about raw materials and processes to the final product before delivery. Chain traceability on the other hand is focused on the information about the product from one link in the chain to the next, it describes what data are transmitted and received, and how (Tracefish, 2001). Olsen (2001) reported that chain traceability is between companies and countries and depends on the presence of internal traceability in each link.

The General Food Law Regulation, 178/2002/EC which came into force with effect from 1st January 2005 defines traceability as: "The ability to trace and follow a food, feed, food-producing animal or substance, through all stages of production, processing and distribution". In this context 'production' includes primary production and reflects a 'farm to fork'. This regulation requires traceability to be established at all stages of the food chain. According to this regulation, all food and feed businesses within the EU in particular are required to:

- Identify the suppliers of; food, feed, food-producing animals and ingredients to their business;
- Identify the businesses to which products have been supplied;
- Maintain appropriate records and ensure that such information is made available to competent authorities on demand.

Traceability requirements are also included in some food management systems. For instance EUREPGAP, BRC, IFS and SQF 2000 all include requirement for traceability[2].

According to Van der Vorst (2003), the basic idea of tracking and tracing is the possibility to determine where a certain item is located and to trace the history of that item. On the basis of that information, it should also be possible to determine the source of any problem of an item, and it should be possible to find out where the other items with the same problem are located in the supply chain. In many literatures, the concept of traceability is often used as synonym to tracking and tracing (Wilson and Clark, 1998; van Twillert, 1999; van Dorp, 2002 as cited by Van der Vorst 2003), and will be used interchangeably throughout this report. *Tracking* refers to the determination of the ongoing location of items during their way through the supply chain (figure 2-I). *Tracing* aims at defining the composition and the treatments an item has received during the various stages in the production life cycle. Chain upstream (backward) tracing aims at determining the history of items and is used to determine the source of a problem of a defective item. The chain downstream (forward) tracing, aims at the determination of the location of items that were produced using for example a contaminated batch of raw materials.

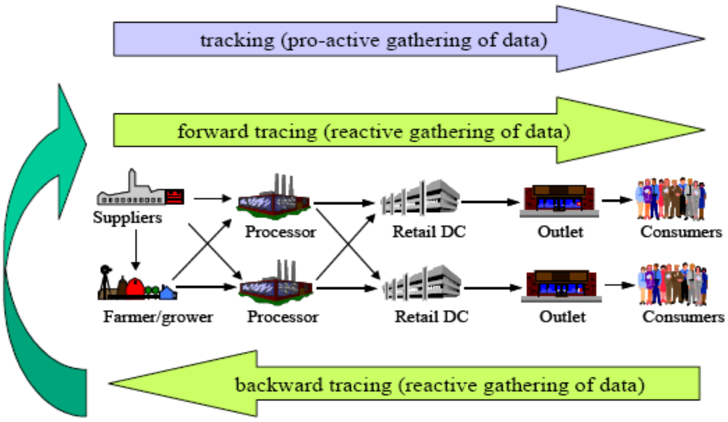



*Figure 2-1 Track and Tracing (Van der Vorst et al., 2003)*

According to EAN UCC (2005), traceability involves trading partners, a physical flow with traceable items and information flows with traceability data. Trading partners can be any actor in the supply chain. The physical flow can include, depending on the industry, any product from initial inputs up to, but not including, sale to the final consumer.

[2] Www.cbi.nl/disclaimer

## 2.3 Characteristics of traceability systems

According to Loftus (2005), the basic characteristics of traceability systems are similar, requiring product identification, data recording and the maintenance of information relating to the product and its movement. However, there remains a lack of clear consensus as to how traceability should be achieved in practice. In a report on traceability systems, Golan *et al*. (2004) outlined three key parameters that can be used to characterise traceability systems, this includes:

- The breadth of a system: the amount of information recorded (e.g. details of an animal's veterinary care, feed regime, etc)
- The depth of a system: how far back or forward the system tracks (to a grain elevator, farm or field); in many cases, the depth of a system is determined by its breadth or attributes of interest
- Precision: the degree of assurance with which the tracing system can pinpoint the movement of a particular product, and is described with reference to an acceptable error rate, or what would happen if there were mistakes in tracking the product.

In practice the shape of any traceability system represents a dynamic interplay between costs and benefits, which are likely to be determined by the sector and specific supply chain needs. In practice however, supply chains are growing in complexity, with multiple suppliers combining ingredients from different suppliers /countries and batch codes being generated as the product is processed along the value chain. Traceability in this context requires a more technology-enabled solution to facilitate accurate *data capture, integration and management*.

### 2.3.1 Types of traceability systems

Basically in order to achieve full traceability across the supply chain, all traceability partners must achieve **internal and external traceability** (EAN.UCC, 2005).

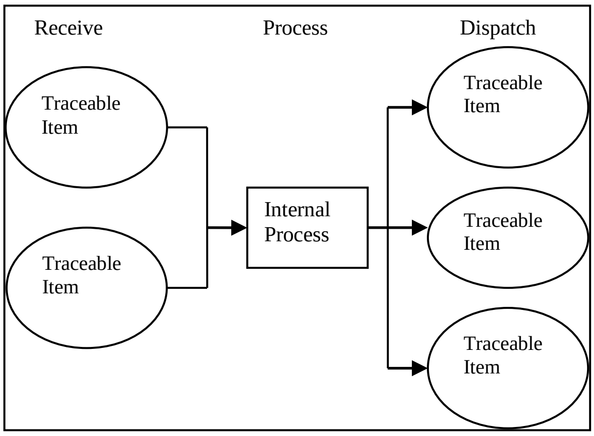



*Figure 2-2: Internal traceability (EAN.UCC, 2005)*

Internal traceability takes place when a traceability partner receives one or several instances of traceable items as inputs that are subjected to internal processes, before one or more instances of traceable items are out. Every trading partner involved in the physical flow of products receives, processes, and dispatches instances of the traceable items (EAN.UCC, 2005: Tracefish, 2001). The figure above shows events when traceability data should be collected:

- Receiving: This is the result the traceable item crossing the boundary from external to internal, transferring from one party to another party.
- Internal process: This involves one or more sub processes performed by the same party without a significant involvement of other trading partners. Each sub process involves traceable item inputs and results in traceable item outputs.
- Despatching: This is the transfer from one actor to another actor in the supply chain

External traceability takes place when instances of a traceable item are physically handed over traceability partner (traceable item source) to another (traceable item recipient). Each traceability partner should be able to trace back to the direct source and be able to identify the direct recipient of the traceable item (one step up, one step down principle) (Olsen, 2001:EAN.UCC, 2005)

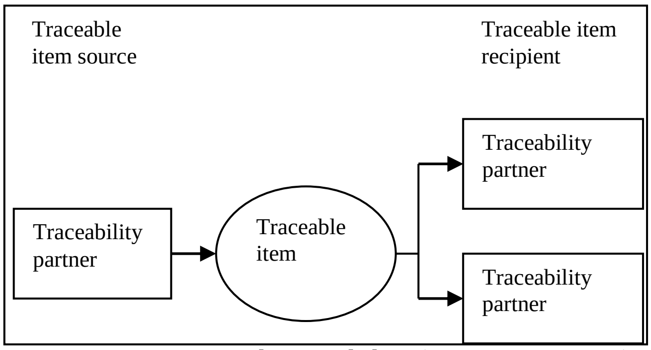



*Figure 2-3. External traceability (EAN.UCC, 2005)*

**Relevance, validity and reliability**

It is important to understand the *meaning, types and characteristics* of traceability systems in order to understand how traceability systems can contribute to food safety. The problem feeling stated in this study is that we need to know the specific requirements of the traceability system so that we can assess the performance level of these systems and consequently increase the level of food safety. However, we cannot do that unless we first understand the meaning, types and characteristics of traceability systems and what the traceability system encompasses. For this reason, these models are found to be very useful and **relevant** in analysing the problem situation. Although many authors have defined traceability in different ways but the central meaning remains the same through out, that is “the ability to know the location of the product at any time”. The fact that many authors have repeatedly referred to the same central meaning makes these models to be **valid** and therefore useful in this study as well. These models are also considered to be **reliable** because, they have been used by many authors and organisations in describing traceability, see for example; Tall (2001), ISO (22000), Tracefish (2001), Olsen (2001), EU regulation 178/2002/EC, Van der Vorst (2003) and EAN. UCC (2005)

## 2.3.2 Interactions between traceability and other management systems

### 2.3.2.1 Traceability and HACCP

Within food manufacturing, it is common to see traceability systems used alongside HACCP to provide verifiable documentation, which monitors the critical control points and allows remedial action to be taken if product falls below quality (FSA, 2002)

According to FSA (2002) the process of determining the ‘why and what’ to trace is accomplished through a detailed hazard analysis (or risk assessment) of all the steps and processes so as to identify those critical points (potential sources of hazard) to food quality and safety. By identifying these steps that are critical to safety and quality of the product, it is also determining the type and amount of information that should be recorded and transferred within the supply chain

Mckean (2001) as cited by Kousta (2006) reported that food safety control and product quality can be assured within the scope of traceability when the parameters that determine the quality and safety of the product are identified at the appropriate level for control, registered and transferred through the supply chain. Thus by measuring *the risk of the product for safety or quality defect* it will enable us to identify the critical parameters towards safety and quality and determine the information that should be recorded in the traceability system. Van der Vorst (2003) also argued that the level of traceability depends on the risk level of the product. Risk level of the product is measured by estimating the probability of occurrence of a hazard and the severity of the consequences of that hazard as shown in the figure below

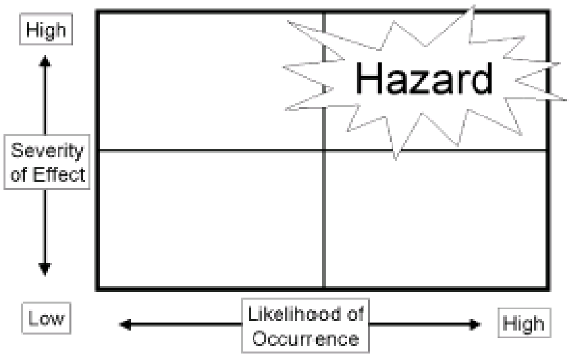



*Figure 2-4 Hazard Analysis (Mortimore S, 2001)*

Results of studies in the US show significant loss in company value (and shareholder losses) when companies are implicated in a recall involving serious food safety hazards. Where less serious hazards are involved e.g. mislabelling, there are no evidence of an implication for stock value. Decisions relating to the implementation of traceability systems are therefore often made with reference to business risk and to protect brand value. The probability of an incident occurring and its consequences may be assessed using a risk matrix as shown in the figure below (FSA, 2002)

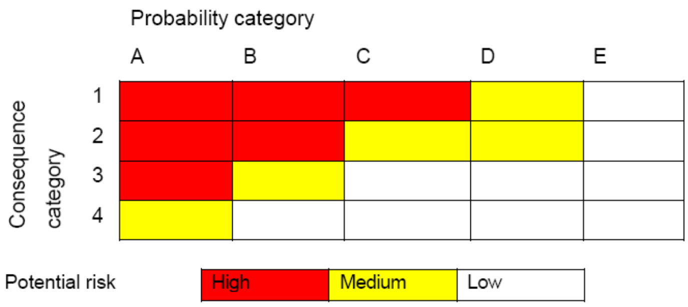



*Figure 2-5 Risk matrixes to guide decisions for implementation of traceability (FSA, 2002)*

*Table 2-1 Risk matrix table (FSA, 2002)*

| **Consequence category**<br>**Quality and hygiene parameters** | **Probability category** |
|---|---|
| **1 Customer fatality, Lose a major customer, Product recall via press, Malicious contamination/ extortion** | **A Possibility of repeated incidents** |
| **2 Lose a minor customer, Unsatisfactory customer audit External audit non-compliance, Major contamination, Customer ill-health, Infestation of product/premises** | **B Possibility of isolated incidents** |
| **3 Multiple retail complaints, Many industrial complaints, Local authority investigation, Minor product contamination, Low hygiene audit score** | **C Possibility of occurring sometime** |
| **4 Individual retail complaint, Product out of specification, Non-compliance, Moderate hygiene audit score** | **D Not likely to occur** |
| | **E Practically impossible** |

## Relevance, validity and reliability

Although the HACCP model described above is very general, but it offers an overview of the relationships that exists between traceability and HACCP. HACCP aims at assuring production of safe food products by using a systematic approach. In other words, if the HACCP system is properly designed, it can be a useful tool in guiding us to understand what is to be traced. For this reason the HACCP model is found to be very **relevant** in this study. The HACCP model has been repeatedly used to analyse the likelihood occurrence of hazards during food processing in many food sectors, for this case it is considered to be a **valid** model. The **reliability** of the HACCP model is not questionable, since this model is widely used worldwide. See for example: EC directive 93/43/EEC, NACMCF (1998).

### 2.3.2.2 Traceability and Efficient Consumer Response (ECR)

In the area of product traceability, product withdrawal and recall, many good practices have been developed and implemented either on a voluntary basis or under the leadership of national organisations such as ECR, emphasising the importance of the collaboration between manufacturers and retailers (ECR Europe, 2004: Kurt, 1993). Through the use of ECR a more effective delivery of the consumer wishes can be achieved (Stijnen *et al.*, 2001). This is a good system to stimulate the information exchange between the different links. Implementing ECR is seen as an important tool to solve the problem of lack of an open information exchange. The ultimate goal of ECR is to achieve a responsive, consumer-driven system in which distributors and suppliers work together as business allies to maximize consumer satisfaction and minimize system cost (Van der Vorst; 2000). ECR Blue Book describes EAN International standards for the use of unique trade item and trading partner identities, data standards, bar code labelling and electronic data exchange as best practice for product traceability[3].

**Relevance, validity and reliability**

The **relevance** of ECR model in this study is that, ECR emphases on the importance of collaboration between manufacturers and retailers. If the degree of collaboration is high, there will be a high level of information sharing which is an important element of the traceability system. Moreover, ECR can be used as a tool to get an overview of what are the requirements in terms of consumer safety. Understanding these requirements can be an important input in the designing of the traceability system. ECR is a **valid** model since it is widely used by many organisations in Europe. The **reliability** of this model is also high because it has been cited in many reliable studies (For instance Stijnen *et al.*, 2001 and Van derVorst; 2000)

## 2.4 Information in traceability systems

According to Hofstede (2003), information constitutes the lifeblood of the netchains. However, currently there are many barriers to netchains integration such as the tension between the tendency to hide and the need to provide the company data (Hofstede, 2003). Trust and transparency, are the key to such barriers in the traceability systems.

According to Hofstede (2003), transparency of a netchain is "the extent of which all the netchain's stakeholders have a shared understanding of, and access to, the product related information that they request, without loss, noise, delay and distortion". In this definition,

- Netchain is a directed network of actors who cooperate to bring a product to customers (Lazzarini *et al*. 2001 in Hofstede, 2003);
- A netchain actor is an organization, usually a producer, distributor, processor or retailer;
- A stakeholder is a netchain actor, or an institutional actor with some stake in the netchain, or a customer;
- A shared understanding is a precondition for transparency that involves sharing or seamless translation of language, meaning and standards at many levels:
    - A shared language,
    - Shared interpretation of key concepts,
    - Shared standards of product quality,
    - Shared reference information models,
    - Shared technological infrastructure;
- Product is a product or service.
- Product related information is meant in the widest sense and can include e.g. information about raw materials, production processes, labour circumstances, or environmental impacts.
- Loss means that an actor does not transmit information. It affects completeness;

[3] http://www.aimdenmark.dk/Sporbarhed

- Noise means that an actor adds non-relevant data to the information. It affects relevancy. This is subjective notion. Noise can point to lack of agreement among actors as to what information is relevant.
- Delay means that an actor delays information. It affects timelines;
- Distortion means that an actor changes, so that the information no longer actually describes the product. It affects validity.

Moreover, Hofstede (2003), referring to Zmund (1978) reported that the quality of the information depends on the following dimensions:

Quality of data

- Relevant: applicable, helpful, needed, significant and useful
- Accurate: accurate and believable
- Factual: factual and true
- Quantity: Complete, effective, material and sufficient
- Reliable: reliable and valid
- Timely: timely and current

Quality of format

- Arrangement: orderly and precise
- Readability: clear, convenient, readable and simple

Quality of meaning

- Reasonable: logical and sensible

**Relevance, validity and reliability**

Knowing what kind of information the stakeholders need is a precondition for transparency, and that the stakeholders can only exchange information if they have a *shared language*. In fact sharing or seamless translation of language, meaning and standards is needed at all levels. For this case this model is considered to be **relevant** to this study. The validity and reliability of this model is also high because it has been discussed by many authors who have high credibility on the field (e.g. Hofstede (2003), Lazzarini *et al*. (2001), Watson (2006) and Food Standards Agency (2002).).

## 2.4.1 Types of traceability information

According to Moe (1998), there are two key components of information required in the traceability system. These two key components are product and process information. In each key component, essential information regarding the type, amount and time/duration can be collected. Extra information can further be collected from the essential information in order to get the detailed information about the product and process as shown in the figure below.

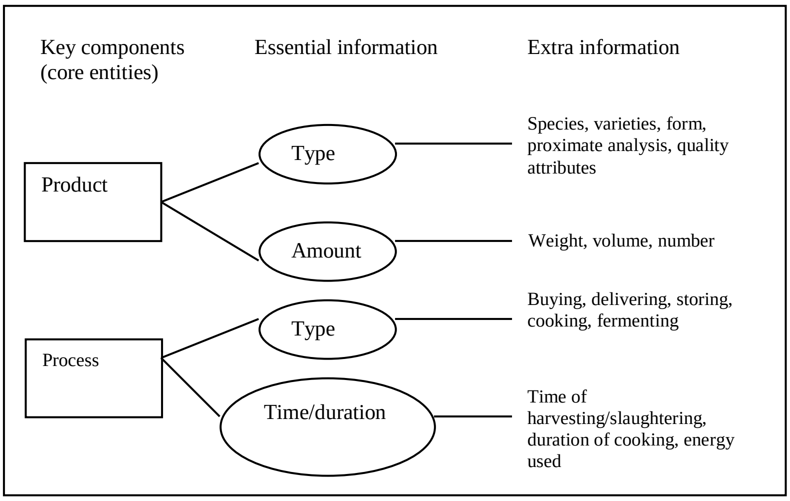



*Figure 2-6 the basic components of information in a traceability system (Moe, 1998)*

According to Moe (1998), the fundamental basis for a traceability system is its ability to trace both products and activities. In order to describe the history of the product and the process Moe (1998) distinguishes three types of information

- *product information* such as information about the species, varieties, forms, quality attributes and proximate analysis
- *Product flow information* such as information about weight, volume and number
- *Processes information* such as time of harvest or slaughter, duration of cooking, duration of storing and transportation as well as about the delivering, the storing, the fermenting and cooking.

**Relevance, validity and reliability**

This model helps us to get a better understanding of the problem situation as it gives us an insight on the types of information in the traceability system. For this case, this model is considered to be very relevant to this study. The model is considered to be **valid** because it is very detailed and many experts in the field, who have high credibility, have validated it. Reliability of this model is also high because it has also been used by other reliable sources for instance, the Food Standard agency, which is an independent regulatory body in Europe, established to protect the public's health.

## 2.5 Traceability information requirements in the fish supply chain

Although the EU regulation 178/2002 of the general food law is not clear about the requirements of the traceability system as described in the introductory part of this report, the regulation 2065/2001 of EU on the other hand, lays down some rules with regard to the type of information which should be provided to competent authorities for fishery and aquaculture products (Tracefish, 2001). According to this regulation, the following information should be made available:

- Commercial name and scientific name
- Production method
- Catch area
- Batch or lot number
- Net weight
- Identification of vessel
- Catch date
- Size of fish
- Preservation
- Name, address of supplier, nature of products which were supplied from him
- Name, address of the customer, nature of products which were delivered to that customer
- Date of transaction/delivery

On a different study, Luten *et al*., 2003 referring to a report of Perez *et al*., 2003 reported that, various industry sectors' representative conducted a survey which aimed at finding out the fish sector opinion and perceived needs for information on fish quality at the distribution chain points where they buy or sell fish (the transaction point). The survey was conducted in the following countries: United Kingdom, Iceland, Denmark, Belgium, Finland, France, Germany, Italy, Netherlands, Norway, Portugal and Sweden. The following table is a synthesis of the results obtained in those countries where the survey was conducted. The symbols express the degree of perceived need:

*Table 2-2: Traceability information requirements (Perez et al., (2003) in Luten et al., (2003)*

| **●General consensus, □Different opinions, ○ Minor interest** | | | | | |
|---|---|---|---|---|---|
| **Information required** | **Vessels/ auctions** | **Wholesalers** | **Processors** | **Retailers/ supermarkets** | **Consumers** |
| 1. Species | ● | ● | ● | ● | ● |
| 2. Landing port | ● | ● | ● | ● | ● |
| 3. Size and weight | ● | ● | ● | ● | ● |
| 4. Freshness category | ● | ● | ● | ● | ● |
| 5. Fishing area | ● | ● | ● | ● | ● |

| | | | | | |
|---|---|---|---|---|---|
| 6. Capture time/date | ● | ● | ● | ● | ● |
| 7. Fishing gear | ● | ● | ● | ● | □ |
| 8. Landing date | ● | ● | ● | □ | □ |
| 9. Environmental information | □ | ● | ● | ● | □ |
| 10. GMP | □ | □ | □ | □ | |
| 11. Ship name/owner | □ | □ | □ | □ | |
| 12. Security (expiry, etc) | □ | □ | □ | □ | □ |
| 13. Appearance/presentation | □ | □ | □ | □ | □ |
| 14. Temperature profile (or days in ice) | ○ | □ | ○ | ○ | |
| 15. Handling method | | ○ | ○ | | |
| 16. Price | | ○ | ○ | | |
| 17. Towing time | | ○ | | | |
| 18. Packaging type | ○ | ○ | □ | □ | □ |
| 19. Method of processing ( manual/mechanical) | | ○ | | | |
| 20. Processing on board | ○ | □ | □ | ○ | ○ |
| 21. Recipes | | | | ○ | ○ |
| 22. Nutritional guarantees | | | | □ | □ |

According to the results of this survey, the most important information on fish perceived by different transaction points with general consensus among the five links is:

1. Species
2. Landing port
3. Size/ Weight
4. Freshness category
5. Fishing area
6. Capture time/ date
7. Landing date
8. Environmental information

It is interesting to see that information such as temperature profile (or days in ice), handling method, method of processing(manual/mechanical) and recipes used, which contribute more to safety was not considered by majority to be most important information in the study. The exact reason why this information was not considered by majority to be most important in this study is not known, but the reason could be that, the survey focused more on quality than on safety.

However, the survey results show no significant difference in terms of information requirements as compared to regulation 2065/2001 of EU. This coherence can therefore help us to get an overall picture in terms of information requirements in traceability systems in the fish supply chain.

**Relevance, validity and reliability**

The use of these two models can help us to get a good overview of the problem situation (i.e. knowing what information is required in the traceability system in fish industry). These two models are therefore **relevant** to this problem situation because they specify the kind of information required in traceability system in fish supply chain. Perhaps **validity** of these two models is not very high because the models do not specify how this information will be stored and how it will be transferred from one actor to the other along the chain. On the other hand, r**eliability** of these two models is high because they have been retrieved from reliable sources, for instance regulation 2065/2001 of the European Union. The other model is a result of a large survey conducted in many countries as discussed above, thus there is no doughty about its reliability.

## 2.6 Instrument to measure effectiveness of quality management IMAQE-Food

Van der Spiegel and co-authors (2003) developed a diagnostic instrument to measure effectiveness of quality management (IMAQE-Food). IMAQE – Food is a very useful tool for food manufacturers in deciding which system is most suitable to achieve their objectives. This diagnostic instrument can be used for providing insight in determining the desired level of quality management. Traceability is an aspect of quality management, and for this case an instrument that is conducive for measurement of the effectiveness of quality management may also be suitable for assessing traceability systems.

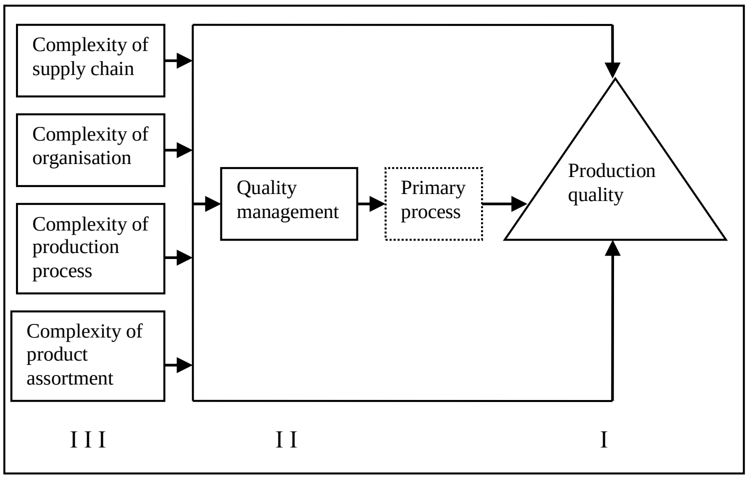



*Figure 2-7: The IMAQE- Food model (Van der Spiegel, 2004)*

The elements of the IMAQE model include quality management, quality performance, and contextual factors which affect these elements i.e. complexity of the supply chain, complexity of the organisation, complexity of the production process, and complexity of the product assortment. In that model, it is hypothesised that a higher production quality is obtained by a higher level of quality management, a higher complexity of contextual factors is expected to relate with a lower production quality, whereas a higher level of quality management is assumed to reduce the influence of these contextual factors on production quality. The most important elements in this study are contextual elements. It is assumed that higher levels of complexity of these contextual factors put a high demand on the designing and execution of the T&T system and negatively contribute on the performance of such a system.

### Relevance, validity and reliability

The **relevance** of this model to this study is that, it provides us with an overview of the contextual situations around which T&T system can be designed and executed. The **validity** of the model is high because the model is very detailed and it has been tasted in various bakeries in the Netherlands and validated by a team of experts in the field. The model is considered to be **reliable** as well because it has been retrieved from reliable sources e.g. International Journal of Quality & Reliability Management (Emerald)

## 2.7 Elements of the traceability system

Kousta (2006) developed a model about T&T system elements. According to Kousta (2006), the model shows the elements and the mechanisms that are involved in the designing of the traceability system and ultimately affect the traceability system performance. The model proposes that the elements of every traceability system are primarily the *traceability objectives, the design of the traceability system and the performance of the traceability system* and secondarily the **contextual factors** which are the *product and process characteristics, the characteristics of the structure of the food supply chain and the characteristics of the organisation of the Food Supply Chain*. The contextual factors are the elements that influence directly the design of the traceability system and ultimately the performance of the system. The contextual factors are used to explain why the design and the performance of the traceability system differ in each food supply chain even if the traceability objectives are the same. The model proposes that the performance of the traceability system is determined by:

- The traceability objectives
- The traceability system design
- The characteristics of the product and the process
- The structure and organisation of the Food Supply Chain.

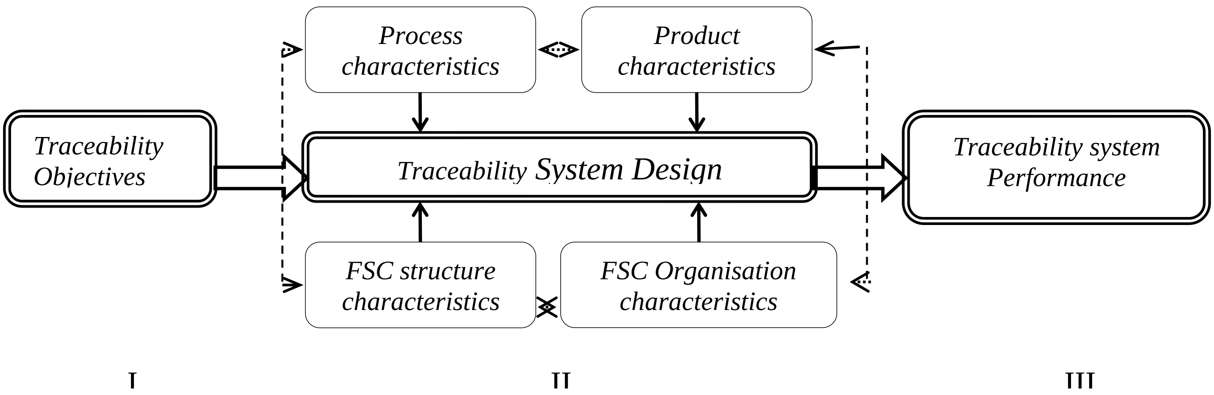



*Figure 2-8. Traceability system parameters Kousta (2006)*

Kousta's model provides a good overview of the elements and the mechanisms that are involved in the design of the traceability system and which ultimately affect the traceability performance but it lacks the depth on how these elements and mechanisms can be employed (implemented/executed) in order to attain a high level of performance of such a traceability systems and how this situation can lead to production of safe food. Kousta's model is more focusing on the designing of the traceability system but not on the implementation/execution of such a system. In this study therefore, much effort will be focusing on how these elements and mechanisms can efficiently be implemented/integrated (designing and execution) in order to attain a high performance level of such a traceability system and consequently lead into food safety.

**Relevance, validity and reliability**

This model is considered to be **relevant** since it depicts the necessary elements of the traceability systems. In order to understand the performance of any traceability system it is indeed important to understand how contextual factors can influence the design and execution of such a traceability system. The **validity** of this model is high because, the model is very detailed and it has been validated by various experts in the field. The **reliability** of this model is high as well because it is a result of master's degree thesis and has been evaluated by people who are expert in the field (e.g. Jack Van der Vorst and Pieternel Luning)

## 2.7.1 Traceability Objectives and strategies

### 2.7.1.1 Traceability Objectives

Companies and their trading partners in a supply chain have different objectives in implementing traceability. Hobbs (2006), reported that such objectives may include:

- To comply with regulatory requirements (e.g., EU Regulation 178/2002 on food law, FDA requirements on establishment and maintenance of records (21 CFR 1) and guidance on recalls (21 CFR 7.59), USDA requirements and guidance on recalls (FSIS Directive 8080.1)
- To reduce business risks above and beyond legal compliance
- Product recall and withdrawal (notably to achieve a greater degree of precision, to demonstrate control, increase efficiency and reduce the cost of product recall or withdrawal)
- To comply with a trading partner's specifications
- Efficient logistics management
- Effective quality management

- To support product safety
- To provide information to consumers and trading partners
- To verify the presence or absence of product attributes (e.g., organic, dolphin safe)
- Brand protection
- Product authentication and anti-counterfeit policies

Meuwissen *et al*. (2003) in Diogo *et al*., 2006 identified that firms have a variety of motivations to adopt traceability such as: Increased transparency, reduced exposure to liability, improved effectiveness of recalls, enhanced logistics, improved control of livestock epidemics, easier product licensing and a price premium, reduces levels of information asymmetry, decrease transaction costs, increases trust levels and thus facilitating contracting.

In a traceability adoption study, Summer *et al*., 2006, reported that traceability of food products back to the farm of origin may be motivated by many considerations in addition to consumer confidence and reducing effects of contagious disease. These include: a) protect the general reputation of firms, an industry or a country; b) differentiate products by suppliers who provide traceability; c) guarantee product origin when origin is an attribute of interest to consumers; d) improve supply management by firms; e) monitor and assure production or processing methods; f) erect implicit international trade restrictions; g) Provide information about suppliers that allows application of liability for food safety or other product quality problems.

**Relevance, validity and reliability**
This model explains the reasons why different firms apply traceability systems. Knowing the reasons why firms apply or adopt a traceability system is useful because it can help us to understand why different firms have different levels of traceability system performance or even why similar firms have different levels of traceability performance. Thus, this model is **relevant** to this study. The **validity** of this model is high because the model is detailed and has been validated by many authors who are expert in the field. This model has been cited in different types of scientific journals, which has high credibility and for this reason the **reliability** of this model is not questionable.

**2.7.1.2 General Traceability strategies**
Van der Vorst, 2003 distinguishes three main strategies of traceability, namely: Compliance-oriented strategy, Process improvement –oriented strategy and market –oriented strategy. According to Van der Vorst, 2003, one of the basic questions companies have to deal with, is which traceability performance level to strive for in the near future; comply with minimum levels of traceability as requested by the government or follow an alternative strategy that might be more fruitful? The strategies are elaborated below as follows:

- *Compliance-oriented strategy*: comply with rules and regulations by implementing minimum requirements. Companies that adhere to a compliance-oriented strategy focus on the registration of incoming and outgoing materials and leave the process as a black box. (Van der Vorst, 2003: Stein, 2006)
- *Process improvement-oriented strategy*: strive for control of the traceability of products within the own link by means of production-integrated measures that achieve both compliance with governmental rules and regulations and a better return. Examples of process-oriented measures are local ICT-systems that register all process data and if necessary change process control (Van der Vorst, 2003: Stein, 2006)

- *Market-oriented (branding) strategy*: aim for the establishment of full traceability within the supply chain to achieve competitive advantage (by creating added value in the market place). This requires the redesign of processes to separate small production lots, standardization of information carriers, adjusted planning and control of production processes, and so on. (Van der Vorst, 2003: Stein, 2006)

Van der Vorst, 2003 argues that which traceability strategy is the best for a specific company of supply chain depends on the trade off between costs and benefits and can differ for each specific product group. High levels of traceability require investments in *processes, infrastructures, information systems and people/relationships*. When this results *in effective recalls management, effective risk management, process improvement and competitive advantages the investments might be worthwhile.* However often, because of the capital-intensive kind of industry, the required investments are very high resulting in a choice for relatively low level of traceability. In that case, prevention via high quality management becomes essential to diminish the risk of product recalls. ECR Europe (2004) reported that the cost of implementation of traceability systems is likely to vary enormously between business and sectors depending on the type of technology adopted, the amount of information required to be stored and the complexity of the supply chain. Therefore, it is more likely that traceability systems will be introduced rapidly where commensurate benefits exist in logistics and process control or where brand market share would be jeopardised without the introduction of such a systems. *These differences lead to a huge spread in the traceability* performances along the supply chains. In many cases companies still focus on their own business instead of the complete supply chain.

**Reliability, Relevance and Validity**

This model is considered to be ***reliable*** since it has been cited in many articles and the contributors of the article from which this model was retrieved have extensive practical experience in supply chain management. The model is also considered to be ***relevant*** to this study because it depicts different strategies firms may have in implementing traceability systems. The model is also ***valid*** because it detailed and provides a clear insight on the strategies firms have in adopting the traceability system.

## 2.7.2 Traceability system design

Traceability system is designed to track and trace the flow of product or product attributes through the production process or supply chain by registering information about product and process characteristics. Implementing a traceability system within a supply chain requires all parties involved to systematically associate the physical flow of materials, intermediate and finished products with the flow of information about them (EAN.UCC, 2003). According to Loftus, (2005) a key feature of any traceability system is the ability to clearly identify, that which is to be traced. Ideally the product identifier should:

- Uniquely identify the unit or batch
- Be secure (fraud proof)
- Be permanent
- Retain identity throughout the product life-cycle
- Be simple to read and capture identifying data
- Not hinder its host.

In practice no single identification system is likely to meet all of these requirements and the choice of method(s) will ultimately be determined by the specific needs of the supply chain in question (Loftus, 2005). According to Van der Vorst (2006), there are a number of steps that can help to analyse the traceability situation in a systematic way in the company. These steps include, determination of the traceability strategy, demarcation of the scope of the project, analysis of the process, determination of improvement measures, implementation of the improvement measures, adjusting procedures and testing the system. These steps can help companies to get a good reflection of their designed system.

### 2.7.2.1Traceability principles and enabling technologies

The European article number (EAN) and Uniform Code Council (UCC) defined key traceability principles and produced an implementation grid, which links them to enabling technologies and relevant EAN•UCC standards. The four key traceability principles according to EAN.UCC (2003) are:

1. Unique identification of products, logistic units and locations
2. Traceability data capture and recording
3. Links management and traceability data retrieval

4. Traceability data communication

*Table 2-3 EAN.UCC traceability Implementation Grid EAN.UCC (2003)*

| Traceability Principles | Enabling Technologies | EAN-UCC System Tools |
|---|---|---|
| Unique identification | Automated identification | GTIN, SSCC, GLN, application Identities |
| Data capture and recording | Automated data capture | EAN/UPC, UCC/EAN- 128 |
| Links management | Electronic data processing | Software applications |
| Data communication | Electronic data interchange | EANCOM/XML |

**1. Unique Identification**

According to EAN.UCC (2003), any trade item and / or location, which need to be traced or tracked, must have a unique identity. It is important to note that a precise identification can only be done when a trade item/Traceable Resource Unit (TRU) has been well defined. Defining a TRU may be one of the most difficult steps involved in the design of a traceability system (Thompson *et al., 2005*).

**2. Data capture and recording**

Traceability requires pre-defined data to be captured and recorded throughout the supply chain. It is important to keep in mind that the traceability information has to be shared between partners and/or stored by each trading partner wherever relevant and applicable. For smaller companies with lower trading volumes and less complex business processes, data capture through manual documentation using traditional approaches (archives, folders) can be a viable and functional solution. Nevertheless, for both large and small companies, the recommended enabling technology is automated data capture (ADC). (EAN.UCC, 2003)

**3. Traceability links management and retrieval**

In a majority of supply chains, products are tracked and traced by their production lot, which has undergone the same transformation (production process) and by their transport/storage path (distribution process). The ability to retrieve traceability data in a fast and accurate manner along a supply chain is critical. This requires the management of successive links between what is received, produced, packed, stored and shipped across the entire supply chain. If one of the partners, in the supply chain, fails to manage these links, this will result in the disruption of the information chain and in the subsequent loss of traceability. It is impossible to attain full product traceability without correctly identifying products in all their configurations at each different point of the supply chain (EAN.UCC, 2003)

**4. Data communication**

An essential feature of any traceability system is the exchange of information. Traceability requires associating the physical flow of products with the flow of information about them. To ensure the continuity of the information flow, each supply chain actor must communicate pre-defined traceability data to the next one, enabling the latter to apply traceability principles. The enabling technology recommended by ECR organisations is Electronic Data Interchange (EDI) where accuracy and speed are seen as important by the company concerned, depending again on its size, trading volume and complexity of business (EAN.UCC, 2003).

There are a number of different systems that can be used for traceability within an organisation or throughout a supply chain, each having advantages and disadvantages. Examples are: Paper based, Computer Based, Bar Code, Radio Frequency Identification, DNA and Biometrics

*Table 2-4 Strengths, weaknesses, opportunities and threats of T&T systems (Marshall, 2004)*

| Traceability system | Strengths, Weaknesses, Opportunities and Threats (SWOT) |
|---|---|
| Paper based | **Strengths:** Low direct costs<br>**Weaknesses:** Disjointed information doesn't allow information to be linked together and Indirect cost of time needed to complete & Slow lane perception<br>**Opportunities:** · Transfer of templates to electronic format<br>**Threats:** Time needed to recall information may exceed legal expectations |
| Computer based | **Strengths:** Information can be correlated to identify efficiencies , Fast Lane Perception<br>**Weakness:** Enhanced costs due to IT purchase<br>**Opportunities:** Interlinking traceability information with sales / production / accounts Interlinking software with external partners (suppliers / customers)<br>**Threats:** Developing / purchasing systems which cannot communicate with other systems and software |
| Bar code based | **Strengths (Current Applications)**<br>Standards for product codes (EAN/UCC), Mature, widely-used technology, Can be used to track individual lots/batches/ packages, Can record expiry dates and is Cost effective<br>**Weaknesses:** Farm environments are very harsh on this technology, resulting in potential loss of data, Direct line-of-sight required for reading<br>**Opportunities:** Ability to couple with RFID technology<br>**Threats:** RFID functionality can theoretically completely replace bar code Functionality |
| Radio Frequency Identification (RFID) | **Strengths (Current Applicable Application)**<br>No physical "line of sight" required to read devices, Mature technology, Tags can be reusable, tags are robust to specific environments, Can be used to track individual packages, Can record expiry dates, it is virtually tamper-proof and is Rapidly expanding in the market<br>**Weaknesses**<br>Is not applicable for small items, Device cannot be used from 'net to knife' due to either disassembly or blending, Cost is prohibitive for low value items, Reliability of reading is uncertain, Difficulty reading items near metal (interference) and the market is young,<br>**Opportunities**<br>Devices can be written/re-written, Devices can monitor and record changes to environmental conditions, Costs are decreasing and are expected to continue decreasing over the medium term.<br>**Threats:** Lack of technology standards, High cost of devices, Lack of understanding of the differences between RFID and traditional bar code technology |
| DNA based | **Strengths**<br>Unique, constant and immutable identifier, Sampling is simple and relatively non-invasive, technical knowledge is transferable between similar products, Available in all organisms and Survives most processing steps<br>**Weaknesses**<br>Testing is performed at a distance, Relatively high cost of testing compared to other methods of identification, Proprietary methods for typing may limit access for mass markets and No visual ID on the animals<br>**Opportunities**<br>Development of new high-volume, fast-turnaround testing/matching Capacity, Public sharing of methods and experience within and between sector participants, combination of DNA with other technologies/methodologies (e.g. RFID/EID)<br>**Threats**<br>Applicability in smaller facilities may be limited in the near-term, due to cost and knowledge base, Roll-out for traceability will require extremely large data storage and retrieval capacity, and common/interoperable data standards, and exclusive participation by large players may develop traceability into a competitive barrier (for smaller players) |

## Relevance, validity and reliability

This model is **relevant** to this study because it gives us an overview on the designing of the traceability system. The elements described in this model can be useful in deriving the indicators, which are necessary in the operationalisation of the research model in the later stages in this study. The **validity** of this model is high because the model is very detailed and has been validated by many experts in the field. Moreover, the EAN.UCC standards are currently extensively used almost all over the world. The **reliability** of the model is also high because it has been developed by highly reputable organisation and its worldwide applicability is a proof of its reliability.

### 2.7.3 Traceability system performance

Performance refers to how an organisation defines and measures progress towards its goals. Once an organisation has analysed its mission, identified all its stakeholders, and defined its goals, it needs a way to measure progress towards those goals. Key Performance Indicators (KPI) constitutes such measurements. According to EAN.UCC (2003), there are five key performance indicators that can be used to assess the overall performance of any traceability system. These indicators are**:** *Reliability, Rapidity/speed, precision/accuracy, coherence and cost.*

#### Reliability

According to EAN.UCC (2003), the traceability system must be stable and reliant, meaning that it has to be capable of retrieving the information required without any risk of error. Overall reliability is determined by the reliability of the *tools, procedures and information sources used*. If, for example, the procedures for recording links between logistic units and consignees are manual, an input error can lead to the failure to recall a trade item that has been identified as presenting a serious risk.

#### Rapidity /speed

The rapidity criteria apply in particular to information request procedures and tools used for locating trade items or any other type of information search concerning the traceability system. Rapidity depends on the information management tools used and their automation as well as the level of co-operation between the supply chain partners. Even if one has good traceability in theory, a traceability system may prove to be totally ineffective in practise because, for example, a manual archiving system is used to handle the volume of information accumulated over the course of several years (EAN.UCC, 2003).

#### Precision/ accuracy

Precision reflects the degree of assurance that the traceability system can pinpoint a particular food product's movement or characteristics. Precision is determined by the batch sizes used in the supply chain, as well as the acceptable error rate. In other words, can the traceability system trace back an individual packet of fish product picked up at a retail store or on the pallet or production batch level? A more precise traceability system is better for limiting the impact of a recall. Systems that have large tracking units that include only a day's production will have poor precision in isolating safety or quality problems. Precision have a direct impact on the time needed to determine the origin of a quality variation or a safety problem and also on the costs in the event of trade item withdrawal or recall (EAN.UCC, 2003).

#### Coherence

The coherence of a system can firstly be seen insofar as how well suited it is in relation to its requirements. Firstly, the traced data should correspond to customer, partner and internal requests. Secondly, the system should also integrate the capacity to be upgraded in order to integrate new functions and extend the parameters of traceability or of the data traced. Coherence assures the durability of the system due to the usage of standards, the compatibility of successive information systems, and the degree of flexibility and adaptability to the environment (EAN.UCC, 2003).

#### Cost

The cost of a traceability system is often difficult to estimate as the traceability system is not an independent system in itself but is integrated into systems that already exist such as: quality management tools, production, logistics or the computer system.

#### Relevance, validity and reliability

The model provides the tools (indicators) that can be used to assess the performance of the traceability system. For this case this model is found to be **relevant** to this study. This model is very detailed and it is specifically showing how the mentioned indicators can be used to measure the performance level of any traceability system. Furthermore, the model has been validated by EAN.UCC. Therefore, the **validity** of this model is considered to be high. The model is considered to be **reliable** since it emanates from highly reputable organisations i.e., EAN International-Uniform Code Council (EAN-UCC). The standards from these organisations are used by many organisations worldwide.

### 2.7.3.1 Verification of traceability systems

Traceability systems are critically reliant on the recording of information accurately through the food chain. There is therefore a great degree of trust and responsibility placed on every operator in the food chain (FSA, 2002). In most audits, traceability systems are assessed through a challenge to the system by *performance and speed*. For instance 'Contaminated' products, selected at random for a test, must be identified back through the production process and any products related through a common process or ingredient or batch must be identified for withdrawal quickly and effectively (FSA, 2002). Unfortunate the industry is too diverse for any blueprint approach to be successful. Nevertheless, traceability systems may be checked to see if they meet the following goals:

- Provide traceability forwards and backwards
- Establish clear manufacturing windows for continuous production
- Be comprehensive and include all materials and ingredients
- Give a response in an appropriate time (relate to risk and shelf-life)
- Provide simple readable traceability information to the customer

Paper records can be lost, spoiled or rewritten, while well-configured computer systems cannot. IT driven recording systems create unalterable data and time verified records, whether they were recorded remotely or by an operator keying in data. IT systems therefore reduce opportunity for information to be entered incorrectly or fraudulently (particularly where machine readable identification systems and remote sensing replace human data entry). Data entry can also be linked to personnel since user identification is recorded against data entry. The level of system access can also be restricted by user identification. IT driven record systems also encourage the management of compliance to standards as a continuous process, since there cannot be a panic completion of all the missing records for the last year on the day before an audit or inspection. However, any information stored will only be as good as the data entered, it is almost impossible to envisage/construct a system, which is completely invincible to fraud (FSA, 2002)**.**

### Relevance, validity and reliability

This model emanates from the competent authority i.e. Food Standard agency. FSA has high credibility in Europe and it is well recognised for its contribution in standardisation. Therefore, the **reliability** of this model is not questionable. The model is also considered to be **relevant** to this study since it gives us an insight on how to asses the performance level of the traceability system. This model is very useful in this study since it gives us a clue regarding the grounds on which the assessment on the performance of the traceability system should be based on. Although this model is not detailed but it is considered to be **valid** since it is the base of many audits according to FSA (2002).

## 2.7.4 Product and Process Characteristics of Agricultural FSCN

Agricultural products have a wide range of characteristics. Den Ouden *et al*. (1996) gave a list of specific *process and product characteristics* of agricultural FSCNs, including the following:

- Seasonality in production, requiring global sourcing.
- Variable process yields in quantity and quality due to biological variations, seasonality, and random factors connected with weather, pests, and other biological hazards.
- Shelf life constraints for raw materials, intermediates and finished products, and quality decay while products pass through the supply chain.
- A requirement for conditioned transportation and storage means (e.g. cooling).

Many authors have also provided an overview of typical *food industry characteristics*; sometimes categorized for different chain actors, and/or the activities they perform (Beulens *et al*., 2004, Trienekens and Van der Vorst 2006). Examples are the unpredictable supply of produce, the quality variation between different suppliers and between different lots of produce, the perish-ability of fresh produce etc. These characteristics influence the implementation of traceability systems. A summary of the factors that have the most effect on the complexity regarding traceability are presented below (Trienekens and Van der Vorst 2006)

- Diverging and converging product streams that make it difficult to follow the different raw materials that go into the product and all the end products that result at the end of the process
- The in-homogeneity of raw materials and (inter-) mediate products, business entities, exchanged between business processes due to e.g. weather conditions, biological variation and seasonality, but also as a possible result of variations in production. A typical characteristic of food products is their variability in form, shape, taste, etc.
- Contamination of (many) different batches of raw materials. Because batches in many food industries are mixed, cross contamination of batches is a general problem in food industries;
- Batch or continuous production. If production takes place in batches, identification can be kept per batch. However, in the case of continuous production (e.g. milk) identification can only be kept through time of production;
- Many sources of batches of raw materials (home and abroad). Because of internationalisation of food chains and networks, sourcing becomes more and more international. This makes traceability hard to achieve
- Many actors with formal and informal relationships exist in the chain. In the food chain often transactions take place through arm's length relationships. Solid administration of transaction often lacks;
- Lack of connections between physical and administrative product flows. In general one may say that food chains and (chain) processes within them are complex systems. Realizing traceability and transparency systems is consequently also complex;
- Variable and multi-level recipes. Products can be based on more than one recipe, for example different raw materials and use of different production means can lead to similar products
- Presence of active material. Active material, for example protein, is contained in other material components of the product and determines the value of end products. The concentration, amount or percentage can vary. Registration of the total product quantity therefore is not sufficient, but the active component should be identified separately;
- Perish-ability of products. For certain materials storage life constraints apply. As a consequence, using up materials according to first in first out (FIFO) may not apply and different batches of the same product, but of different age, cannot be grouped and must be handled separately.

#### 2.7.4.1 Characteristics of fish and fish products

Fish industry trade globally in a vast range of fish species (Luten *et al*., 2003), these species have different potential hazards (FDA, 2001). The fact that different fish species have different potential hazards implies that detailed information about these species is required during processing in order to be able to judge the safety level of the finished products. For instance, Histamine is considered to be a potential hazard in some fish species such as Yellow fin tuna (*thanus albacore*) and Dorado (*Coryphaena hipparus*) FDA (2001). Histamine is formed due to decarboxylation of histidine, which is a natural occurring chemical compound in these species. Another issue to consider in traceability system is the origin of fish (farmed or wild).

In assessing the safety of wild and farmed fish, EFSA's CONTAM Panel reviewed a wide range of contaminants and concluded that the two contaminants for which high consumers of fish might exceed the provisional tolerable weekly intake (PTWI) are:

(I) Methyl mercury which is found at elevated concentrations in tuna and other top predatory fish which are mostly caught in the wild, and

(ii) Dioxins and dioxin-like PCBs for which higher levels are found in fatty fish, e.g. herring and salmon caught in the wild (FSA, 2005).

In a report by FAO (1995), it was reported that there are several changes, which occur following the death of fish. These changes include: A) Sensory changes; B) Autolytic changes; C) Bacteriological changes; D) Lipid oxidation and hydrolysis

## A) Sensory changes

Sensory changes are those perceived with the senses, i.e., appearance, odour, texture and taste. The first sensory changes of fish during storage are concerned with appearance and texture (Martinsdóttir et al., 2001). However, the characteristic sensory changes in fish post mortem vary considerably depending on fish species and storage method (FAO, 1995). The most dramatic change is onset of rigor mortis. The rate in onset and resolution of rigor varies from species to species and is affected by temperature, handling, size, physical condition of the fish and the method used for stunning and killing the fish (FAO, 1995). The technological significance of rigor mortis is of major importance when the fish is filleted before or in rigor. In rigor the fish body will be completely stiff; the filleting yield will be very poor, and rough handling can cause gaping. If the fillets are removed from the bone pre-rigor the muscle can contract freely and the fillets will shorten following the onset of rigor (Azam *et al*., 1990 as cited by FAO, 1995)

## B) Autolytic Changes

Autolysis means "self-digestion". According to Huss (1995), there are at least two types of fish spoilage: *bacterial and enzymatic*. Autolysis has been shown to accelerate the growth of spoilage bacteria by providing a superior growth environment for such organisms (Aksnes and Brekken, 1988 as cited by Huss, 1995). The inductions of bacterial spoilage in fish by autolysis also results in the decarboxylation of amino acids, producing biogenic amines and lower the nutritive value of the fish significantly.

## C) Bacteriological changes

Huss, (1995) reported that there are different bacterial species that can be found on the fish surfaces. The bacteria on temperate water fish are all classified according to their growth temperature range as either psychrotrophs or psychrophiles. Psychrotrophs (cold-tolerant) are bacteria capable of growth at 0°C but with optimum around 25°C. Psychrophiles (cold-loving) are bacteria with maximum growth temperature around 20°C and optimum temperature at 15°C. Mesophiles on the other hand, are bacteria with an optimum growth temperature that is between 20°C and 45°C. According to Huss, (1995), higher numbers of mesophiles can be isolated in warmer waters such as in the tropics. In polluted waters, high numbers of *Enterobacteriaceae* may be found. In clean temperate waters, these organisms disappear rapidly, but it has been shown that *Escherichia coli* and *Salmonella* can survive for very long periods in tropical waters and once introduced, may almost become indigenous to the environment (Fujioka *et al.,* 1988 as cited by FAO, 1995). Bacteria on fish caught in tropical waters will often pass through a lag-phase of 1-2 weeks if the fish are stored in ice, thereafter exponential growth begins. At spoilage, the bacterial level on tropical fish is similar to the levels found on temperate fish species (Gram, 1990; Gram *et al.,* 1990).

## D) Changes due Lipid oxidation and hydrolysis

Huss, (1995) reported that there are two distinct reactions in fish lipids, which are of importance for quality deterioration. These reactions are: *Oxidation and hydrolysis*. These reactions result in production of a range of substances among which some have unpleasant (rancid) taste and smell. Some may also contribute to texture changes by binding covalently to fish muscle proteins. The various reactions are either *non-enzymatic* or catalyzed by *microbial* enzymes or by *intracellular* or *digestive* enzymes from the fish themselves. The relative significance of these reactions depends on fish *species and storage temperature*. Fatty fish are, of course, particularly susceptible to lipid degradation which can create severe quality problems even on storage at subzero temperatures.

## Relevance, validity and reliability

The **relevancy** of this model to this study is that it helps us to understand various changes that occur soon after the death of fish. Understanding these changes is important in designing and hence execution of the traceability system. This model is very detailed, since it explains clearly what happens when the fish dies. For instance the model explains about; Sensory changes, Autolytic changes, Bacteriological changes and Lipid oxidation and hydrolysis. The **validity** of this model is therefore high. The model is considered to be **reliable** because it has been sited from reliable sources e.g. FAO.

### 2.7.4.2 Characteristics of fish production process

Fish production process is subject to a number of factors. Such factors are briefly described below.

### A. Environmental Chemical Contaminants & Pesticides (A Chemical Hazard)

Environmental chemical contaminants and pesticides in fish pose a potential human health hazard. FDA (2001) reported that fish are harvested from waters that are exposed to varying amounts of industrial chemicals, pesticides, and toxic elements. These contaminants may accumulate in fish at levels that can cause illness. Concern for these contaminants primarily focuses on fish harvested from fresh water, estuaries, and near-shore coastal waters (e.g. areas subject to shore side contaminant discharges), rather than from the open ocean (FDA, 2001). Under ordinary circumstances, it would be reasonably likely to expect that, without proper controls, unsafe levels of environmental chemical contaminants and pesticides could enter the process at the receiving step. It is therefore necessary to ensure that there is proper control of environmental chemical contaminants at the receiving section. According to Mortimore (2001), such a proper control can be achieved through proper application of the HACCP system

### B. Allergens and Colour additives in fish and fish products

Certain food and colour additives can cause an allergic-type reaction (food intolerance) in consumers. Examples of such food and colour additives that are used on fish and fishery products include: sulfiting agents (FDA, 2001). Sulfiting agents are mostly used during on-board handling of shrimp and lobster to prevent the formation of “black spot.” They are sometimes used by cooked octopus processors as an antioxidant, to retain the red colour of the octopus skin. These food and colour additives are permitted for use in foods, with certain restrictions, but their presence must be declared on the label. This label declaration is particularly important to sensitive individuals (FDA, 2001). A number of foods contain allergenic proteins that can pose a health risk to certain sensitive individuals. Such foods include: Peanuts, Soybeans, Milk, Eggs, Tree nuts and Wheat. Unintentional as well as intentional introduction of allergenic proteins must be controlled through a rigorous sanitation regime, either as part of a prerequisite program or as part of HACCP itself. Inclusion of these substances in fish product may constitute a significant health hazards and therefore food manufactures should be able provide evidence of full traceability for these ingredients (FSA, 2002)

### C. Effects of temperature during processing and/or storage

Huss, 1995 reported that both enzymatic and microbiological activities are greatly influenced by temperature. Figure below shows the effect of temperature on the growth rate of the fish spoilage bacterium *Shewanella Putrefaciens.* At 0°C, the growth rate is less than one-tenth of the rate at the optimum growth temperature. Microbial activity is responsible for spoilage of most fresh fish products. The shelf life of fish products, therefore, is markedly extended when products are stored at low temperatures. Appendix 1 and 2 contains information on the growth and inactivation of bacterial pathogens. In summary, appendix 1 and 2 indicates that:

- If the product is held at internal temperatures above 70°F (21°C) during processing, exposure time should ordinarily be limited to two hours (three hours if *Staphylococcus aureus* is the only pathogen of concern);
- If the product is held at internal temperatures above 50°F (10°C), but not above 70°F (21°C), exposure time should ordinarily be limited to six hours (twelve hours if *Staphylococcus aureus* is the only pathogen of concern);

- If the product is held at internal temperatures both above and below 70°F (21.1°C), exposure times above 50°F (10°C) should ordinarily be limited to 4 hours, as long as no more than 2 of those hours are above 70°F (21.1°C).

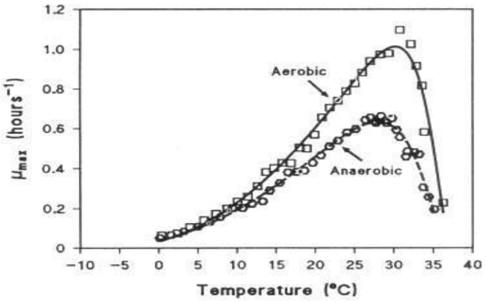



*Figure 2-9: Effect of temperature on the Shewanella putrefaciens (Dalgaard, 1994)*

The figure above shows the e Effect of temperature on the maximum specific growth rate (µmax) of Shewanella putrefaciens grown in a complex medium containing TMAO (Dalgaard, 1994)

Generally, all fish spoil in a similar way, with 4 distinct phases of spoilage (FAO, 1997). Most fish will keep on ice for about 15 days before becoming inedible, and this time can be divided roughly into successive periods of 0 to 6, 7 to 10, 11 to 14 and over 14 days. Phase 1 is characterised by very little deterioration apart from some slight loss of natural or characteristics flavour and odour. Phase 2 is characterised be a considerable loss of flavour and odour. Phase 3 is characterised by stale taste, appearance and texture and fish begins to show obvious signs of spoilage, and the gills and belly cavity have an unpleasant smell. In phase 4 the fish are putrid and generally regarded as inedible.

### Relevance, validity and reliability

Understanding the impact of time/temperature combination is very crucial in fish processing, because both enzymatic and microbiological activities are greatly influenced by temperature. Understanding enzymatic and microbial properties of fish will help us to know where and when to apply control measures so as to maintain quality and safety of fish/fish product. On the other hand it can help us to know where to collect data for traceability purposes and in this regard the model is **relevant** for this study. The importance of time/temperature in fish processing has been reported by many authors and has been extensively studied by many people. For instance: McMeekin *et al.* (1993), Huss (1995), Gram *et al.*, (1990), and Dalgaard (1994). Moreover, the model is very detailed. These two factors give a high degree of **validity** to this model. The **reliability** of this model is high as well since the concept of time/temperature control in fish processing is emphasised by all quality assurance systems and is an applicable concept worldwide.

## 2.7.5 Food Supply chain complexity

The netchain model introduces the concept of netchain analysis. According to Lazzarini *et al.*, (2001), A netchain is a set of networks comprised of horizontal ties between firms within a particular industry or group, which are sequentially arranged based on vertical ties between firms in different layers (Netchains = chains +networks).

Each firm is positioned in a network layer and belongs to at least one supply chain: i.e. it usually has multiple (varying) suppliers and customers at the same time and over time. Other actors in the network influence the performance of the chain. What happens between two companies does not solely depend on the two parties involved, but on what is going on in a number of other relationships (Håkånsson and Snehota (1995) as cited by Van der Vorst (2006). Therefore, the analysis of a supply chain should preferably take place or be evaluated within the context of the complex network of food chains, in other words a Food Supply Chain Network (FSCN). Lazzarini refers to a 'netchain' and defines it as "a directed network of actors who cooperate to bring a product to customers" (Lazzarini *et al*. 2001).

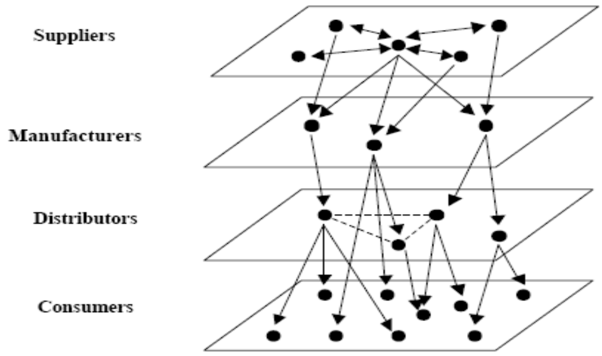



*Figure 2.10.An example of a generic netchain (Lazzarini et al., 2001)*

### Relevance, validity and reliability

The net-chain model helps us to understand the relationship between various actors in the chain. This is an important element in designing a traceability system. The model shows how agents in each layer are related to each other and to agents in other layers; the model is therefore **relevant** to the study. Although this model is not very detailed but its **validity** is high because it has been cited in many articles (74 in total) and it has been validated in many studies. The **reliability** of this model is also high because it was published in the Supply Chain Management Journal and validated by a large field study.

### 2.7.5.1 Food Supply chain management

According to Spekman *et al.,* (1998), there are three important levels of supply chain management. The first level is ***co-operation***, whereby firms exchange bits of essential information and engage some suppliers/customers in longer-term contracts; this has become the threshold level of interaction. That is, co-operation is the starting point for supply chain management and has become a necessary but not sufficient condition. The next level of intensity is **co-ordination** whereby both specified workflow and information are exchanged in a manner that permits JIT systems, EDI, and other mechanisms that attempt to make seamless many of the traditional linkages between and among trading parties. Trading parties can co-operate and co-ordinate certain activities but still not behave as true partners. Again, this evolution is a necessary, but not sufficient, condition for total supply chain management. The next level of intensity is **collaboration**. Collaborative behaviour engages partners in joint planning and process beyond level reached in less intense trading relationship (Spekman *et al.,* 1998).

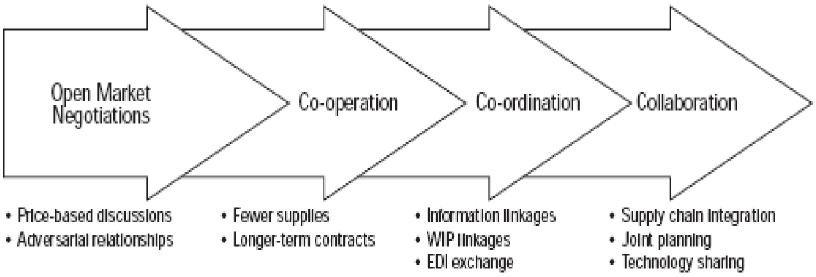



*Figure 2-11.Transitions from open-market negotiations to collaboration (Spekman et al., 1998)*

Figure 2-11 summarizes the requisite transition from being an important supplier to becoming a supply chain partner. The transformation is depicted as linear although it is a step function since the changes required to move from one level to another require changes in mind set and strategic orientation among supply chain partners.

### Relevance, validity and reliability

The model provides an overview of various levels of supply chain management and the relationship which exists between these levels. Understanding the characteristics of the supply chain is a crucial aspect when designing the T&T system. Therefore, due to this reasons the model is found to be **relevant** to this study. Although this model seems to be very general, but it is **validity** is high because it has been extensively tested/ validated by many people and in many supply chains (22 in total, both in America and in Europe, see *Spekman et al., 1998*). This model is also **reliable** because it is extensively used in the supply chain management field and has also been sited by other authors: e.g. Porter (1985), Kamann (1989), Zuurbier (1996) and Hughes (1994) as shown in Spekman *et al.*, 1998,

### 2.7.5.2 The diversity and complexity of the fish supply chain

Fish industry trades globally in a vast range of finfish and shellfish species and their products, and which is hugely diverse in comparison to other protein sources. Fish is pursued and captured in the wild by independent fisherman. This encompasses enormous variability in comparison to the controlled farming, often monoculture, or other protein sources.

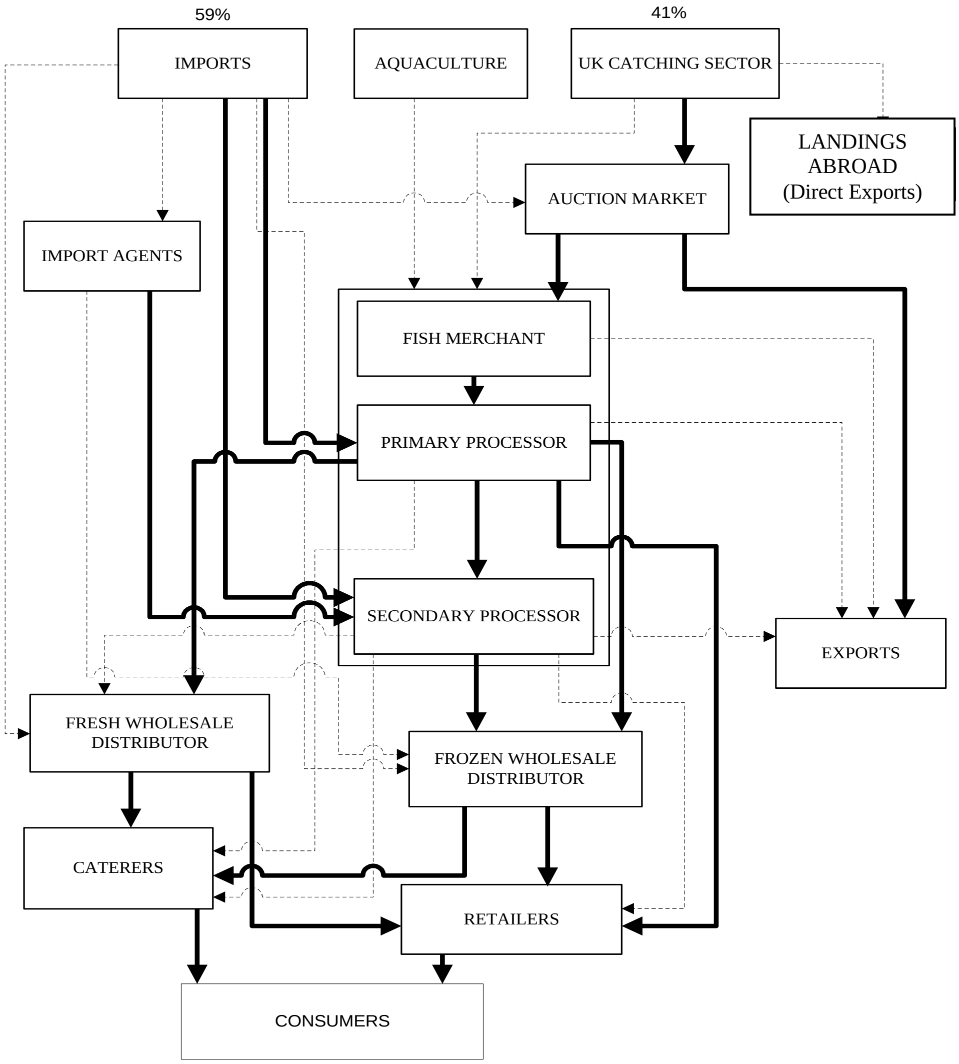



*Figure 2-12: Demersal Fish Distribution Chain in UK (Tracefish, 2001)*
(The most common links are shown in bold)

A similarly wide range of live, chilled, frozen, processed and added-value fishery products are then produced and traded within the various distribution chains, again often with specialised food handling and food safety requirements (Tracefish, 2001). This complex chain involves various landings, port auction markets, fish merchants, primary processors, secondary processors, transport and storage, inland markets, wholesalers, retailers and caterers. Moreover, fish change ownership many times and are handled by many different food businesses whilst passing though such complex chains. An example of this complexity is the distribution chain for demersal fish in the UK, as shown in the figure above (Tracefish, 2001)

It was noted in Tracefish (2001), that a large amount of information is generated and used in these distribution chains, for both legal and commercial reasons, but that much if not most of that information is effectively lost in respect of chain traceability. It is generated for particular reasons, such as fisheries management or accounting purposes, usually in a specific form for its particular purpose, and is not made available for other purposes. In addition, this information is often not tied to the physical units of fish it describes and so is useless for the purpose of traceability. Even if initially tied, those units may later be transformed, for example in the sorting of fish at an auction market, and so the linkage to the particular fish may be lost.

**Relevance, validity and reliability**

This model is considered to be **relevance** to this study because it provides an overview of the diversity of fish industry and briefly explains what happens when fish move along the chain; this is an important issue to consider in traceability system. The **Validity** of this model is also high since the model is very detailed. The **reliability** of the model is also high because this model is a result of a large survey conducted in UK by Tracefish in 2001.

## 2.7.6 Organisations characteristics/complexity

Food-producing organisations are normally complex. The complexity is due to the fact that these organisations deal with agrifood products, which are complex in nature. Luning *et al.*, (2002), defined an organisation as a collection of people working together to achieve a common purpose/goal. Within an organisation people are able to accomplish tasks, which were not possible when acting alone. Organisations are generally considered as open systems that interact with their environments in the continuous process of transforming resource inputs into product outputs (finished goods/services). The well being of an organisation depends on: Organisational structure, the way in which procedures and instructions are given, employee involvement, working conditions of employees and top management commitment.

### 2.7.6.1 Employee involvement in the organisation

In showing the relationship that is desirable in the organisation Ivancevich (1994), proposed a quality based control model.

The quality based control model includes; management establishing the system and then providing workers with training and information; then management and workers set specification and standards and then workers inspecting the results of production during the production process. Failure to meet production specification results in revision of the system. When the production meets or exceeds standards workers feel pride and receive recognition.In quality management employee involvement is considered as an essential ingredient for quality improvement (Heizer and Render, 1993 in Luning *et al.*, 2002). Employee involvement means including the employee in every step of the process from product design to final packaging. Building communication networks that include employee encourages employee involvement and consequently high performance level during execution of various tasks. This idea is also supported by Dimitriades (2000) and Imai (1986). Involvement of workers in the T&T system design may contribute positively on the execution of T&T systems and on the overall performance of such a system.

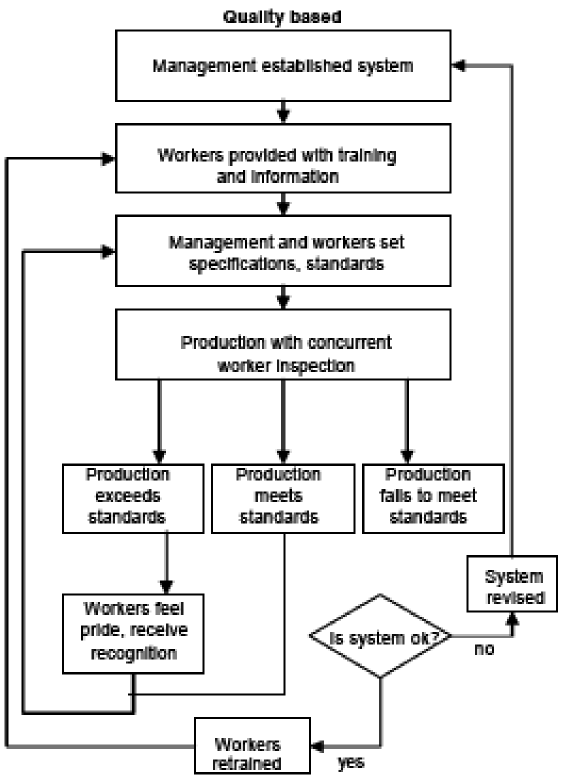



*Figure 2-13 Quality based model (Ivancevich, 1994)*

### 2.7.6.2 Working conditions in food industries

The environment in which people works have a positive impact on their ability to execute work, if the working environment is good people will be motivated and their ability to execute various tasks will be high and vice versa. Luning and co-authors (2002) reported that the typical situation in the food industry may be as follows:

- Low level of education, sometimes combined with language problems, makes it more difficult to involve operators or employees in problem solving activities
- The production circumstances are often hindering, like noise, bad smell, high humidity etc. these conditions are dissatisfying and are not motivating people if they are not reduced to acceptable levels
- As a consequence of the functional organisation structure, most knowledge is centralised in the specialised departments. This implies that, the responsibility for improvement is assessed by specialists coming from those departments, on the other hand, operators have much knowledge and experience, but are often not involved in improvement activities
- Equipment is often not very accessible for improvement. The knowledge is allocated with the supplier of the equipment, who also carries out modifications. The user of the equipment often can not put any requests or need and is restricted to the assortment of equipment as offered by (few) suppliers
- Poor feed back of information about quality performance results. Especially the lowest level operators in the organisation are not well informed or only indirectly about quality results, which is not very stimulating.
- Improvement activities are usually not rewarded. Especially acknowledgement and support of top management are missing
- Soft organisation methods are not very common in the food sector. In general, the culture is more solution –oriented and pro- active; where for discussion and analysis less time is spent.

In another study conducted by US Bureau of labour statistics (2006), it was reported that, many production jobs in food manufacturing involve repetitive, physically demanding work. According to this study, food manufacturing workers are highly susceptible to repetitive-strain injuries to their hands, wrists, and elbows. This type of injury is especially common in meat-processing, fish processing and poultry-processing plants. Production workers often stand for long periods and may be required to lift heavy objects or use cutting, slicing, grinding, and other dangerous tools and machines. Because of the considerable mechanization in the industry, most food manufacturing plants are noisy, with limited opportunities for interaction among workers.

Although this model is much focussing on the quality improvement, but it is very crucial in this study because it helps us to understand the general situation in the food processing industries and particularly in fish industry. This can be very helpful in understanding why workers behave differently during the process of executing their tasks. When this model is combined with motivation model and decision-making model it can provide us with better insight on understanding of workers behaviour in the food industry.

## 2.7.6.3 Temporary workers

A temporary worker is someone who is normally employed for a limited period (in most cases) whose job is usually expected by both sides to last for only a short time. Temporary workers may be employed directly by the employer or by private agencies (Foote, 2004).

There are variable reasons which make many organisations to take temporary staff. In most cases temporary workers are used during holidays, maternity and sickness cover, staffing for peak loads, or manning a special project. Temporary workers also help to reduce and contain costs (Foote, 2004). Companies have the benefit of the staff they need when they need them, without the fixed costs of permanent labour when skills and capacity are not needed. Temporary workers are considered to be a buffer against fluctuations of demand for employees. Despite of the reasons mentioned above, there are many disadvantages of hiring temporary workers. Temporary employees are in a constant state of employment flux because they are never guaranteed consistent employment, nor are they assured of a solid start or finish date for their assignment. Temporary workers lack motivation and commitment as compared to permanent workers, temporary workers lack proper training, proper working skills and work experience (Foote, 2004). If the company is characterised by a large number of temporary workers, it is likely therefore that many activities including T&T activities will not be carried out perfectly. This situation therefore, may contributes negatively on the T&T system design and its execution and therefore hinders high performance of the T&T system

### 2.7.6.4 Top management commitment

For a successful implementation of T&T system, management must clearly show its commitment to the T&T system. In addition, prior to implementation of the T&T system, the objectives of the T&T system as far as that organisation is concerned should be clearly established. Management commitment and support are essential for the development, implementation and monitoring of a T&T system in order to ensure continuous effectiveness of the system (Dimitriades, 2000 and Imai, 1986). All staff should understand the importance of the T&T system and the consequences of its failure on the food safety. Management commitment is one of the cornerstones of ISO 9001:2000, requiring top management to develop and improve the QMS throughout the organisation. Although ISO 9001:2000 is more focusing on Quality Management Systems (QMS), its approach on top management commitment can as well be used to explain the importance of top management commitment on the T&T system design and execution.

Top management commitment can be demonstrated by: ensuring that regulatory and legal requirements of T&T system are understood and appropriately addressed, the organisations' policy about T&T system is understood and implemented at all relevant levels of the organization, T&T system objectives and plans are established as necessary and that the responsibilities of all functions affecting T&T system are clearly defined. Management should make provisions for the necessary resources and personnel to maintain the system, including a management representative, who will ensure that the requirements of this system are met. Management should review the system annually to determine its effectiveness (ISO 9001:2000)

## 2.8 Execution of traceability system

Execution is the process of beginning a task and carrying it through to completion (www.answers.com). There are a number of factors that can contribute to proper execution of T&T system in organisations. These factors include; communication of T&T procedures and instructions, compliance with T&T regulation and procedures, employees working conditions, training etc.

### 2.8.1 Motivation

Motivation is described as a psychological feature that arouses an individual to act towards a desired goal, the reason for the action that gives purpose and direction to behaviour (dictionary, 2004). There are two main types of motivation – extrinsic (external) and intrinsic (internal) motivation.

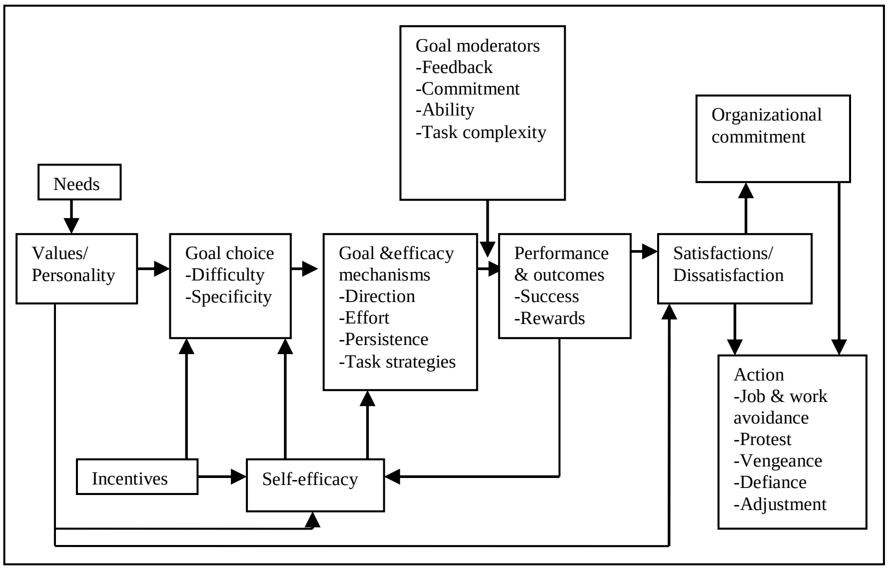



*Figure 2-14. The motivation process (Meyer et al., 2004)*

Extrinsic motivation affects all relationships in an organisation and is influenced by many areas including salaries, benefits and training opportunities. Therefore, the organisation can motivate its workers by providing the necessary experience, training, working conditions, salaries and benefits (Luning *at el.*, 2002). Intrinsic motivation is associated with psychological rewards such as opportunity to use one's ability, a sense of challenge and achievement, receiving appreciation, involvement, positive recognition, and good treatment – Herzberg Theory (Gatewood *et al.*, 1995 in Bango, 2005). The figure above explains the process of *work motivation*, and indicates areas in which the organization can influence this process (Meyer *et al.*, 2004). According to this model, Managers can potentially enhance employees' motivation through various attempts to increase job satisfaction. Job satisfaction is not a unitary or global construct, rather; it is multidimensional (as shown in the motivation process model from Meyer *et al.*, 2004). Top management must identify the key elements among employees, which impact the employee's level of job satisfaction within organizational settings. This is accomplished by constantly scanning their external environments, hiring new talents, and developing significant resources to train their employees. This new knowledge transfers through the organization striving for reduced structural, process, and interpersonal barriers in sharing information, ideas, and knowledge among organizational members.

**Relevance, validity and reliability**

Understanding the mechanism underlying motivation of workers is very important in execution of traceability activities. If workers are well motivated, they will execute their duties at a higher level and vice versa for this reason this model is considered to be **relevant** to this study. The **validity** of the model is also high since this model has been validated by many authors in a number of studies (Gatewood *et al.*, 1995 and Meyer et al., 2004). The credibility of these authors is very high and for this case the model is considered to be **reliable**.

## 2.8.2 Training and communication

A) Training- Training is a planned process to modify attitude, knowledge, or skill behaviour through learning and experience to achieve performance in activity or range of activities. Its purpose in work situation is to develop abilities of the individual and satisfy the current and future manpower needs of the organisation (Armstrong, 1966 in Derry, 1990). Training can be considered as a process that facilitates learning. Learning is defined as a process of acquiring or improving the ability to perform a behaviour pattern through experience and practice (Koelen and Van den Ban, 2004). As discussed in previous sections, food products are complex in nature due to various physiological, chemical, biological and physical characteristics. In order to overcome these complexities, it is important to provide training to workers so as to increase their cognition, knowledge and execution ability.

The importance of training has been emphasized by (Ishikawa, 1985 and Edge, 1990 in Luning *et al.*, 2002). Training is also considered to be an important prerequisite in the development of the HACCP program (FDA, 2001). On the same sense, training is considered to be important prerequisite for the designing and execution of T&T system.

**Relevance, validity and reliability**

This model is relevant to this study because it helps us to understand the importance of training when dealing with complexities during production processes. The validity of this model is not very high because it is not very descriptive. However, the model is very reliable because many authors have emphasized the importance of training in processing industries.

**B) Communication**

Communication is defined as a process of information transferring. In other words, it is a process of sending and receiving messages through channels which establishes common meanings between source and receiver (Koelen and Van den Ban, 2004). This definition is illustrated in the SMCR model as shown below.

The SCMR (Sender-Message-Channel-Receiver) model suggests that the received information is the same as the information that has been transferred by the sender. However, it often appears that a receiver arrives at an interpretation that differs from the meaning as intended by the sender. In such a situation the result of the communication process is ineffective because the sender and the receiver do not manage to establish a common meaning. Traceability systems (both internal and external) deal with flow of information, which involves the sender and the receiver. Therefore for the traceability system to be effective both parties should be able to refer to the same meaning of message when sending/receiving the information.

In any organisation settings, there are many ways through which communication is executed. These range from traditional means such as messengers, to modern means such as letters and telephone, to very modern ways such as internet, emails and television conferencing. If good communication channels are available among workers or between workers and management or between chain actors, then, information transferring will be very effective, resulting in high performance of the traceability system. Important to note is the ability to match the medium of transfer and the type of message or information

Baron and Greenberg (2000) stressed that communication is most effective when it uses multiple channels, such as both oral and written messages. However, they also argued that when the type of message being sent is for clear and routine matters (such as track and tracing matters), then written media is most appropriate. An assumption is made that oral media would be most inappropriate for track and tracing activities because these activities are routine in nature.

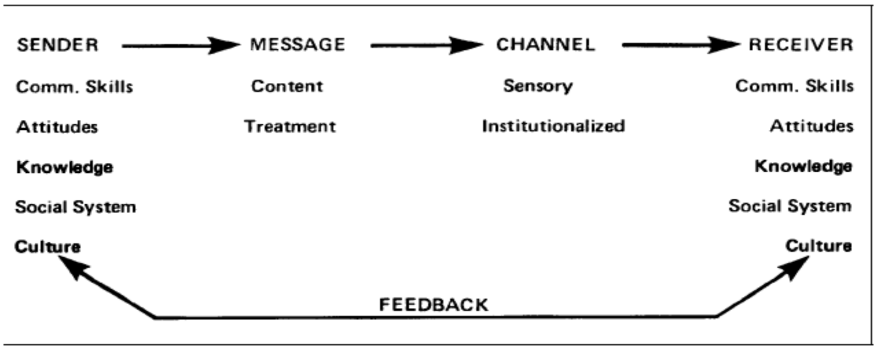



*Figure 2-15 SCMR Model of communication (Koelen and Van den Ban, 2004)*

**Relevance, validity and reliability**

The **relevancy** of this model to this study is that it helps us to understand various ways in which information communication can be done. Understanding information communication process during execution of the T&T system is very important and for this reason the model is considered to be relevant to the study. The model is also very detailed, since it explains clearly how communication is done in practise thus the **validity** of this model is high. The model is considered to be **reliable** because it has been sited from many reliable sources

## 2.9 General research question

How can traceability system be designed and executed so as to attain a high level of traceability system performance, given that traceability system designing and execution are influenced by, product complexity, production process complexity, organisation complexity and supply chain complexity?

## 2.10 Specific research question

1. What are the major bottlenecks in traceability system design and execution in fish supply chain in Tanzania?
2. What attributes of product complexity influences/affects T&T system design and execution
3. What attributes of production process complexity influences/affects T&T system design and execution
4. What attributes of organisation characteristics/complexity influences/affects T&T system design and execution
5. What attributes of supply chain complexity influences/affects T&T system design and execution

## 2.11 Hypothesis

1. *High level of T&T system design and high level of T&T system execution positively contribute on the high performance level of the T&T system*

2. *High levels of complexity of product, production process and Supply chain put higher requirements on T&T systems design and T&T system execution and negatively contribute on the performance of the T&T system.*

# Chapter 3

# Traceability system performance from Techno-managerial approach

In this chapter the conceptual (T-M) research model will be developed based on the selected models from studied literature. Special attention will be given to the model that was developed by Kousta (2006) and IMAQE-Food model, which was developed by Van der Spiegel and co- authors (2003)

A techno-managerial approach is used in the development of the conceptual research model in this thesis. According to Luning and Marcelis (2006), techno-managerial approach takes into account both food production characteristics and quality behaviour of people in the organisational context, and the mutual dependency of food and human systems. The approach involves the integrated analysis of theories from technological and managerial sciences. The authors hypothesise that such an approach will support a broader and more complete analysis of food quality management issues (such as T&T issues), whilst enabling the development of more appropriate solutions. Within techno-managerial perspective it is assumed that food quality is dependent on both food and human behaviour and their interaction, whereby food behaviour is supposed to be dependent on the dynamic properties of the food product (raw materials, ingredients, etc.) itself in relation to the applied technological conditions. Likewise, human behaviour is supposed to be dependent on the dynamic properties of people in relation to the applied administrative conditions.

Taking into account the techno-managerial perspective in this thesis, it is assumed that performance of the traceability system is dependent on the food behaviour, human behaviour and T-M conditions/characteristics that may impact T&T system design and execution.

## 3. 1 Description of the conceptual research model

The main frame of Kousta’s (2006) model has been maintained in my conceptual T-M research model with a slight modification on the primary elements (T&T system design), as well as on the secondary elements (contextual factors).

The conceptual model is composed of 5 main parts: the contextual factors, the T&T system design & execution, traceability system requirements and traceability system performance & food safety level

The first part of the conceptual model is about contextual factors. Contextual factors can be described as the environment in which an organization operates which directly or indirectly affect the performance level of the traceability system. Contextual factors include product complexity, production process complexity, supply chain complexity and organisation complexity/characteristics. High levels of product complexity, production process complexity and supply chain complexity are assumed to put a high requirement/demand on the design and execution of the traceability system. High requirement/demand in traceability system can be in terms of requiring more information collection points, more detailed information, more data processing, collection of more samples, collection of samples at a higher level e.g. at ingredient level etc. However, organisation complexity/characteristic is considered to be somehow different from the rest of the contextual factors. A high level of organisation complexity/characteristics contributes positively on the design and execution of the T&T system and thus does not put a high or low requirements/ demands on the T &T system. For instance high level of employee involvement (as an indicator of organisation complexity) does not put a higher requirement/demand on the T & T system but positively contributes to the design and execution of the traceability system.

The contextual factors are composed of several elements derived from various studied literatures in this study. These elements are assumed to be good indicators to measure the complexity of these factors. Such indicators include; product complexity (spoilage rate of fish, risk level of fish product and diversity of fish species), production process complexity (number of processing lines, number of processing steps, nature of production process structure and sources of raw material supply), Fish supply chain complexity (the level of supply chain partnership and diversity of chain actors), organisation complexity/characteristics (employees involvement, working conditions of employees, rate of temporary workers and extent of top management commitment).

The second part of the conceptual model is T&T system design. The design of the traceability system has been extensively described in EAN.UCC (2003). According to EAN.UCC (2003), any traceability system is composed by the following elements: type of identification, mode of data registration, location of data storage, mode of information communication and the degree of data standardisation. These elements are assumed to be good indicators to measure level of designing of the T&T system since they have also been referred by other authors such as Kousta (2006), Loftus (2005), Vernede *et al*., (2003) and Tracefish (2001), as important components of the traceability system design. Some more elements such as appropriateness of the location of information collection point (ICP), level of using HACCP system during T&T system design and determination of traceable resource unit (TRU) have been added to enhance the T&T system design. The importance of ICP and TRU in the designing of the T&T system has been discussed by other authors such as Coporale *et al*., 2001 and Thompson *et al*., 2005 respectively.

Traceability system execution is composed by elements/indicators such as; Level of communication of T&T procedures and instructions, degree of compliance with regulations and procedures, degree of accuracy of T&T documentations and frequency of verification of T&T system. These indicators have been extracted from literatures/models of various authors such as Baron and Greenberg (2000) and Luten *et al*., 2003 respectively. Originally these indicators were not directly linked to execution of the T&T system but linked to implementation of various tasks in the organisation. Execution simply means carrying out the task from the beginning to its completion, which means it is an implementation process. Therefore these indicators are considered to be good enough to measure execution of the T&T system.

The third part of the conceptual model is about traceability system requirements. This element is based on Perez *et al*., 2003, Tracefish (2001) and Regulation 2065/2001 of EU. Traceability system requirement is mainly composed by one indicator namely T&T system registrations. It is assumed that it is possible to measure the extent of implementation of the traceability system requirements by checking the degree of data registrations in the company. This process will be possible through the use of document analysis. The fourth part of the conceptual research model is about traceability system performance. The indicators in this case are: speedy/time or rapidity, Reliability and precision/accuracy. The details of these indicators are shown on the respective part below. The last part of the conceptual research model is about food safety level. The indicator for this element is the percentage of the recalled or rejected products. It is assumed that if the percentage of products that are rejected of recalled in a year are very high then the level of food safety is low.

## 3.2 Indicators of the research model

In order to measure the influence of the factors indicated in the theoretical research model, indicators are assigned to each factor. These indicators can be qualitative or quantitative, tangible or intangible (Van der Spiegel, 2004), but they must be addressed on a nominal, ordinal, indicative or rational scale to give a normative value to the model. The following section discusses various indicators which can be used to operationalise the conceptual research model

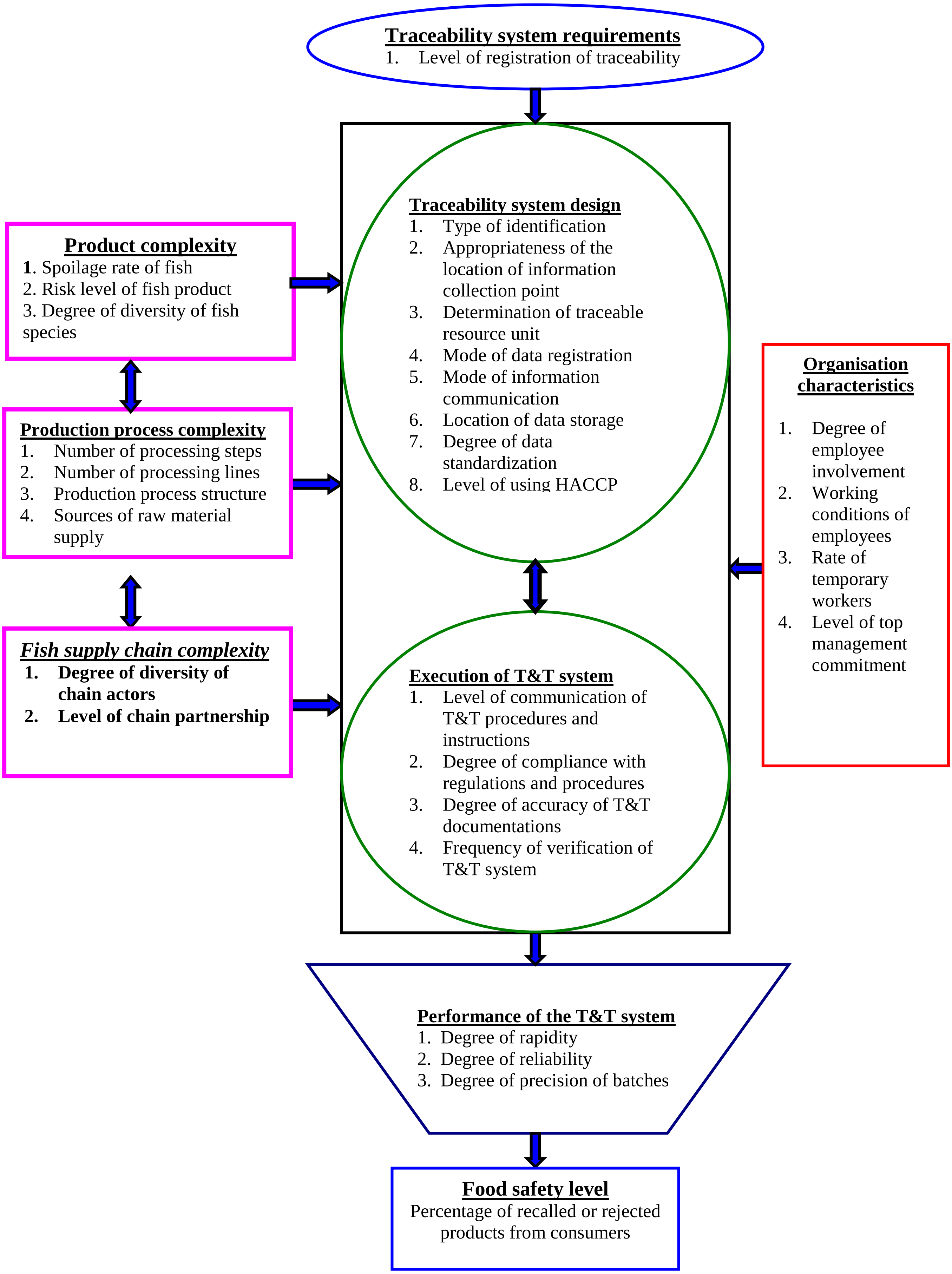



*Figure 3-1 The Conceptual Research model*

### 3.2.1 Indicators for product complexity

Food products and especially manufactured products are often very complex. They consist of a wide variety of chemical compounds, which can affect each other and thus also final intrinsic quality attributes. Besides, complex chemical, enzymatic, physical and physiological reactions may occur simultaneously (Luning e*t al*., 2002). Therefore, understanding complexity of the products is an essential factor to consider during production and during designing and execution of T&T system. Understanding the complexity of the product is useful in that it can help us to know which specific information should be collected with respect to T&T system, how detailed this information should be, how, where and when to collect sample with respect to T&T system and product safety. It is assumed that high levels of product complexity put a higher demand/requirement on the T&T system design and execution, since more/detailed information collection and analysis need to be done for this product.

**I.1** ***Degree of Diversity of fish species***

More traceability information is required when dealing with many species of fish because different species of fish have different potential hazards (FDA, 2001). So a profound knowledge on specie related hazards, product reactions and synergistic effects in fish is required during fish processing and during T&T system design and execution (Appendix 5). In general, fish industry trade globally in a vast range of fish species which have different characteristics (Luten *et al*., 2003). When dealing with many species of fish with potential hazards (such as parasites, natural toxins, histamine/scombrotoxins, pesticides, antibiotics, drugs and methyl mercury), you need to collect more samples (detailed samples) for analysis so as to be able to judge the safety level of the final product. This situation generates a large volume of data. For this reason, it can be argued that high level of diversity of fish species with potential hazards put a higher demand/requirement on the T&T system design and execution[4].

Classification of this indicator:
Low: only 1 or 2 fish species with potential hazards are manufactured throughout the chain
Medium: between 2 and 10 fish species with potential hazards are manufactured throughout the chain
High: more than 10 species of fish with potential hazards are manufactured throughout the chain

**I.2** ***Rate of Spoilage of fish***

When dealing with high spoilage rate fish, you need to collect more data about time /temperatures so as to be able to judge the safety level of the fish. FAO (1997) and Gupta & Misra (1997) reported that, all fish spoil in a similar way/similar reactions, with 4 distinct phases of spoilage. Most fish will keep in ice (approximately 0°C) for about 15 days before becoming inedible. This time can be divided roughly into successive periods of <u>0 to 6</u>, <u>7 to 10</u>, <u>11 to 14</u> and <u>over 14 days</u>. From (FAO, 1997) report, it can be deduced that if the fish becomes inedible (completely spoiled) when kept in ice within 6 days then it can be judged as a high spoilage rate fish. If appearance and texture of fish begin to show signs of spoilage such as gills and belly cavity developing unpleasant smell when kept in ice for 7 to 10 days then spoilage rate of the fish is medium. If the fish is characterised by very little deterioration apart from some slight loss of natural or characteristic flavour and colour when kept in ice for more than 11 days then the fish can be judged to be a low spoilage rate. Dealing with high spoilage rate fish therefore put higher demand on the T&T system design and execution in terms of requiring more data collection than low spoilage rate fish.

Classification of spoilage rate

Low spoilage rate (more than 11 days in ice): characterised by very little deterioration apart from some slight loss of natural or characteristic flavour and odour in other words, the fish is okay even after been kept on ice for more than 11 days.

[4] High requirement/demand in traceability system can be in terms of requiring more information collection points, more detailed information, more data processing, collection of more samples, collection of samples at a higher level e.g. at ingredient level

Medium spoilage rate: appearance and texture of fish begin to show signs of spoilage. Gills and belly cavity have an unpleasant smell when the fish is kept on ice for 7 to 10 days

High spoilage rate: fish is putrid and generally regarded as inedible when kept on ice for 0 to 6 days

### I.3 *Risk level of product for safety*

According to FSA (2002*)*, the risk associated with a food product normally influences the choice of the traceability system design. If the risk level of the product for safety is high, then more samples/information on that product needs to be collected during production process. In most cases not only more information is needed but also information is needed at a more detailed level. This process put a high demand on the sampling design and generates large volume of data. In other words, high-risk level of the product for safety put a high demand on the designing and execution of the traceability system. Van der Vorst (2003) also reported that the level of traceability depends on the risk level of the product.

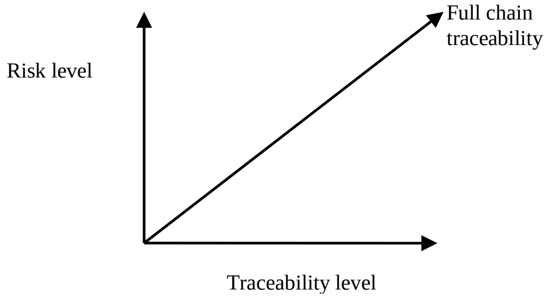



*Figure 3-2: Risk level and traceability, based on Van der Vorst (2003)*

In addition, if the risk level of the product is high, it is assumed that there will be more critical information points (CIP) during processing, designed to reduce the likelihood occurrence of the risk. Many critical information points will thus, put high demand on the design and or execution of the T&T system. The risk level of the product for safety is estimated by: Severity of the hazard X Probability of occurrence of that hazard. The classification of the risk is based on the matrix in table 3.1

*Table 3-1: Assessment of the risk level of the product (FSA, 2002)*

| | Potential risk<br>I. High Risk<br>II. Medium Risk<br>III. Low Risk | PROBABILITY CATEGORY<br>Possibility of repeated incidents (Once per month) | Possibility of isolated incidents (several times per year) | Possibility of occurring sometime (once /year) | Not likely to occur (Once / 10 years) | Practically impossible |
|---|---|---|---|---|---|---|
| SEVERITY | Customer fatality<br>Malicious contamination | I | I | I | II | III |
| | Customer ill-health<br>Major contamination | I | I | II | II | III |
| | Multiple retail complaints<br>Minor product contamination | I | II | III | III | III |
| | Individual retail complaint<br>Product out of specification | II | III | III | III | III |

NB. An incident refers to occurrence of a microbiological and/ a chemical hazards

Examples of levels of this indicator:

*Low risk*: when the incident is not likely to occur once in 10 years and once it occurs, it is simply from an individual consumer complaining about product being out of specification

*Medium risk*: when there is a possibility of a repeated incident once in a year and which may result to customer ill health

*High risk*: when there is a possibility of a repeated incident several times per year and which results to customer fatality (for instance due product being contaminated with pathogens)

## 3.2.2 Indicators for production process complexity

### *I.4 Number of processing steps/lines*

Having many production lines/steps means also having many data generation points, which means more points for information collection needs to be included in the traceability system. A large volume of data put a higher demand on the design and execution of traceability system than when dealing with low volume of data. Moreover, generating a large volume of data is tedious work and is susceptible to errors (FDA, 2001), something that may affect performance of the traceability system. Therefore many processing lines/steps may put a higher demand on the design and execution of traceability system

Classification of this indicator
Small: 1-5 processing steps
Medium: 6-10 processing steps
Large: > 10 processing steps

### *I.5 Production process structure*

As shown in the food industry characteristics model (Trienekens and Van der Vorst, 2006), Production process structure can be a straight line structure, Divergent and/or convergent structure. Diverging and converging product streams make it difficult to follow the different raw materials that go into the product and all the end products that result at the end of the production process. Divergent process (where product flows diverge into a larger number of products) and convergent process (where a large number of product flows converge into a single product) are common practices during fish processing (see appendix 4). Divergence of materials into more products generates a track of numerous different lots (e.g. brined fillet, brined loin, chilled loin, frozen log and frozen block) and more information is required to be registered in the traceability system (Moe, 1998; Golan *et al*., 2004). Vernède and co-authors, (2003) also supported the idea that registering information about the product identity is especially required before and after convergent and divergent processes. It is assumed that if divergence and/or convergence process occurs outside the company, the registering of the necessary information can not be guaranteed. On the other hand, if convergence and/or divergence process occurs within the company, the registering of the necessary information can be done correctly since the process is within the control of the processor. However, convergence and divergence process may occur both outside and inside the company and thus put more demand on the T&T system design and execution.

I.5a Sub indicator: Divergence process
Classification of this indicator
Low: divergence process occurs within the company
Medium: divergence process occurs outside the company
High: divergence process occurs inside and outside the company

I.5b Sub indicator: Convergence process
Classification of this indicator
Low: convergence process occurs within the company
Medium: convergence process occurs outside the company
High: convergence process occurs inside and outside the company

### *I.6 Sources of raw material supply*

As shown in the food industry characteristics model (Trienekens and Van der Vorst, 2006), many sources of raw material supply makes traceability system more difficult. If the company has many different sources of raw materials (Fish) supply, then more tests are required to judge the safety level of the product. For instance, if the company obtains its fish from a specific farm, which operates with clear specifications, then hazards can well be established/ predicted and the safety level can be determined. On the other hand, if the company obtains its fish from wild sources (ocean/lakes), then it is difficult to establish/ predict all the hazards, so the raw material have a higher chance of having unknown hazards therefore more analysis are necessary to be carried out by the company so as to assess the safety level of the final products. According to FSA (2005), Fish originating from wild have a significant higher level of toxicological contaminants (such as methyl mercury and dioxins and dioxins like PCBs) and thus present a highest safety risk. Raw materials supplied from wild sources therefore put a higher demand on the design and execution of the traceability system than farmed fish.

Classification for this indicator
Low: Less than 20% of raw materials are supplied from wild sources
Medium: 20- 50% of the raw materials are supplied from wild sources
High: More than 50% of the raw materials are supplied from wild sources

### 3.2.3 Indicators for fish supply chain complexity

As shown in the demersal fish distribution chain in the UK (Tracefish, 2001), fish supply chain is very complex because it involves many actors. Luten *et al*., (2003) found that normally fish change ownership many times and are handled by many different food businesses whilst passing such a supply chain. He further observed that the traceability system becomes very difficulty as the supply chain becomes more diverse. The reason for this is that while fish is changing the ownership, most information is not exchanged as well, as a result the final consumer have only very minimal information

***I.7 Degree of Diversity of chain actors***

The degree of diversity of chain actors refers to the number of actors operating in that chain. As mentioned in a generic net-chain model (Lazzarini *et al.*, 2001), each firm in the supply chain is positioned in a network layer and belongs to at least one supply chain i.e. it usually has multiple (varying) suppliers and customers at the same time. When the firm belongs to many chain actors, then more information is required about them or is required to be supplied to them. The chain actors can be suppliers, manufacturing companies, buyers, wholesalers, retailers and consumers. Having many actors in the chain is therefore associated with receiving and sending more information than when there are only few actors in that respective chain. Therefore, many actors in the chain put a high demand on the design and execution of the traceability system.

Classification for this indicator
Low level: a fish supply chain consists of one supplier, one fish processing company and one buyer
Medium level: a fish supply chain consists of multiple suppliers, one fish processing company and one buyer or a fish supply chain consists of one supplier, one fish processing company and a multiple buyers
High level: a fish supply chain consists of multiple suppliers, one fish processors and multiple buyers

***I.8 level of chain partnership***

According to Spekman *et al.,* (1998), co-operation is the lowest level of partnership followed by co-ordination (intermediate level) and the highest level is collaboration. As the level of chain partnership increases partners dedicate more resources to sustain and further the goals of the supply chain as result information is easily exchanged. When the level of chain partnership is low, there is less information to be transferred since Partners exchange bits of essential information only upon request but when the level of chain partnership is high, there is more information to be transferred because partners carry out joint planning of all activities and exchange all information on regular bases. Therefore, high level of chain partnership is associated with more information/detailed information sharing, and thus positively contributes to the design, and execution of the traceability system

Classification for this indicator

Low (co-operation): Partners exchange only bits of information upon request e.g. product information (e.g. quantity, price etc.)

Medium (co-ordination): partners exchange product and process information on a regular basis such information include (prices, quantity and production method, and time/temperature)

High (collaboration): partners carry out joint planning of all activities and exchange all information about product, process and customers on regular bases

### 3.2.4 Indicators for organisation complexity

Organisation is defined as a collection of people working together to achieve a common goal (Luning *et al*., 2002). It is assumed that if the organization is well functioning, then execution of T & T activities will also be at a higher level i.e. since the organisation functions at a higher level, then it positively contribute on the designing and execution of the T & T system.

#### *I.9 Degree of employee involvement*

Early inclusion of employees in the designing process of the traceability system will lead to a better understanding of its purpose and importance. This may contribute to a more positive attitude, which leads to a more desirable intention to execute traceability system at a high level. Many authors have stressed the importance of employee's involvement. Luning *et al*., (2002) referring to Heizer & Render, (1993) stated that in quality management employee involvement could be considered as an essential ingredient in execution of duties in the organisation (Quality based model, Ivancevich, 1994). Thus early involvement of employees in the traceability system design may lead to a high execution level of the traceability system.

Classification of this indicator

Low: Employees are just informed and instructed about how to work with T&T system during execution stage.

Medium: Employees suggestions and opinions are taken into account during designing

High: Employees are completely involved in T&T system from the moment of conceptualization, throughout the execution process

#### *I.10 working conditions of employees*

The environment in which people works have a positive impact on their ability to perform various tasks in the organisation, if the working condition is good, people will be motivated and their ability to execute various tasks will be higher than the organisation with poor working conditions. As mentioned in the working conditions model (Luning and co-authors, 2002), Poor working conditions such as ; noise conditions, bad smell, high humidity and poor feedback are dissatisfying and not motivating if they are not reduced to acceptable levels and thus may hinder T&T system design and execution. On the other hand, good working conditions positively contribute to the design and execution of the T & T system since it positively affects the ability and motivation of employees.

Classification of this indicator

Low: Noise conditions, bad smell, high humidity and no feed back information

Medium: Quiet working condition, good humidity but the smell is bad and there is no feedback information

High: Quiet working condition, good smell, good humidity and feedback information

#### *I.11 Rate of temporary workers*

Temporary employees are in a constant state of employment flux because they are never guaranteed consistent employment, nor are they assured of a solid start or finish date for their assignment. Temporary workers lack motivation and commitment as compared to permanent workers, temporary workers lack proper training, proper working skills and work experience (Foote, 2004). If the company is characterised by a large number of temporary workers, it is likely therefore that many activities including T&T activities will not be carried out perfectly. This situation therefore, may contributes negatively on the T&T system execution and therefore hinders high performance of the T&T system

Classification of this indicator
Low: less than 30% of all employees are temporary employees
Medium: between 30 and 60% of all employees are temporary employees
High: more than 60% of all employees are temporary employees

#### *I.12 Level of top management commitment*

For a successful implementation of T&T system, management must clearly show its commitment to the T&T system. Top management commitment can be demonstrated by: ensuring that regulatory and legal requirements of T&T system are understood and appropriately addressed, the organisations' policy about T&T system is understood and implemented at all relevant levels of the organization, T&T system objectives and plans are established as necessary and that the responsibilities of all functions affecting T&T system are clearly defined. Management should make provisions for the necessary resources and personnel to maintain the system, including a management representative, who will ensure that the requirements of this system are met. Management should review the system annually to determine its effectiveness.

Classification of this indicator
Low: T&T system is not stated in the organisations' policy, there is no T&T system reviews and is not stated who is responsible for the implementation of the T&T system
Medium: T&T system is stated in the organisations' policy but there is no T&T system reviews and is not stated who is responsible for the implementation of the T&T system
High: T&T system is clearly stated in the organisations' policy, presence of T&T system reviews and it is clearly stated who is responsible for the T&T system implementation

### 3.2.5 Indicators for traceability system requirements

#### *I.13 Level of registration of traceability information*

For traceability performance to be high, all involved parties should register all types of information required in the traceability system. This Information is shown by (Perez *et al*., 2003 as sited by Luten *et al*., 2003) and in EU regulation 2065/2001. The traceability information requirements include: *commercial and scientific name of the fish, landing port, size/weight, freshness category, fishing area, capture time/date, landing date, environmental information, production method, batch or lot number, preservation method, name and address of the supplier and date of transaction*.

In order to get an idea on the type of traceability information that is registered by the company, documents and registrations analysis should be carried out. If the company registers only information about method of processing, quantity, price and handling method it will be assigned to a lower level in the classification because this information was not considered by all stakeholders to be the most important information. On the other hand, if the company registers all information about product, process, product flow, supplier and product safety information such as information about nutritional guarantee, packaging type, time/temperature, appearance, expiry dates, landing dates, fishing gear, landing date, method of processing, quantity, price, handling method, species, landing port, size and weight, freshness category, fishing area, capture time &date, fishing gear, landing date, environmental information and recipes used will be assigned to a higher scale because such an information was considered by majority to be the most important information in the traceability system.

Classification of this indicator (based on Moe, 1998 and Traceability information requirements (Perez *et al*., (2003) in Luten *et al*., (2003))
Low level: Only information about method of processing, quantity, price, handling method and time/temperature
Medium level: Only information about nutritional guarantee, packaging type, time/temperature, appearance, expiry dates, landing dates, fishing gear and landing date

High level: All product, process, product flow, supplier and product safety information such as information about nutritional guarantee, packaging type, time/temperature, appearance, expiry dates, landing dates, fishing gear, landing date, method of processing, quantity, price, handling method, species, landing port, size and weight, freshness category, fishing area, capture time &date, fishing gear, landing date, environmental information and recipes used.

### 3.2.6 Indicators for traceability system design

***I.14 Type of identification***

According to Loftus (2005), Tracefish (2001), EAN.UCC (2003), the best product identifier should: uniquely identify the unit of batch, be secure (fraud proof), be permanent, retain identity throughout the product life cycle, be simple to read and capture identifying data and not hinder its host. The more advanced the type of identification such as Radio Frequency Identification (RFID), the more advanced the design of the traceability system is and put less demand on the execution of the traceability system and which positively contribute to high performance level of the traceability system. In other words, simple type of identification such as the use of paper label is associated with less advanced design of traceability system and put a higher demand on the execution of the traceability system because the use of paper label is tedious, time consuming and is not fraud proof.

*Table 3-2: Comparison of 3 data carrier tools (as adapted from Ayalew et al, 2006; Kousta, 2006)*

| Criteria | **Paper** | **Barcodes** | **RFID** |
|---|---|---|---|
| Data quantity | Low | Medium (Bytes) | High (Kbytes) |
| Data density | Very low | Low | Very high |
| Influence of external factors (dust, optical covering…) | High | High | No influence |
| Operating costs | High | Low | None |
| Purchase cost | Very low | Low | Medium/high |
| Unauthorized copying/modification | High | Slight | Impossible |
| Readability by people | High | Limited | Impossible |
| Time to make information available | High (longer time) | Real time | Real time |
| Degradation/wear | High | Limited | No influence |
| Machine readability | Poor | Good | Good |
| Influence of direction and position | Low | Low | No influence |
| Reading speed (including handling of data carrier) | Low | Low, ≈4S | Very fast ≈ 0.5S |
| **Overall classification** | **Simple** | **Medium** | **Advanced** |

***I.15 Appropriateness of the location of information collection point***

The reliable traceability system is characterised by the collection of all necessary information at critical information points (CIP) of the production chain, resulting in a clear improvement in the efficiency of the data collection process (Caporale *et al.*, 2001). CIP about safety status may be based on the established critical control points in the HACCP plan. It is assumed that allocation of information collection point is more appropriate if it is based on the HACCP plan. It is further assumed that the level of appropriateness increases if the HACCP plan is based on the quantitative risk assessment. More appropriate allocation of information collection point will thus put low demand on designing and execution of the traceability system and contribute positively on the performance of the T&T system.

Classification of this indicator

Low: T&T information is collected at all processing steps based on internal discussion

Medium: T&T information is collected from selected processing steps only, without detailed/scientific reason as to why information is collected at those points.

High: T&T information is collected at all appropriate CIP and it is based on HACCP system

### *I.16 Determination of Traceable Resource Unit (TRU)*

Achieving chain traceability requires comprehensive planning during the initial stages of development, particularly when addressing the issue of the definition of a traceable resource unit (TRU) (Kim and others 1995 as cited by Thompson *et al*., 2005). Defining a TRU may be one of the most difficult steps involved in the design of a traceability system. A TRU is simply defined as a unit of trade, such as a whole fish or a batch of fish. Traceable Resource Unit (TRU) is the reference unit, which is tracked and traced. However, this may invariably change during processing as new TRUs are being assigned at each step within the food chain. The initial TRU must follow each fish or lot, through all steps of processing, distribution, and retail. This process can become very complicated, especially during processing, and it may be difficult to keep from mixing fish from several batches, especially when processing may include portioning, additional ingredients, processes, storage, and transportation. Mixing of batches can occur between resource units, which may cause problems in identifying individual batches. Each firm must develop a system of assigning new TRUs during processing, distribution, and retail (Thompson *et al*., 2005). The decision on the definition of TRU lies on the discretion of the organisation (e.g. it can be a batch of fish of any size, a whole fish or an ingredient). It is assumed that a highly sophisticated T&T system is the one that can manage to track and trace its products to an ingredient level, in this way a more specific location of a safety problem can be identified.

Classification of this indicator
Low: A shipping truck containing different batches of different fish
Medium: A batch of same type of fish
High: A single carton from a particular batch of fish

### *I.17 Mode of data registration*

According to Tracefish (2001) and EAN.UCC (2003), the decision about what should be the mode of data registration is of paramount important during T&T system design. The more advanced the mode of data registration the more advanced the design of the traceability system is and less demand it puts on the execution of the traceability system.

Classification for this indicator (based on table 3-2 above)
Low: low data quantity, very low data density, can be highly influenced by external factors such as dust, water etc., high unauthorised copying, and very long time to make information, high rate of degradation, and low reading speed
Medium: low data quantity, low data density, can be slightly influenced by external factors such as dust, water etc., low unauthorised copying, and real time to make information, limited rate of degradation, good machine readability and good reading speed
High: high data density, high data quantity, can not be influenced by external factors such as dust, water etc., unauthorised copying is impossible, real time to make information, impossible degradation and very fast reading speed

### *I.18 Mode of information communication*

According to Tracefish (2001), one of the important processes during traceability system design is about what should be the mode of information communication. EAN.UCC (2003), reported that this process deals with how to collect, share and store traceability data during the physical flow. It determines how to exchange data with trading partners. The more advanced the mode of information communication the more advanced the design of the traceability system is and which positively influence performance of the traceability system. I.e. The digital transfer is faster and less prone to errors as compared to printed and/or oral communication. Moreover, more advanced mode of information communication put a low demand on execution of the traceability system. For example sending traceability information by using papers/letters through post office is highly time consuming, tedious work and prone to errors because the information can be lost. For this case simple mode of information communication put a high demand on the execution of the traceability system.

Classification for this indicator

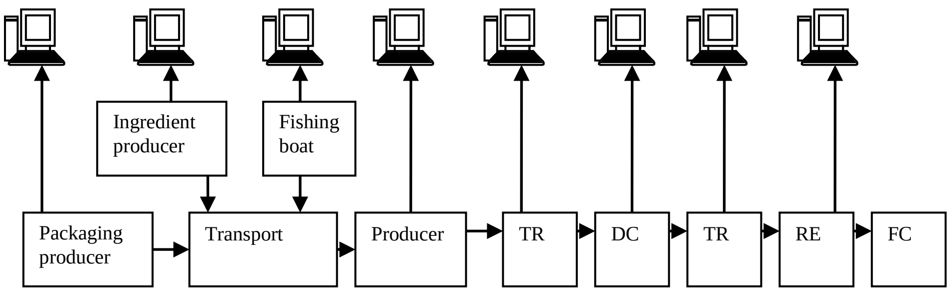
*Low:* The system is characterised by; very low versatility (i.e. can not transmit numbers, graphs, artworks or photographs, can not be stored and retrieved, not easily accessible to everybody and is slow (for example oral communications)

Medium: The system is characterised by medium versatility, limited information can be stored and retrieved, information can be accessible to few people and information transfer is slow. E.g. printed information

Advanced: The system is characterised by high versatility (i.e. can transmit numbers, graphs, artworks, and photographs), information can be stored and retrieved, easily accessible to everybody and is very fast in transferring information e.g. electronic data interchange (EDI)

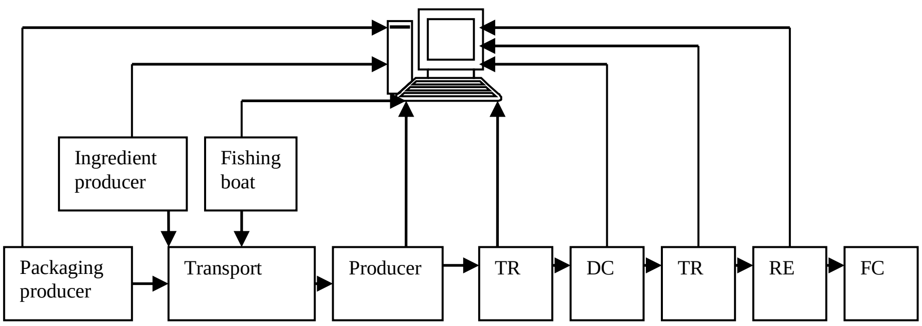
### *I.19 Location of data storage*

According to Tracefish (2001) and EAN.UCC (2003), the decision about where to store data during T&T system design is of paramount important. The more advanced the location of data storage the more advanced the design and execution of the traceability system is and which positively influence performance of the traceability system. In other words, the location of the data storage dictates the level of the traceability system design within the chain and determines the traceability performance within the chain. When using central databases, it is easy to retrieve information, meaning you can retrieve many/more information within a short time than when individual databases are used (Petersen and Green, 2005). Therefore, the use of advanced location of data storage such as central databases positively contributes on the performance of the traceability system.




TR-Transport, DC-Distribution Centre, RE-Retailer, FC-Final Consumer

*Figure 3-3: Individual database traceability system (Petersen and Green, 2005)*




TR-Transport, DC-Distribution Centre, RE-Retailer, FC-Final Consumer

*Figure 3-4: Centralised database traceability system (Petersen and Green, 2005)*

Classification of this indicator

Simple: Not easily accessible by many people, very low data quantity, information storage and retrieve is very slow (e.g. Paper files)

Medium: Accessible by few people, high data quantity, information storage and retrieve is fast (e.g. Individual databases)

Advanced: Highly accessible by many people, very high data quantity, information storage and retrieve is very fast (e.g. Central databases)

*I.20 Degree of data standardisation*

One of the important processes during traceability system design is about what should be the level/degree of data standardisation (Tracefish (2001) and EAN.UCC (2003)). The commonly use of standards optimises traceability data storage, processing and communication within the supply chain and contributes positively to advanced design of the traceability system. When there is no standard the communication process in the supply chain becomes difficult, because the sender and the receiver of the information might not be referring to the same thing. This situation put a high demand on the execution of the traceability system. Therefore, use of more advanced data standardisation, contributes positively on the advanced design of the traceability system and put a low demand on the execution of the traceability system and positively influence performance of the traceability system.

Classification of this indicator
Simple: No standards used
Medium: Use of printed forms made locally at the company
Advanced: Use of international standards such as EAN.UCC standards

*I.21 Level of using HACCP system in the T&T system design*

The HACCP (Hazard Analysis Critical Control Point) system involves the identification of specific hazards throughout the process involved in the production of a food product and focuses on the preventative measures for their control to assure the safety of the food (FDA,2001). From this concept, HACCP is considered as a quality assurance system. On the other hand, traceability system is considered as risk mitigation and management tool as well as a critical component of quality assurance in the agri-food industry (Loftus, 2005), since it deals with the whereabouts of products in the supply chain. Trienekens and Van der Vorst (2006), consider traceability and HACPP to be irretrievably intertwined as part of a product quality management system. ISO 22000 considers traceability as a means of enhancing the HACCP system. As it can seen all systems are important in ensuring the safety of food. HACCP system is a widely used system and has been validated and reviewed in many studies. It is therefore assumed that high level of usage of HACCP system in the designing of the traceability system will contribute positively on the designing and hence on the performance of the traceability system and therefore high level of food safety.

Classification of this indicator
Low: HACCP system is not used during designing of the T&T system
Medium: HACCP system is only used at the initial stages of the T&T system design
High: HACCP system is entirely used in all stages of T&T system design and during execution.

### 3.2.7 Indicators for execution of traceability system

*I.22 Level of Communication of T&T procedures and instructions*

As shown in the "SCMR" model (Koelen and Van den Ban, 2004), communication in an organisation is a process of sending and receiving messages through channels which establishes common meaning between source and receiver. Baron and Greenberg (2000) stressed that communication is most effective when it uses multiple channels, such as both oral and written messages (i.e. continuum of verbal Communication Media model). The advantage of oral communication is that the sender can use the feedback from the receiver to decide whether or not the message has been interpreted correctly. The disadvantage of this form of communication is that one cannot remember everything every day. So communication becomes effective if it is both oral and written. Thus if communication level is high (both oral and written), then execution of the traceability system will be at a high level since rules and procedures will be clearly understood. Therefore, high level of information communication positively contributes to a high level of T&T system design and execution.

Classification of communication of rules and procedures
Low: only oral communication is used between management and employees
Medium: only written communication is used between management and employees
High: Both oral and written communication is used between management and employees

### *I.23 Degree of compliance with regulations and procedures*

Compliance is the act of conforming to a specification, standard, principles or law that has been clearly defined (http://www.answers.com). From this definition it is clear therefore that in order to determine how well the T&T system is executed in a certain organisation we need to have a look on two things. The first thing is to know the requirement from the regulation e.g. EU regulation 2065/2001, EU regulation 178/2002 and traceability information requirements as reported by *Perez et al*.,2003 in Luten *et al*., 2003. The second thing is to know the policy of the organisation about T&T system and determine whether the organisation is currently doing in accordance with what it is stated in the organisation policy or T&T system manual. This process will enable us to determine to what extent they do what they planned to do (extent of compliance). It is assumed that high level of compliance to the rules and procedures will positively contribute to high performance of the T&T system.

Classification of this indicator

Low: compliance with organisation policy only as stated in the quality manual.

Medium: compliance with international regulation such as EU regulation 2065/2001 and EU regulation 178/2002

High: compliance with both organisation policy and international regulation such as EU regulation 2065/2001 and EU regulation 178/2002

### *I.24 Degree of accuracy of T&T documentations*

In practice, traceability systems often usefully include information about what has happened to the food (its processing history) as well as where it came from and whom it was sent to. For example, specifications of ingredients, and records of storage and processes applied to meet safety, quality and legal requirements. This should include a link to documents associated with implementing such a system (FSA, 2002). Moreover, traceability systems are in essence joined-up record keeping systems that bring together information collected at key stages in the production and supply process. The more stages at which information is gathered the fuller will be the overall picture achieved (FSA, 2002). Linking together this information can enable the path of a particular ingredient or unit of production to be accurately established. The accuracy of documentations about ingredient usage, production and dispatch are therefore vital for achieving robust traceability. Hofstede (2003) mentioned some of the factors that can be useful in determining the quality of documented information. Such factors include: readability, completeness, arrangement, timely, usefulness, logical and sensible.

The following classification can be made for indicator

Low: T&T documents are everywhere in the company, often not complete, not well readable and not arranged in a systematic order.

Medium: T&T documents are in a specific place, well readable but often not complete and not arranged in a systematic order

High: T&T documents are in a specific place, complete, well readable and systematically arranged

### *I.25 Frequency of verification of T&T system*

Verification procedure is one of the key principles of the HACCP system. Verification and auditing methods, procedures and tests, including random sampling and analysis, can be used to determine if the HACCP (in this case T&T) system is working correctly (FDA, 2001). The frequency of verification should be sufficient to confirm that the system is working effectively (FDA, 2001). Examples of verification activities include: review of the system and its records and review of deviations. For the same token, establishing verification procedures for T&T system can be a desirable way of understanding if the established T&T system is working correctly or not. In practice, one can not verify the system before designing it, for this case verification can be considered to be a good indicator for T&T system execution, since it measures if the system is operating as it was intended. According to FSA (2002), the accuracy of the information provided by a traceability system is critical in an emergency; verification of information collected is therefore also critical. The more frequent is the verification of the T&T system the more reliable is the system and the more it contributes on the performance of the T&T system.

The classification for this indicator can be as follows
Low: No verification or verification is done once before implementation of the system
Medium: Every time that a change is made on the system e.g. whenever there is a change in supplier or buyer
High: Verification is done on scheduled basis e.g. once per year and whenever there are changes on the system such as change in supplier or buyer

## 3.2.8 Indicators for traceability system performance

Once the organisation has analysed its mission, identified all its stakeholders, and defined its goals, it needs a way to measure progress towards those goals. According to traceability system performance model EAN.UCC (2003), there are five key performance indicators that can be used to assess the overall performance of any traceability system. These indicators are**:** *Reliability, Rapidity/speed, precision/accuracy, coherence and cost.* Due to the nature of this study only rapidity/speed, reliability and precision/accuracy will be used to as indicators to measure performance of the traceability system in this study. The overall traceability system performance can be judged to be high if reliability, rapidity/speed and precision/accuracy are at high level.

### *I.26 Degree of rapidity*

The information request concerning the traceability of items must be rapid. However, Rapidity depends on a number of factors such as the information management tools used and their automation as well as the level of co-operation between the supply chain partners. A longer reaction time would make contaminated products to reach a large number of consumers. If the speed upon which the information about the traceable item can be obtained is high, then the performance of the traceability system can be judged to be high and vice versa. Currently the general food law (regulation 178/2002) does not specify the minimum time required for the provision of traceability information. This situation makes judgement of this particular indicator a bit cumbersome.

Classification of this indicator
Low: more than 24 hours
Medium: between 4 hours and 24 hours
High: within 4 hours

### *I.27 Degree of reliability*

Traceability system must be reliable, meaning that it should be capable of retrieving the information required without any risk of error. Overall reliability is determined by the reliability of the tools, procedures and information sources used EAN.UCC (2003). If the tools, procedures and information sources used are reliable (for instance, approved by the EU or FDA), then the performance of the traceability system is likely to be high.

Classification of this indicator
Low: Locally made tools, local procedures and local sources of information are used
Medium: Local and international approved tools, procedures and information sources are used
High: All used tools, procedures and information sources are internationally approved (EU/FDA approval)

### *I.28 Degree of precision between successive batches*

Performance of the traceability system is also determined by the precision of the size of the successive batches. A batch or a lot is a defined quantity produced at a certain time and placed in a uniform manner (Petersen and Green, 2005). The size of an individual batch is important in reducing risk and liability for individual companies. In general, the smaller the batch size, the lower the amount of product at risk for food safety issues. High level of precision in size between successive batches leads to high performance level of the traceability system since in case of any problem, product recall and withdraw can be done more systematically than in a situation where there is no precision in batch size.

Classification of this indicator:
Low: the actual batch size is not known
Medium: the actual batch size is known but is variable from time to time
High: the actual batch size is known and is constant at all the time

### 3.2.9 Indicators for food safety level

***I.29 Percentage of rejected/recalled products from customers***

If a fault in a product is discovered after thousands of products have been sold to consumers, then the corrective action needed can involve not only stopping further supply until the fault is rectified in all new products offered for sale, but also affected products sold to consumers might need to be recalled to fully safeguard consumers. If the percentage of the rejected/recalled products from the consumers due to microbiological and or chemical hazards is high then it can be judged that the level of food safety assurance in that particular company is low.

Classification of this indicator:
Low: More than 5 % of all produced products in a year are recalled /rejected
Medium: between 2 and 5 % of all produced products in a year are recalled /rejected
High: less than 1% of all produced products in a year are recalled /rejected

## 3.3 Influencing factor, Operational indicators and questions

Formulation of operational indicators has been dealt with in the previous section (section 3.2). This section deals with formulation of assumptions underlying these indicators and questions associated with each indicator. The questions will be done mainly by interviews with company directors/general managers, quality assurance managers and production managers from the selected fish processing companies in Tanzania. Some questions will be done by general document analysis and through observation/participation in production process activities since it is not possible to do all the questions by interview. In most cases both methods of data collection will be used to maximise information collection process (triangulation of sources). The answers to these questions will enable us to classify the operational indicator into low, medium or high level as discussed in section 3.2.

*Table 3-3: Indicators, assumptions and questions from the research model*

| indicator | *Assumptions* | Questions |
|---|---|---|
| | **Product complexity** | |
| **Spoilage rate of fish.**<br>Based on (Dalgaard *et al.*, (1994), FDA (2001), FAO (1997), and Gupta and Misra (1997)) | When processing fish with high spoilage rate you need to collect more information so as to be able to judge the safety level of fish. Thus, fish with high spoilage rate put a higher demand on the design and execution of T&T system | 1. What is the maximum storage time in ice, for each species of fish, such that after that time the fish become inedible?<br>a) More than 11 days<br>b) Between 7 and 10 days<br>c) Between 0 and 6 days<br>2. What is the percentage of fish that fall under category 1a, 1b and 1c above? |
| **Risk level of Product for safety** (Both microbiological and chemical hazards) (Based on FSA (2002), NACMCF (1998), Kousta (2006) and Van der Vorst (2003)) | It is assumed that if the risk level of the product is high, then full traceability system is required compared to a situation where the risky level of the product is low, and in this regard more traceability requirements/demands are put on the design and execution of the T&T system. In other words, the higher the risky of the product, the more full/detailed traceability system is required. | 1. How often does contamination (with pathogens or chemicals e.g. pesticide) occur in your fish above the acceptable limit?<br>a. Once in 10 yeas<br>b. Once in a year<br>c. Several times in a year<br>d. Others. Please specify.<br>2. What is the perceived risk level of your product?<br>a. Low<br>b. Medium |

| | | |
|---|---|---|
| | | c. High |
| **Degree of diversity of fish species with potential hazards.** Based on FDA (2001) and Luten *at al.*, (2003) | Different fish species have different characteristics. For this reason, the more different species with different characteristics you have, the more detailed information you need to collect about species related hazards. Therefore more number of fish species put higher requirements on the design and execution of the traceability system | 1. How many types of fish species are you dealing with?<br>a. 1 or 2 species of fish<br>b. Between 2 and 10 species of fish<br>c. More than 10 species of fish<br>2. What are the common (English) and scientific names of fish that you process?<br>3. What are the potential hazards normally associated with each species of fish |
| **Production process complexity** | | |
| **Number of processing steps** Based on Moe, 1998; Vernède et al., 2003; Golan et al., 2005 and FDA, 2001 | Having many production steps means also having many data generation points, which means more points for information collection needs to be included in the T&T system. A large volume of data put a higher demand on the design and execution of T&T system | 1. What is the average number of processing steps does each type of finished product go through?<br>a. Between 1 and 5 processing steps<br>b. Between 6 and 10 processing steps<br>c. More than 10 processing steps |
| **Number of processing lines** Based on (Moe, 1998; Golan et al., 2005 and FDA, 2001 | The higher the number of processing lines the more advanced the level of designing of the traceability system needs to be and the more care needs to be taken in the execution of traceability procedures | 1. How many processing lines are there in the company?<br>a. Only one processing line<br>b. Between 2 and 5 processing lines<br>c. More than 5 processing lines |
| **Production process structure** (convergence and divergence process) Based on (Moe, 1998; Vernède *et al.*, 2003; Golan *et al.*, 2005 and FDA, 2001 | Diverging and converging product streams make it difficult to follow the different raw materials that go into the product and all the end products that result at the end of the production process. Thus, converging and diverging process put a high demand on the design and execution of the traceability system | 1. What is the structure of your production process system?<br>a. Straight line structure<br>b. Divergence structure<br>c. Convergence structure<br>d. All of the above<br>2. Where does a convergence process take place?<br>a. Outside company<br>b. Inside company<br>c. Both outside and inside the company |
| **Sources of raw materials (RM) supply**. (Based on Trienekens and Van der Vorst 2006) | When having raw materials coming from wild sources you need to carry out many analyses so as to judge the safety level of the RM. This situation put a higher demand on the design and execution of the traceability system | 1. Where do you get your raw materials (fish)<br>a. From a specific farm (aquaculture)?<br>b. From wild sources (sea/ocean)<br>c. Both, from specific farm and from the ocean/sea<br>2. What is the percentage of the raw fish that are originating from a specific farm (aquaculture) if any?<br>3. What is the percentage of the raw fish that are originating from a wild sources e.g. sea/ocean? |
| **Fish supply chain complexity** | | |
| **Degree of diversity of the chain actors** (Based on Lazzarini et al., (2001), Van der Vorst (2006)) | Having many actors in the chain is associated with receiving and sending more information than when there are only few actors in that respective chain. Therefore, many actors in the chain put a high demand on the design and execution of the T&T system. | 1. How many raw fish suppliers do you have?<br>a. Only one supplier<br>b. Between 2 and 10 suppliers<br>c. More than 10 suppliers<br>2. How many buyers do you have?<br>a. Only one retailer<br>b. Between 2 and 10 retailers<br>c. More than 10 retailers |
| **Level of chain partnership** (Based on Spekman et al., (1998) and ECR Europe (2004)) | When the level of chain partnership is high, there is more information to be transferred because partners carry out joint planning of all activities and exchange all information on regular bases. Therefore high level of chain partnership | 1. What information do you normally exchange with your partners?<br>a. Only information about product (e.g. quantity and price)<br>b. Information about product and process only (e.g. quantity, price, |

| | | |
|---|---|---|
| | contribute positively on the T&T system design and execution and hence T&T system performance. Moreover, it is also assumed that high level of chain partnership is associated with high level of chain collaboration and sharing of all business information on regular bases. | time/temperature, production method)<br>c. All business information including product, production process and customers information<br>2. What is the perceived level of chain collaboration?<br>a. Low<br>b. Medium<br>c. High |
| **Organisation complexity/characteristics** | | |
| **Degree of employees involvement** Ivancevich (1994), and Heizer & Render (1993) in Luning *et al*., (2002)) | Early inclusion of workers in the designing process of the T&T system will lead to a better understanding of its purpose and importance. This may contribute to a more positive attitude, which leads to a more desirable intention to execute traceability system at a high level. | 1. At what stage of the T&T system development are employees informed /involved in the T&T system?<br>a. Employees are just informed about what they should do during execution stage<br>b. Employees are involved during designing stage<br>c. Employees are involved from the moment of conceptualization throughout the execution process<br>2. How frequently are employees encouraged to suggest improvement in the T&T system<br>a. Not encouraged at all<br>b. Sometimes<br>c. Always |
| **Working conditions of employees** (Based on Luning *et al*., (2002) and US Bureau of labour statistics, 2006) | Poor working conditions such as, noise conditions, bad smell, high humidity, poor feedback are dissatisfying and not motivating. On the other hand, good working conditions positively contribute to the design and execution of the T & T system thereby contributing to high performance level of the T&T system | 1. How often do employees receive feedback information from the management regarding T&T system execution?<br>a. Not at all<br>b. Sometimes<br>c. Always<br>2. What is the level of satisfaction from management point of view regarding the current working conditions?<br>a. Bad<br>b. Satisfactory<br>c. Good<br>3. What is the status of the current working condition?<br>a. Noise condition, bad smell and high humidity<br>b. Quiet working condition, good humidity but the smell is bad<br>c. Quiet working condition, good humidity and good smell |
| **Rate of temporary workers** (Based on Foote, 2004) | Temporary workers lack; motivation, commitment, proper training, proper working skills and work experience If the company is characterised by a large number of temporary workers, it is likely that many tasks including T&T activities will not be carried out perfectly. This situation contributes negatively on the T&T system design and its execution | 1. How many employees are working in the company?<br>2. How many employees work on temporary bases?<br>3. How many temporary employees work with the T&T system?<br>a. less than 30% of all employees are temporary employees<br>b. between 30 and 60% of all employees are temporary employees<br>c. more than 60% of all employees are temporary employees |
| **Top management commitment** (Based on ISO 9001:2000) | Management commitment and support are essential for the development, implementation and monitoring of a T&T system in order to ensure continuous effectiveness of the system. It is assumed that high commitment of the top management is associated with a clear policy statement about | 1. How often do you do T&T system review?<br>a. No T&T system reviews<br>b. Presence of T&T system reviews but the duration for the review is not specified<br>c. T&T system reviews is done annually or when there are changes in the system such as changes in buyers or suppliers<br>2. Who is responsible for the implementation of the T&T system at management level? |

| | | |
|---|---|---|
| | the T&T system design and execution, clear statement regarding the T& T system reviews and a clear statement regarding the personnel responsible for the implementation of the T&T system at the managerial level | |
| **Traceability system requirements** | | |
| **Level of T & T registrations** (Based on Perez *et al*., 2003, Tracefish (2001) and Regulation 2065/2001 of EU) | More extended registration of traceability information contributes positively to a higher level of T&T system design and execution because it enables a more precise tracking and tracing of a problem and therefore contributes positively on the overall performance of the T&T system | 1. What kind of information do you register in the traceability system?<br>a. Only information about method of processing, quantity, price, handling method and time/temperature<br>b. Only information about nutritional guarantee, packaging type, time/temperature, appearance, expiry dates, landing dates, fishing gear and landing date<br>c. All product, process, product flow, supplier and product safety information such as information about nutritional guarantee, packaging type, time/temperature, appearance, expiry dates, landing dates, fishing gear, landing date, method of processing, quantity, price, handling method, species, landing port, size and weight, freshness category, fishing area, capture time &date, fishing gear, landing date, environmental information and recipes used. |
| **Traceability system design** | | |
| **Appropriateness of the location of information collection point** (Based on Caporale *et al*., 2001). | The reliable traceability system is associated with collection of all necessary information at critical information points (CIP) of the production chain, resulting in a clear improvement in the efficiency of the data collection process. It is assumed that allocation of information collection point is more appropriate if it is based on the HACCP system. It is assumed that more appropriate allocation of information collection points will result in a more reliable T&T system and therefore contribute positively on the performance of the T&T system. | 1. At what point/step in the production process do you collect the T&T information?<br>a. T&T information is collected at all processing steps based on internal discussion<br>b. T&T information is collected at some selected processing steps only<br>c. T&T information is collected at all CIP and it is based on HACCP system<br>d. Others please specify………… |
| **Determination of the traceable resource unit** (TRU) (Based on Thompson *et al*., 2005). | A highly sophisticated T&T system is the one that can manage to track and trace its products to an ingredient level, in this way a more specific location of a safety problem can be identified | 1. What is the extent of information collection?<br>a. A shipment truck<br>b. Batch level<br>c. A carton<br>d. Others. Please specify |
| **Type of identification** Based on ECR, 2004; EAN.UCC (2003), Loftus (2005): and Tracefish (2001) | The more advanced the type of identification such as RFID, the more advanced the design of the T&T system is and less demand on the execution of the T&T system and which positively contribute to high performance level of the T&T system. | 1. What kind of identification tool do you use in your organisation?<br>a. Paper label<br>b. Bar codes<br>c. Radio frequency identification (RFID)<br>d. Others. Please specify |
| **Mode of data registration** Based on ECR, 2004; EAN.UCC (2003), | The more advanced the mode of data registration the more advanced the design of the T&T system is and less demand on the execution of the T&T | 1. How is the traceability information registered in your organisation?<br>a. By using paper files<br>b. By using bar codes |

| | | |
|---|---|---|
| and Tracefish (2001) | system, something which positively contribute to high performance level of the T&T system. | c. By using RFID<br>d. Others. Please specify if any. |
| **Location of data storage_(**Based on EAN.UCC (2003) and Tracefish (2001)) | When using central databases, it is easy to retrieve information (you can retrieve many/more information within a short time) than when individual databases are used. Therefore, the use of advanced location of data storage such as central databases contributes positively on the execution of T&T system. | 1. Where do you store your T&T system data?<br>a. In paper files<br>b. In individual databases<br>c. In central databases<br>d. Others. Please specify. |
| **Mode of information communication** EAN.UCC (2003), and Tracefish (2001) | More advanced mode of information communication put a low demand on execution of the T&T system. For example sending T&T information by digital means is faster and less prone to errors compared to printed and oral communication | 1. How do you communicate T&T information with your partners?<br>a. Communication is done orally<br>b. Communication is done by using printed formats<br>c. Communication is done electronically<br>d. Others. Please specify. |
| **Degree of data standardisation** Based on EAN.UCC (2003) and Hofstede, 2003 | The commonly use of standards optimises T&T data processing and communication within the supply chain. Therefore the use of high levels of standards put a lower demand on the design and execution of the T&T system. | 1. What kind of standards do you normally use during data registration?<br>a. No standards are used<br>b. Locally made standards are used<br>c. Internationally approved standards are used e.g. EAN.UCCC standards<br>d. Others. Please specify |
| **Level of using HACCP system in the T&T system design** Based on FDA (2001), Loftus (2005) and ISO 22000 | HACCP system is a widely used system and has been validated and reviewed in many studies. It is therefore assumed that high level of usage of HACCP system in the designing of the traceability system will contribute positively on the performance of the traceability system and therefore high level of food safety. | 1. Do you have the HACCP system in your company<br>a. Yes…………b) No……………<br>2. If yes, do you use the HACCP system when designing your T&T system?<br>a. Yes……………b) No…………<br>3. If yes, what is the level of using HACCP system in the T&T system design?<br>a. HACCP system is not used during designing of the T&T system<br>b. HACCP system is only used at the initial stages of the T&T system design<br>c. HACCP system is entirely used in all stages of T&T system design and during execution. |
| | **Execution of traceability system** | |
| **Communication about procedures and instructions regarding T & T** Based on Luning *et al*., 2002, (Ivancevich, 1994) and Baron &Greenberg, 2000 | Clear written instructions will prevent misunderstanding of required tasks, which will lead to better execution of the T & T system. Therefore high level of communication of rules and procedures (e.g. use of oral and written communication) will contribute positively on the T&T system design and execution and hence high performance of the T&T system | 1. How do you communicate with employees about T&T procedures and instructions?<br>a. Oral communication<br>b. We communicate by writings<br>c. Both oral and written communication are used<br>d. Others. Please specify.<br>2. If communication is done by writings, can you please show these writings? |
| **Compliance to regulations and procedures** Based on Luten et al., 2003, EU regulation 178/2002 and EU regulation 2065/2001 | It is assumed that high level of compliance to the regulations and procedures will positively contribute to high performance level of the T&T system.<br>(This question will mainly be done by using document analysis and observation of the existing situation) | 1. Which category below does you registered information complies with<br>a. Complies with organisation policy<br>b. Complies with EU regulation such as EU regulation 2065/2001<br>c. Complies with both organisation policy and EU regulations such as EU regulation 2065/2001<br>2. Is T&T system clearly elaborated in your company policy? |

| | | |
|---|---|---|
| | | a. Yes………b) No…………….<br>3. If the answer is yes, can you please show me you company policy statement? |
| **Degree of accuracy of T&T documentations**<br>Based on FSA (2002) and Hofstede (2003) | The accuracy of documentations about ingredient usage, production and dispatch contributes positively for achieving a more robust traceability. | 1. At what place (physical location) do you keep your T&T documentations? Please sow<br>2. Are T&T documentations completed? Please show (document analysis)<br>3. Are T&T documentations well readable? Please show (document analysis)<br>4. Are T&T documentations arranged in a systematic way? Please show |
| **Frequency of verification of T&T system**<br>Based on FSA (2002) and FDA (2001) | The more frequent is the verification of the T&T system the more reliable is the system and the more it contributes on the performance of the T&T system. | 1. How frequently do you do verification of the T&T system?<br>a. No verification or verification is done once before implementation of the system<br>b. Every time that a change is made on the system e.g. whenever there is a change in supplier or buyer<br>c. Verification is done on scheduled basis e.g. once per year and whenever there are changes on the system such as change in supplier or buyer<br>d. Others. Please specify |
| | **Performance of the traceability system** | |
| **Time needed for tracing the products**<br>Based on EAN.UCC (2003) and Kousta (2006) | The less time needed to trace the products indicates higher performance of the traceability system | 1. How long does it take you to provide an information about a specific product that you produced some months ago (e.g. six months ago, in case your customer want this information)<br>a. Less than 4 hrs<br>b. Between 4 and 24 hrs<br>c. More than 24 hrs<br>d. Others. Please specify |
| **Reliability of procedures**<br>Based on EAN.UCC (2003) and Kousta 2006 | The more the reliable the tools, procedures and information sources used, the higher the level of traceability system performance | 1. What kind of tools do you use e.g. thermometers, weighing scale? Etc<br>a. Locally made tools<br>b. National approved tools<br>c. International approved tools<br>d. Others. Please specify<br>2. What are the sources of T&T procedures and instructions in your company?<br>a. Local sources<br>b. National sources<br>c. International sources<br>d. Others. Please specify |
| **Accuracy/Precision**<br>Based on EAN.UCC (2003) and Kousta (2006) | The more precisely/ accurately the size of the batch , the less the time needed for track and tracing the product and so the higher the level of traceability system performance | 1. What is the average size of your batch?<br>a. the actual batch size is not known<br>b. the actual batch size is known but is variable from time to time<br>c. the actual batch size is known and is constant at all the time |
| | **Food safety level** | |
| **Level of rejected products due microbiological hazards and or chemical hazards**<br>Based on FSA (2002), NACMCF (1998), Huss (1995) and ICMSF (1998) | A high number of rejected products due to microbiological and or chemical hazards indicate that a low level of product safety is realized. | What is the level of product recall/reject from your customers in your organisation?<br>a. less than 1% of all produced products in a year are recalled /rejected<br>b. between 2 and 5 % of all produced products in a year are recalled /rejected<br>c. More than 5 % of all produced products in a year are recalled /rejected |

# Chapter 4
# Research Methodology

## 4.1Type of research

The exploratory qualitative research was carried out in this research project in order to gain an insight on the Technological and managerial factors contributing to performance of the T&T system. To achieve this, a case study was carried out in 4 different fish processing companies in Tanzania.

The research model developed in chapter 3 has been used as a hand hold tool to investigate the existing situation in these companies with regard to their; contextual situation, T&T system design, T&T system execution and T&T system performances, with the intention of exploring the bottlenecks on their T&T system. To do so, a triangulation method was used to collect information from various sources in these companies so as to maximize the availability of information. A triangulation method is a process where by the same information is collected from various sources (such as direct interview, document analysis, physical process analysis/observation). A bottleneck can be seen as a cause (key issue) for that specific problem. Developed solutions from these bottlenecks could thus help these companies to improve their traceability systems.

## 4.2. Short descriptions of the selected companies

### 4.2.1Sea Products Ltd (Tanga region)

Sea Products Ltd. is a private owned company located at Gofu area in Tanga region. The company started in 1993 in Mwambani area. In 1998 the Company was moved to Gofu area as a result of company expansion. The company deals mainly with production of frozen products originating from various fish species from the Indian Ocean (for details see appendix 10). The main customers of this company are Frigo Livorno (Italy) and Aqua-food (France). The company has a total of 120 employees (thus can be classified as medium size company according to European Commission, 2003). The processing capacity of the company is about 8 tons of finished products per day. The EU approval number for this company is APP- 218.The Company operates mainly with artisan/small fishermen and fish suppliers (Appendix 7). Some of these suppliers collect their raw materials around Tanga coast while others collect their raw materials far away from Tanga (such as Kilwa, Mafia, Dar es Salaam and Mtwara). The number of fish suppliers in this company is approximately 277.The Company uses HACCP program as its quality assurance system. The details of the T&T system for this company are shown in appendix 11

### 4.2.2 Nile Perch Fisheries Ltd (Mwanza region)

Nile Perch Fisheries limited is a private limited company incorporated in the year 1991 and started its production commercially from December 1992. NFL is engaged in the processing and exporting of Lake Victoria perch (*Lates Niloticas*). The processing capacity of this plant is 80 tons of R.M per day. The Company has a well equipped in house laboratory to assess microbiological quality of the products, equipment and hygienic standards of personnel. The total work force of the Company is about 600 workers (thus can be classified as big size company according to European Commission, 2003). The processing section is operating in three shifts of 8 hours each. The EU approval number for this company is APP- 208.The Company operates mainly with big suppliers who can approximately bring 1 ton of RM after every 3 to 5 days. All suppliers obtain their raw material at Lake Victoria which is just nearby. The major buyers of Nile perch fillets from this company are in Europe. This company is operating according to HACCP principles. The details of the T&T system for this company are shown in appendix 12

### 4.2.3. Tanzania Fish Processors (TFP - Mwanza region)

Tanzania fish processors Ltd was incorporated in 1992 with the sole purpose of processing and exporting premium quality Nile perch fillets all over the world. It is part of Alpha group, which is the world's largest producer, and exporter of Nile perch fillets. TFP is one of the biggest Nile Perch

Fish Processing plant with a processing capacity of 120 tons of whole fish per day. It provides direct employment for 500 workers/staff and indirect employment for around 2000 people. It is EU approved processing plant with approval number APP- 209 and HACCP implementing processing plant. The range of products produced varies from chilled and frozen skinless & skin-on Nile Perch fillets, headed and gutted frozen Nile Perch trunks and frozen Nile perch portions. The export markets are mainly Europe, Japan, USA, Australia and China with large market being in Europe. The details of the T&T system for this company are shown in appendix 13

## 4.2.4 Vicfish Ltd (Mwanza region)

Vicfish Ltd is an export oriented fish processing establishment, which has been approved by the EU (APP- 205). The company was established in early 1992. The installed capacity is 55-60 tons of finished products per day (24 Hrs) but the currently utilised capacity is about 25 to 30 tons of finished products per day. The major export products are frozen/chilled Lake Victoria perch fillets, portions and headed & gutted fish. Major export by-products include frozen fish maws. Major markets for the main products are Europe, USA and Japan while the major market for the by-products is China. Currently the total manpower is about 500 employees. The company operates in two shifts (A and B). The quality assurance system applied in this company is HACCP program. The details of the T&T system for this company are shown in appendix 14

*Table 4-1: summary of selected companies*

| **Company name** | **No. of workers** | **Size** | **Age (Yrs)** | **Location** | **Fish types** | **EU number** | **N0. of suppliers** | **Market** |
|---|---|---|---|---|---|---|---|---|
| Sea Products | 120 | Medium | 14 | Tanga | Various | APP - 218 | 277 | Europe |
| Nile Perch Fisheries | 600 | Large | 16 | Mwanza | Nile perch | APP - 208 | 25 | Europe, Japan and Israel |
| Tanzania Fish Processors | 500 | Large | 15 | Mwanza | Nile perch | APP - 209 | 49 | Europe, USA, Japan, China and Australia |
| Vicfish Ltd | 500 | Large | 15 | Mwanza | Nile perch | APP- 205 | 12 | Europe, USA, Japan and China |

## 4.3. Criteria for Selection of Companies

Selection of these companies in this research was based on the assumption that these companies differ in some contextual situation/factors such as diversity of fish species, diversity of fish suppliers, size of the company etc. The criteria used to categorise the size of these companies is based on the definition of the European commission (2003), which is shortly shown below.

*Table 4-2: Revised European Commission definition for SME*

| Enterprise category | Number of Employee | Turnover (€) |
|---|---|---|
| Micro | <10 | <2 million |
| Small | <50 | <10 million |
| Medium sized | <250 | <50 million |

Another reason was that these companies are also the biggest fish processing companies in Mwanza (and Tanzania in general) and are all operating according to EU regulations. Moreover, these companies were all involved in the EU ban (importing fish to European Union) between 1997 and 1999. Sea products Ltd was not involved in this ban. So, it was interesting to explore their T&T system design and execution.

It was therefore expected that the levels of the corresponding contextual factors will be different and will influence/affect T&T system design and execution in a different ways.

## 4.4. Indicators

The indicators of this research project are both qualitative and quantitative as shown in the previous chapter. Most of the indicators do not have units since they are qualitative. However, some indicators like time needed for tracing the products is measured in hours.

## 4.5 Method of information collection

Before starting information collection process, the permission was sought from the following competent authorities (Headquarters of the Ministry of Natural Resources and Tourism, Fisheries division - Dar es salaam, QC Office - Tanga region and QC Office - Mwanza region). Information was collected through direct observation, face to face interviews and through documents analysis. The information collection process was done basing on the developed questionnaire. The questionnaire results from the indicators of the research model. For each indicator, questions and answers categories/levels have been developed. These levels make it possible to judge each indicator. The interview consisted of closed questions as well as open-ended questions which allowed exploratory of all information to be obtained. During the interview, questions were separated so that some questions were asked to specific respondents e.g. company directors/ general managers, quality assurance managers and production managers. Therefore, not all questions were asked to everyone. The details of information collection process are shown in appendix 15 and the interview document is shown in appendix 6. In summary, a total of 12 people were interviewed i.e.3 people in each processing company.

## 4.6 Duration

The duration for data/information collection was 3 months starting from 14$^{th}$ March to 10$^{th}$ June 2007. The first week was spent at the ministry of natural resources and tourism, fisheries division headquarters to get an overview of various traceability system used in fish processing companies in Tanzania. 3 weeks were spent at Sea Products Ltd in Tanga. 2 months were spent in Mwanza where three more fish processing factories were visited.

# Chapter 5
# Results and discussion

## 5.1. Introduction
The internship was undertaken with the main objective of getting an insight into various traceability systems in fish processing industries in Tanzania. In this research project, the internship has been combined together with thesis to facilitate the process of data collection.

## 5.2 Results and discussion
In this section, a brief discussion is given regarding analyses which have been carried out to determine both managerial and technological factors contributing to performance level of the T&T system. The conducted analysis is based on the Document analysis, physical process analysis (observation) and direct interviews with fish processing experts (Company directors/General managers, Quality assurance managers and production managers). Following little number of respondents in this study, the statistical analysis was not possible. Therefore, the discussion on various indicators is rather general. The summary of the overall results obtained in this study is shown in appendix 3.

### 5.2.1 Product complexity
*Table 5-1: Summary of the results for product complexity*

| Indicator | Method | SPL | NPFL | TFPL | VFL | Score | Description |
|---|---|---|---|---|---|---|---|
| Spoilage rate of fish | Interview | Low | Low | Low | Low | Low | Spoilage rate is low because the fish is okay/good even after been kept on ice for more than 11 days. |
| | Documents | | | | | | |
| | Observation | | | | | | |
| Risk level of fish product | Interview | Low | Low | Low | Low | Low | The incident is not likely to occur once in 10 years and when it occurs, it is simply from an individual consumer complaining about product being out of specification |
| | Documents | Low | Low | Low | Low | Low | |
| | Observation | | | | | | |
| Degree of diversity of fish species | Interview | High | Low | Low | Low | High/ Low | Low: only 1 or 2 fish species are manufactured throughout the chain High: more than 10 species of fish with potential hazards are manufactured throughout the chain |
| | Documents | High | Low | Low | Low | High/ Low | |
| | Observation | High | Low | Low | Low | High/ Low | |

SPL: Sea Products Ltd, NPFL: Nile Perch Fisheries Ltd, TFPL: Tanzania Fish Processors Ltd, VFL: Vicfish Ltd

(a) Spoilage rate of fish
The score for this indicator is low for all companies (interview analysis, table 5-1 above). The maximum storage time in ice, for all species of fish processed in all 4 companies was found to be more than 15 days and therefore spoilage rate of fish is generally low. It is therefore concluded that the spoilage rate of fish in these companies does not put higher demands in T&T system since it is low.

(b) Risk level of product for safety (microbiological and chemical hazards)
The score for this indicator is low for all companies (Both, in document and interview analysis, table 5-1 above). It was found that for the past five years there have been no potential pathogens or hazardous chemicals detected either in the raw materials or in the final products. It was also noted that all companies get only few complaints (one to three) from customers in a year regarding their products being out of specification and they had never had a complain about customers being ill or complains about customer fatality. (This means both probability of occurrence and severity are low,

hence low risk). For this case the risk level of products in these companies does not put higher demands on their T&T system design and execution

(c) Degree of diversity of fish species with potential hazards
The score for this indicator is high for Sea Products Ltd and low for other companies (in, document, interview and observation analysis, table 5-1 above). All companies in Mwanza deal with only one species of fish (Nile perch- *Lates niloticus).* Sea Products company deals with processing of more than 30 species (appendix 10). It is therefore concluded that the degree of diversity of fish species put higher requirements (have higher potential impacts) in the T&T system design and execution at SPL but not in the other companies in Mwanza.

## 5.2.2 Production process complexity

*Table 5-2: Summary of the results for production process complexity*

| Indicator | Method | SPL | NPFL | TFPL | VFL | Score | Description |
|---|---|---|---|---|---|---|---|
| Number of processing steps | Interview | High | High | High | High | High | More than 15 processing steps are there |
| | Documents | High | High | High | High | High | |
| | Observation | High | High | High | High | High | |
| Number of processing lines | Interview | Low | Low | Low | Low | Low | Only one processing line |
| | Documents | Low | Low | Low | Low | Low | |
| | Observation | Low | Low | Low | Low | Low | |
| Production process structure | Interview | High | High | High | High | High | Divergence and convergence processes occurs both inside and outside the company |
| | Documents | High | High | High | High | High | |
| | Observation | High | High | High | High | High | |
| Sources of raw material supply | Interview | High | High | High | High | High | More than 50% of the raw materials are supplied from wild sources (in fact 100% of all raw material are from wild sources) |
| | Documents | High | High | High | High | High | |
| | Observation | | | | | | |

SPL: Sea Products Ltd, NPFL: Nile Perch Fisheries Ltd, TFPL: Tanzania Fish Processors Ltd, VFL: Vicfish Ltd

(a) Number of processing steps
The overall score for this indicator is high for all companies. (In both: document, interview and observation analysis in table 5-2 above). All products which are processed in all 4 companies go through more than 15 processing steps. When a product goes through many processing steps you need to make sure that all products from the previous batch are cleared in all steps before proceeding with the next batch. In practice this is not easy to achieve and more often this situation creates product jam (in all companies). It is therefore concluded that many number of processing steps have a higher potential impact on the T&T system design and execution in all companies and negatively contribute on their T&T system performance.

(b) Number of processing lines
The score for this indicator is low for all companies (Both, for interview, documents and observation analysis, table 5-2 above). It was found that all companies have single processing lines. It is therefore concluded that number of processing lines in these companies does not put higher demands on the T&T system design and execution.

(c) Production process structure
The overall score for this indicator is high in all 4 companies, (as shown in; document, interview and observation analysis in table 5-2 above). Converging and diverging are common practices (both, outside and inside) in all companies. In most cases, converging takes place in beaches while diverging is taking place inside the companies. Converging and diverging processes during production creates a higher demand on the design and execution of the T&T system and hence contribute negatively on the overall performance of the T&T system in these companies

(d) Sources of raw material supply

The overall score for this indicator is high for all 4 companies as shown in table 5-2 above (for both document and interview analysis). It was found that Sea products Ltd obtains all its raw materials (100%) from the Indian Ocean whereas, all other companies in Mwanza obtain their raw materials (100%) from Lake Victoria. Obtaining raw material from wild sources such as lake and ocean creates more demand on the T&T system in these companies since such raw materials have higher chances of having unknown hazards as compared to raw materials obtained from a specific farm. This situation therefore contributes negatively on the overall performance of their T&T system.

### 5.2.3 Food supply chain complexity

*Table 5-3: Summary of the results for fish supply chain complexity*

| Indicator | Method | SPL | NPFL | TFPL | VFL | Score | Description |
|---|---|---|---|---|---|---|---|
| Degree of diversity of chain actors | Interview | High | High | High | High | High | Fish supply chain consists of multiple suppliers, one fish processors and multiple buyers |
| | Documents | High | High | High | High | High | |
| | Observation | | | | | | |
| Level of chain partnership | Interview | High | High | High | High | High | High (collaboration): partners carry out joint planning of all activities and exchange all information about product, process and customers on regular bases |
| | Documents | | | | | | |
| | Observation | | | | | | |

SPL: Sea Products Ltd, NPFL: Nile Perch Fisheries Ltd, TFPL: Tanzania Fish Processors Ltd, VFL: Vicfish Ltd

(a) Degree of diversity of chain actors
The score for this indicator is high in all 4 companies. (For both: document and interview analysis as shown in table 5-3 above). All 4 companies have more than 20 suppliers of raw materials and at least 5 buyers. Having more chain actors put more requirements (higher potential impact) during designing and execution of the T&T system in these companies than when there are few actors in the same chain.

(b) Level of chain partnership
The score for this indicator is high in all 4 companies. (Interview analysis: table 5-3 above). All companies discuss with their partners all business matters (product, process, and product flow and customers information). High level of chain partnership positively contributes on the design, and execution of the traceability system.

### 5.2.4 Organisation characteristics/complexity

*Table 5-4: Summary of the results for organisation characteristics/complexity*

| Indicator | Method | SPL | NPFL | TFPL | VFL | Score | Description |
|---|---|---|---|---|---|---|---|
| Degree of employee involvement | Interview | Low | Low | Low | Low | Low | Low: Employees are just informed and instructed about how to work with T&T system during execution |
| | Documents | | | | | | |
| | Observation | | | | | | |
| Working conditions of employees | Interview | Low | Low | Low | Low | Low | Low: Noise conditions, bad smell, high humidity and no feed back information |
| | Documents | | | | | | |
| | Observation | Low | Low | Low | Low | Low | |
| Rate of temporary workers | Interview | High | High | High | High | High | High: more than 60% of all workers are temporary workers including employees who are working with the T&T system |
| | Documents | | | | | | |
| | Observation | | | | | | |
| Level of top management commitment | Interview | Med ium | Medi um | Medi um | Medi um | Medi um | Medium: T&T system is stated in the organisations' policy but there is no T&T system reviews although it is stated who is responsible for the implementation of the T&T system |
| | Documents | Med ium | Medi um | Medi um | Medi um | Medi um | |
| | Observation | | | | | | |

SPL: Sea Products Ltd, NPFL: Nile Perch Fisheries Ltd, TFPL: Tanzania Fish Processors Ltd, VFL: Vicfish Ltd

(a) Degree of employee's involvement in T&T issues
The overall score for this indicator is low in all 4 companies (interview analysis: table 5-4 above). Employees are not involved in the initial stages of the T&T system design but rather are just informed of what they have to do during execution stage. This situation contributes negatively on the T&T system execution and T&T system performance in these companies

(b) Working conditions of employees
The working condition in all 4 companies was more-less similar in all aspects (long standing hours during working, poor feedback to employees, noise condition, high humidity and bad smell). This situation contributes negatively on the execution of the traceability system in these companies and hence on the overall performance of the T&T system. The overall score for this indicator is therefore low as indicated in table 5-4 (from both analysis; interview and observation).

(c) Rate of temporary workers
The score for the rate of temporary workers is high in all 4 companies, (Interview analysis in table 5-4). Around 95 % of all employees are casual workers (i.e. working on temporary basis) including workers who are dealing with the T&T system. High levels of temporary workers in these companies contribute negatively on the execution of the T&T system and on the overall performance of their T&T system. The overall score for this indicator is therefore high.

(d) Level of top management commitment
The interview analysis shows that the T&T system is indeed mentioned in the policies of all 4 companies and that quality assurance manager of each of the 4 companies is responsible for the design and execution of the T&T system at the managerial level. However, the document analysis shows that in all 4 companies there are no T&T system review documents to indicate how frequently these companies conduct the T&T system review. The overall score for this indicator is therefore medium (table 5-4 above). High level of top management commitment contributes positively on the design and execution of the T&T system and hence on the overall performance of the T&T system.

### 5.2.5 Traceability system requirements

*Table 5-5A: Summary of the results for traceability system requirements*

| Indicator | Method | SPL | NPFL | TFPL | VFL | Score | Description |
|---|---|---|---|---|---|---|---|
| Level of registration of traceability information | Interview | High | High | High | High | High | High level: All product, process, product flow, suppliers and product safety information are shown |
| | Documents | High | High | High | High | High | |
| | Observation | | | | | | |

SPL: Sea Products Ltd, NPFL: Nile Perch Fisheries Ltd, TFPL: Tanzania Fish Processors Ltd, VFL: Vicfish Ltd

Document and interview analysis were conducted to find out what kind of registrations these companies are recording in their traceability system. The following table shows the summary of these findings

*Table 5-5B: Summary of T&T system registrations in visited fish processing companies*

| Company | SPL | NPFL | TFPL | VFL |
|---|---|---|---|---|
| T&T system registrations | Supplier name | Supplier name | Supplier name | Supplier name |
| | Origin of fish | Origin of fish | Origin of fish | Origin of fish |
| | Boat reg.No. | Boat reg.No. | Boat reg.No. | Boat reg.No. |
| | Quantity supplied | Quantity supplied | Quantity supplied | Quantity supplied |
| | Common name | Common name | Common name | Common name |
| | Scientific name | Scientific name | Scientific name | Scientific name |
| | Company name | Company name | Company name | Company name |
| | Company address | Company address | Company address | Company address |
| | Processing date | Processing date | Processing date | Processing date |
| | Production method | Production method | Production method | Production method |
| | Expiry date | Expiry date | Expiry date | Expiry date |

| | | | | |
|---|---|---|---|---|
| | Carton number | Carton number | Carton number | Carton number |
| | Carton weight | Carton weight | Carton weight | Carton weight |
| | Code/grade | Code/grade | Code/grade | Code/grade |
| | Keeping Temp. | Keeping Temp. | Keeping Temp. | Keeping Temp. |
| | Destination | Destination | Destination | Destination |
| | Source of packaging material | Source of packaging material | Source of packaging material | Source of packaging material |
| | FAO fishing zone | FAO fishing zone | FAO fishing zone | FAO fishing zone |
| | EU number (APP) | EU number (APP) | EU number (APP) | EU number (APP) |

Table 5-5B above shows that all 4 companies record the same type of information in their T&T system. The reason is that all companies use a format which is given by the ministry of Natural resources and tourism which is the competent authority in Tanzania. The ministry prepares this format in collaboration with the European Union. Therefore, the conclusion is that the overall score for this indicator is high. High level of registrations of the T&T information in these companies positively contributes on the performance of their T&T system.

### 5.2.6 Traceability system design

*Table 5-6: Summary of the results for traceability system design*

| Indicator | Method | SPL | NPFL | TFPL | VFL | Score | Description |
|---|---|---|---|---|---|---|---|
| Type of identification | Interview | Low | Low | Low | Low | Low | Low data quantity, low data density, high influence of external factors e.g. water and dust, high unauthorised copying, longer time to get information etc. |
| | Documents | Low | Low | Low | Low | Low | |
| | Observation | Low | Low | Low | Low | Low | |
| Appropriateness of information collection point | Interview | Low | Low | Low | Low | Low | Low: T&T information is collected at all processing steps based on internal discussion only |
| | Documents | | | | | | |
| | Observation | Low | Low | Low | Low | Low | |
| Determination of traceable resource unit | Interview | High | Medium | Medium | Medium | High/ Medium | <u>Medium</u>: A batch of same type of fish<br><u>High</u>: A single carton from a particular batch of fish |
| | Observation | High | Medium | Medium | Medium | High/ Medium | |
| Mode of data registration | Interview | Low | Low | Low | Low | Low | low data quantity, very low data density, highly influenced by external factors such as dust, water etc., high unauthorised copying, long time to make information, and high rate of degradation |
| | Documents | Low | Low | Low | Low | Low | |
| | Observation | Low | Low | Low | Low | Low | |
| Mode of information communication | Interview | Medium | Medium | Medium | Medium | Medium | Limited information can be stored and retrieved, information can be accessible to few people and information transfer is slow. E.g. printed information |
| | Observation | | | | | | |
| Location of data storage | Interview | Low | Low | Low | Low | Low | Low: Not easily accessible by many people, very low data quantity, information storage and retrieve is very slow (e.g. Paper files) |
| | Documents | Low | Low | Low | Low | Low | |
| | Observation | Low | Low | Low | Low | Low | |
| Degree of data standards | Interview | Low | Low | Low | Low | Low | Low: No standards are used |
| | Documents | Low | Low | Low | Low | Low | |
| | Observation | | | | | | |
| Level of using HACCP | Interview | Medium | Medium | Medium | Medium | Medium | Medium: HACCP system is only used at the initial stages of the T&T system design |
| | Documents | Medium | Medium | Medium | Medium | Medium | |

SPL: Sea Products Ltd, NPFL: Nile Perch Fisheries Ltd, TFPL: Tanzania Fish Processors Ltd, VFL: Vicfish Ltd

(a) Type of identification

The analysis (both document, interview and observation analysis in table 5-6) show that the score for this indicator is low because all 4 companies use paper system as their main type of identification (details are shown in appendix 11 through 14). Simple types of identification such as the use of paper label put a higher demand on the execution of the traceability system in these companies and negatively contribute on the overall performance of the T&T system in these companies because the use of paper label is tedious, time consuming and is not fraud proof.

(b) Appropriateness of the location of information collection point

The overall score for this indicator is low as shown from both analyses (interview and observation analysis in table 5-6 above). Information collection process takes place all the way from receiving section to the packing section in all 4 companies (details are shown in appendix 11 through 14). Not collecting traceability information at appropriate places/sections creates more demand/requirement on the T&T system design and execution in these companies and so contributes negatively on the performance of the T&T system in these companies

(c) Determination of traceable resource unit (TRU)

The results (both interview and observation analysis in table 5-6 above) show that there is a major difference between Sea Products Ltd in Tanga (SPL)and other 3 companies in Mwanza as far as the issue of TRU is concerned. At SPL the TRU is defined as each individual carton, which is identified by using a specific product code and carton number. The score of this indicator in this company is therefore high. The procedure in the other 3 companies in Mwanza is different because these companies use the batch system as TRU. In these companies a batch is defined as a product (RM) supplied by one supplier at a time (details are shown in appendix 11 through 14). The overall score for this indicator in these 3 companies is thus medium.

(d) Mode of data registration

The analysis (both document, interview and observation analysis as shown in table 5-6) show that the score for this indicator is low because all 4 companies use manual system for registration of traceability information (details are shown in appendix 11 through 14). This situation is attributed by the fact that the type of identification used by all these companies is based on the paper system as discussed above. Such types of data registration negatively contribute on the overall performance of the T&T system in these companies.

(e) Location of data storage

The analysis (both document, interview and observation analysis as shown in table 5-6) show that the score for this indicator is low since all 4 companies store the traceability data in the paper files (details are shown in appendix 11 through 14). The use of paper files as a means of storage of traceability information creates more demand/requirements during execution of the T&T system and negatively contributes on the performance of the traceability system in these companies since it may take more time to retrieve the required information. Moreover, the paper files can get lost quite easily and are not fraud proof.

(f) Mode of information communication

The interview analysis (table 5-6 above) shows that the score for this indicator is medium because, all 4 companies use multiple means to communicate information along the chain. These include oral communication/telephone, printed papers, and digital transferring of information. The most commonly used method is the use of printed papers. The use of printed papers as a means of information communication put high requirements on the execution of the T&T system and negatively contribute on the performance of the traceability system in these companies since papers can torn out quite easily, not durable and are not fraud proof.

(g) Degree of data standardisation
The analysis (both document and interview analysis in table 5-6 above) shows that the score for this indicator is low for all 4 companies because all 4 companies do not have proper commonly established data standards (details are shown in appendix 11 through 14). The use of commonly established standards optimises traceability data processing and communication within the supply chain and contributes positively to advanced design and execution of the traceability system and vice versa. All companies do not have commonly established standards and this situation contributes negatively on the design and execution of their T&T system.

(h) Degree of using HACCP system in T&T system designing
The analysis (both document and interview analysis in table 5-6 above) shows that the score for this indicator is medium for all 4 companies because all 4 companies have the HACCP system in their plants. However, the use of this system in the designing and execution of the T&T system is not fully utilised since the T&T information is collected from all processing steps and is not according to HACCP plan (details are shown in appendix 11 through 14). This situation contributes negatively on the T&T system design and on the overall performance of the T&T system in these companies.

## 5.2.7 Traceability system Execution

*Table 5-7: Summary of the results for traceability system execution*

| Indicator | Method | SPL | NPFL | TFPL | VFL | Score | Description |
|---|---|---|---|---|---|---|---|
| Level of communication of T&T procedures and instructions | Interview | High | High | High | High | High | High: Both oral and written communication is used between management and employees |
| | Documents | High | High | High | High | High | |
| | Observation | | | | | | |
| Degree of compliance with regulations and procedures | Interview | High | High | High | High | High | High: Complies with both company policy as stated in the quality manual and international regulations such as EU regulation 2065/2001 |
| | Documents | High | High | High | High | High | |
| | Observation | | | | | | |
| Degree of accuracy of T&T documentations | Interview | Medium | Medium | Medium | Medium | Medium | Medium: T&T documents are in a specific place, well readable but often not complete and not arranged in a systematic order |
| | Documents | Medium | Medium | Medium | Medium | Medium | |
| Frequency of verification of T&T system | Interview | Low | Low | Low | Low | Low | No verification is done or verification is done once before implementation of the system |
| | Documents | Low | Low | Low | Low | Low | |
| | Observation | | | | | | |

SPL: Sea Products Ltd, NPFL: Nile Perch Fisheries Ltd, TFPL: Tanzania Fish Processors Ltd, VFL: Vicfish Ltd

(a) Level of Communication about T&T procedures and instructions
The results (from both document and interview analysis in table 5-7 above) show that the score for this indicator is high for all 4 companies. All 4 companies use both means of communication i.e. oral and written communication during execution of the T&T system. Baron and Greenberg (2000) stated that communication is most effective when it uses multiple channels, such as both oral and written messages. High level of information communication contributes positively on the execution of the T&T system and on the overall performance of the T&T system.

(b) Degree of compliance with regulation and procedures during execution of T&T system
The analysis (both from document and interview: table 5-7 above) shows that the score for this indicator is high in all 4 companies because all 4 companies register the most important required information as shown in table 5-5B. High level of registration of the required information implies that these companies comply with the EU regulations. This situation positively contributes on the performance of the T&T system

(c) Degree of accuracy of T&T documentations
The results (both document and interview analysis in table 5-7 above) shows that the overall score for this indicator is medium in all 4 companies. It was found that all 4 companies indeed put all T&T documents in one location and that all documents are well readable but often not complete and not arranged in a systematic way. This makes the overall score for this indicator to be medium. Low degree of accuracy in T&T documentations contributes negatively on the T&T system execution and on the overall performance of T&T system since information retrieve can not be done precisely

(d) Frequency of verification of T&T system
The analysis (both document analysis and interview analysis in table 5-7 above) shows that the overall score for this indictor is low in all 4 companies. It was found that none of the 4 companies is doing verification of T&T system. This situation contributes negatively on the designing and execution of the T&T system in these companies.

## 5.2.8 Traceability system performance

*Table 5-8A: Summary of the results for traceability system performance*

| Indicator | Method | SPL | NPFL | TFPL | VFL | Score | Description |
|---|---|---|---|---|---|---|---|
| Degree of rapidity | Interview | High | High | High | High | High | High: within 4 hours |
| | Documents | | | | | | |
| | Observation | High | High | High | High | High | |
| Degree of reliability | Interview | Medium | Medium | Medium | Medium | Medium | Medium: Local and international approved tools, procedures and information sources are used |
| | Documents | Medium | Medium | Medium | Medium | Medium | |
| | Observation | | | | | | |
| Degree of precision of batches | Interview | Low | Low | Low | Low | Low | Low: the actual batch size is not known |
| | Documents | | | | | | |
| | Observation | Low | Low | Low | Low | Low | |

SPL: Sea Products Ltd, NPFL: Nile Perch Fisheries Ltd, TFPL: Tanzania Fish Processors Ltd, VFL: Vicfish Ltd

(a) Time needed to provide the information about the product.
Simulation processes was conducted in 3 out 4 visited companies in order to get an idea about how long it would take for a company to provide the required information regarding a specific product. The table below shows the summary of the simulation process.

*Table 5-8B Summary of Simulation process*

| Company name | Sea Products ltd | Nile perch ltd | TFP | Vick fish ltd |
|---|---|---|---|---|
| First simulation | 2:55 Minutes | 3:53 Minutes | 3:52 Minutes | Not done |
| Second simulation | 2:45 Minutes | 3:27 Minutes | 2:48 Minutes | Not done |
| Average | 2:50 Minutes | 3:40 Minutes | 3:20 Minutes | Note done |

The results from the table above show that most of these companies can provide the required information within 4 hr. The overall score for this indicator is therefore high. It is assumed that if the time in which the information can be made available is high/fast, then performance of the T&T system is high

(b) Reliability
The analysis (both document and interview in table 5-8A above) shows that the overall score for this indicator is medium for all 4 companies. It was found that all 4 companies use both internationally approved tools/procedures as well as locally made tools/procedures (the united republic of Tanzania, fisheries act, 2003. the fisheries regulation 2004, regulation 73) as well as EU regulation 2065/2001. High level of reliability of tools and procedures used in the traceability system contributes positively on high performance level of the T&T system. The overall score for

this indicator is medium because these companies use both sources (Local and international procedures/tools).

(c) Precision/accuracy
The analysis (both interview and observation as indicated in table 5-8A above) shows that the overall score for this indicator is low. It was found that there is no uniformity in batch size for all three companies. Which means the level of precision/accuracy as far as batch size is concerned is low (the other company, Sea products ltd- Tanga is not using the batch system). High level of precision in size between successive batches contributes positively to high performance level of the T&T system since product recall and withdraw can be done more systematically.

### 5.2.9 Food safety level

*Table 5-9: Summary of the results for food safety level*

| Indicator | Method | SPL | NPFL | TFPL | VFL | Score | Description |
|---|---|---|---|---|---|---|---|
| % of recalled or rejected products from consumers | Interview | High | High | High | High | High | High: less than 1% of all produced products in a year are recalled /rejected |
| | Documents | High | High | High | High | High | |
| | Observation | | | | | | |

SPL: Sea Products Ltd, NPFL: Nile Perch Fisheries Ltd, TFPL: Tanzania Fish Processors Ltd, VFL: Vicfish Ltd

(a) Percentage of rejected/recalled products from customers
The analysis (document and interview in table 5-9 above) shows that the overall score for this indicator is high. It was found that the % of products recall/rejected from consumers due to either chemical and/or microbiological hazards is less than 1% of all exported products from the year 2000 to the year 2007 in all 4 companies. High rate of product recall/rejects from the consumers due to either microbiological and/or chemical hazards provides a good indication of low assurance in food safety in that company.

It was further observed that all 3 companies in Lake Victoria have a strict monitoring and control of environmental chemical contaminants and pesticides. A number of strategies are used to control the entry of these environmental chemical contaminants and pesticides in to products. These strategies include; Lake Victoria survey (to determine agricultural and industrial practices near the lake area), supplier's certification (presence of a legal certificate indicating that fish have been harvested from uncontaminated waters), records of testing and monitoring (Soil, water, or fish flesh, chemical contaminant test results for those contaminants that are reasonably likely to be present as shown in appendix 8 and appendix 9), quality assurance program (each lot received is checked for presence of certificate which is issued by lot by lot basis) and organoleptic and sensory evaluation of all batches of fish at the receiving section by the quality assurance manager/receiving supervisor and processing workers. All these records are well documented and kept for future references.

## 5.3 Identification of Bottlenecks

As stated earlier, a bottleneck is a cause (key issue) for the specific problem. It is associated with lessening of throughput of the whole or part of the system. The inefficiencies brought about by the bottleneck often create a hindrance to progress and overall performance of the system. A bottleneck can be caused by one major factor/situation or a combination of factors/situations in the system. In this project two major bottlenecks have been identified. These bottlenecks are caused by a combination of contextual situations/factors as explained in the section below.

### 5.3.1 High usage of paper based traceability system

The analysis conducted in this study shows that there is a high usage of paper based traceability system in all 4 companies (table 5-6). The details of the traceability system in these companies are shown in appendix 11 through 14. Paper based T&T systems are providing limited functionalities, are time consuming, are not fraud proof etc. (SWOT analysis-table 2-3, Marshall (2004), Petersen and Green (2005), and AMR (2005)). As mentioned above, a number of contextual situations have led into identification of this bottleneck (based on document, observation and direct interview analysis). Such contextual situations include*; high degree of diversity of fish species, high degree of diversity of chain actors, presence of many number of processing steps, high degree of divergence and convergence and presence of wild sources of raw materials*. The summary of these results is shown in appendix 3. High level of these contextual factors put high requirements/demands (and thus have a higher potential impact) on the designing and execution of the T&T system and on the overall performance of T&T system. This is to say that a paper based traceability system can not cope up with higher level of complexities of these contextual situations if higher level of traceability system performance is to be achieved. It is on this ground that the paper based traceability system is seen as a major bottleneck in the traceability system of the visited companies. Some of the advantages and disadvantages of the paper based traceability system are summarised in the table bellow.

*Table 5-10: Pros and cons of paper based T&T system (Petersen and Green (2005), AMR (2005))*

| Advantages | Disadvantages |
|---|---|
| 1. Based on existing assurance /stock control documentation system<br>2. Inexpensive to implement<br>3. Flexible in terms of the processing system to which it can be applied<br>4. Data input is easy and precise | 1. Manually intensive with respect to writing and collecting of records.<br>2. Reliant on correct procedural operations being carried out, e.g. may be unreliable due to operator error.<br>3. Trace-back of information is time consuming and often difficult especially when the process operations involve more than one raw material/ingredient.<br>4. Processing and maintenance of data records is time consuming compared with other traceability methods such as bar coding and integrated IT systems<br>5. Records are not easily reviewed therefore only limited strategic use of information can be made.<br>6. Not fraud proof<br>7. Highly accessible with external environment such as dust and water<br>8. Higher rates of degradation<br>9. Needs more space to keep paper files |

Although paper based traceability system is the simplest form of recording information and tends to be at least part of most traceability systems, but Paper based T&T systems (with limited or standard computer software) can only be appropriate for simple processes (low complexities). The paper system relies on the user to formulate effective recording templates that can be used to record the vital parameters associated with the product. The paper system can appear to be the most straightforward and least cost option for a small operation, however the operator must consider the time needed to record and maintain paper records and the ability to cross reference through records if a problem occurs (Marshall, 2004). Nevertheless, the disadvantages of paper based T&T system outweighs the advantages as the level of complexity of the contextual factors increases (as discussed above). For this case a more advanced T&T system would be more appropriate. With these reasons in mind, the use of paper based traceability system is therefore viewed as one of the major bottleneck in achieving high level of traceability system performance in these companies.

## 5.3.2 Low degree of commitment from top management

The analysis conducted in this study (Both: document, interview and observation analysis) shows that the level of commitment from top management in all 4 companies is not high. Management commitment and support are essential for the development, implementation and monitoring of a system in order to ensure continuous effectiveness of the system (ISO 9001:2000). Identification of this bottleneck is a result of a combination of many contextual situations which have been discussed above. Such situations include *poor working conditions of employees*, *low level of involvement of employees in the designing of the T&T system, high rate of temporary workers (table 5-4 above), low degree of accuracy of T&T documentations and low frequency of verification of T&T system (table 5-7 above).* Low levels of these conditions coupled with presence of paper based traceability system, contribute negatively (have a higher potential impact) on the execution of the traceability system and therefore on the overall performance of the T&T system in these companies. It is assumed that performance is a function of design and execution. Therefore, to obtain high performance in the system both design and execution has to be high. If you have a highly sophisticated system but poorly executed, then you will end up with poor performance and vice versa.

The contextual situation/factors mentioned above are directly linked to management commitment because they are *under the sphere* of influence of the management. According to Luning *et al.*, 2002, there are four main functions of the management. These functions are: *planning*, *controlling, organising and leading*. Planning refers to setting performance objectives and deciding how to achieve them, controlling refers to measuring performance and taking action to ensure desired results, organising on the other hand means arranging tasks, people, and other resources to accomplish the work. Leading refers to inspiring people to work hard to achieve high performance. As it can be seen in these definitions of the function of the management, these contextual situations are indeed part of management functions. For this reason, management commitment is viewed as one of the major bottleneck in achieving high performance of the system.

In summary, two major bottlenecks have been identified. The first bottleneck is high usage of paper based traceability system. This bottleneck is more related to the design of the T&T system and is more technological. The second bottleneck is low commitment of the top management. This bottleneck is more related to the execution of the T&T system and is more managerial in nature, hence techno-managerial approach. The above identified bottlenecks were discussed with managements of all 4 companies in which the research was conducted. All 4 companies agreed that indeed these bottlenecks are contributing to low performance of their T&T systems.

# Chapter 6
# Evaluation of Solutions for the Identified bottlenecks

This chapter focuses on the assessment of solutions for the identified bottlenecks following the analysis which has been conducted from previous chapters. Solutions to the identified bottlenecks are shortly presented followed by critical evaluation of these solutions. The evaluation of these solutions is based on the following factors: Advantages, disadvantages, cost implications, how easy the solution can be implemented, widely applicability, relevance, reliability and validity to the sector.

*Table 6-1: Criteria for evaluation of solutions*

| Criteria | Requirements |
|---|---|
| Advantages | Advantages should outweigh disadvantages |
| Disadvantages, | There should be less disadvantages |
| Cost implications | Costs should be comparatively low |
| How ease to implement | Should be easy to be implemented |
| Widely applicable | Should be widely applicable either in that sector or related sectors |
| Relevance | Relevance should be high |
| Reliability | Reliability should be high |
| Validity | Validity should be high |

## 6.1 Solutions for high usage of paper based traceability system

### Solution 1: Use of barcode based traceability system

Bar codes are carriers of data. In simple terms, a bar code consists of a series of parallel, adjacent bars and spaces. Predetermined width patterns are used to represent actual data in the bar code. This data can be the item number or attribute information related to the item. A bar code reader (scanner) is moved across the bar code and during that time, the width pattern of the bars and spaces is analysed by the reading equipment and the original data is recovered (EAN/UCC, 2002). Essentially a bar code utilises a numeric or alphanumeric code as a means of identification. This code is applied to a label and is read with a contact reader (EAN/UCC, 2005). Bar coding is a relatively mature technology that has been used extensively in the fish sector. Recently, efforts have been made to define a standard (EAN/UCC) for assigning bar code identifiers. This standard is based on merging the EAN (European Article Number) and the UCC (Uniform Council Code) standards which were the two most widely known and applied standards (Marshall, 2004). The main purpose of bar codes is to identify items and eliminate/reduce human error by providing an electronic method to interface with enterprise and other corporate computer systems. Three main types of bar coding are relevant to the food industries. These are One-dimensional bar code, two-dimensional bar code and molecular bar code (Marshall, 2004)

*One-Dimensional Bar Code* is the most widely used form of bar coding. These bar codes usually include the identification number, and can include other information such as sell-by (best before) dates, and price. *Two-Dimensional Bar Code* is a form of bar coding which allows information to be coded as either a matrix (image), or stacked (multi-line). The key advantage over one-dimensional bar codes is that it allows for the recording of much more information, and that information can be added at any point in the supply chain. Another significant advantage is that in terms of readability and damage, two-dimensional bar codes are much more robust than one-dimensional barcodes. *Molecular Bar Code* has yet to be widely adopted. It allows for using DNA information to develop the bar code identifier. The key benefit is that it allows for the assignment of a unique, tamper-proof identifier (Marshall, 2004)

Bar codes can not only be used to label and identify raw materials and products through the supply chain, but can also be used to label locations (e.g. docks, processing stations) or individual pieces of equipment). Bar code systems rely on the use of hand held scanners for reading bar codes and inputting additional data, printers for re-labelling and a coordinated computer system to manage the information. The system can be implemented at various levels, from reading information on incoming raw materials to final product (AMR, 2005).

### Education, training and applicability

Bar coding has already been widely adapted throughout the food and food products industries (EAN/UCC, 2005). The required skills are generally known by existing workers rendering incremental training and education costs negligible. Bar code technology is widely used by most companies in essentially all developed countries. A Barcode ID system that applies to the trade in goods of all types is already in operation throughout the world, under the auspices of EAN International and the Uniform Code Council. This system is widely used in the food industry, including current trade in processed fishery products (Marshall, 2004)

*Table 6-2: Advantages and disadvantages of Bar code T&T systems (AMR, 2005and Marshall, 2004)*

| Advantages | Disadvantages |
|---|---|
| 1. Data input is easy and often menu led, minimizing potential errors.<br>2. Additional information can be entered into the hand held device so that product quality records such as temperatures etc. are also included in the data-sets.<br>3. Each scanner can be used to collect data from various process steps therefore minimizing capital expenditure and maximizing use of equipment.<br>4. Real time availability of records results in improved stock and process control.<br>5. Information can be down-loaded to a data-base which can collate and process the information to provide the necessary reports and records.<br>6. Standards for product codes (EAN/UCC)<br>7. Mature, widely-used technology<br>8. Can be used at the individual animal level (e.g. livestock and poultry)<br>9. Can be used to track lots/batches<br>10. Can be used to track trays and/or individual packages<br>11. Can record expiry (/best before) dates<br>12. Most enterprise software systems (ERP) have track/trace functionality based on bar code product standards<br>13. Cost effective | 1. Requires capital expenditure for equipment in order to successfully implement. This is especially true where processing information is to be automatically logged and integrated with the scanned data.<br>2. Technology can be unreliable, so an additional paper based system is recommended as a back-up system<br>3. Paper bar codes are easily damaged, losing all information<br>4. Farm environments are very harsh on this technology, resulting in potential loss of data<br>5. Direct line-of-sight required for reading (making high speed reading of individual items difficult)<br>6. Bar coding is not tamper proof 100% |

## Solution 2: Use of RFID based traceability system

Radio Frequency Identification (RFID) is an identification technology that requires the fixing of a device (e.g. tag or label) that contains a microchip. The millimetres-thick microchip has an attached antenna that transmits information to a remote reader. The reader can be either handheld or fixed. It is not necessary that the reader have direct line of sight to the tag since the information is passed via radio waves. The read range of the chip is dependent on its frequency. Tags can be either passive (transmit data only at the request of the reader), or active (broadcast information when desired). Passive tags are powered by the radio waves transmitted by the reader. Active tags generally have their own power supply (e.g. battery). In its most basic case, RFID is an electronic version of bar code technology. The tag or label in which an RFID chip is housed can take on many different forms, making it a versatile technology. The housing is often customer developed to protect the chip from specific environmental conditions (e.g. protection from heat, cold, water, impact …) (Marshall, 2004).

RFID tags can be attached to fish boxes, freezing racks etc. and are used to carry the traceability information in a format that can be read automatically and at a distance. The advantage of this method is that the box needs only to be placed on a scale or passed through a detector for the identification information to be automatically determined and only additional information added (e.g. quality grades, weight etc.). This can be achieved by inputting the data via drop down menus on a touch screen interface. RFID tags are well suited to harsh environments where barcodes fail. For example, RFID tags can be embedded into crab floats and read by an on-board scanner during trap recovery to monitor fishing activity (AMR, 2005).

The costs associated with RFID vary significantly between the various applications of the technology (e.g. ear tags, bolus, labels, pallet tracking, Etc.) The key cost elements of an RFID implementation are: 1) Transponder (e.g. tags, bolus, labels, etc.), 2) Electronic Reader, 3) Data Accumulator (e.g. personal computer), 4) Software and 5) Labour. In general the reader, data accumulator, and software are treated as fixed costs, whereas the electronic tags and labour are treated as variable costs. The general trend is that technical costs associated with RFID applications are declining over time. This means that RFID will continue to become more widely affordable as time goes on (Marshall, 2004).

**Education, training and applicability**

RFID technology tends to need the same operational expertise regardless of the position in the supply chain. Fluency in the operation of most RFID instruments is acquired in a relatively short period of time. Due to its ability to automatically capture data without human intervention RFID has the potential to eliminate or simplify processes. This functionality also enables the development or refinement of existing processes (e.g. automated check-out), and may have the additional impact of reducing in-process inventories. However, these need to be considered and analyzed on an individual basis. RFID may reduce administration costs through improved, more accurate, and timely data capture. RFID technology is being used throughout the world (Marshall (2004), EAN/UCC (2005)).

*Table 6-3: Advantages and disadvantages of RFID T&T systems (AMR, 2005 and Marshall, 2004)*

| Advantages | Disadvantages |
|---|---|
| 1. Flexibility- the system can be customized to user's specific needs.<br>2. Increased efficiency in data storage and access with increased volume and complexity of data. As volume increases in a semi-automated system you do not have to exponentially add staff to shuffle paper.<br>3. Easier data compilation and production of statistics summaries for business management.<br>4. Less labour required for data entry and maintenance (i.e. lower labour costs).<br>5. Promotes structured processes which lead to increased efficiency.<br>6. Faster data communication with other partners in the supply chain or with internal divisions of a business.<br>7. Fewer errors in communicating data.<br>8. Less consumption of paper (environmental benefits).<br>9. Less storage space required for archiving paper records.<br>10. Increased information accessibility- the paper copy can only be physically accessed where it is stored/located, information stored electronically can be accessed from anywhere in the world with compatible infrastructure. For example web-mail or internet based access.<br>11. Increased security and auditing- paper copy can be physically seen by anyone with no record of who saw/accessed it, while electronic copy can | 1. Requires capital cost at start up for hardware and software. But this should be evaluated against potential cost savings in material, labour and other resources.<br>2. Relies on either ID tags/labels throughout process or Bar code scanning an additional capital cost.<br>3. Requires training for staff in new equipment and new processes.<br>4. May require higher level of computer expertise for some staff managing the systems..<br>5. Complexity of integrating the technology and systems. The technology should be suited/ customized for the system, which requires understanding of the systems.<br>6. Requires affixing the technology to the item to be traced (e.g. a tag or a label) – so is not applicable to racking individual small items at the 'unit level'<br>7. Device cannot be used from 'net to knife' due to either disassembly or blending<br>8. Cost is prohibitive for low value items (e.g. tags/labels cost many cents each<br>9. Reliability of reading is uncertain with missed reads being common. This is especially true when trying to read individual cases that are packed on a pallet. Tags that are near the middle of the pallet are often not read, or read incorrectly<br>10. Potential to lose the transponder (e.g. ear tag |

| | |
|---|---|
| have auditing for who created, edited, viewed the data with date/time stamps.<br>12. Ability to translate information into multiple languages.<br>13. No physical "line of sight" required to read devices<br>14. Mature core technology (e.g. ear tags)<br>15. Can be embedded in various forms making it virtually tamper-proof<br>16. Specialty tags are robust to specific environments (e.g. wet, dirty, cold, Can be used at the individual animal level (e.g. livestock and poultry) | falls off, bolus is regurgitated, label destroyed<br>11. Difficulty reading items near metal (interference)<br>12. Lack of interoperability between tags and readers of different vendors<br>13. Lack of international standards for allowable frequencies (in particular with UHF frequencies<br>14. Market is young, fast paced, and growing rapidly, resulting in many vendors and products, which is making the buying decision somewhat confusing |

These two solutions are typical technological solutions. From techno-managerial approach, any technological solution must have managerial consequences and vice versa. In this case the managerial consequences of the proposed solutions above are on the training required before application of these solutions. Employees should be trained well to be able to make use of such technology.

*Table 6-4 Evaluation of the proposed solutions (Bar codes and RFID)*

| Criteria | Bar codes | RFID |
|---|---|---|
| Advantages | The advantages of this solution are discussed in detail in table 6-2 above | The advantages of this solution are discussed in detail in table 6-3 above |
| Disadvantages | The disadvantages of this solution are discussed in detail in table 6-2 above | The disadvantages of this solution are discussed in detail in table 6-3 above |
| Cost implications | The costs of implementing this solution are relatively low | The costs of implementing this solution are relatively high (e.g. tags/labels cost many cents each comparing to the price of the item) |
| How ease to implement | This solution is relatively ease to implement although it needs expert intervention | This solution is not difficult to implement. However it needs high experts interventions |
| Widely applicable | This solution is widely applicable (world wide) as a traceability system | This solution is widely applicable (world wide) as a traceability system. However, currently RFID is not as applicable as Bar codes (ECR, 2004) |
| Relevance | Bar codes are already in use in may fish industries world wide, so it is a relevant solution in this problem | RFID technology is also applicable in fish industry. However, it is relevance is low because it can not be used for tracing small items, moreover it can not be used during converging and diverging processes. |
| Reliability | Reliability of this solution as a traceability system is high although bar codes are not 100% temper proof | Reliability of this solution is also high. However, Reliability of reading is uncertain with missed reads being common. This is especially true when trying to read individual cases that are packed on a pallet. |
| Validity | Bar code is a mature core technology so its validity in this case is high | The validity of this solution is also high because RFID is also a mature core technology |

As far as the assessment criterion above is concerned, the more appropriate solution for the visited companies is the use of bar codes traceability system. This solution is easy to implement and does not cost so much money. It is also already used world wide in fish industries as a traceability system (EAN/UCC, 2005 and Tracefish, 2001). Moreover, there are many advantages than disadvantages in using this solution as highlighted in table 6-2 above. Although there are also many advantages of using RFID but there are also many disadvantages as delineated in table 6-3 above, this situation limits the applicability/suitability of this solution to this problem.

## 6.2 Solutions for Low degree of commitment from top management

## Solution 1: Use of total quality management (TQM)

TQM is *the* way of managing for the future, and is far wider in its application than just assuring product or service quality – it is a way of managing people and business processes to ensure complete customer satisfaction at every stage, internally and externally (Dean and Evans, 1994). Internal customer is any next person in the process (Ishikawa, 1985 in Luning *et al*., 2002).TQM combined with effective leadership, results in an organisation doing the right things right, first time (DTI, 2007).

The core of TQM is the ***customer-supplier*** interfaces, both externally and internally and at each interface lie a number of ***processes***. This core must be surrounded by ***commitment*** to quality, ***communication*** of the quality message, and recognition of the need to change the ***culture*** of the organisation to create total quality. These are the foundations of TQM, and they are supported by the key management functions of ***people***, ***processes*** and ***systems*** in the organisation (DTI, 2007).

### Commitment & leadership in TQM

According to Dimitriades (2000), TQM is an approach for improving the competitiveness, effectiveness and flexibility of an organisation for the benefit of all stakeholders. It is a way of planning, organising and understanding each activity, and of removing all the wasted effort and energy that is routinely spent in organisations. It ensures the leaders adopt a strategic overview of quality and focus on prevention not detection of problems. Whilst it must involve everyone, to be successful, it must start at the top with the leaders of the organisation. All senior managers must demonstrate their seriousness and commitment to quality, and middle managers must, as well as demonstrating their commitment, ensure they communicate the principles, strategies and benefits to the people for whom they have responsibility. Only then will the right attitudes spread throughout the organisation. Leaders must take responsibility for preparing, reviewing and monitoring the policy, plus take part in regular improvements of it and ensure it is understood at all levels of the organisation. Effective leadership starts with the development of a mission statement, followed by a strategy, which is translated into action plans down through the organisation.

### Culture change

The failure to address the culture of an organisation is frequently the reason for many management initiatives either having limited success or failing altogether. A culture change, e.g., from one of acceptance of a certain level of errors or defects to one of right first time, every time, needs two key elements (DTI, 2007 ).

- Commitment from the leaders
- Involvement of all of the organisation’s people

### People and management systems in TQM

The only point at which true responsibility for performance and quality can lie is with the **People** who actually do the job or carry out the process, each of which has one or several suppliers and customers. However, people will not engage in improvement activities without commitment and recognition from the organisation’s leaders, a climate for improvement and a strategy that is implemented thoughtfully and effectively. An appropriate documented **Quality Management System** will help an organisation not only achieve the objectives set out in its policy and strategy, but also, and equally importantly, sustain and build upon them. It is imperative that the leaders take responsibility for the adoption and documentation of an appropriate management system in their organisation if they are serious about the quality journey (Dimitriades, 2000). Essentially TQM is not focusing on traceability systems. However, if the concept of TQM is applied in the company, overall commitment from the top management will be high and therefore execution of the T&T system will be high and will contribute positively on the high performance level of T&T system.

## Solution 2: Use of Kaizen Principles

Kaizen is a Japanese term for a formal system to promote continuous improvement (Imai, 1986). Kaizen can principally be delineated in three major orientations. Process orientation, Improving & maintaining standards orientation and People orientation (Berger 1997)

### Principle 1: Process orientation

*Kaizen* is *process-oriented*, i.e. before results can be improved; processes must be improved, as opposed to result-orientation where outcomes are all that counts (Imai, 1986). *Kaizen* does *not* state that results are of minor importance, but rather that management attention should be directed towards creating sound processes since it is assumed that good results will follow automatically. According to Berger (1997) this principle has at least two practical consequences for the improvement process.

*First*, management's main responsibility is to stimulate and support the effort of organizational members to improve processes. In order to be improved, a process must be understood in detail, which in turn means that variability and interdependence in the separate activities and methods used to combine people, machines, material and information have to be known and controlled. Monitoring and improving process variability requires that a majority of employees are actively involved. Consequently, management needs to support employees with adequate skills and training in simple process-oriented methods. *Second*, process-orientation calls for evaluating criteria which can monitor and bring attention to the improvement process itself, while simultaneously acknowledging its outcome. This indicates that *kaizen* serves as a management system for monitoring employee motivation (Berger 1997).

### Principle 2: Improving and maintaining standards

Lasting improvements can only be achieved if innovations are combined with an ongoing effort to maintain and improve standard performance levels (Imai, 1986). *Kaizen* is distinctive in its focus on small improvements of work standards as a result of an ongoing effort. Furthermore, "There can be no improvement where there are no standards" (Imai, 1986) which in essence denotes the relation between *kaizen* and maintaining standard procedures for all major operations (Standard Operating Procedures (SOPs)). (Berger 1997). One indication of the *kaizen* (and perhaps Japanese) pragmatic view on standards is the claim that: The standard should be binding on everyone, and it is management's job to see that everyone works in accordance with the established standards (Imai, 1986)

### Principle 3: People orientation

*Kaizen* is *people-oriented* and should involve everyone in the organization from top management to workers at the shop floor (Imai, 1986). Two practical features can be derived from these principles.

*First*, in order for everyone to be involved, there needs to be a form and content for ongoing improvements that make use of everyone's contribution in relation to e.g. skill and hierarchical level. According to Imai (1986), there are three types of *kaizen* activities, each with its own form and focus in the overall improvement process. **Management-** oriented *kaizen* concerns the gradual improvement of systems procedures such as planning and control, organization, decision-making processes and information systems but also to some extent the improvement of machinery and equipment. **Group**-oriented *kaizen* as a permanent approach is represented in QCC and other small group activities in which employees focus primarily on improving work methods, routines and procedures. **Individual-** oriented *kaizen* is the third form of improvement work which to a large extent can be equated with suggestion systems. The primary focus is to improve one's own work, i.e. on the spot improvements of work methods, routines and the use of resources.

*Second*, the principle suggests that the motivation for *kaizen* is predominantly intrinsic. Intrinsic needs for skill development, quality and worth combined with management acknowledgement for efforts and reward systems for results, are proposed to be sufficient motivation for workers to participate in improvement activities (Berger 1997).

*Table 6-5 Evaluation of the proposed solutions (TQM and Kaizen Principles)*

| Criteria | TQM | Kaizen Principles |
|---|---|---|
| Advantages | Implementation of this solution can lead to: increased morale for workers during execution of T&T system and so can lead to high performance of the T&T system, Reduced costs such as: manufacturing costs, scrap costs and overhead costs, increased customer confidence on the T&T system (because TQM is customer focus) | Kaizen focus on identifying potential improvements by understanding the functions of the current system and its weaknesses and relative inefficiencies so it can be a useful solution because weaknesses and inefficiencies of the current T&T system design and execution will be considered first and this is a positive intervention |
| Disadvantages | Implementation of this solution does not demand radical organisational reform as a result benefits may not be seen for several years | Implementation of this solution requires specialised training and so it needs high expertise. Moreover, the benefits of implementing this solution may not be seen for several years as it focuses on small incremental improvements |
| Cost implications | The money a company invests in TQM is generally spent: either as part of the initial costs of implementing TQM, such as training, education, materials, and so on; or as part of the ongoing expenses required to maintain the program without significant changes. These costs are high for a short run but they are low in a long run. | The cost implications for this solution are high because it requires specialised trainings and high expertise. |
| How ease to implement | TQM is not easy to implement because it requires cultural change in the organisation and at the same time the benefits are far reaching. | Implementation of this solution can be hard as it requires specific knowledge on Kaizen Principles. Moreover, this solution also requires culture change in the organisation. |
| Widely applicable | TQM as an approach /philosophy is used in many organisations world wide | Kaizen principles are not used in many companies world wide. It is an approach which is widely used in Japan. |
| Relevance | The relevance of using TQM in this problem is high because it is focusing on the strategic planning and leadership which is an important tool of enhancing top management commitment during designing and execution of the T&T system in the organisation | Kaizen concept focuses on process, standards and people. These three tools are important for designing and execution of the T&T system and for this case its relevance in solving this problem is high. |
| Reliability | TQM is a reliable approach/philosophy and it is used in many supply chains | Reliability of this concept is probably not very high because it has not been tested in many supply chains world wide |
| Validity | The validity of this solution is high though in some cases companies have failed to implement it. | The validity of this concept is also not very high because it is used only in few companies world wide |

As far as the assessment criterion above is concerned, the more appropriate solution for the visited companies is the use of TQM. Although this solution is not easy to implement and also has high initial costs but in a long run the advantages may offset the disadvantages. Moreover, TQM is already used world wide in many organisations. The fact that TQM is widely used world wide makes it more relevance, reliable and valid solution than Kaizen principles. However, there are many similarities between the two approaches as it can be seen in the table above.

In general TQM solution is seen as a first step to solve traceability problems in these companies. To fully solve the T&T problems in these companies both solutions need to be implemented.

# Chapter 7
# Evaluation

This chapter deals with how well the whole project has been carried out. It includes how the research question, the hypothesis and the objective of the study have been reflected throughout the study. It also deals with personal experiences during the whole study period and the general recommendations for future studies.

## 7.1 Evaluation of the models and theories

To this end, a number of models and theories have been thoroughly studied. In all cases the reflection has been on the use of technological and managerial models and hence T-M approach as proposed by Luning *et al.,* (2002). The starting point of this thesis is from the study conducted by Kousta (2006) and Van der Spiegel (2003). The reliability, validity and relevance of these two models in this study are high since these models have been evaluated by people who are experts in this field. The relevance, validity and reliability of all other models used in this study have been fully discussed in chapter 2 and have been found to be good enough to extract various indicators which are necessary for the operationalisation of the research model. However, the relevance of the models used to focus on the execution of the traceability system and organisation characteristics/complexity were probably not good enough. This led into poor identification of the indicators in those two areas. However, this is probably due to my technological background, time constraints and the nature of the study in general.

## 7.2 Evaluation of the research model

The research model consists of 5 parts. The first part is about contextual factors (product complexity, production process complexity, Fish supply chain complexity and organisation characteristics/complexity), the second part is about traceability system requirements, the third part is about T&T system design and execution, the fourth part is about traceability system performance and the fifth part is about food safety level. The contextual factors refer to the environment in which the system operates. The inclusion of the contextual factors in the research model was necessary since they help the researcher to understand fully the factors affecting/influencing the designing and execution of the system. The second part (traceability system requirement) is also justifiable because it is practically impossible to design and execute any system (T&T system) without having a clear mind of the requirements of such a system. Traceability system objectives were left out (not included in the model) as proposed by Kousta (2006) in her conceptual research model on the expense of this concept (traceability system requirements Vs traceability system objectives). Integration of first, second and third part is therefore necessary in order to realise a certain performance level of the T&T system and consequently food safety level. The research model has been partially evaluated by few experts (mainly from fish processing companies). It is highly regretted that other experts in the field could not be reached within the time frame of this study to validate the research model. Nevertheless, the aim of this study *was not to validate* the research model but rather to use the developed model to analyse the existing situation in the visited companies.

## 7.3 Evaluation of the Analysis

Information/data collection process was mainly based on document analysis, observation analysis and direct interview analysis (triangulation of sources). This was done for the purpose of maximizing information collection process. Quantitative statistical analysis was not possible due to the nature of the study so the information gathered was analysed qualitatively. The conducted analysis identified two major bottlenecks. The identified bottlenecks are: High usage of paper based traceability system and poor commitment from the top management. The paper based traceability system was identified as a major bottleneck because all visited companies use this system in their traceability system and at the same time these companies have the following contextual situation (high degree of diversity of fish species, high degree of diversity of chain actors, many number of processing steps, high degree of divergence and convergence and wild sources of raw material (appendix 3)). It is practically difficult to achieve high performance in the traceability system by using a paper based traceability system while having high level of complexity of the mentioned factors above because high level of these contextual factors put more demand on the design and execution of the T&T system which is low in this case (paper based) .

The second major bottleneck is poor commitment from the top management. The conducted analysis
(Document, interview and observation) shows the following contextual situation in the visited companies (poor working conditions of employees, low level of involvement of employees in the designing of the T&T system, high rate of temporary workers, low degree of accuracy of T&T documentations and low frequency of verification of T&T system (appendix 3)). Given contextual situation like this, it is difficult to obtain high traceability system performance because these contextual situations negatively contribute on the execution of the T&T system and on the overall performance of the T&T system. All these contextual situations can be changed by the top management if there is high commitment to T&T system. For this case poor commitment from the top management is seen as one of the major bottleneck in this study.

Solutions to these bottlenecks have been critically evaluated on the basis of their advantages, disadvantages, cost implication, relevance, reliability, validity and how easy the solution can be implemented.

## 7.4 Intervention role of the researcher

This thesis has been conducted in the area of food quality management. The main focus of Food quality management is the use of Techno-managerial approach as proposed by Luning *at el.*, 2002. The emphasis of this approach is that, food quality management problems should be approached from both technological as well as managerial disciplines. Throughout this research, this concept has been taken into account. However, it has been difficult to maintain the balance between the two disciplines. The ladder has been on the managerial disciplines than on the technological ones. This came as a surprise to me because my background is from technological disciplines (Food science and technology) and so it was expected that there would be more technological models than managerial ones. However, this is probably due to the nature of the problem at hand.

Based upon the research model, a questionnaire was developed with questions formulated around the identified indicators. The answers to each question were categorised to represent a certain level of operation i.e. low, medium and high. Prior to execution of this questionnaire, the questionnaire was supposed to be validated by a couple of experts to check its applicability and relevance of the questions to the problem situation. This part of my thesis was not properly addressed as I failed to get experts in the field of study.

Nevertheless, the solutions proposed after a thorough analysis are valid, reliable and relevant to the identified bottlenecks and emanate from both disciplines; technological (use of bar code traceability system) and managerial (use of TQM). The technological solution (use of bar code) was discussed with the management of all companies and indeed all companies seem to embrace this solution and are now trying to see the possibility of implementing this solution. The managerial solution was not discussed because only when I came back to Wageningen the solution was formulated to the identified bottleneck. This problem was encountered mainly because of time constraints and lack of accessibility to literature (e.g. reputable library and internet) during internship period.

## 7.5 Conclusions

The objective of this research was to gain an insight on the traceability systems performance in fish industries in Tanzania by investigating the major bottlenecks on the designing and execution of such systems under the given complexity conditions of the contextual factors, with the intention of developing scenarios for improvement and thereby contributing to improvement of food safety through such systems. The factors influencing/affecting the performance of the traceability system are shown in chapter 3, figure 3-1. The main research question was "how can traceability system be designed and executed so as to attain a high level of traceability system performance, given that traceability system designing and execution are influenced by, product complexity, production process complexity, organisation complexity and supply chain complexity"? The main factors that should be focused on during designing and execution of the T&T system are presented in chapter 3, figure 3-1. The bottlenecks on the designing and execution of such a system are presented in chapter 5; section 5.3 and the solutions to such bottlenecks are briefly discussed and evaluated in chapter 6.

There is insufficient evidence to make a clear and strong statement with regard to the main hypothesis of this study because it was not possible to measure and judge each indicator in the conceptual model based on the case study.

## 7.6 Recommendations

Based on the results and evaluation made in this study, the following recommendations are made. Future studies should focus on: a more practical research, meaning should consult more experts on the filed and collect enough data for statistical analysis, Should focus more on the integration between T&T system design and execution and existing quality assurance systems in the company such as HACCP system, should focus on the execution and organisation characteristics areas because these two area have been under explored in this study, a more extensive study that should cover the whole supply chain instead of focusing on only one actor in the whole supply chain. Future studies should also focus on motives and objectives that companies have in adopting a traceability system.

# 7: References


1. Abila, R.O. (2002). *A Socio-Economic Analysis of the Fishery Cooperatives of Lake Victoria (Kenya).* PhD Thesis, University of Hull.
2. AMR (Archipelago Marine Research, 2005). Traceability in the BC Seafood sector
3. Ayalew G., McCarthy U., McDonnell K., Butler F., McNulty P.B., Ward S.M. Electronic Tracking and Tracing in food and feed Traceability.
4. Bango Letitsia (2005). FQM masters thesis. Wageningen University, Netherlands
5. Baron, R.A. & Greenberg, J. (2000). *Organisational Behaviour*. Prentice Hall: New Jersey
6. Berger A. (1997). Continuous improvement and kaizen: standardization and organizational designs. Integrated Manufacturing Systems, Centre for Research on Organisational Renewal, Chalmers University of Technology, Goteborg, Sweden
7. Beulens A.J.M, Broens D.F, Folstar P and Hofstede G.J (2003). Food Safety and Transparency in Food Chain and Networks Relationships and Challenges. Wageningen University. The Netherlands
8. Beulens, A.J.M., Coppens, L.W.C.A. and Trienekens, J.H., 2004. *Traceability requirements in food supply chain networks*. Wageningen University, Wageningen
9. Caporale V. Giovannini A. Di Francesco C. & Calistri P. Importance of the traceability of animals and animal products in epidemiology. *Rev. Sci. tech. off. Int. Epiz.* 2001, 20 (2)
10. Dalgaard, P. (1994). Qualitative and quantitative characterization of spoilage bacteria from packed fish. *Int. J. Food Microbial.* (In press).
11. Dalgaard, P. (1994). Modelling of microbial activity and prediction of shelf life for packed fresh fish. *Int.* J. *Food Microbial.* (In press).
12. Dean, W, Evans, J.R (1994), *Total Quality Management, Organization and Strategy*, West Publishing Company, St Paul, MN
13. Den Ouden, M., A.A. Dijkhuizen, R.B.M. Huirne and P.J.P. Zuurbier. 1996. Vertical co-operation in agricultural production-marketing chains
14. Derry, Sharon J. (1990). Learning strategies for acquiring useful knowledge. Dimensions of thinking and cognitive instruction, ed. Beau Fly Jones & Lorna Idol.
15. Dimitriades Z. S. (2000). Total involvement in quality management. Department of Business Administration, University of Piraeus, Greece.
16. Diogo M, Souza M. and Julie A.C, (2006). Traceability Adoption at farm level: An Empirical Analysis of the Portuguese pear Industry. University of Massachusetts. USA.
17. DTI (2007). TQM-From quality to excellence. Department of trade and Industry. UK.
18. EAN.UCC, 2002. Traceability of fish guidelines. Application of EAN.UCC standards in implementing EU legislation and business requirements regarding consumer information and traceability.
19. EAN.UCC, 2003. Traceability implementation guidelines
20. EAN.UCC, 2005. GS1, Traceability standard (IRT: Traceability) Version 1.
21. ECR Europe (2004). Efficient Consumer Response. Using traceability in the supply chain to meet consumer safety expectations.
22. *European Commission Recommendation 2003/361/EC of 6 May 2003, OJ L 124 of 20.5.2003, p. 36*
23. FAO. 1997. The State of Food and Agriculture. Rome: Italy
24. FAO, 1995 Quality and changes in fresh fish
25. FAO/WHO (2002).Global Forum of Food Safety Regulators Marrakech, Morocco
26. Food Standards Agency (FSA, 2002). Traceability in the food chain
27. Food Standard Agency (FSA, 2005) EFSA advice on the safety and nutritional contribution of wild and farmed fish
28. Foote D.A., 2004. Temporary workers, managing the problem of unscheduled turnovers. Emerald management Vol. 42 No. 8 pp 963-973
29. FDA (2001). Food & Drug Administration. Centre for Food Safety & Applied Nutrition. Fish and Fishery Products Hazards and Controls Guide 3rd Edition (http://www.cfsan.fda.gov/~comm/haccp4.html)

30. Gatewood, R.D., Taylor, R.R. and Ferrell, O.C. (1995). Management: Comprehension, analysis and application. Publisher Chicago (etc.), Irwin.
31. Golan E., Krissoff B., Kuchler F., Nelson K. & Price G. (2004). – Traceability in the US food supply: economic theory and industry studies. Agricultural Economic Report No. AER830, March. Economic Research Service of the United States Department of Agriculture,
32. Gram, L. (1990). Spoilage of three Senegalese fish species stored in ice and at ambient temperature. Paper presented at *SEAFOOD 2000* in Halifax, Canada.
33. Gram, L., C. Wedell-Neergaard and Huss H.H. (1990). the bacteriology of spoiling Lake Victorian Nile perch *(Lates niloticus). Int. J.Food Microbial. 10,* 303-316.
34. Gupta S, Misra TN. 1997. Manganese phthalocyanine for the detection of fish freshness by its trimethylamine emission, Sensors and Actuators B41:199-202.
35. HOBBS J.E (2006). Liability and Traceability in Agri-Food Supply Chains. *Department of Agricultural Economics, University of Saskatchewan, Canada*
36. Hofstede, G.J (2003). “Transparency in Netchains” V.1.6 focal area “transparency”. Wu Information Technology Group. Wageningen, The Netherlands
37. Huss, H. H. (1991), *Assurance of Seafood Quality*. FAO Fisheries Technical Paper No. 348.
38. Huss H.H , Development and use of the HACCP concept in fish processing *International Journal of Food Microbiology, 15 (1992)* 33-44 33 ~: t) 1991 Elsevier Science Publishers B.V.Review *72, chnological Laboratom. Ministo, t~f Fisheries, Technical University, Lyngby, Denmark* (http://www.fao.org/docrep/v7180e/v7180e06.htm)
39. Huss, H. H (1995), *Quality and quality changes on fresh fish.* FAO Fisheries Technical Paper No. 334. Rome: FAO
40. ICMSF (1998). International Commission on Microbial Specifications for foods) Application of the hazard analysis critical point, (ltACCP) system t~ ensures microbiological safety and quality. Blackwell Scientific Publications. London.
41. Imai, M. (1986), KAIZEN – the Key to Japan’s Competitive Success, Random House, New York, NY.
42. ISO 2000. International Standard ISO 9000:2000 Quality Management Systems - Fundamentals and vocabulary
43. ISO 9001: 2000. Quality Management Systems - Cross Reference Map
44. ISO 22000, Food safety management systems: Requirements for any organization in the food chain
45. Ivancevich, J.M., Lorenz, P. and Skinner, S., 1994. Management, quality and competitiveness. Irwin, Boston
46. Koelen M.A and Van den Ban A.W. (2004). Health education and Health promotion. Wageningen, the Netherlands.
47. Kousta Maria (2006). Food Quality Management masters thesis. Wageningen University, Netherlands
48. Kurt Salmon Associates Inc. (1993), *Efficient Consumer Response: Enhancing Consumer Value in the Grocery Industry*, Food Marketing Institute, Washington, DC.
49. Lazzarini S.G., Chaddad F.R and M.L. Cook M.L (2001) Integrating supply chains and network analyses, the study of netchains. In: J. on Chain and Network Science, Vol. 1
50. Loftus R., 2005. Traceability of biotech-derived animals: application of DNA-technology. Rev.Sci.Tech.Off. Int. EPZ, 2005,24 (1), 231-242
51. Luning P. A, Marcelis W. J and Jongen, W.M.F (2002). Food Quality Management, a techno-managerial approach, Wageningen University, The Netherlands.
52. Luning P. A and Marcelis W. J. (2006). A techno-managerial approach to food quality management, Wageningen University, The Netherlands.
53. Luten. J. B, Oehlenschlager J, Olafsdottir G (2003). Quality of Fish from catch to consumer. Labelling, Monitoring and traceability. Wageningen, the Netherlands
54. Marshall Peter (2004). Traceability module, AquaTT, Independent Food Quality Certification (I:FQC)

55. Martinsdóttir, E., Sveinsdóttir, K., Luten, J., Schelvis-Smit, R. and Hyldig, G. 2001. *Sensory Evaluation of Fish Freshness*: Reference Manual for the Fish Sector. QIM Eurofish.
56. Meyer, J.P., Becker, T.E. & Vandenberghe, C. (2004). Employee Commitment and Motivation: A Conceptual Analysis and Integrative Model. *Journal of Applied Psychology*, *6*, 991-1007
57. Moe, T. 1998: Perspectives on traceability in food manufacture. Trends in Food Science and Technology
58. Mortimore S., 2001, How to make HACCP really work in practice.
59. NACMCF (1998). National Advisory Committee on Microbiological Criteria for Foods, US Food Safety and Inspection Service.
60. Olsen, P. (2001). *Traceability of fish products*. 1st Tracefish Conference, Copenhagen,
61. Petersen A and Green D. (2005). Seafood Traceability: A practical guide for the U.S. industry.
62. McMeekin T. A., Ratkowsky, D.A, Olley, J., and Ball A. (1993). Relation between temperature and growth rate of bacterial cultures.
63. Stein Onsrud, (2006). CEO TraceTracker USA Inc. Creating value through whole chain traceability. Food traceability conference. Dallas USA.
64. Spekman E. R, Kamauff Jr, J.W and Myhr N. An empirical investigation into supply chain management. A perspective on partnerships. International journal of physical distribution & logistics Management, Vol.28 No.8, 1998.
65. Stijnen, D.A.J.M.; Volker C.M., Geerligs J.W.G., *Cases ECR- Koelvers en Nederweert,* Den-Haag, 2001
66. Summer D. A and Pouliot S (2006), Traceability, Liability and incentives for Food Safety and Quality. Department of Agricultural and Resource Economics, University of California. USA
*67.* Tall, A. (2001). Traceability procedures based on FDA and CFIA regulations – an understanding. *Infofish International* 5:49-51.
*68.* Thompson M, Sylvia G. and Morrissey M.T. 2005, Seafood traceability in the U.S. Current Trends, System Design, and Potential Applications. Comprehensive reviews in food science and food safety
69. Tracefish 2001. European Commission Concerted Action Project QLK1-2000-00164. Traceability of Fish Products. *Second Draft Information Standard for the Captured Fish Distribution Chains.* [05.12.2001] http://www. Tracefish.org
70. Trienekens J.H. and Van der Vorst J.G.A.J (2006), Traceability in Food Supply Chains, in: Safety in Agri-Food Chains, (Eds) Luning, P.A., DeVlieghere, F., Verhé, R., Wageningen Academic Publishers, p. 439-470
71. United republic of Tanzania, fisheries acts (2003), fisheries regulation 2004, regulation 73 (4)
72. U.S. Bureau of labour statistics, Department of labour, Career to industries, 2006-07 Edition, (http://WWW.bls.gov/oco/cg/cgs011.htm)
73. Van der Spiegel M, Luning P.AZiggers., G.W. and Jongen W.M.F (2003) Development of the instrument IMAQE-Food to measure effectiveness of quality management. Wageningen, the Netherlands
74. Van der Spiegel M. (2004), Measuring effectiveness of food quality management. PhD thesis Wageningen University, Wageningen, The Netherlands
75. Van der Spiegel M. and Luning P.A. (2005). Understanding quality behaviour in food supply chains, concept document for critical review article, Wageningen University.
76. Van der Vorst J.G.A.J. (2000). Doctoral Thesis Effective food supply chains: generating, modelling and evaluating supply chain scenarios, Wageningen University.
77. Van der Vorst J.G.A.J. (2003). Performance levels in food traceability and the impact on chain design: results of an international benchmark study**.** Department of Management Research, Wageningen University, the Netherlands.
78. Van der Vorst J.G.A.J. (2006). Performance measurement in Agri-Food supplies chain networks. Logistics and Operations Research Group, Wageningen University, Hollandseweg 1, 6706 KN Wageningen, The Netherlands

79. Vernède, R., Verdenius, F and Broeze, J. 2003. Traceability in Food Processing Chains, State of the art and future developments; KLICT Position paper
80. Watson T.R (2006). Data Management, Databases and Organisations. 5th ed. USA.

# 8. **Appendices**

## Appendix 1: Limiting conditions for pathogen growth (FDA, 2001)

| Limiting Conditions for Pathogen Growth | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pathogen | ***Min. $a_w$ (using salt)*** | ***Min. pH*** | ***Max. PH*** | ***Max. % Water phase salt*** | ***Min. temp.*** | ***Max temp.*** | ***Oxygen requirement*** |
| *Bacillus Cereus* | .92 | 4.3 | 9.3 | 10 | 39.2°F<br>4°C | 131°F<br>55°C | Aerobe |
| *Campylobacter jejuni* | .987 | 4.9 | 9.5 | 1.5 | 86°F<br>30°C | 113°F<br>45°C | Micro-aerophilic* |
| *Clostridium botulinum*, type A, and proteolytic B and F | .935 | 4.6 | 9 | 10 | 50°F<br>10°C | 118.4°F<br>48°C | Anaerobe** |
| *Clostridium perfringens* | .93 | 5 | 9 | 7 | 50°F<br>10°C | 125.6°F<br>52°C | Anaerobe** |
| Pathogenic strains of *Escherichia coli* | .95 | 4 | 9 | 6.5 | 43.7°F<br>6.5°C | 120.9°F<br>49.4°C | Facultative anaerobe*** |
| *Listeria monocytogenes* | .92 | 4.4 | 9.4 | 10 | 31.3°F<br>-0.4°C | 113°F<br>45°C | Facultative anaerobe*** |
| *Salmonella* spp. | .94 | 3.7 | 9.5 | 8 | 41.4°F<br>5.2°C | 115.2°F<br>46.2°C | Facultative anaerobe*** |
| *Shigella* spp. | .96 | 4.8 | 9.3 | 5.2 | 43°F<br>6.1°C | 116.8°F<br>47.1°C | Facultative anaerobe*** |
| *Staphylococcus aureus*- growth | .83 | 4 | 10 | 20 | 44.6°F<br>7°C | 122°F<br>50°C | Facultative anaerobe*** |
| *Staphylococcus aureus*- toxin | .85 | 4 | 9.8 | 10 | 50°F<br>10°C | 118°F<br>48°C | |
| *Vibrio cholerae* | .97 | 5 | 10 | 6 | 50°F<br>10°C | 109.4°F<br>43°C | Facultative anaerobe*** |
| *Vibrio parahaemolyticus* | .94 | 4.8 | 11 | 10 | 41°F<br>5°C | 113.5°F<br>45.3°C | Facultative anaerobe*** |
| *Vibrio vulnificus* | .96 | 5 | 10 | 5 | 46.4°F<br>8°C | 109.4°F<br>43°C | Facultative anaerobe*** |
| *Yersinia enterocolitica* | .945 | 4.2 | 10 | 7 | 29.7°F<br>-1.3°C | 107.6°F<br>42°C | Facultative anaerobe*** |

* Requires limited levels of oxygen ** requires the absence of oxygen *** grows either with or without oxygen. **** Growth significantly delayed (>24 hr.) at 131°F (55°C)

## Appendix 2: Time/temperature for controlling pathogen (FDA, 2001)

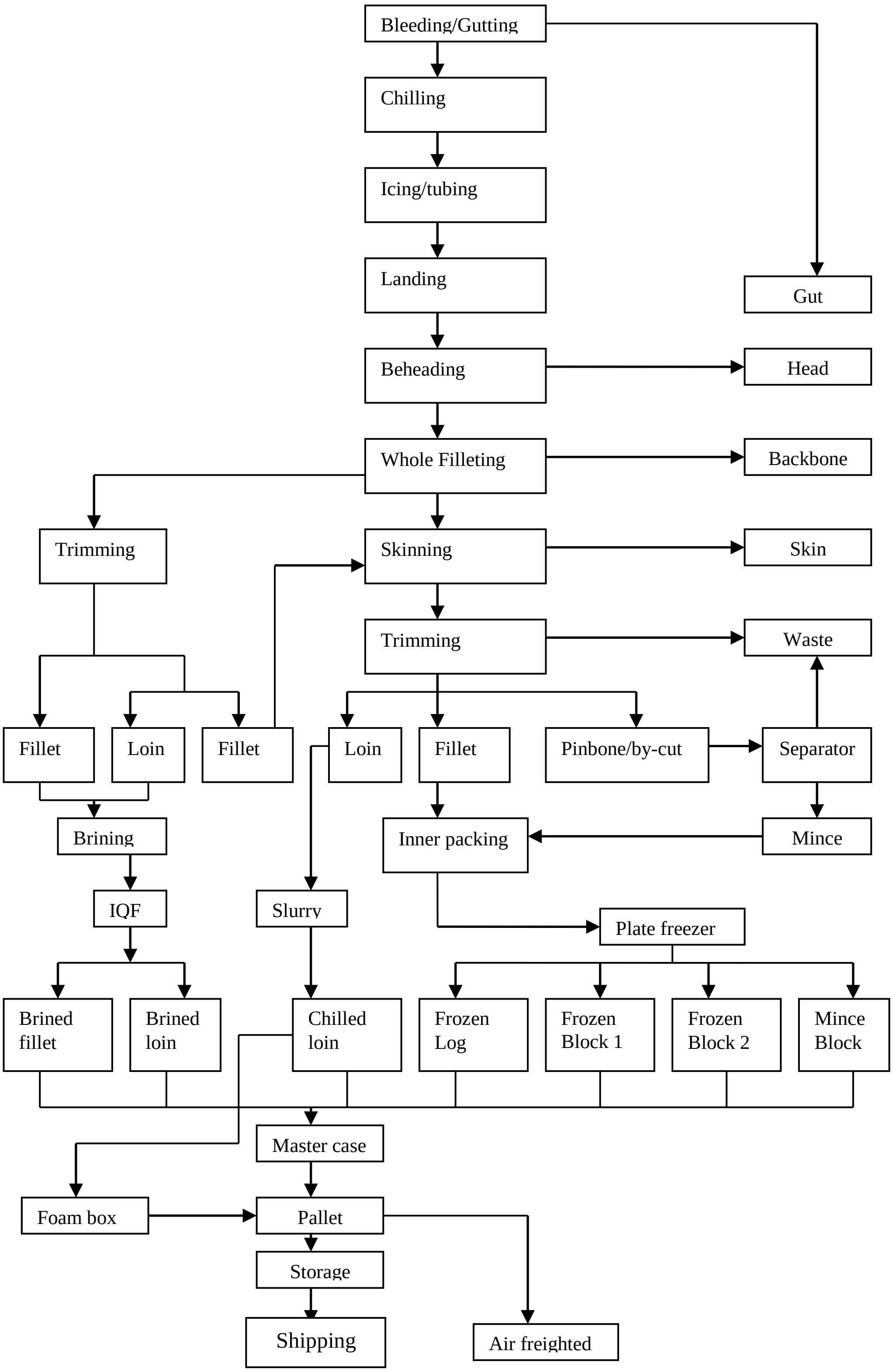
| **Time/Temperature Guidance for Controlling Pathogen Growth and Toxin Formation in Fish** | | |
|---|---|---|
| Potentially Hazardous Condition | Product Temperature | Maximum Cumulative Exposure Time |
| Growth and toxin formation by ***Bacillus cereus*** | 39.2-43°F (4-6°C)<br>44-50°F (7-10°C)<br>51-70°F (11-21°C)<br>Above 70°F (above 21°C) | 5 days<br>17 hours*<br>6 hours*<br>3 hours |
| Growth of ***Campylobacter jejuni*** | 86-93°F (30-34°C)<br>Above 93°F (above 34°C) | 48 hours<br>12 hours |
| Germination, growth, and toxin formation by ***Clostridium botulinum*** type A, and proteolyses B and F | 50-70°F (10-21°C)<br>Above 70°F (above 21°C) | 11 hours<br>2 hours |
| Germination, growth, and toxin formation by ***Clostridium botulinum*** type E, and nonproteolytic B and F | 37.9-41°F (3.3-5°C)<br>42-50°F (6-10 °C)<br>51-70°F (11-21°C)<br>Above 70°F (above 21°C) | 7 days<br>>2 days<br>11 hours<br>6 hours |
| Growth of ***Clostridium perfringens*** | 50-54°F (10-12°C)<br>55-57°F (13-14 °C)<br>58-70°F (15-21°C)<br>Above 70°F (above 21°C) | 21 days<br>1 day<br>6 hours*<br>2 hours* |
| Growth of pathogenic strains of ***Escherichia coli*** | 44.6-50°F (7-10°C)<br>51-70°F (11-21°C)<br>Above 70°F (above 21°C) | 14 days<br>6 hours<br>3 hours |
| Growth of ***Listeria monocytogenes*** | 31.3-41°F (-0.4-5°C)<br>42-50°F (6-10°C)<br>51-70°F (11-21°C)<br>Above 70°F (above 21°C) | 7 days<br>2 days<br>12 hours*<br>3 hours* |
| Growth of ***Salmonella*** species | 41.4-50°F (5.2-10°C)<br>51-70°F (11-21°C)<br>Above 70°F (above 21°C) | 14 days<br>6 hours<br>3 hours |
| Growth of ***Shigella*** species | 43-50°F (6.1-10°C)<br>51-70°F (11-21°C)<br>Above 70°F (above 21°C) | 14 days*<br>12 hours*<br>3 hours* |
| Growth and toxin formation by ***Staphylococcus aureus*** | 44.6-50°F (7-10°C)<br>51-70°F (11-21°C)<br>Above 70°F (above 21°C) | 14 days<br>12 hours*<br>3 hours |
| Growth of ***Vibrio cholerae*** | 50°F (10°C)<br>51-70°F (11-21°C)<br>Above 70°F (above 21°C) | 21 days<br>6 hours*<br>2 hours* |
| Growth of ***Vibrio parahaemolyticus*** | 41-50°F (5-10°C)<br>51-70°F (11-21°C)<br>Above 70°F (above 21°C) | 21 days<br>6 hours*<br>2 hours* |
| Growth of ***Vibrio vulnificus*** | 46.4-50°F (8-10°C)<br>51-70°F (11-21°C)<br>Above 70°F (above 21°C) | 21 days<br>6 hours<br>2 hours |
| Growth of ***Yersinia enterocolitica*** | 29.7-50°F (-1.3-10°C)<br>51-70°F (11-21°C)<br>Above 70°F (above 21°C) | 1 days<br>6 hours<br>2.5 hours |
| * Additional data needed. | | |

## Appendix 3: A table of the summary of results

| Indicator | Score | Descriptions |
|---|---|---|
| **Product complexity** | | |
| Spoilage rate of fish | low | The fish is okay even after been kept on ice for more than 11 days |
| Risk level of product for safety (microbiological and chemical hazards) | low | The incident is not likely to occur once in 10 years and when it occurs, it is simply from an individual consumer complaining about product being out of specification |
| Degree of diversity of fish species with potential hazards | Low for others | only 1 or 2 fish species with potential hazards are manufactured throughout the chain |
| | High for SPL | more than 10 species of fish with potential hazards are manufactured throughout the chain |
| **Production process complexity** | | |
| Number of processing lines | Low | 1-5 processing lines |
| Number of processing steps | High | 10 processing steps |
| Production process structure | High | convergence process occurs inside and outside the company |
| Sources of raw material supply | High | More than 50% of the raw materials are supplied from wild sources |
| **Fish supply chain complexity** | | |
| Degree of diversity of chain actors | High | a fish supply chain consists of multiple suppliers, single fish processors and multiple buyers |
| Level of chain partnership | High | partners carry out joint planning of all activities and exchange all information about product, process and customers on regular bases |
| **Organisation complexity** | | |
| Employee’s involvement | Low | Employees are just informed and instructed about how to work with T&T system during execution stage |
| Working conditions of employees | Low | Noise conditions, bad smell, high humidity and no feed back information |
| Rate of temporary workers | High | more than 60% of all employees are temporary employees |
| Top management commitment | Medium | T&T system is clearly stated in the organisations’ policy, absence of T&T system reviews but clearly stated who is responsible for the T&T system implementation |
| **Traceability system requirements** | | |
| T&T system registrations | High | Product/ process, product flow, supplier and product safety information is registered |
| **Traceability system design** | | |
| Appropriateness of the location of information collection point | Low | T&T information is collected at all processing steps based on internal discussion |
| Determination of traceable resource unit | Medium for others | Batch |
| | High for SPL | Carton |
| Type of identification | Low | Paper |
| Mode of data registration | Low | Manual |
| Location of data storage | Low | Paper files |
| Mode of information communication | Medium | Both printed/oral communication and digital transferring of information (EDI etc |
| Degree of data standardisation | Low | No standards used |
| Degree of using HACCP system in T&T system | Medium | Only some aspects of the traceability system are determined by the HACCP system |

| | | |
|---|---|---|
| designing | | |
| **Execution of the traceability system** | | |
| Degree of compliance with regulations and procedures | High | Complies with both organisation policy as stated in the quality manual and international regulations such as EU regulation 2065/2001 |
| Level of communication of T&T procedures and instructions | High | Both oral and written communication is used between management and employees |
| Degree of accuracy of T&T documentations | Medium | T&T documents are in a specific place, well readable but often not complete and not arranged in a systematic order |
| Frequency of verification of T&T system | Low | No verification is done, verification is done once before implementation of the system |
| **Traceability system performance** | | |
| Time needed to provide the information about the product | High | within 4 hours |
| Reliability | Medium | Local and international approved tools, procedures and information sources are used |
| Precision/accuracy | Low | The actual batch size is not known |
| **Food safety level** | | |
| Percentage of rejected/recalled products from customers | High | Less than 1% of all produced products in a year are recalled /rejected |

## Appendix 4: General fish processing flow diagram



## Appendix 5: Potential vertebrate species related hazards (FDA, 2001)

| Market names | Latin names | Hazards | | | | |
|---|---|---|---|---|---|---|
| | | Biological | Chemical | | | |
| | | Parasites | Natural toxins | Histamine | Chemical | Drugs |
| | | CHP 5 | CHP 6 | CHP 7 | CHP9 | CHP1 1 |
| Barracuda | *Sphyraena spp.* | | CFP | | X | |
| Blue fish | *Pomatomus saltatrics* | | | X | X | |
| Bream | *Nemipterus japonicus* | | | | X | |
| Cobia | *Rachycentron canadum* | X | | | | |
| Emperor | *Lethrinus spp.* | | | | | |
| Snake Mackerel | *Ruvettus pretiosus* | | G | X | | |
| Grouper | *Epinephelus spp.* | X | CFP | | | |
| Grunter | *Conodon nobilis* | | | | | |
| Rainbow runner | *Elagatis bipinnulata* | X | CFP | X | | |
| Mackerel, Spanish | *Scomberomorus spp.* | X | | X | | |
| Mackerel, Spanish | *Scomberomorus cavalla* | X | CFP | X | | |
| Mahi-mahi | *Coryphaena spp.* | | | X | | |
| Marlin | *Makaira spp.* | | | X | | |
| Perch, Nile | *Lates niloticus* | | | | X | |
| Perch, Nile aquacultured | *Lates niloticus* | | | | X | X |
| Perch, Ocean | *Sebastes spp.* | X | | | | |
| Sardine | *Sardina pilchardus* | | | X | | |
| Pomfret | *Alectis ciliaris* | | CFP | | | |
| Puffer | *Fugu spp.* | | T | | | |
| Snapper | Etelis spp. | | CFP | | | |
| Snapper | Lutjanus spp. | | CFP | | | |
| Snapper | Pristipomoides spp. | X | CFP | X | | |

Note. ASP = Amnesic shellfish poison; CFP = Ciguatera fish poison; G = Gempylotoxin; PSP = Paralytic shellfish poison; T = Tetrodotoxin

## Appendix 6: The Questionnaire

## Questionnaire for Quality Assurance Managers

**General information:**
Name ……………………… Position ……………………… Organization…………………

1. How long have you been working with this organization....................................................
2. What is your education level…………………………………………………………..

**A. Questions about product complexity**

1. What is the maximum storage time in ice, for each species of fish, such that after that time the fish become inedible?
   a) More than 11 days
   b) Between 7 and 10 days
   c) Between 0 and 6 days

2. What is the percentage of fish that fall under category 1a above..................................................?

3. What is the percentage of fish that fall under category 1b above…………………………………?

4. What is the percentage of fish that fall under category 1c above…………………………………..?

5. How often does contamination (with pathogens) of raw fish occur above the acceptable limit.....................................................................................................................................?

6. How often does contamination (with pathogens) of finished products occur above the acceptable limit…………………………………………………………………………?

7. How often does contamination (with chemicals e.g. pesticides) of raw fish occur above the acceptable level…………………………………………………………………………?

8. How often does contamination (with chemicals e.g. pesticides) of finished products occur above the acceptable levels……………………………………………………………….?

9. How often do you get incidents of customers being ill after consuming your products?
   a. Never
   b. Once per year
   c. Several times per year

10. How often do you get incidents of customer fatality after consuming your products as a result of pathogenic bacteria contamination?
    a. Never
    b. Once per year
    c. Several times in a year

11. How many types of fish species are you dealing with?
    a. 1 or 2 species of fish
    b. Between 2 and 10 species of fish
    c. More than10 species of fish

12. What are the common (English) and scientific names of fish that you process?
    a. Common (English) name…………………………………………………….
    b. Scientific Name………………………………………………………………

**13.** What are the potential hazards that are normally associated with each species of fish mentioned in 14 above ……… ………… ………… ………… …………… …?

**B. Questions about production process complexity**

14. What is the average number of processing steps does each type of finished product go through?
    a. Between 1 and 5 processing steps

b. Between 6 and 10 processing steps
c. More than 10 processing steps

15. Do you keep T&T records during processing?
    a. Yes……………………………………………………………………………..
    b. No………………………………………………………………………………

16. If yes, at which processing steps do you keep these records
    ………………………………………………………………………………………………..

17. What kind of records do you keep in each step from above (please mention)
    …………………………………………………………………………………………………

18. How many processing lines are there in the company?
    a. Only one processing line
    b. Between 2 and 5 processing lines
    c. More than 5 processing lines

19. From where do you get your raw materials (fish)
    a. From a specific farm (aquaculture)?
    b. From wild sources (sea/ocean)
    c. Both, from specific farm and from the ocean/sea

20. What is the percentage of the raw fish that are originating from a specific farm (aquaculture) if any.......................................................................................................................?

21. What is the percentage of the raw fish that are originating from wild sources e.g. sea/ocean.......................................................................................................................?

22. What is the structure of your production process system?
    a. Straight line structure
    b. Divergence structure
    c. Convergence structure
    d. All of the above
23. Where does a convergence process take place?
    a. Outside company
    b. Inside company
    c. Both outside and inside the company
24. What is the frequency of registering information before divergence processes takes place………………………………………………………………………………?

25. What kind of information do you normally register (Please mention) …..…………
    ……………………………………………………………………….…………….?

26. What is the frequency of registering information after convergence processes takes place……………………………………………………………………………….?

27. What kind of information do you normally register (Please mention) ……………. …
    ……………………………………………………………………………………..?

**C Questions about Fish supply chain complexity**

28. How many raw fish suppliers do you have?
    a. Only one supplier
    b. Between 2 and 10 suppliers
    c. More than 10 suppliers

29. How many fishermen (on average) do each fish supplier has?
    a. Only one fishermen
    b. Between 2 and 10 fishermen
    c. More than 10 fishermen

**D. Questions about Organisation characteristics**

30. At what stage of the T&T system development are employees informed /involved in the T&T system?
    a. Employees are just informed about what they should do during execution stage
    b. Employees are involved during designing stage
    c. Employees are involved from the moment of conceptualization throughout the execution process
31. How frequently are employees encouraged to suggest improvement in the T&T system
    a. Not encouraged at all
    b. Sometimes
    c. Always

32. How often do employees receive feedback information from the management regarding T&T system execution or T&T system performance?
    a. Never
    b. Sometimes
    c. Always

33. Are there written T&T procedures? Yes/No………………………………………………

34. Are the T&T procedures well readable and concise? Yes/No…………………………….

35. Are there written T&T instructions? Yes/No……………………………………………..

36. Are the T&T instructions specific enough to enable smooth execution of the T&T system? Yes/No…………………………………………………………………………………

37. How often do you do T&T system review?
    a. Never
    b. Once in a year
    c. Once in six months

38. Who is responsible for the implementation of the T&T system at the management level…………………………………………………………………………..?

**E. Questions about traceability system requirements**

39. What kind of information do you register in your traceability system ……………………………………………………………………………………………………………………………………………………………………………………………………………………………...?

**F. Questions about traceability system design**

40. What kind of identification tool do you use in your organisation?
    a. Paper label
    b. Bar codes
    c. Radio frequency identification (RFID)
41. What are the reasons behind selection of this type of identification tool ……………………………………………………………………………………………………………………………………………………………………………………………………………………………?
42. What kind of identification tool is used by the fish suppliers ……………………………………………………………………………………………….?
43. What is the percentage of fish suppliers that use the same type of identification tool as the company ………………………………………………………………………………….?

44. How is the traceability information registered in your organisation?
    a. Manual
    b. Manual and automatic
    c. Complete automatic

**45.** How is traceability information registered by the fish suppliers
    a. Manual
    b. Manual and automatic
    c. Complete automatic

46. How do you communicate T&T information with your partners?
    a. Printed paper /oral communication
    b. Both by printed paper /oral communication and digital transferring of information (EDI )
    c. Only digital transfer of information e.g. electronic data interchange (EDI)

47. Where do you store your T&T system data?
    a. In paper files
    b. In individual databases
    c. In central databases

48. Where do the fish suppliers keep their traceability records
……………………………………………………………………………………………?

49. At what point in the production process do you collect the T&T information?
    a. No specific processing point
    b. During packaging
    c. At CCP's
    d. Others

**50.** Why do you collect information at this point
………………………………………………………………………………………………..?

51. What is the extent of information collection in your organisation?
    a. Product level
    b. Batch level
    c. Individual ingredient level e.g. individual whole fish

**G. Questions about traceability system execution**

52. To what extent is the registered information complies with the EU regulations?
    a. Less than 10% compliance
    b. Between 10 and 50% compliance
    c. More than 50% compliance

53. Is T&T system clearly elaborated in your company policy? Yes/No …………………………..

54. To what extent does execution of the T&T system comply with the company policy
………………………………………………………………………………………………………………
……………………………………………………………………………………………....?

55. How do you communicate with employees about T&T rules and procedures?
    a. Oral communication
    b. We communicate by writings
    c. Both oral and written communications

56. At what place (physical locations) do you keep your traceability documentations?

57. Are T&T documentations complete?

58. Are T&T documentations well readable?

59. How frequently do you do verification of the T&T system?

**H. Questions about traceability system performance**

60. How long does it take you to trace a product in your store?
    a. Less than 4 hrs
    b. Between 4 hrs and 24 hrs
    c. More than 24 hrs

61. How long does it take you to provide an information about a specific product that you produced some months ago (e.g. six months ago, in case your customer want this information)
    a. Less than 4 hrs
    b. Between 4 and 24 hrs
    c. More than 24 hrs

62. What kind of tools do you use e.g. thermometers, weighing scale? Etc
    a. Locally made tools
    b. National approved tools
    c. International approved tools
63. What are the sources of T&T procedures and instructions in your company?
    a. Local level
    b. National level
    c. International level

64. What is the average size of your batch………………………………………………………?

65. How often do you change the size of your batch …………………………………………?

**I. Questions about Food Safety Level**

66. What is the extent of product recall/reject from your customers?
    a. Less than 1% of all produced products in a year are recalled /rejected
    b. Between 2 and 5 % of all produced products in a year are recalled /rejected
    **c.** More than 5 % of all produced products in a year are recalled /rejected

## Questionnaire for Organisation directors/General managers

**General information:**

Name ……………………… Position ……………………… Organization…………………

1. How long have you been working with this organization....................................................
2. What is your education level…………………………………………………………..

**A. Questions about Fish supply chain complexity**

1. How many buyers do you have?
    a. Only one buyer
    b. Between 2 and 10 buyer
    c. More than 10 buyer
2. What is the percentage of buyers that are from the EU…………………………………….?

3. How often do you communicate with your business partners?
    a. When there is business problem
    b. Sometimes
    c. Always

4. What information do you normally exchange?
    a. Only information about product
    b. Information about product and process
    c. All business information including product information, production process information and customers information
5. How often do you plan business together
    a. Never
    b. Sometimes
    c. Always
6. What is the perceived level of chain collaboration?
    a. Low
    b. Medium
    c. High

**B. Questions about Organisation characteristics**

7. What is the level of satisfaction from management point of view regarding the current working conditions for employees?
    a. Low
    b. Medium
    c. High

## Questionnaire for production managers

**General information:**
Name ……………………… Position ……………………… Organization…………………

1. How long have you been working with this organization.....................................................

2. What is your education level……………………………………………………………..

**A. Organisation complexity/characteristics**

1. How many employees are working in the company……………………………………………..?

2. How many employees work on temporary bases............................................................................?

3. How many temporary employees work with the T&T system…………………………………….?

## Appendix 6: Improved Questionnaire

## Questionnaire for Quality Assurance Managers

### General information:
Name ……………………… Position ……………………… Organization…………………

1. How long have you been working with this organization....................................................
2. What is your education level…………………………………………………………..

### Product complexity:
**Spoilage rate of fish**

1. Concerning the rate of spoilage of fish .What is the maximum storage time in ice, for each species of fish, such that after that time the fish become inedible?
   a. More than 11 days
   b. Between 7 and 10 days
   c. Between 0 and 6 days
2. What is the percentage of fish that fall under category 1a, 1b and 1c above…………………………………………………………………………………………….?

**Product complexity**
**Risk level of Product for safety**

1. Could you indicate how often does contamination (with pathogens or chemicals e.g. pesticide) occur in your fish above the acceptable limit?
   a. Contamination occur once in 10 yeas
   b. Contamination occur once in a year
   c. Contamination occur several times in a year
   d. Others. Please specify……………………….

2. Could you please indicate what is the perceived risk level of your product
   a. Low
   b. Medium
   c. High

**Degree of diversity of fish species with potential hazards**

1. How many types of fish species are you dealing with?
   a. 1 or 2 species of fish
   b. Between 2 and 10 species of fish
   c. More than 10 species of fish
2. What are the common (English) and scientific names of fish that you process………………………………………………………………………………………………………. ..?

3. Could you please mention the potential hazards that are normally associated with each species of fish mentioned in 2 above……………………………………………………………………………………..?

### Production process complexity
**Number of processing steps**

1. What is the average number of processing steps does each type of finished product go through?
   a. Between 1 and 5 processing steps
   b. Between 6 and 10 processing steps
   c. More than 10 processing steps

**Number of processing lines**

1. How many processing lines are there in the company?
   a. Only one processing line
   b. Between 2 and 5 processing lines
   c. More than 5 processing lines

**Production process structure**

1. What is the structure of your production process system?

a. Straight line structure
b. Divergence structure
c. Convergence structure
d. All of the above

2. Where does a convergence process take place?
   a. Outside company
   b. Inside company
   c. Both outside and inside the company

### Sources of raw materials (RM) supply

1. From where do you get your raw materials (fish)
   a. From a specific farm (aquaculture)?
   b. From wild sources (sea/ocean)
   c. Both, from specific farm and from the ocean/sea
2. What is the percentage of the raw fish that are originating from a specific farm (aquaculture) if any…………………………………………………………………………………………………?

3. What is the percentage of the raw fish that are originating from a wild sources e.g. sea/ocean…………………………………….....................................................?

## Organisation complexity/characteristics

### Degree of employees' involvement

1. At what stage of the T&T system development are employees informed /involved in the T&T system?
   a. Employees are just informed about what they should do during execution stage
   b. Employees are involved during designing stage
   c. Employees are involved from the moment of conceptualization throughout the execution process
2. How frequently are employees encouraged to suggest improvement in the T&T system
   a. Not encouraged at al
   b. Sometimes
   c. Always

### Working conditions of employees

1. How often do employees receive feedback information from the management regarding T&T system execution?
   a. Not at all
   b. Sometimes
   c. Always

### Top management commitment

1. How often do you do T&T system review?
   a. No T&T system reviews
   b. Presence of T&T system reviews but the duration for the review is not specified
   c. T&T system reviews is done annually or when there are changes in the system such as changes in buyers or suppliers
2. Who is responsible for the implementation of the T&T system at management level…………………………………………………………………………?

### Traceability system requirements

### Level of T & T registrations

1. What kind of information do you register in the traceability system?
   a. Only information about method of processing, quantity, price, handling method and time/temperature
   b. Only information about nutritional guarantee, packaging type, time/temperature, appearance, expiry dates, landing dates, fishing gear and landing date
   c. All product, process, product flow, supplier and product safety information such as information about nutritional guarantee, packaging type, time/temperature, appearance, expiry dates, landing dates, fishing gear, landing date, method of processing, quantity, price, handling method, species, landing port, size and weight, freshness category, fishing area, capture time &date, fishing gear, landing date, environmental information and recipes used.
   d. Others. Please specify……………………………………………………

## Traceability system design

### Appropriateness of the location of information collection point

1. At what point/step in the production process do you collect the T&T information?
    a. T&T information is collected at all processing steps based on internal discussion
    b. T&T information is collected at some selected processing steps only
    c. T&T information is collected at all CIP and it is based on HACCP system
    d. Others please specify…………………………………………………..

### Determination of the traceable resource unit

1. What is the extent of information collection?
    a. A shipment truck
    b. Batch level
    c. A carton
    d. Others. Please specify…………………………………………………….

### Type of identification

1. What kind of identification tool do you use in your organisation?
    a. Paper label
    b. Bar codes
    c. Radio frequency identification (RFID)
    d. Others. Please specify…………………………………………………….

### Mode of data registration

1. How is the traceability information registered in your organisation?
    a. By using paper files
    b. By using bar codes
    c. By using RFID
    d. Others. Please specify if any…………………………………………………..

### Location of data storage

1. Where do you store your T&T system data?
    a. In paper files
    b. In individual databases
    c. In central databases
    d. Others. Please specify…………………………………………………..

### Mode of information communication

1. How do you communicate T&T information with your partners?
    a. Communication is done orally
    b. Communication is done by using printed formats
    c. Communication is done electronically
    d. Others. Please specify………………………………………………………………

### Degree of data standardisation

1. What kind of standards do you normally use during data registration?
    a. No standards are used
    b. Locally made standards are used
    c. Internationally approved standards are used e.g. EAN.UCCC standards
    d. Others. Please specify…………………………………………………………..

### Level of using HACCP system in the T&T system design

1. Do you have the HACCP system in your company
    a. Yes……………………………………………………………………
    b. No…………………………………………………………………….
2. If yes, do you use the HACCP system when designing your T&T system?
    a. Yes…………………………………………………………………..
    b. No……………………………………………………………………
3. If yes, what is the level of using HACCP system in the T&T system design?
    a. HACCP system is not used during designing of the T&T system
    b. HACCP system is only used at the initial stages of the T&T system design

c. HACCP system is entirely used in all stages of T&T system design and during execution.

**Execution of traceability system**

**Communication about procedures and instructions regarding T & T**

1. How do you communicate with employees about T&T procedures and instructions?
   a. Oral communication
   b. We communicate by writings
   c. Both oral and written communication are used
   d. Others. Please specify……………………………………………………..

2. If communication is done by writings, can you please show these writings?

**Compliance to regulations and procedures**

1. To what extent is the registered information complies with the EU regulations?
   a. Less than 10% compliance
   b. Between 10 and 50% compliance
   c. More than 50% compliance
2. Is T&T system clearly elaborated in your company policy?
   a. Yes………………………………………………………………………………
   b. No…………….
3. If the answer is yes, can you please show me you company policy statement?

**Degree of accuracy of T&T documentations**

1. At what place (physical location) do you keep your T&T documentations? Please sow
2. Are T&T documentations completed? Please show
3. Are T&T documentations well readable? Please show
4. Are T&T documentations arranged in a systematic way? Please show

**Frequency of verification of T&T system**

1. How frequently do you do verification of the T&T system?
   a. No verification or verification is done once before implementation of the system
   b. Every time that a change is made on the system e.g. whenever there is a change in supplier or buyer
   c. Verification is done on scheduled basis e.g. once per year and whenever there are changes on the system such as change in supplier or buyer
   d. Others. Please specify…………………………………………………………………

**Performance of the traceability system**

**Time needed for tracing the products**

1. How long does it take you to provide an information about a specific product that you produced some months ago (e.g. six months ago, in case your customer want this information)
   a. Less than 4 hrs
   b. Between 4 and 24 hrs
   c. More than 24 hrs
   d. Others. Please specify…………………………………………………………

**Reliability of procedures**

1. What kind of tools do you use e.g. thermometers, weighing scale? Etc
   a. Locally made tools
   b. National approved tools
   c. International approved tools
   d. Others. Please specify……………………………………………………………..
2. What are the sources of T&T procedures and instructions in your company?
   a. Local sources
   b. National sources
   c. International sources
   d. Others. Please specify…………………………………………………………….

**Accuracy/Precision**

1. What is the average size of your batch?

a. the actual batch size is not known
b. the actual batch size is known but is variable from time to time
c. the actual batch size is known and is constant at all the time

**Level of food safety**
**Level of rejected products due microbiological hazards and or chemical hazards**

1. What is the level of product recall/reject from your customers in your organisation?
   a. less than 1% of all produced products in a year are recalled /rejected
   b. between 2 and 5 % of all produced products in a year are recalled /rejected
   c. More than 5 % of all produced products in a year are recalled /rejected

## Questions for Organisation directors/General managers

## General information:

Name ……………………… Position ……………………… Organization…………………

1. How long have you been working with this organization....................................................
2. What is your education level…………………………………………………………..

## Fish supply chain complexity

### Degree of diversity of the chain actors

1. How many raw fish suppliers do you have?
   a. Only one supplier
   b. Between 2 and 10 suppliers
   c. More than 10 suppliers

2. How many buyers do you have?
   a. Only one retailer
   b. Between 2 and 10 retailers
   c. More than 10 retailers

### Level of chain partnership

1. What information do you normally exchange with your partners?
   a. Only information about product (e.g. quantity and price)
   b. Information about product and process only (e.g. quantity, price, time/temperature, production method)
   c. All business information including product information, production process information and customers information

2. What is the perceived level of chain collaboration?
   a. Low
   b. Medium
   c. High

3. How often do you communicate with your business partners?
   a. When there is business problem
   b. Sometimes
   c. Always

## Organisation complexity/Characteristics

### Working condition of employees

1. What is the level of satisfaction from management point of view regarding the current working conditions?
   a. Bad
   b. Satisfactory
   c. Good

2. What is the status of the current working condition?
   a. Noise condition, bad smell and high humidity
   b. Quiet working condition, good humidity but the smell is bad

c. Quiet working condition, good humidity and good smell

## Question for production managers

**General information:**

Name ……………………… Position ……………………… Organization…………………

1. How long have you been working with this organization.....................................................

2. What is your education level………………………………………………………………..

**Organisation complexity/characteristics**

**Rate of temporary employee**

1. How many employees are working in the company……………………………………..?

2. How many employees work on temporary bases..............................................................?

3. How many temporary employees work with the T&T system…………………………...?
    a. less than 30% of all employees are temporary employees
    b. between 30 and 60% of all employees are temporary employees
    c. more than 60% of all employees are temporary employees

## Appendix 7: Sea products Ltd. Supplier list

| Station | Name | Code | | Station | Name | Code |
|---|---|---|---|---|---|---|
| Moa | Ali | 1111 | | Dar | Mwipi | 1163 |
| Boma | Yahaya | 1112 | | Dar | Chenge | 1164 |
| Monga | Mthihiri | 1113 | | Mwambani | Shali | 1165 |
| Kwale | Omari | 1114 | | Dar | Nahodha | 1166 |
| Doda | Athmani | 1115 | | Geza | Ramani | 1167 |
| Mtimbwani | Rama | 1116 | | Pemba | Mwalimu | 1168 |
| Mabokweni | Athmani | 1117 | | Unguja | Mikidadi | 1169 |
| Sahare | Mohamedi | 1118 | | Pemba | Husseni | 1170 |
| Deep Sea | Ashraf | 1119 | | Pemba | Mrima | 1171 |
| Mwambani | Kwabibi | 1120 | | Pemba | Hatibu | 1172 |
| Mwambani | Haji | 1121 | | Pemba | Haji | 1173 |
| Kiwavu | Awathi | 1122 | | Mwambani | Hatibu | 1174 |
| Mwarongo | Hassani | 1123 | | Chogwe | Mohamedi | 1175 |
| Tundaua | Omari | 1124 | | Pemba | Hamisi | 1176 |
| Tundaua | Ali | 1125 | | Mwambani | Ally | 1177 |
| Kigombe | Haji | 1126 | | Pemba | Bakari | 1178 |
| Matakani | Mohamedi | 1127 | | Sadani | Ambari | 1179 |
| Pangani | Haji | 1128 | | Mwambani | Gobe Hamisi | 1180 |
| Pangani | Shaibu | 1129 | | Mchukuuni | Martin | 1181 |
| Pangani | Mashaka | 1130 | | Deep Sea | Ally | 1182 |
| Pangani | Ngozi | 1131 | | Deep Sea | King | 1183 |
| Pangani | Kombo | 1132 | | Deep Sea | Abuu | 1184 |
| Pangani | Mohamedi | 1133 | | Pemba | Mussa | 1185 |
| Pangani | Masudi | 1134 | | Mtundani | Mthihiri | 1186 |
| Mikinguni | Jumaa | 1135 | | Boma | Mthihiri/Ally | 1187 |
| Geza | Mwamsemu | 1136 | | Kigamboni | Othmani | 1188 |
| Kipumbwi | Ali | 1137 | | Pemba | Abdalah/Mohamadi | 1189 |
| Kipumbwi | Makata | 1138 | | Kasera | Urari | 1190 |
| Pemba | Abdallah | 1139 | | Dar | Fadhila | 1191 |
| Pemba | Kombo | 1140 | | Ndumi | Jumaa | 1192 |
| Pemba | Yusuf | 1141 | | Deep Sea | Hamisi | 1193 |
| Pemba | Nassiri | 1142 | | Mchukuuni | Mary | 1194 |
| Pemba | Eliasa | 1143 | | Nyange | Pemba | 1195 |
| Pemba | Nassoro | 1144 | | Deep Sea | Said | 1196 |
| Pemba | Sulemani Issa | 1145 | | Pemba | Waladi/Issa | 1197 |
| Pemba | Hamadi | 1146 | | Dar | Anomitris | 1198 |
| Dar | Ramadhani | 1147 | | Pemba | Hamisi/Nassoro | 1199 |
| Dar | Mwishee | 1148 | | Unguja | Mberwa/Mbaraka | 1200 |
| Dar | Mussa | 1149 | | Mwakidila | Kassim Omary | 1201 |
| Dar | Golwe | 1150 | | Small | Agents | 1000 |
| Dar | Hassani | 1151 | | Ngome | Jumaa | 1202 |
| Dar | Mpepo | 1152 | | Magaoni | Ally | 1203 |
| Dar | Jumaa | 1153 | | Pemba | Salim Scud | 1204 |
| Dar | Mtupa | 1154 | | Pemba | Haji | 1205 |
| Dar | Hamidu | 1155 | | Vyeru | Kadiri | 1206 |
| Dar | Salehe | 1156 | | Jasini | Kadiri | 1207 |
| Dar | Hamisi | 1157 | | Mbuyuni | Ruga | 1208 |
| Dar | Sultani | 1158 | | mwambani | Ruga | 1209 |
| Dar | Gulam | 1159 | | Mwarongo | Etc etc until number | 1388 |

## Appendix 8: Dioxin, heavy metal and hydrocarbon analysis

The analysis for determination of Dioxin, heavy metal and poly-aromatic hydrocarbon is normally carried from Chemiphar laboratory at Kampala, Uganda

| Dioxin | Heavy metal | Poly-aromatic hydrocarbon |
|---|---|---|
| 2,3,7,8-Tetra chlorodibenzodioxine | Total Aluminium | Benzo(a)pyrene |
| 1,2,3,7, 8- Pentachlorodibenzodioxine | Iron (ICP) | Acenaphthylene |
| 1,2,3,4,7,8 Hexachlorodibenzodioxine | Cadmium | Acenaphthene |
| 1,2,3,6,7,8-Hexachlorodibenzodioxine | Mercury | Fluorene |
| 1,2,3,7,8,9-Hexachlorodibenzodioxine | Copper | Anthracene |
| 1,2,3,4,6,7,8-Heptachlorodibenzodioxine | Lead | Fluoranthene |
| Octa chlorodibenzodioxine | Zinc | Pyrene |
| 2,3,7,8- Tetra chlorodibenzofuraan | | Benzo(a)anthracene |
| 1,2,3,7,8- Pentachlorodibenzofuraan | | Chrysene |
| 2,3,4,7,8- Pentachlorodibenzofuraan | | Dibenzo(a,h)anthracene |
| 1,2,3,4,7,8- Hexachlorodibenzofuraan | | Benzo(b)fluoranthene |
| 1,2,3,6,7,8- Hexachlorodibenzofuraan | | Benzo(k)fluoranthene |
| 1,2,3,7,8,9 Hexachlorodibenzofuraan | | Indeno(1,2,3,c,d)pyrene |
| 2,3,4,6,7,8- Hexachlorodibenzofuraan | | Benzo(g,h,i)perylene |
| 1,2,3,4,6,7,8- Heptachlorodibenzofuraan | | |
| 1, 2,3,4,7,8,9- Heptachlorodibenzofuraan | | |
| Octachlorodibenzofuraan | | |

## Appendix 9: Determination of pesticides residuals

Determination of pesticide residuals in fish is done at South African Bureau of Standards laboratory (SABS). These pesticides include residual content of organochlorine (OCs) (including endosulphan), organophosphorus (Ops) and Pyrethroid pesticide as well as Polychlorinated biphenyls (PCBs). For the determination of the PCBs, the representative congeners of the PCBs are normally selected. Here are the details

| PCB | Organo-chlorine (OCs) | Organo-phosphorus (Ops) | Pyrethroids |
|---|---|---|---|
| 2,4,4’-Trichlorobiphenyl (PCB-28) | Alpha-BHC | Dichlorvos, Mevinphos | Cyhalothrin |
| 2,2’,4,5,5’-Pentachlorobiphenyl (PCB-101) | Lindane, Aldrin | Sulfolep, Diazinon | Cyfluthrin |
| 2,2’,3,4,4’,5’-Hexachlorobiphenyl (PCB-138) | Heptachlor, Endrin, Endosulfan sulphate | Parathion-methyl | Cypermethrin |
| 2,2’,5,5’-Tetrachlorobiphenyl (PCB-52) | Heptachlor epoxide | Chlorpyrifos-methyl | deltamethrin |
| 2,2’, 4,4’,5,5’-Hexachlorobiphenyl (PCB-153) | PP’-DDE, Dieldrin, β-Endosulfan | Pirimiphos-methyl | |
| 2,2’,3,4,4’,5,5’-Heptachlorobiphenyl (PCB-180) | PP’-DDD, OP’-DDT, PP’-DDT | Malathion, Parathion | |
| | Methoxychlor | Chlorfenvinphos | |
| | α-Endosulfan | Prophenophos | |

## Appendix 10: List of fish species processed at Sea Products Ltd.

| Common name | Scientific name | Common name | Scientific name |
|---|---|---|---|
| Octopus | *(Octopus vulgaris*), | Parrot/Blue Fish | *Scarus spp* |
| Cuttlefish | (*Sepia pharaonis* | Sword Fish | *Xiphias gladius* |
| Squid | *Loligo forbesi* | Yellow fin Tuna | *Thunnus albacare* |
| Prawns | *Penaeus indicus* | Marlin | *Macaira mazara* |
| Crab | *Scylla serrata* | Baracuda | *Spharaena spp* |
| Lobsters | *Panulirus ornatus* | Cobia | *rachycentron canadus* |
| Slipper Lobster | *Thenus orientalis* | King snapper | *Lethrinus mahsena* |
| Grouper | *Epinephelus malabaricus* | Rosy snapper | *Aprion microlepis* |
| Red snapper | *Lutjanus spp* | Emperor | *Aprion virescens* |
| Dorado | *Coryphaena hippurus* | Rainbow runner | *Elegatis bipinnulatus* |
| Spanish Mackerel | *Scomberomorus commerson* | Grunter Bream | *Pomadasys multimaculatum* |
| Trevally | *Caranx sexfasciatus* | Wahoo | *Acanthocybiun solandri* |

## Appendix 11: Traceability system at Sea products ltd.

Trucks collect raw materials from the designate landing sites leaving fresh ice in clean transport/storage tubs for the next catch. Trucks transport raw material on ice in insulated tubs back to the factory. The raw material is then offloaded from the trucks and carried into the Receiving section. While offloading, the temperature of the raw material is checked by a Receiving supervisor and recorded. The receiving supervisor also performs an organoleptic test checking colour, odour, and the presence of sand and other foreign debris. Any lot that is found to have been time/temperature abused (for instance having an 'off' colour and odour) is immediately rejected. Raw material that is of the required freshness is immediately washed under running water and then placed in a chilled water dip for a few minutes. Once there is enough processing space available to accommodate it, the fresh raw material is transferred into the next Processing section, where filleting, skinning and trimming is done.

After this step, the semi-processed materials are then transferred to the next processing section. The product is then washed individually under showers and placed in a chilled water dip to bring the core temperature down to below 10° C. The product is then graded and then packed in polythene bags then after, the product is placed individually on freezing trays that are in turn placed in freezing trolleys ready for freezing in the blast freezer. The product is blast frozen to a core temperature of minus 18° C or less.

All frozen products are then transferred in to clean trays in the packing area where they are individually graded and packed in designated master cartons. The master cartons are marked with production and expiry dates, as well as product codes, weight and box numbers. Packed products are then stored in cold storage at a temperature of minus 18° C or less until shipment date. All suppliers are given a permanent code through which all suppliers can be identified (Appendix 7). For traceability purposes, all products are given permanent codes as shown in the table below.

Sea products Ltd product code

| Item/product | Receiving code | Packing code |
|---|---|---|
| Octopus | 150 | 1110 to 1177 depending on the grade |
| Cuttlefish | 250 | 1210 to 1218 depending on the grade |
| Squid | 350 | 1310 to 1364 depending on the grade |
| Prawns | 450 | 1410 to 1465 depending on the grade |
| Crabs | 550 | 1510 to 1555 depending on the grade |
| Lobster | 650 | 1610 to 1687 depending on the grade |
| Finish | 750 | 1710 to 1840 depending on the species and grade |

During processing all products are accompanied with the identification label from receiving section to packing section. For example 150/1128/120507 where

150: Means Octopus product
1128: Means the Octopus are coming from Pangani collection site
12: Means production date (12th day of the month)
05: Means Month (May)
07: Means year of production (2007)

All finished products are packed in master cartons. These master cartons are coded and numbered. All grades of all products have a specific corresponding code. For example, if octopus of grade 500grams – 800 grams is packed in a master carton, its product code – 1115 – is stamped on the box. If the box is the 2000th box produced of this grade, then the box number 2000 is stamped following the product code. Therefore, the code for box number 2000 of octopus grade 500 grams – 800 grams will be 1115/2000. The daily report about product code and box number is recorded on GMP 8. The production and expiry dates are stamped separately. All other necessary information such as product name (common name and scientific name), address of the manufacturer, EU approval number, FAO fishing zone number and keeping temperatures are stencilled on the master carton. During shipment, codes and numbers corresponding to each shipped cartons are manually read and recorded in a special form/paper and kept for future references. In summary, the traceability system used in this company is paper based traceability system

## Appendix 12: Traceability system at Nile perch Fisheries Ltd (NFL)

All whole fish from different landing areas are offloaded separately. For traceability purposes, the collection source checklist and the fish movement certificates from the landing sites are checked and counter signed. Productions from different sources are identified at all stages during processing. Frozen products are packed in cartons with required information such as variety, grade, production code, type of packing, country of origin, EU number of the manufacture, net weight etc. Fresh products are packed in styro boxes with country of origin and approval number of the processing plant. All other information is labelled as per buyer's/ destination country's requirement. The grades are separated by colour coding namely red cello tape, green cello tape and blue cello tapes used for strapping the boxes.

Details regarding precautions for handling and storage are marked on the cartons. One day's production is packed in three codes. The total production of a shift is considered as a lot and is comprised by many batches. In this company, the source and the fish collectors are identified by their order of offloading in each shift (in ascending order i.e. 1 to 10). The coding system for fresh/chilled and frozen products is designed shift wise for better traceability.

### Coding system for the first shift

For coding of products processed in first shift, the first digit of the code denotes the year, followed by month, date and shift and thereafter serial number of fish collector (based on the order of offloading). Processing shift codes are not specifically mentioned as it is included in the date of processing. Date (1st to 31st) represent processing shift number one. All the dates start from 01 to 31 represents the first shift. For example in code: 2111013

2 Represents the year 2002
11 Represents the month - November (Digits 01 to 12 for January to December)
10 Represents the date of processing
13 Represents code for the fish collector (According to the order of Offloading in the shift)

### Coding system for Second Shift

A standard number 33 is added to the corresponding date of processing for the identification of second shift to the date. Rest of the code are similar to previous coding system, which means all dates starting from 34 to 64 represent the second shift. For example in code: 211433
2 Represents the year 2002
11 Represents the month November (Digits 1 to 12 for January to December)

43 Represents the date 10 (33 is added)
3 Represent code for the fish collector (According to the order of Offloading in the shift)

### Cording system for Third Shift

A standard number 65 is added to the corresponding date of processing for the identification of shift on that date. Rest of the codes are similar to the previous coding system i.e. all the dates start from 66 to 97 represents the third shift. For example in code 211753

2: Represent the year 2002
11: Represent the month November (digits 1 to 12 for January to December)
75: Represents the date 10 (65 is added)
3: Represents code for the fish collector (according to the order of offloading in the shift)

To make identification process easier throughout the despatch and distribution, each day's production is separated into lots on a weekly basis. The week starts on Sunday and ends on Saturday. The day of the week is identified as "1" through "7". The day's code is stamped on all chilled fillet boxes. In summary, the traceability system used in this company is paper based traceability system

### Appendix 13: Traceability system at Tanzania Fish Processors Ltd (TFP)

The factory has written legal contracts/agreements with its fish suppliers. The contracted suppliers have fishing and supply permit from the competent authority of Tanzania. The competent authority maintains the list of all fish suppliers in all factories.

Each fish supplier is contracted on the basis of his historical data of fish supply and he will sign a contract that fish supplied by him will be of prime quality, caught by legal fishing gear and not by poison and is safe for human consumption. Since fishing boats, transportation boats and workers at landing sites and fishing areas are under direct control of fish suppliers therefore this becomes duty of fish suppliers to assure that the landing sites and fishing areas are maintained with required standards of cleanliness and personnel hygiene. Suppliers also assure that fish is handled properly and kept at right temperature from the landing site to the factory jetty. The company can terminate the fish supplier permit at any time with prior notice to the supplier depending on its quality.

At the time of agreement, suppliers submit the list of all fishing boats they posses. Most of transportation boats & trucks belong to the company and few are privately owned. All boats and trucks are certified by competent authority.For the purpose of fish collection, all fish suppliers collect flake ice produced by the company only. Fishing boats operate directly from the recognised landing sites to allocated fishing area for fishing and bringing back their catch to the landing sites. At the landing sites, fish will be transferred from fishing boats to transportation boats. The transportation boats/trucks collect fish for 1-3 days and come back to the company. Before leaving, the boats and trucks are locked by supplier. The complete operation at the landing site is supervised by beach management units (BMU). BMU gives a permit to the supplier for their every day supply from the landing site. Quality assurance manager audits all fish suppliers once in every three months.

At company jetty, fish from transportation boats & trucks are received. The quality inspector at jetty collects traceability forms issued by BMU and crosscheck for confirmation of the name of supplier, landing site and truck & boat registration number from his list. After confirmation he checks the freshness of the fish by sensory evaluation and records the temperature of the fish. Based on the evaluation report, he can accept or reject the batch of fish. He also does visual sensory evaluation for pesticide contamination along with the fish off-loaders and documents it. Visual sensory evaluation for pesticide contamination is also done by fish cleaning personals at the time of fish washing under the guidance of the quality inspector, who documents all this information. Then the quality inspector assigns supplier code for each supplier serially according to the order of offloading of fish and considering each supplier as one batch. After inspection, washing, grading, weighing and chilling of fish in ice it is supplied to filleting section. Fish from one supplier to the other supplier are well segregated throughout the processing line. All the necessary checks like temperature, quality and personnel hygiene checks are carried out at different stages of production steps and recorded.

At the time of arrangement of fillets in freezer trays supplier code & grades are marked on slips to identify the boxes of each supplier and grade and even the fillets of different suppliers are pressed in different freezers. The freezer supervisor takes accounts of all types and grades of products before putting inside the freezer. This helps in marking the boxes with traceability code. Each sealable carton/box of fillets is marked with a traceability code. The traceability code of TFP contains year of production, production shift, fish supplier code and date of production. Coding for frozen and chilled products is different. For frozen products, the coding is as follows.

Packing Codes frozen products

| | | | | | |
|---|---|---|---|---|---|
| January | A | May | E | September | J |
| February | B | June | F | October | K |
| March | C | July | G | November | L |
| April | D | August | H | December | M |

Therefore the code for frozen products will show, for example, as marked with traceability code – 07A126B, where: 07 = Year of production (2007), A = Shift, 1 = Supplier code, 26 = Date of production, B = Month of production

For the chilled products, the coding is as follows,

Packing Codes for chilled products

| | | | | | |
|---|---|---|---|---|---|
| January | N | May | S | September | W |
| February | P | June | T | October | X |
| March | Q | July | U | November | Y |
| April | R | August | V | December | Z |

Codes for packing shift

| | |
|---|---|
| 1 | Production of afternoon shift and packed by afternoon shift |
| 2 | Production of afternoon shift and packed by night shift |
| 3 | Production of night shift and packed by night shift |
| 4 | Production of night shift and packed by morning shift |

Thus the code for the chilled products will show the traceability code as – P710101, where;
P = Month of production, 7 = Year of production (2007), 1 = Packing shift, 01 = Supplier’s code
01 = Date of packing

Thus fish from one supplier, processed and packed in a shift constitutes one batch. Boxes produced from each batch of fish are recorded at the time of loading of consignment (shipment) for future references.

A label on each carton/box contains the following information: Product name (frozen/chilled Nile perch fillets), Country of origin (Tanzania), EU approval number (APP- 209), Name and address of exporter (Tanzania Fish Processors Ltd. P. o. box 3001 Mwanza, Tanzania), Name and address of importer, Batch code, Date of Export, Net weight and Storage temperature. In summary, the traceability system used in this company is paper based traceability system

## Appendix 14: Traceability system at Vicfish Ltd

All fish from different landing areas are offloaded, processed and packed separately. All fish suppliers posse legal contracts which enable them to supply raw fish to this company. In general there are about 22 different fish suppliers; each fish supplier has about 10 to 20 fishermen. While offloading, the receiving supervisor and section workers do visual sensory evaluation for pesticide contamination. For traceability purposes the company uses six digit coding system. For example, the code 26A0706 means,

26: Date of production, A: Processing shift A, 07: Production month (July), 06: Production year (2006)

All finished cartons are stamped with the respective traceability code followed with the lot number. A lot represents an individual supplier. All suppliers are given numbers according to the order of offloading raw fish in the receiving section. Receiving section supervisor assigns this number to the supplier and maintains the record in the respective file. In addition to traceability code and lot number, all cartons contain the basic information such as, common name of the product, scientific name of the product, keeping temperature, address of the manufacturer, EU approval number, FAO fishing zone number, net weight of the carton, production date, expiry date and grade. Boxes produced from each batch of fish are recorded at the time of loading of consignment (shipment) for future references. In summary, the traceability system used in this company is paper based traceability system

## Appendix 15: Summary of the Information collection procedure

| Indicator | Document | Interview | Observation | Respondant |
|---|---|---|---|---|
| **Product complexity** | | | | |
| Spoilage rate of fish | | √ | | QAM |
| Risk level of fish product | √ | √ | | QAM |
| Degree of diversity of fish species | √ | √ | √ | QAM |
| **Production process complexity** | | | | |
| Number of processing steps | √ | √ | | QAM |
| Number of processing lines | √ | √ | √ | QAM |
| Production process structure | √ | √ | √ | QAM |
| Sources of raw material supply | √ | √ | | QAM |
| **Fish supply chain complexity** | | | | |
| Degree of diversity of chain actors | √ | √ | | GM |
| Level of chain partnership | | √ | | GM |
| **Organisation characteristics** | | | | |
| T&T procedures and instructions | √ | √ | | QAM |
| Degree of employee involvement | | √ | | QAM |
| Working conditions of employees | | √ | √ | QAM,GM |
| Rate of temporary workers | | √ | | QAM, PM |
| Level of top management commitment | √ | √ | | GM |
| **Traceability system requirements** | | | | |
| Level of registration of traceability information | √ | √ | | QAM |
| **Traceability system design** | | | | |
| Type of identification | √ | √ | √ | QAM |
| Appropriateness of the location of information collection point | | √ | √ | QAM |
| Determination of traceable resource unit | | √ | √ | QAM |
| Mode of data registration | √ | √ | √ | QAM |
| Mode of information communication | | √ | | QAM |
| Location of data storage | √ | √ | √ | QAM |

| | | | | |
|---|---|---|---|---|
| Degree of data standardization | √ | √ | | QAM |
| Level of using HACCP | √ | √ | | QAM |
| **Execution of T&T system** | | | | |
| Level of communication of T&T procedures and instructions | √ | √ | | QAM |
| Degree of compliance with regulations and procedures | √ | √ | | QAM |
| Degree of accuracy of T&T documentations | √ | √ | | QAM |
| Frequency of verification of T&T system | √ | √ | | QAM |
| **Performance of the T&T system** | | | | |
| Degree of rapidity | | √ | √ | QAM |
| Degree of reliability | √ | √ | | QAM |
| Degree of precision of batches | | √ | √ | QAM |
| **Food safety level** | | | | |
| % of recalled or rejected products from | √ | √ | | QAM |

QAM: Quality assurance manager, PM: Production manager, GM: General Manager

## Appendix 16: The united republic of Tanzania, Fisheries acts 2003. The fisheries regulation 2004, Regulation no. 73 (4) Sixth Schedule

District…………………………………………………………………………………………….
Name/code of the fish landing station……………………………………………………………

(A) Compiled history record

| Data | Name of supplier | Boat reg. No. | Origin of fish | Quantity supplied (Kg) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | Total | |

(B) History attestation

I, the purchaser of fish loaded in motor vehicle or vessel No………………….. Confirm that the history of the fish indicated above is correct.
Name of purchaser…………………………………………………………………..
Signature………………………………………….Date……………………………

(C) Accompanying certificate

Owner/Operator of the truck/Boat…….…………………………………………………
Truck/Boat Registration Number……………………………………………………..
Species (Scientific name)…………………………………………………………..
Destination………………………………………………………………………….

(D) Health attestation

I the undersigned fish inspector hereby certify that the fish has been inspected and found organonolepticaly wholesome and compliant with other statutory requirements.
Name of the inspector………………………………………………………………….
Signature………………………….Date………………………Stamp………………….

(E) Verification of whole fish at the factory

Remarks: (i) Received (Quantity)……………………………………………………….
(ii) Received (Quantity)……………………………………………………….
Receiving person……………………………………………………………………….
Title………………………………..Date…………………………..Time……………..
Signature……………………………………………………………………………..

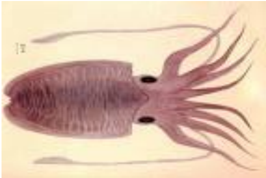
## *Appendix 17: Template of fish processed in studied companies*

Prawns

Tiger Prawns

Squid

Processed Squid

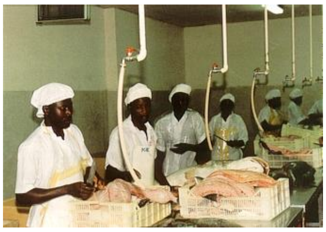


Cuttlefish

Octop

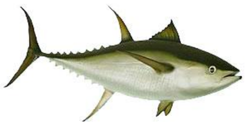
Slipper

Nile Perch



Nile Perch

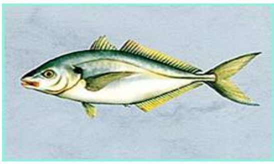
Red Snapper



Yellow fin

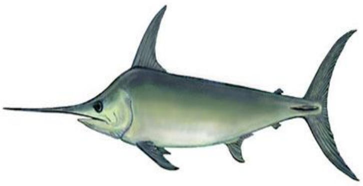
Mud Crab

Spanish mackerel



Trevally

Whole Lobster



Sword Fish

Dorado