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AN ASSESSMENT OF THE BUSINESS VALUE OF TRACEABILITY PRACTICES IN THE ITALIAN FISHERY PROCESSING INDUSTRY

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AN ASSESSMENT OF THE BUSINESS VALUE OF TRACEABILITY PRACTICES IN THE ITALIAN FISHERY PROCESSING INDUSTRY

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A mia madre Ornella, a
mio padre Costante e
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ABSTRACT

AN ASSESSMENT OF THE BUSINESS VALUE OF TRACEBILITY PRACTICES IN THE ITALIAN FISHERY PROCESSING INDUSTRY

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Traceability is often perceived by food industry executives as an additional cost of doing business, one to be avoided if possible. However, a traceability system can in fact comply the regulatory requirements, increase food safety and recall performance, improving marketing performances and, as well as, improving supply chain management. Thus, traceability affects business performances of firms in terms of costs and benefits determined by traceability practices. Costs and benefits affect factors such as, firms' characteristics, level of traceability and lastly, costs and benefits perceived prior to traceability implementation. This thesis was undertaken to understand how these factors are linked to affect the outcome of costs and benefits.

Analysis of the results of a plant level survey of the Italian ichthyic processing industry revealed that processors generally adopt various level of traceability while government support appears to increase the level of traceability and the expectations and actual costs and benefits. None of the firms' characteristics, with the exception of government support, influences costs and level of traceability. Only size of firms and level of QMS certifications are linked with benefits while precision of traceability increases benefits without affecting costs. Finally, traceability practices appear due to the request from "external" stakeholders such

as government, authority and customers rather than "internal" factors (e.g. improving the firm management) while the traceability system does not provide any added value from the market in terms of price premium or market share increase.

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INTRODUCTION

1.0 BACKGROUND

Traceability is a process allowing business partners of the agrifood supply chain to trace back input purchased and processed as well to track final products through the food chain (Desserault, 2006:1). Traceability is not a novel practice in itself. Traceability has always existed between buyers and sellers to the extent that commercial activities have involved the capacity to track and trace the provenance of a product (Desserault, 2006:1). The novel aspect that the traceability concept brings to business practices, is a process that links the information flow from the beginning to the end of a agrifood supply chain (Desserault, 2006:1). Traceability is defined by European General Food Law as "…*the ability to trace and follow a food, feed, food-producing animal or substance through all stages of production and distribution*". This definition shows the complexity of a traceability system; it is one that links all business partners from the beginning to the end of a supply chain (Desserault, 2006:1).

Among others, two main considerations are important for traceability in the agrifood supply chain. First, is that food is perishable. Perishability of food is a major safety concern for producers, processors, distributors and final consumers (Desserault, 2006:1). Second, is that food industries are operating with thin margins of profits; thus the cost of traceability practices can reduce such profits (Desserault, 2006:1). These distinctive aspects of the food supply chain make traceability a more challenging and difficult process to implement as compared to other industrial sectors.

This thesis establishes an assessment of a business value of the traceability practices in the Italian ichthyic processing industries. In particular, an examination of the relationships existing among the factors such as firm characteristics, level of traceability and expected costs and benefits which may affect the actual costs

and benefits due to traceability systems in an *ex-ante* and *ex-post* comparison[1] will be conducted.

The traceability practices in the food industry as business activities are influenced by several driving factors as follows (Desserault, 2006:2-5):

- ✓ *Food safety* – The demand of higher food safety is a result of major disease as, for example, BSE in Europe and North America and dioxins scandal in Belgium. Then, governments have demanded for food industry enterprises along the supply chain, a higher level of safety through the traceability system implementation. For example, retailers may require assurances from wholesalers or processors, and processors will require these assurances from other processors or farmers (Hobbs, 1996a:16-26);
- ✓ *Regulatory compliance* – Regulatory agencies and governments are also demanding a higher level of safety for the food industry. In 2002, the EC stated in the European General Food Law that all food operators are obliged to have in place a traceability system to be able to trace and track food products and ingredients. In 1996, Hobbs (1996a:16-26) presented traceability to the UK Ministry of Agriculture, Fisheries and Food as part of the solution to the regulatory compliance problem: *"…as part of the government's strategy to restore consumer confidence in British beef and to improve animal identification and traceability*";
- ✓ *Recall* – The key aspect of food safety is the capacity to effectively and rapidly achieve recalls in the food industry. This is the reason why the process of recalling or withdrawing products must be carried out efficiently and the origin and destination of product units must be known. The costs incurred by a

[1] According to Myrdal (1939) in the discussion about the monetary equilibrium, he defines the *ex ante* and *ex post* concepts. He defines *ex ante* value as on anticipations or forecasts of future economic variable while *ex post* value was, in contrast, based upon actual bookkeeping results. Black (1997) defines *ex ante* as something looked at in advance, that may not be borne out in practice, therefore it would be difficult to assess. This is because firms often do not announce their intentions and when they do one may not necessarily believe the announcements. In contrast, *ex post* is the value of the variable and after the event is in principle observable (Bailey, *et. al.,* 2002:253).
Based on these definitions, I define *ex ante* costs/benefits as anticipated as pre-regulation EC n.178/2002 and *ex post* costs/benefits as post-regulation EC n.178/2002 that has introduced traceability system in the food supply chain in EU.

recall are high and can negatively impact profitability. An efficiency recall can reduce the probability of a food safety issue and reduce recall costs by allowing for only a specific portion of a production lot to be recalled. Furthermore, an efficiency recall can protect the image of the firms' brand by a possible damage of a food scandal (Food Standard Agency, 2002:16; Golan *et al.,* 2004:16-21);

- ✓ *Consumer demand for transparency* – Nowadays, consumers are interested into knowing a lot about foods, as for instance its provenience, product process and product characteristics. According to Moe (1998:211-214) the driving part of the development of traceability system is the increasing demand for food safety and transparency from consumers. For example, Buhr (2002:103-114) shows the importance of consumer demand for transparency when interviewing various enterprises within the food supply chain. The primary reason study participants implemented traceability practices was because consumers demanded to know where their food came from and how it was produced. Therefore, traceability plays a role influencing consumer choice in the purchasing decisions;
- ✓ *Supply chain management* – According to Bowersox *et al*.,(2002) supply chain management consists of firms collaborating to enhance strategic positioning and to improve operating efficiency. This means minimizing costs of at least two business partners rather than minimizing the costs of each partner separately. This is particularly true for transaction cost. Traceability may allow business partners to think differently about their business relations with suppliers and customers;
- ✓ *Market* – In some markets, chains request their suppliers to have traceability systems in place. This means that to have access to some markets, the fundamental key requirement is to adopt a traceability system. Then, for these operators adopting traceability systems could allow for a competitive advantage in comparison to other competitors;
- ✓ *Certification of specific attributes* – Often food companies as marketing strategies target specific market segments. For this reason, such companies promoting distinctive characteristics of a product to a group of consumers

share a common profile. To make this, traceability can certify such attributes or characteristics and then emphasize their importance. This is possible through recordkeeping that establishes their creation and preservation. Traceability allows products to be certified for identity preservation, defined as "*the set of measures taken to preserve and communicate the exact identity and source of food and food ingredients to the end user*" (Meuwissen *et al.*, 2003:50).

The factors mentioned above, highlight the importance of the food industry implementing traceability in order to track what is produced, processed and distributed. While several studies have pointed to the benefits and technical aspects, few studies have explored the economics and business characteristics related to traceability practices in the food supply chain.

1.1 ECONOMIC PROBLEM

The Institute of Internal Auditors states that a conversion to a new system is one of the highest risks that an organization can face (Swanson, 2004:1-5). Traceability is a new system. The implementation of traceability system is a major challenge that has been undertaken by food chain operators in the last years. According to Verdenius (2006:26) traceability is often seen as an imposition requiring investment, but not contributing to any profits or competitiveness. This is one reason why traceability has been slow to be introduced in the food sector (Verdenius, 2006:26). Traceability systems can be costly to implement and operate and it is not an activity that automatically creates value for the final customer. These findings are consistent in the study by Zins Beauchesnes *et associés* (2003:8) which found that 22.6% of the plants surveyed expressed concern over the costs of traceability. For this reason, there is considerable uncertainty about the benefits of a traceability system. According to Ross Systems (2004:6), the current challenge for many food processors is to identify an automated approach to traceability that is both cost-effective and a good fit with current business operations and future standards.

The economic problem underlying traceability is that the uncertainty over its costs and benefits has never been empirically studied at the industry level in the food

supply chain. The factors affecting the actual outcomes of costs and benefits of traceability implementation help to contribute to a better understanding of the impact of traceability on food operators.

1.2 RESEARCH PROBLEM

As mentioned in the previous section, there is little understanding or documentation about costs and benefits of traceability system implementation perceived by food processors (Meuwissen *et. al.,* 2003:58-59). Most studies have focused on the technical characteristics of traceability instead of economic considerations. Meuwissen *et al.*, (2003:167-181) state that additional research on traceability systems is needed which includes important economic aspects such as costs and benefits along the production chain. Furthermore, traceability systems that adopt IT systems create organizational implications that need to be investigated further (Senneset *et al.*, 2007:817).

Costs and benefits of traceability of food products are only partially known so far. Only a few studies determining costs and benefits of improved traceability (Hurburgh, 2003; Wilson, Xavier, Dahl 2005), modeling firms' incentives for implementing tracking and tracing technologies (Hobbs, 2004:1-32) or estimating consumers' willingness-to-pay for improved traceability exist (Dickinson and Bailey, 2002:348-364; Hobbs *et al.,* 2005:53-62). Thus at the moment, firms' decisions concerning investments in tracking and tracing technology are not very well understood. Research problems regarding the factors that could affect costs and benefits caused by traceability implementation such as firms' characteristics, level of traceability and expected costs and benefits are presented.

The research problem is that there is no empirical research which investigates factors which affect costs and benefits of traceability system implementation as perceived by food processors. Without an industry survey it is impossible to know which and how factors impact on actual costs and benefits.

1.3 CONTRIBUTION TO LITERATURE, INDUSTRY AND GOVERNMENTS

A business value assessment of the factors which affect the actual costs and benefits of the traceability practices could aid researchers, industry managers and policy makers as follows.

First, this thesis will benefit the academic perspective filling the gap in literature review about economic aspects of traceability practices as previously mentioned. In particular, researchers seeking to design additional empirical studies investigations, that regard the relationships existing among factors that influence the actual outcome of costs and benefits of traceability practices.

Second, the results of an empirical analysis of traceability practices could bring some useful insights to the food industries which have implemented or will implement traceability systems. For instance, it may reveal a dimension of the level of traceability which is more convenient to invest in increasing the level of traceability than other dimensions or it might reveal that there is a firms' characteristic that increases the expected and actual costs and benefits than others. Then, firms that are planning to implement a traceability system can take into account that some of their characteristics may determine higher costs or lower benefits than other firms; for instance, which of the firms' characteristics are more linked to actual costs or benefits. In addition, this thesis could provide useful insights about possible surprises on costs and benefits that emerged by traceability system implementation.

Third, governments and food safety authorities could benefit from such research in developing legislation or industry programs designed to enhance traceability practices, supporting a breakthrough in the efficiency and effectiveness of food safety practices. For instance, governments could understand in-depth how government support impacts the level of traceability or influences the firms' business.

1.4 OBJECTIVES AND RESEARCH QUESTIONS

The overall goal of this thesis is to establish an assessment of the factors, such as firms' characteristics, level of traceability and expected costs and benefits, which

impact on actual costs and benefits as resulting from implementing traceability practices in the Italian ichthyic processing industry.

The specific objectives are:

- ✓ investigating the role that, "level of traceability", "firms' characteristics", particularly government supporting, "expected costs and benefits", played with traceability of "actual costs and benefits". Specifically, testing the relationships among the following factors:
  a) "level of traceability", "expected costs and benefits" and "actual costs and benefits". This relationship measures how the level of traceability is more linked with expected costs and benefits or actual costs and benefits;
  b) "firms' characteristics", "expected costs and benefits" and "actual costs and benefits". This relationship measures the effect that firms' characteristics have on expected and actual costs and benefits;
  c) "firms' characteristics" and "level of traceability". This relationship informs which of the firms' characteristics influence the level of traceability.
- ✓ investigating, through an in-depth analysis (*ex-ante* and *ex-post* comparison), the importance of the specific costs and benefits of traceability implementation;
- ✓ develop useful recommendations for future academic research on traceability systems in the food supply chain;
- ✓ develop useful recommendations for the ichthyic processing industries that intend to implement traceability system in their plants;
- ✓ develop useful recommendations for the governments which are involved in supporting traceability practices in the food supply chain.

Therefore, in order to respond to the objectives of the thesis mentioned above, three key research questions have been developed as follows:

- ✓ how the level of traceability is more closed with expected costs and benefits than actual costs and benefits?
- ✓ what are the relationships between firms' characteristics, in particular government support and expected and actual costs and benefits?

- ✓ which of the firms' characteristics, in particular government support, determine the level of traceability?

1.5 ORGANIZATION OF THE THESIS

The thesis is organized into six chapters. Chapter one provides an introduction of the thesis with particular emphasis on the economic and research problems, contribution to literature, industry and governments and objectives that lead to the aim of the thesis. Chapter two will provide a deep literature review of background information about traceability in the agrifood supply chain with particular emphasis on related costs and benefits and government support. In addition, I will describe a case study's research of an Italian ichthyic processing industry. Chapter three will describe briefly the Italian fishery supply chain. Chapter four presents the conceptual framework with description models that will be used for testing hypothesis. At the end of the Chapter, a description of generating processes of indexes used, the survey design, the questionnaire description, the limitations of the survey, the characteristics of the sample and the response rate resulted by the survey conducted will be presented. Chapter five will present the results and descriptive statistics as emerged by testing hypothesis. An explanation and reasons for statistical methods used will be provided. Finally, Chapter six will present the conclusions and summary results. Moreover, a particular emphasis on implications and recommendations for future researches, industry and governments will be provided.

CHAPTER TWO

IMPACT OF TRACEABILITY PRACTICES ON THE FOOD SUPPLY CHAIN: LITERATURE REVIEWS AND AN APPLICATION TO THE ITALIAN FISHERY SUPPLY CHAIN

2.0 INTRODUCTION

This Chapter discusses the concept of traceability and its applications within the food supply chain. The aim of Chapter two is to provide useful background information, both from the literature review and a case study's analysis which are the basis of the following chapters. Thus, this Chapter will split in two parts. First, traceability will be defined and then, its processes, sub-processes and technological applications will be explained including the functions of tracking and tracing food. In addition, business and economic aspects of costs and benefits and government involvement, as reflected in the key process of legislation, into traceability practices will be presented.

Second, I will present the results which emerged from a case study's analysis of an application of a traceability system in the Italian fishery supply chain: Scardovari Consortium's.

2.1 DEFINING AND PROCESS OF TRACEABILITY

Traceability is not a new concept, but it is an innovation system that European food operators need to implement in their plants to comply with the European General Food Law[2]. Traceability can be defined in several ways depending on its purposes (e.g. for regulation, food safety, supply chain management or marketing). A definition by ISO[3] 8402 (1994) says that "*traceability is the ability*

[2] EC Regulation n.178/2002.
[3] International Standard Organizations.

to trace the history, application or location of an entity by means of recorded information". Such a definition does not specify any recommendations, but is broadly recognized by important organizations such as USDA[4], ECCNET[5], ECR Europe[6], EAN.UCC[7] and EPC[8].

A more specific definition is provided by ISO 9000:2000: "*Traceability is the ability to trace the history, application or location of that which is under consideration. When considering a product, traceability can relate to the origin of materials and parts, the processing history and the distribution and location of the product after delivery".* Such a definition focuses more on the traceability concept in the entire food chain.

European Food Law[9] defines traceability as "*the ability to trace and follow a food, feed, food-producing animal or substance through all stages of production and distribution".* Such a definition is interesting, because it introduces the traceability also for feed. Stages of production and distribution means any stage including import, from and including the primary – production of food and including its sale of supply to the final consumer and where relevant for food safety, the production, manufacture and distribution of feed (Food Standard Agency, 2002:7). By this definition it is possible to extract an implicit aspect of traceability (i.e. it is an end-to-end process in which different companies collaborate to link the interfaces determined by its different directions, areas or sub-processes).

The Codex Committee on Food Import and Export Inspection and Certification System (CCFICS)[10] defines traceability as "*the ability to identify a food (product identification), how it was changed (if appropriate), where it came from and where it was sent (one step backward and one step forward), (product information) and the linkages between product identification and product information, while also noting that the applicability of these elements will depend on the objectives being pursued by the individual texts".*

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[4] United States Department of Agriculture.
[5] Canada's National Product Registry.
[6] Efficient Consumer Response.
[7] EAN International – Uniform Code Council.
[8] Electronic Product Code.
[9] Regulation N°178/2002 – art.3.
[10] 11th session, Adelaide, Australia, 2 – 6 December 2002, Agenda Item 7 CX/FICS/02/11/7 Paragraph 7.

The above traceability definitions illustrate that every traceability definition is broad. According to Golan *et al.*,(2004:3) the definition of traceability is necessarily broad because the food industry is complex due to the variety of food products available for the consumers and to the range of inputs and ingredients used. Furthermore, traceability is a tool for achieving a number of different objectives. As a result, no traceability system definition is complete.

Therefore, there is not a single internationally accepted definition of traceability for food products (FAO, 2004:1). Then, the traceability definition differs from one operator to another depending on the business activity, sequential position in the supply chain (upstream or downstream) and applicable legislation (ECR Europe, 2004:24). For Can-Trace[11] (2004:21-31) traceability definition has to take into account that traceability is also a part of business systems. Therefore, traceability has to be strongly developed with logistic process, GMP[12], food safety programs, such as HACCP[13] and QMS[14].

As previously mentioned, traceability is a system designed to track and trace products and their components through the food supply chain. Tracking is the capability to locate a product based on specific criteria at any point of the supply chain. Such a concept is important because firms must be able to identify and locate their products in order to withdraw or recall them when necessary (one step forward legal principle). Tracing is the capability to identify the origin and characteristics of a product based on criteria determined at each point of the food supply chain. This is a critical point for firms, because they must be able to determine the sources of products received in an accurate and fast manner when necessary (one step backward legal principle).

In order to identify the location of a product, it is necessary to define the positions of intermediaries and their location through the food chain. EAN France (2004:9) defines the concepts of upstream and downstream traceability that correspond to the point of view of a supply chain partner. Upstream traceability describes the

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[11] Can – Trace is a Canadian industry initiative designed to develop information standards to track and trace food products for a variety of food safety, quality and supply chain improvement applications.

[12] Good Manufacturing Practices.

[13] Hazard Analysis Control Critical Points.

[14] Quality Management Systems.

procedures and tools implemented in order to locate an event that has already occurred before the partner concerned has become legally or physically responsible for the products while downstream traceability describes the procedures and tools implemented in order to locate an event that has occurred after the transfer of property or after the physical transfer of products from the partner to a third party.

Traceability is developed in order to trace and track products in the food supply chain and also within a specific intermediary. Therefore, one has to differentiate between the concepts of chain traceability and internal traceability. Chain traceability refers to the ability to trace the history, application or location of an entity by means of recorded identifications throughout the entire food chain (CIES, 2004:6). Internal traceability refers to the ability to follow the path of a specified unit of a product and/or batch within one company or company unit. It takes place independently of the commercial partners (CIES, 2004:6).

The efficiency and effectiveness of a traceability system depend on the accuracy of the system used by each intermediary. The traceability objectives of each supply chain partners may differ in terms of the drivers, that push to implement traceability system and also by the quantity of information collected. As a result, traceability has various levels of efficiency for each of the different sectors of the food industry and supply chain levels.

It is also important to consider that a traceability system for tracking and tracing every input as a process to satisfy every objective would be enormous and highly expensive (Golan *et al.*, 2004:17). Then, it is necessary that food operators decide what are the objectives of the traceability system in order to prioritize investments.

According to Golan *et al.,* (2004:3) various objectives help to drive differences in breadth, depth and precision of traceability systems. These three variables are described as follows (Golan *et al.*, 2004:17). Breadth describes the amount of information collected. A recordkeeping system cataloging all of a food's attributes would be enormous, unnecessary and expensive. The breadth will vary depending on the nature of the product, on farm practices or other food chain operations, customer specifications and legal or codes of practice requirements. Depth

describes how far back or forward the system is which tracks the relevant information. This means how many supply chain stages are involved in the traceability system. Precision reflects the degree of accuracy with which the tracing system can pinpoint a particular food product's movement or characteristics. Such variables characterize the traceability system that each operator has to develop and implement and then, they characterize the accuracy of a specific food supply chain.

2.2 THE SUB-PROCESS: SUPPORT SYSTEM AND TRACEABILITY TECHNOLOGIES

A general traceability system is based on four main elements (ECR Europe, 2004: 23-48; Indicod, 2003: 8 - 12):

1. *Unique identification of products, logistic units and locations.* This is the basic principle of traceability: any trade item and/or location must have a unique number to facilitate tracing and tracking through the food supply chain. Each stakeholder has to be able to identify all the operators and products along the food supply chain. This means that, the logistic unit[15], consumer unit[16], location unit[17] and productive batch of the same manufacturing process have to be univocally identified with a standard code;
2. *Traceability data capture and recording.* Traceability implementation requires that each product has an unique number, that is recorded by each intermediary along the food supply chain. To ensure traceability, each firm has to record in a standard code system the logistics units, consumer units and location units. The most widespread identification and standard code system used is the

[15] Logistics units are usually packages of goods (retail or trade units) assembled for transport or storage, where the unit needs to be tracked and traced individually in the supply chain. Logistic unit may consist of single item, carton, pallet or container. Each package type may contain a standard set of contents or some unique combination for a particular customer's requirement (www.gs1india.org/ABOUT/EANsyst4.htm, appeared on Internet 14 october 2008 h.17.15).
[16] Consumer unit is a form of a product that consumer buys at the retail level (e.g. a single bottle of wine).
[17] Location unit is a physical place where the product has been harvested, processed, packaged, etc. (e.g. name and address, exact location of operation).

EAN.UCC[18]. It identifies the standard and transfers the traceability data. EAN.UCC is an univocal number composed by three codes:

- ✓ SSCC (Serial Shipping Container Code) identifies the logistic units. It is a number which is shared among partners and/or stored by each trading partner where applicable;
- ✓ GTIN (Global Trade Item Number) identifies the consumer unit/trade items[19] at the consumer level. GTIN and number of batch/lot identifies univocal the consumer unit in all the world;
- ✓ GLN (Global Location Code) identifies the locations units where the product has been farmed, harvested, processed, packaged, etc.

According to GS1 (2007:23) there are two types of data required for traceability practices. First, are the master data which seldom changes, such as product, party and location information. Second, are the transactional data. These data are unique to each individual transaction (e.g. lot number, shipment identifier and shipment date, etc).

Further, it is strongly important to identify additional key information requirements, that may be related to specific regulatory requirements (e.g. labelling regulation, origin, method of production, etc.);

3. *Links management and traceability data retrieval*. After collecting the traceability data, the data has to be managed in order to be able to trace and track the product. Data management allows the distribution channel of a product to be reconstructured from raw material to retail level. Basically, products are traced and tracked by lot or batch. Then, it is necessary to record the links between lots or batches and logistics units along the supply chain. In particular, it is important to link correctly and precisely:
   - ✓ input lots and lots of production;
   - ✓ lots of product: raw material and packages of finished product;
   - ✓ lots of production and logistics units: between storage intermediate lots and logistic unit;

[18]It is a tool to facilitate business transactions, e-commerce, modality standard to trace and track to improve the management of the supply chain, reduce costs and increase the value of the product.
[19] Unit consumer or packaging.

- ✓ between logistic units.

4. *Communication*. Traceability requires the sharing of information among partners of the food supply chain. In addition, it is important to communicate traceability data to the consumer in order to gain and maintain consumer trust.

   An example of traceability communication at the consumer level is the Effelle Pesca s.r.l. Effelle Pesca is an Italian ichthyic processing industry located in the North of Italy. The traceability information is communicated to the consumer through the website (www.effellepesca.com). Consumers have to simply enter the website and insert in the proper space the code of the product purchased.

2.2.1 TECHNICAL TOOLS OF TRACEABILITY

According to Food Standard Agency (2002:21), the key point of all supply chain technologies is the ability to identify the things that move: pallets, packages, units of product, etc. The simplest typology of identification is the label which information, such as bar code, is written on (Food Standard Agency, 2002:21). Basically, there are two types of traceability tools.

The first type is paper based. It is an old tool, but it is still used sometimes alone and sometimes mixed with electronic tools. Paper is very simple to use and cheap, but it facilities making errors.

The second type of traceability tools is electronic based. They are very simple to use, have quick access, are error free and easy to integrate with other systems (e.g. accountability system), but they are more expensive than paper tools. Next, I describe the most important electronic tools used for traceability practices:

- ✓ *Optical systems.* According to Food Standard Agency (2002:21), barcode is a machine-readable system, which uses a simple coding system with various thicknesses of bars and spaces. It is readable by scanner which recognizes the contrast between bars and spaces. The weakness of such a tool, is that sometimes the size and print quality of the code is not adequate to ensure that it is readable. The standard system of identification more often used is

EAN.UCC[20]. It contains five standards: SSCC, GLN, GTIN, GRAI[21] and GSRN[22] (Food Standard Agency, 2002:21-22). It reduces errors, allows a more precious data exchange, reduces time of moving, contains a lot of information in a small space and has the option to select only some information. Furthermore, barcode is a tool quickly readable by scanner.

EAN/13 is a code used by EAN.UCC which is unique and unambiguous for the product identification (Food Standard Agency, 2002:21-22). It converts four different thicknesses of bars and spaces into 13 digit codes that computers look up against a database. It is used for most point of sales applications and contains price information;

- ✓ *EAN.UCC/128* is similar to EAN/13, but it contains more information as combinations of the identification and the serial numbers for transport units, lots, batches numbers and the serial numbers for transport units. It is not scanned at the point of sale. It is used for logistics management applications (Food Standard Agency, 2002:22);
- ✓ *PDF* (Portable Data Files) can carry out more information than barcode. PDF does not allow having the access to a remote database (Food Standard Agency, 2002:22). The PDF file is a number of "cut down" barcodes stacked on top of one another. The PDF417[23] standard can encode more than kilobyte of data;
- ✓ *Radio Frequency Identification* (RFID). RFID is a new technology used for traceability practices. The transfer of data, from the identifier to the reader, is

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[20] EAN International-Uniform Code Council was a supply chain standards family name, formerly the EAN.UCC System, that included product barcodes which are printed on the great majority of products available in stores worldwide and electronic commerce standards. EAN International was the global office for the more than 100 Member Organizations around the world. In 2005 the organization changed its name to GS1.
The Uniform Code Council (UCC) was the Numbering Organization in the USA to administer and manage the EAN.UCC System. In 2005 the UCC changed its name to GS1 US.

[21] Global Returnable Asset Identifier is the GS1 Identification key for types of reusable package or transport equipment that are considered an asset. It is used to enable tracking as well as recording of all relevant data associated with the individual asset or asset reference. The GRAI is assigned for the life time of the asset and may be bar coded using Application Identifier.

[22] Global Service Relation Numbers is the GS1 Identification Key used to identify the recipient of services in the context of a service relationship. It is used to enable access to a database entry for recording recurring services. The GSRN is normally assigned by the service provider and may be bar coded using Application Identifier.

[23] PDF417 is a stacked linear bar code symbol used in a variety of applications such as primarily transport, identification cards and inventory management.

achieved by a radio frequency link (radio tag) (Food Standard Agency, 2002:22-23). Radio tag is composed from a tag system (chip) and a software which adapts and converts information. There are two types of RFID system: active and passive. Active systems are composed from a battery and do not necessitate a reader. It consumes less energy, but it works only for a short time. The passive system is composed from chip, condenser and antenna. It requires a lot of energy, but it works for a long time.

RFID is used also in critical environmental situations (e.g. high humidity, salt, etc.); it can read more tags at the same time, recording a large amount of data and it is readable at a long distance and also not visible. On the other hand, RFID is more expensive than barcode and is not compatible with all goods. RFID may contribute to improving the traceability process in the medium and long term when industry standards will be fully developed and implemented (ECR Europe, 2004:37);

- ✓ *Feature identification systems*. According to Food Standards Agency (2002:24) the features identification relies on collecting intrinsic data about an item from its natural features or properties which can be used to provide a unique (or near unique) form of identification;
- ✓ *The vascular pattern of the retina and iris scans* are present from birth to death and unique to each animal (Food Standard Agency, 2002:24). An image of these with digital camera can be captured. Such images can be converted into a unique record for each animal and following can be stored in a database. The cost of such a tool is similar to RFID identification for livestock and it is permanent and secure. DNA samples can be collected from animals at any point during their life cycle from blood, meat, saliva, etc. DNA analysis can be used to identify the animals, from which meat originated even after death. The cost of DNA analysis is declining and it would be expected that it will be widely applied in the future for both livestock and plants (Food Standard Agency, 2002:24);
- ✓ *Optical signatures* can be encoded into plastics during manufacture. A fluorescent reader on the bag will give the same unique identification (Food Standard Agency, 2002:25);

- ✓ *Chemical signatures* have high costs and they are at the first stages of their development. A chemical signature is an electronic nose that allows the identification through the analysis of chemical flyer components (Food Standard Agency, 2002:25).

2.3 TRACEABILITY WITHIN THE AGRI-FOOD INDUSTRY

In this section, I will discuss and describe costs and benefits and government influence into traceability practices in the agri-food industry. Traceability can be analyzed by various approaches: social science, business administration, economics, biology, food sciences, medicine, engineering, etc. Although, the purpose of this thesis is to establish an assessment of the business value of traceability implementation, I will examine traceability by economic and business approaches, through the costs, benefits and government involvement analysis.
Next, I will provide background information about costs, benefits and government involvement of traceability practices as extracted from literature reviews.

2.3.1 COSTS OF TRACEABILITY

"It is clear that traceability comes at a cost. But the cost of not having it, or having inefficient systems in place may be severe both for governments, consumers, individual companies and the food industry as a whole" (Food Standard Agency, 2002:51).

Although traceability is not a new concept, it is an innovation system that European food operators have to implement in their plants. Each innovation traceability has costs and benefits. Such consideration is also confirmed by Theuvesen *et al.,* (2005:914) who point out that traceability creates private and public benefits as well as costs. As a consequence, the acknowledgement of costs plays a crucial role for decision making to traceability system implementation in the food supply chains. According to Sparling and Sterling (2004:1-8) food manufacturers and distributors perceived traceability as an extra cost to market a product. Food industries operate with thin profit margin per unit and traceability

could be an additional cost, that negatively impacts on the profitability of a product (Desserault, 2006:6).

Traceability costs differ and depend on many factors and conditions. Costs can depend on the legislation, size of firm, activities, philosophy of the firms, technology adopted for traceability system, etc. In addition, these costs depend on the existing technological infrastructures of the company (e.g. IT equipment), characteristics of products and production processes (e.g. usage of continuously refilled silos and tanks), structure and complexity of the supply chain (Theuvesen *et al*., 2005:918) and the amount of information required to be stored (Food Standard Agency, 2002:50).

Moreover, the presence of small – scale production systems and spot-market transactions are obstacles to tracking and tracing products and result in high costs to improve traceability (Theuvesen, 2004:125-138).

A list of possible traceability costs is presented in table 2.1 which is divided into two categories: implementation and maintenance/operation. The reason for such division is because, generally firms perceived the cost of traceability as such.

Personnel, in the table 2.1 represented by "Production line, supervisory staff, managerial/administrative staff time", is an important traceability cost both for implementation (Meuwissen *et al.*, 2003:177) and maintenance. Such costs depend on the quantity and quality i.e. specialized skills and knowledge of human resources necessary for system implementation and use (Theuvesen, *et al.*, 2005:918). In a study conducted by Mora *et al.,* (2003:218) in a sample of 15 firms, representative of the 20% of the overall Italian beef processors, the medium and large companies[24] had to hire additional personnel to comply with requirements introduced by traceability regulations. This probably can be explained by the size of the companies. Medium and large companies have a larger amount of data to be handled.

An important cost/barrier could be the reluctance of the workforce and staff to use new technologies (e.g. IT). This is especially true for the implementation stage of

[24] The companies were classified into large (with turnover in excess of 30 million Euros), medium (with a turnover between 10 – 30 million Euros) and small (with annual turnover of less than 10 million Euros, with an average of 4 million Euros).

traceability system, because the introduction of new technologies require personnel change the modality of work process and that they adapt to new traceability technologies. Such a barrier is particularly important for personnel between 50 – 60 years of age, who are less comfortable using new technologies.
As reported in many traceability definitions, traceability involves data collection and management. This is an important key-point of traceability practices. Sometimes this could be a barrier, because collecting and managing data is difficult.

Table 2.1 - A list of the most important traceability costs

TYPE OF COST	COSTS
Implementation	Production line, supervisory staff, managerial/ administrative staff time and disruption of production
	Purchase of new equipment and software
	Training courses
	External consultants
	Materials
	Certifications and audits
Maintenance/operation	Production line, supervisory staff, managerial/ administrative staff time and disruption of production
	Upgrading equipment and software
	Training courses
	External consultants
	Materials
	Audits

Source: selected from Meuwissen *et al.,* (2003); Mora *et al.,* (2003) and further sources.

According to Meuwissen *et al.*, (2003:177) other implementation costs are concerning "new equipments - hardware (computers, palmtops, barcode systems, printers, etc.) - and software (programs and applications)" fundamental for the

management of traceability systems. Such costs could be very important depending on whether such equipments are not already installed in the plant. If they are already installed, it is important to make sure that they will be adequate for traceability system objectives of the firm.

The renovation of a plant is another implementation cost. According to Mora *et al.* (2003:218) 54% of the companies analyzed had to make partial changes to their structures. In terms of size it is interesting to note that all the companies that have modified their structures and layout of their facilities, were those of medium and large size.

Another traceability cost is the data entry at the first stage of the operations within a firm, that is normally the first stage after suppliers have delivered raw materials, because data entry is manual and spent time. According to Mora *et al.,* (2003:221) one out of four Italian beef processors interviewed, perceived such a barrier as very important. In fact, manual data entry results in a large number of errors.

The disruption of production is a really important cost. It is linked with reluctant workforce, because traceability practices necessitates keeping separate each lot, printing different labels, etc. This increases the workload for the workforce, because they have to interrupt the product flow.

Training courses are also a traceability cost. The firm's personnel, who use a traceability system, have to be trained in the relevant procedures of using new traceability software. It is basically a cost of implementation, but it also could be a maintenance/operation cost when there is an upgrading of the traceability software or new functions of the software are added.

The cost of external consultants is often important, especially when the firms do not have specialized personnel for traceability practices within the firm. The external consultants deal with the design and implementation of the traceability software (e.g. IT – engineer), understanding and complying with traceability, labeling and hygiene regulations and assistance for certification and audits (e. g. veterinaries).

An important cost/barrier is the lack of unique identification (standard) of raw materials, semi-finished and finished products. In research conducted in the salmon supply chain, it was found that seven out of eight farmed salmon

companies interviewed, do not use unique item identification (Senneset *et al*., 2007:817). The existence of an unique identification standard is one of the basic prerequisites of both internal and chain electronic traceability and, therefore it represents one of the most important barriers of electronic traceability implementation.

2.3.2 BENEFITS OF TRACEABILITY

Traceability determines various benefits in the food supply chain. According to Golan *et al.,* (2004:iii) it is important to take into consideration that traceability alone does not provide any benefit. Traceability is only a way to verify that benefits are realized. Traceability does not create any credence attribute, but it simply verifies their existence. Traceability is simply a system that improves other business functions such as logistics, inventory management, quality control, marketing, etc. While it is not difficult to asset and acknowledge costs, as mentioned in the previous paragraph, many benefits however are difficult to assess (e.g. possible price premium).

Various authors classify traceability benefits in different ways. According to Sparling and Sterling (2004:3) benefits are divided into four categories: regulatory, market and customer response, recall scope and supply chain (Fig. 2.1). Golan *et al.,* (2004:4) indicate that traceability has three main objectives: improve supply chain management, facilitate trace back for food safety and quality and, finally differentiate market foods with subtle or undetectable quality attributes. According to Sykuta (2005:365-377) there are three types of traceability benefits: inventory control and supply chain management, identifying and control quality failures and, finally marketing information based on product characteristics.

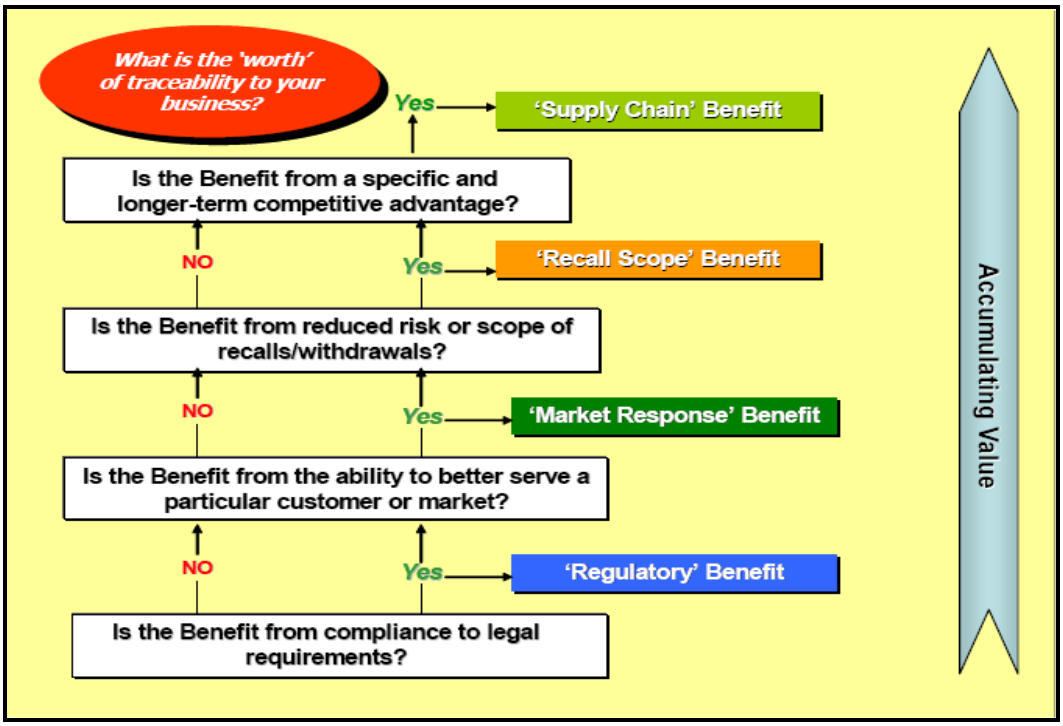
All the traceability benefits classifications overlap three out of four categories of benefits: supply chain management, market and food safety aspects. Only for regulatory benefits is it uncertain as to whether it is benefits or not.

Benefits can also be distinguished at several levels of the food chain, depending on the role played by stakeholders through the food chain. For example, primary

producers have certain benefits that differ from those consumers (Verbeke *et al.*, 2001:251).

Starting from the traceability benefits classifications of Sparling and Sterling (2004:3), Sykuta (2005:365-377) and Golan *et al.,* (2004:4), I will now explain in-depth every category of benefits.

Figure 2.1 – Four key types of traceability benefits



Source: Sparling and Sterling, 2004.

2.3.2.1 Regulatory benefits

One of the main important drivers of traceability implementation is to comply to traceability regulations (Food Standard Agency, 2002:16). Implementing traceability system in a food chain allows regulatory requirements to be met (e.g. EC regulation n. 178/2002). The EC regulation n.178/2002 requires every food chain operator to adopt a traceability system for the EU products and imported food products in EU market. For instance, if an extra-EU firm wants to export to EU, it must have in place a traceability system to comply with EC Regulation n. 178/2002. Thus, regulatory compliance is a fundamental prerequisite to having access to different food markets.

Furthermore, traceability satisfies the legislation requirements of labelling regulations with reference to the potential development of a brand (Verbeke, 2001:251). According to Schmidt (2000:2), in most Countries it is a legal requirement that a claim of a product can be verified to ensure the truthfulness of the claim (e.g. origin of product and production method).

In addition, the compliance of regulatory requirements is often an important prerequisite to having access to public financial funds. For instance, to have access to some Italian public agri-food supports, an applicant is required to have proof of a certified traceability system UNI 10939:2001.

2.3.2.2 Recall and risk management benefits

According to Senneset *et al.*, (2007:805) and Gellynck *et al.*, (2004:3), traceability also determines recalls and risk management benefits. Traceability can significantly limit recall scopes or the amount of product which must be recalled in order to capture all contaminated products. According to Food Standard Agency (2002:16) traceability is a tool to facilitate prompt action to remove products from sale and to protect brand reputation (from a failure in product quality or a food safety incident).

The effectiveness of traceability recalls depend on the existence of an efficient monitoring system of the whole distribution network that quickly allows proceeding to an effective recall whenever a risky situation is present (Sodano *et al.*, 2003:196).

According to Theuvesen *et al.,* (2005:918) in agriculture and food industry risk management aims at lowering losses due to product recalls. The amount of losses is influenced by the likelihood as well as the short-term and long-term damages of recalls. The probability of recalls is also strongly influenced by product characteristics; meat and milk, for instance, are more susceptible to microbiological contaminations than cereals or other dry products. Short-term damages stem from logistic costs of recalls, reduced turnover due to out-of-stock items, costs of laboratory analyses, crisis of communication with retailers and consumers and quick-fix improvements in internal processes. Long-term damages stem from costs of corporate image, firm reputation and brand value, costs of

product relaunches and intensified marketing over a more fundamental redesign of internal processes and supply chain (Theuvesen *et al.*, 2005:918).

As previous mentioned, traceability is also important for product liability and brand reputation. It is a significant topic for food operators in the light of recent food safety crises, such as BSE or avian flu. According to Golan *et al.,* (2004:7) traceability system can shift liability and recoup the claim along the food chain and, finally avoid liability in case of food crises. This traceability benefit helps to safeguard food operators' brands.

2.3.2.3 Market and customer response benefits

Traceability determines various market and customer benefits. Markets and customer response benefits are often the main driver for traceability system implementation. Benefits are generated when traceability allows business partners to meet the specific needs requested by customers. If customers, such as wholesalers or retailers, require from their suppliers (e.g. processors) the adoption of a traceability system, then a traceability system becomes a fundamental prerequisite to having access to specific markets.

Traceability can also provide market benefits through the differentiation of the products to assure supply chain partners and consumers that a product meets specific production, processing or distribution standards. For instance, organic products are produced using specific standard agricultural practices. According to Schmidt (2000:2) traceability has contributed to differentiating products in the marketplace business, requiring businesses to label their product in a way that involves tracking and tracing products.

According to Hobbs (2005:57-62) there is uncertainty if traceability could provide a price premium, but the knowledge that consumers are willing to pay (WTP) a high price. Consumers have frequently indicated they are willing to pay a higher price for safer food (Henson, 1996:403-420), even if it is generally expected that food is safe.

According to Meuwissen *et al.*, (2003:169), traceability is able to improve consumer trust since it provides more information about the food product purchased. This also allows improvement of the firm image. An example of improving consumer trust, is given by the Scardovari Consortium who

implemented a traceability system which allows consumers to have access to product information, including where and when the products were caught or harvested, its history, its processing, etc. Consumers have to simply input a lot code, written on the label of the packaging, to the website (http://www.scardovari.org/scardovari/tracciabilita/ricerca.asp).

2.3.2.4 Supply chain benefits

Supply chain benefits relate to the chain traceability. Traceability is assisting supply chain partners to work together to eliminate inefficient practices that do not add value to consumers. According to Sparling and Sterling (2004:6) traceability is a proven tool to raise the efficiency and effectiveness of a supply chain. The main point of supply chain benefits is that traceability can reduce the transaction costs. A survey conducted by Sodano *et al.,* (2003:201) in the Italian processing tomato industry showed that transaction costs can be reduced by traceability practices. Private labels can exploit the larger benefits from the "transaction cost reduction effect" of traceability. The reduction of transaction costs is highly important especially for small-medium firms, specializing in niche products who take advantage of the effect in reduction of such costs (Sodano *et al.,* 2003:6). The result will be a higher market share of private label[25], brands proliferation and a lower investment in those quality control systems and processes innovation, useful for vertical differentiation strategies.

Furthermore, supply chain management benefits include the improvement of real-time inventory management, which in turn reduces product waste as well as ensuring a more consistent quality delivery to supply chain end users – the food consumer.

Traceability can reduce out-of-date product losses, lower inventory levels, accelerate the identification of processes and suppliers and raise the effectiveness of logistics and distribution operations (Sparling and Sterling, 2004:6-7).

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[25] Brand owned not by a manufacturer or producer, but from a retailer or supplier who gets its goods made by a contract manufacturer under its own label. Also called private brand. (Business dictionary - http://www.businessdictionary.com/definition/private-label.html appeared on Internet 14 october 2008 h.15.19).

The new traceability technologies help to meet supply chain benefits. Some chains adopt RFID technologies in order to improve their distribution efficiency. The electronic information systems are highly efficient for storing and moving collected data and for identity preservation (Buhr, 2002:113). New technologies are making it easier to record and pass on information in digital format which are more cost-effective and more reliable over time.

Traceability can measure the value added of each business partner of the food chain and determine the price obtained by each intermediary. Such consideration is important in the light of the fact that one supply chain will be competing with another supply chain instead of competition among individual firms (National Farm Products Council, 2004).

In addition, traceability also has an effect on the organizational food chain system. According to Sodano *et al.,* (2003:201) traceability can heavily affect the nature of the relationships along a food chain replacing contractual relationships which strongly relied on trust with highly engineered technological links based on formal short-period contracts.

2.3.3 TRACEABILITY AND PUBLIC INTERESTS

In this section, I will focus on the background information about traceability in the food chain, and on the role played from governments on the traceability practices in the agrifood sector with special emphasis on the ichthyic sector. In the first part, I will describe the public interests in traceability practices while in the second part, I will explain the most significant legislation that affects traceability practices.

The public interests of governments on traceability practices in the agrifood sector are various. According to Food Standards Agency (2002:16) traceability has two main objectives in the food supply chain:

- ✓ to protect public health facilitating the rapid withdrawal of products from sale as increasingly traceability systems are being developed;
- ✓ to carry mandatory information regarding products forward through the food chain and to provide support to label claims with regard to product origin.

The Food Standards Agency (2002:16) has listed the following public interests in traceability practices :

- ✓ to protect public health through the withdrawal of food product from sale;
- ✓ to help prevent frauds when analysis cannot be used for authenticity (e.g. free-range eggs, organic food);
- ✓ to control zoonotic diseases (e.g. tuberculosis, salmonellas, BSE);
- ✓ to enable control with regard to human and animal health in emergencies (e.g. contamination of land or raw material);
- ✓ to control epizootic and enzootic livestock diseases through the rapid identification of disease sources and dangerous contacts;
- ✓ to monitor and control livestock numbers for subsidy claims.

According to Schmidt (2000:2), the fishery supply chain traceability also allows monitoring the natural resources. The monitoring of natural resources (e.g. hygiene quality of the sea and lagoons, which ichthyic resources are catching and/or harvesting) is strongly important, because the quality of such products depends on the quality of water (e.g. pollution, presence of bacteria, etc.).

Moreover, traceability data could be useful in the ichthyic sector, because it is a sector where illegal practices are wide spread. Thus, traceability data may provide a lot of information useful for the Fish Inspection Agencies or other competent authorities for recalls, post-marketing monitoring purposes and control quota system (FAO, 2004:4).

2.3.3.1 Traceability regulations

Now, I will provide an overview about the key EU legislation of traceability in the food supply chain. The more important organizations involved in the legislation and supporting of traceability practices at EU level are:

- ✓ *European Commission* is the EU executive body. It has three main tasks: to initiate EU policies, act as the guardian of EU treaties and supervise implementation of EU law;
- ✓ *Council of Ministers* is responsible for determining EU polices and voting on legislation;
- ✓ *European Parliament* has the power of vetoing legislation in certain areas such as consumer protection, health, environmental or a single market;

- ✓ *European Court of Justice* rules on disputes involving interpretation and application of the EU treaties and legislation;
- ✓ *European Food Safety Authority* (EFSA) is the keystone of European Union risk assessment regarding food and feed safety. In a close collaboration with National Authorities and in an open consultation with its stakeholders, EFSA provides independent scientific advice and clear communication about existing and emerging risks.

Italian government has two main organizations involved in traceability legislation:

- ✓ *Ministry of Forestry and Agrifood Policies* work out and organize the agriculture, forestry, fishing and food policies lines at National, European and International levels;
- ✓ *Ministry of Healthy* is the central body of National Health Service. It safeguards human and animal health, hygiene, food safety and organizes the National Health Service. Ministry of Health is represented by *Local Health Firm* (ASL[26]) which provides the health services at the local level.

As mentioned above, traceability is strongly linked to other disciplines such as quality, labelling, hygiene, etc. Therefore, legislation affecting traceability practices also has to take into account various legislations that affect these other disciplines.

Next, I will mention the most significant legislation and standards affecting traceability.

Mandatory legislations

After the BSE and dioxin food scandals, European Union began to revise the food safety legislation, publishing "The White Book for Food Safety" on 12th January 2000. It contains the fundamental guidelines for new EU food safety policy.

The key legislation regarding traceability in the agrifood and ichthyic sectors are:

- ✓ EC decision[27] n. 356/1994 implemented an own – check system (HACCP). It outlines detailed rules for the application of Council Directive[28] 91/493/EEC as regards own health checks of fishery products;

[26] Azienda Sanitaria Locale.

[27] A Decision is binding entirely to whom it is addressed. No national legislation is required. Both the Council and the Commission can adopt decisions.

- ✓ EC regulation[29] n.104/2000 lays on the ichthyic products labelling on sales at retailer level according to the consumer information in article 4:
  - ➢ the commercial name of the species;
  - ➢ the production method (caught at sea or inland or farmed);
  - ➢ the catch area (especially for the products caught at sea). The catch areas are detected through FAO areas;
- ✓ EC regulation n.2065/2001 details rules for the application of 2000/104/EC regulation to inform consumers about ichthyic products laid down in this regulation;
- ✓ EC regulation n. 1830/2003 concerns traceability and labelling for food and feed GMO products which require labelling of biotechnology-derived or GM products;
- ✓ EC regulation n. 41/2004 regards the repealing of certain directives of food hygiene and healthy conditions for productions and placement in the market of products of animal origin for human consumption and amending Council Directives 89/662/ECC and 92/118/EEC and Council Decision 95/408/EC;
- ✓ EC regulation n. 852/2004 reefers to hygiene of foodstuffs;
- ✓ EC regulation n. 853/2004 states specific hygiene rules for food of animal origin;
- ✓ EC regulation n. 854/2004 states specific rules for management of official controls on animal products for human consumption;
- ✓ EC regulation n. 1935/2004 states materials and articles in contact with food and repeals Directives 80/590/EEC and 89/109/EEC;
- ✓ EC regulation n. 183/2005 states requirements for feed hygiene;

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[28] The Directives are laws binding on the Member States as to the result to be achieved, but the choice of method is up to the individual Member State. In practice, National implementing legislation in form deemed appropriate in each member State is necessary in most cases. This is an important point, as businesses affected by a directive have to take account of the national implementing legislation as well as the directive. All directives set a date by which Member States have to transpose it in national legislation. After that date, in case of non-implementation, the directive should that have not implemented the directive in time.

[29] A Regulation is a law that is binding and directly applicable in all Member States without implementing any national legislation. Both the Council and the Commission can adopt regulations.

- ✓ Italian legislative Decret[30] n. 193/2007 in accomplishment to Directive EC n.41/2004 concerning food safety controls and application of EC Regulations in the food sector.

The most important traceability regulation in EU was published on 28th January 2002. It is EC regulation n. 178/2002 (also called "General Food law") that introduces traceability on the agrifood sector. It states the general elements and requirements of food law, establishing the European Food Safety Authority (EFSA) and states procedures in matter of food safety. Some of the elements of EC n.178/2002 were established into regulation n. 1760/2000 concerning the mandatory and volunteer traceability in the beef sector.

The information required in regulation n.178/2002 follows:

- ✓ information which shall be made available to competent Authorities:
  - ➢ names, address of suppliers and nature of the products bought from suppliers (raw materials);
  - ➢ names, address of customers and nature of products sold to customers;
  - ➢ date of transaction/delivered.
- ✓ additional information strongly recommended to record are:
  - ➢ volumes or quantities;
  - ➢ batch numbers, if any;
  - ➢ pre-packed or bulk;
  - ➢ raw or processed products.

EC regulation n. 178/2002 ruled that every food chain operator must document "*..one step forward and one step backward*" the business relationship. More detailed traceability requirements depend on specific regulations and from modus operandi of regulations.

Articles 18, 19 and 20 are the most important in the "General food law":

- ✓ articles 18 states that:
  a) traceability should be established at all stages of food production;
  b) traceability has to be established one step backward and one step forward in the food chain;

[30] The legislative Decret is a rule act having force of law issues of Government on proxy of the Parliament.

c) all food and feed which are placed on the market, should be adequately labeled or identified to facilitate traceability;
d) provisions for applying traceability requirements of specific sectors;

- ✓ article 19 states the general liabilities of food business operators in case of product recalling. The specific responsibilities are:
  a) every food business operator that recalls a product for health reasons, has to inform respective authorities and customers, if it believes that food can hurt the consumer;
  b) retailers and distributors, on the limits of their activities, have to withdraw products from the markets which do not comply with food safety requirements and have to guarantee food safety;
  c) food business operators have to immediately inform competent authorities if they think that a food on the market could cause injuries to human health;
- ✓ article 20 states responsibilities of feed manufacturer: "…*food and feed imported into the Community for placing on the market within the Community shall comply with the relevant requirements of food law or conditions recognized by the Community to be least equivalent there to or where a specific agreement exists between the Community and the exporting country with requirements contains therein".*

EC regulation n.178/2002 does not state any specific methodology, that food business operators have to follow to establish a traceability system. Thus, food firms can choose the methodologies which best fit their needs to ensure an efficient traceability system (Folinas *et al.,* 2006:623). As a consequence many initiatives establish a traceability methodology, such as guidelines or standards. Next, I will describe the most important initiatives.

Certifications/standards

The most relevant Italian volunteer standards of traceability have been provided from UNI[31], while ISO has established an International standard such as ISO

[31] Italian Organization of Standardization. www.uni.com.

22005[32]/2007 which standardize the methodologies of traceability practices in the food and feed chain.

UNI has provided two types of standards: UNI 10939:2001 and UNI 11020:2002. UNI 10939 defines the key elements and requirements for the adoption of traceability system in the food chain that can be certified by a third part certification. Such certification guarantees and documents the traceability of a product through all stages of the food chain involved. UNI 10939 clarifies many aspects of the article 18 of the EC Regulation n.178/2002.

The standard UNI 11020:2002 defines the key elements and requirements for the adoption of traceability system within a food firm that can be certified by a third part certification. Standards UNI 10939 and 11020 have just been substituted by ISO 22005:2007.

As mentioned above, the traceability standard actually effective on traceability in the agrifood and feed supply chain, is the ISO 22005:2007. It designs the traceability system based on the following key elements:

- ✓ defining the objectives of traceability system;
- ✓ stating rules and documents which apply to the traceability system;
- ✓ defining products and ingredients of traceability system;
- ✓ determining the positions of every organization in the food chain, identifying suppliers and customers;
- ✓ detecting the material flows;
- ✓ determining information that has to be managed;
- ✓ establishing the procedures and documentations;
- ✓ establishing modality of food chain management.

2.3.3.2 Incentives and penalties of traceability in the agrifood sector

The incentives and penalties for the traceability systems adoption are very important for business strategies of food firms. In some cases motivations, kinds, depth, breadth, precision of traceability systems could depend on incentives and penalties provided.

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[32] "Traceability in the feed and food chain – General principles and basic requirements for systems design and implementation".

Basically, incentives are financial supports at various governments levels through the appropriate legislation and projects. Incentives could cover different costs (e.g. hardware, software, certification) depending on the particular legislation or project.

An example of supporting legislation is the Italian legislative Decret n.228/2001, which supports the application of a volunteer traceability system in the food and feed chains, establishing agreements of chain and a plan of control of traceability system. On the other hand, an example supporting project was "Adri.fish", which supported the adoption of a traceability system in a shellfish chain in the Northern Adriatic regions.

Italian legislative Decret n.190/2006 refers to penalties about traceability. It disciplines sanctions for the violations of the articles n.18, 19 and 20 of the EC regulation n.178/2002. For instance, if a firm violates article 18 it has to pay a fine from 750 to 4,500 Euros.

2.3.4 LINKAGES WITH OTHER REQUIREMENTS AND MANAGEMENT TOOLS

As previously mentioned, traceability is linked with food labelling, quality and safety management systems. Traceability can provide product and process information that usually appear written on the product label (e.g. fish species and origin of the product). Labelling or parts of it, in addition to other aspects, are essential components of the risk communication among managers and consumers (FAO, 2004:7). Currently, some essential traceability information should be written on the label (e.g. name of the final seller, etc.) while some additional information should be accompanying documents (e.g. who transported the food to the retail shop or supermarket, etc.) and, in addition, some information should be recorded at handling and processing stations (e. g. HACCP records in the ichthyic processing plant).

A proper labelling of the final product at the end of the food chain is aimed at assuring consumers through the information conveyed on the label or tag; however, traceability systems should generally go beyond this labelling information in order to be effective (FAO 2004:7).

According to FAO (2007:2) traceability is a tool that should be applied within a broader food control system (e.g. already operating under a HACCP and Hygiene – GHP[33] and GMP[34] – system).

Mandatory traceability can be positively linked to certification and internal quality control systems. According to Sodano *et al.,* (2003:201), mandatory traceability can lower firms' incentives to invest in certification system as well as in internal quality control. This is because traceability:

- ✓ reduces problems of asymmetric information and thus the necessity of certification;
- ✓ lowers the consumers' safety risk perception and thus their demand for assurance;
- ✓ weakens the power of other legal tools, such as tort liability, of creating incentive for firms to reduce food safety problems.

In addition, traceability is linked to other management systems which are very important, because traceability alone does not ensure the appropriate effectiveness and efficiency itself and adequate level of consumer protection per se and it is not a stand-alone activity. Traceability is also connected to quality assurance. Products and processes of traceability are parts of quality assurance management system also because many applications of traceability systems within the food chain at present, seek to enable finished products to be identified within a defined assured supply chain (Food Standard Agency, 2004:34).

Traceability is also linked to HACCP system. According to Food Standard Agency (2004:34) within food manufacturing, traceability systems are used alongside HACCP to provide verifiable documentation which monitors the critical control points and allows remedial action to be taken if a product falls below quality standards, because HACCP has traceability components, too.

[33] Good Hygienic Practice.
[34] Good Manufacturing Practice.

2.4 AN APPLICATION OF A TRACEABILITY SYSTEM: THE CASE STUDY ANALYSIS OF SCARDOVARI CONSORTIUM IN THE ITALIAN FISHERY SUPPLY CHAIN

2.4.0 INTRODUCTION

In the second part of Chapter two, I will present the results from a case study research to provide some additional background information about the business value assessment of the traceability system application in an Italian fishery supply chain: Scardovari Consortium. In particular, an *ex – ante* and *ex – post* assessment of costs and benefits, associated to the traceability system implementation, will be discussed.

This section will be organized into four sub-sections. The first sub-section will explain motivations, research contributes, objectives and research questions of the case study's analysis. The second sub-section will present the case study with the description of Scardovari Consortium, the process of traceability implementation, in addition to methods and data used for the analysis. The third sub-section will present the descriptive results with particular emphasis on the narrative description for important costs and benefits and, eventually surprises which emerged from *ex-ante* and *ex-post* comparison to the traceability system implementation. In the fourth and last sub-section the conclusions, with particular emphasis on recommendations for traceability implementation and some outcomes useful for future surveys, will be provided.

2.4.1 MOTIVATIONS, RESEARCH CONTRIBUTES, OBJECTIVES AND RESEARCH QUESTIONS

2.4.2.1 Motivations

As previously mentioned, the implementation of traceability system is a major challenge that has been undertaken by food chain operators over the last few years. Furthermore, traceability can be costly to implement and maintain and it is not an activity that absolutely creates value for the final customer, as mentioned in Chapter one.

The economic problem is that there is uncertainty over costs and benefits of traceability practices. The knowledge of more information about costs and

benefits may help to contribute to a better understanding of the impact of traceability practices on business performances. In particular, it could be useful to identify important and unimportant costs and benefits and, in addition, to identify possible reasons of eventual surprises, that emerge comparing expectations and actual outcomes of traceability system. Without an empirical research within an industry it is impossible to know which are the important costs and benefits and in particular, if there are surprises which emerge comparing expectations and actual outcomes.

2.4.2.2 Contribution to academic literature, industries and policy makers

An in-depth assessment of costs and benefits affecting the business value of traceability could aid researchers, industry managers and policy makers as follows.

First, the case study research may contribute to filling the gaps in literature review and it might help researchers who are seeking to design additional empirical studies and investigating economic and business aspects of traceability in the food chain. In particular, the case study analysis will provide useful information, that together with the literature reviews, will contribute to formulating reasonable hypotheses to be tested in the following chapters or in further research.

Second, for the industry managers the results of the results of case study's analysis could bring insights to industry managers regarding the improvement of traceability systems implementation and maintenance, discovery of costs and benefits not previously known, etc.

Third, policy makers and food safety authorities could benefit from the case study analysis in developing legislation or industry programs designed to enhance traceability practices and breakthrough the efficiency and effectiveness of food safety practices.

2.4.2.3 Objectives

The main objective of the case study's analysis, is to provide useful information and improve knowledge about the economic and business aspects of traceability practices in the fishery supply chain. In particular, a qualitative cost-benefit-analysis of the traceability system in an Italian fishery supply chain focusing on

surprises as emerged by traceability system implementation through *ex-ante* and *ex-post* comparison, will be conducted.

Going through more details, the specific objectives of the case study research are:

- ✓ to investigate in-depth the important costs and benefits due to traceability practices;
- ✓ to analyze in-depth, eventual surprises which emerge comparing expectations and actual outcomes;
- ✓ to develop useful recommendations for future economic research;
- ✓ to develop helpful insights to business and policy decision makers which implement traceability systems.

2.4.2.4 Research questions

Several research questions have been developed in order to achieve the objectives of the case study's research:

- ✓ what are and how can we explain the important costs and benefits perceived by firm management due to traceability system implementation?
- ✓ which are and how can we explain eventual surprises which emerge comparing expectations and outcomes?
- ✓ what are and why eventual costs and benefits are not well understood?

2.4.3 METHODS

2.4.3.1 The case study

The qualitative research will be conducted using the case study method. The case study method is one of several ways of doing social science research. Rather than using large samples and following a rigid protocol to examine a limited number of variables, the case study method involves an in-depth and longitudinal examination of a single instance or event: a case. It provides a systematic way of looking at events, collecting data, analyzing information and reporting the results. As a result researcher may gain a sharpened understanding of why the instance happened as it did and what might become important to look at more extensively in future research.

In addition, case study analysis lends itself to both generating and testing

hypotheses (Eckstein, 1975:79-137). This methodology usually investigates a contemporary phenomenon within its real – life context when the boundaries between phenomenon and context are not clearly evident (Yin, 1994:13).

Case study research can also be used to accomplish various aims: providing description (Kider, 1982), testing theories (Pinfield, 1986:365-388) or generating theories (Gersick, 1988:9-41). It typically combines data collection methods such as archives, interviews, questionnaires and observations. The evidence may be qualitative (e.g. words), quantitative (e.g. numbers) or both (Eisenhardt, 1989:534-535).

According to Van Der Velde *et al.,* (2004:16) there are four types of research. First, is the descriptive research which attempts to create an inventory of attributes pertaining to a particular phenomenon, without rigorously investigating the relationships among them. Second, is the explorative research that begins examining potential relationships among various factors and attributes of a phenomenon, without providing an explicit theory or developing rigorous hypothesis[35]. Third, is the empirical research in which various relationships are explicitly evaluated for correlations among various phenomena, expectations are met or theories are upheld. The four and last method, is the advisory or prescriptive research as pertaining to applied research questions as would be found within organization.

The research method pursued in this study is exploratory[36], where the focus is on identifying themes within the data that could be utilized in future theoretical frameworks development and generating hypothesis. In addition, it is hoped that interesting phenomenon and trends can be identified that will aid in theoretical development at a later juncture. It is also hoped that interesting hypothesis could be extracted for future research. In addition, the research method used here is also empirical to meeting expectations and making some hypothesis for further research.

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[35] This method of inquiry is also known as "Grounded theory", which is an inductive method of inquiry detailed by Strauss and Corbin (1998) in their text Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory [Sage Publications, 2nd edition, 1998)].

[36] The exploratory case studies set out research questions to be addressed in subsequent work (Seuring, 2005).

With a little understanding or documentation of the costs and benefits of traceability system implementation perceived by food processors (Meuwissen *et. al*., 2003:178-179) the case study is revelatory[37], because it is hoped that it can illuminate a previously unexplored phenomenon. Single – case studies are also ideal for revelatory cases which an observer may have access to, a phenomenon that was previously inaccessible.

2.4.3.2 In-depth interview

In-depth interview is a kind of qualitative interview in social sciences. The objective of qualitative interviews is to collect data with a qualitative approach from interviewed people. The qualitative approach enters inside the individual interviewee view of the world (Corbetta, 2003:77-93). In this way, it is possible to know in-depth all the aspects regarding a certain topic of which there is a little information available (e.g. literature). Thus, the main objective of qualitative research is going in-depth to disclose the complexity of phenomenon investigated. Furthermore, an in-depth interview can collect all the in-depth information and can have a holistic vision of phenomena that contains non-verbal communication. The choice of interviewees is not random but has to be conducted by a systematic plan. For instance, the interviewees have to have certain characteristics. The interviewer drives and manages the interview on the right path.

Qualitative interviews are distinguished from level of standardization or more clearly from the different levels of freedom/constriction for interviewee and interviewer. According to Corbetta (2003:78-88) there are three kinds of interviews:

- ✓ *structured*, where questions are previously established in terms of content and form;
- ✓ *semi-structured*, where questions are previously established on the content, but not in terms of form;
- ✓ *unstructured*, where questions are not established in terms of content and form.

[37] The revelatory case studies illuminate a previously unexplored phenomenon (Seuring, 2005).

The choice of the kind of interview depends on objective of the research and characteristics of phenomenon under investigation.

Semi-structured interview

In a semi-structured interview, the interviewer has to follow a "trace" of interview with topics that have to be treated during the interview, but the order of questions and ways of asking questions are the free choice of the interviewer. The advantage of semi-structured interview is that both interviewer and interviewee have freedom but at the same time all the important topics contained in the "trace" have to be discussed. Moreover, an interviewer can add questions and introduce other topics, although they are not foreseen on the "trace".

2.4.3.3 Scardovari Consortium's[38] case study: an introduction

The case study here discusses an Italian fishery supply chain: the Consortium of Cooperatives Fishermen Polesine of Scardovari, here simply called Scardovari Consortium.

The Scardovari Consortium is the main primary producer, processor and packager of shellfish in the Mediterranean Sea with a turnover of 33 millions of Euros (Rossetti, 2007:17). It is located in the Scardovari lagoon close to the mouth of river Po in Northern Adriatic sea.

The Scardovari Consortium was created in 1976 and is composed of twelve (12) co-ops which harvest and farm shellfish. The overall co-ops are composed of over one thousand and five hundred (1.500) fishermen. Every day, each co-op supplies shellfish to the depuration and packaging plants of Scardovari Consortium where shellfish are depurated and packaged. Daily, Scardovari Consortium establishes quantities that each co-op has to harvest in order to maintain a stable asset of the shellfish market and to maintain an equilibrium in the biological environment.

Scardovari Consortium produces about 4,000 tons of *Mytilus galloprovincialis* and 9,000 tons of *Tapes philippinarum* per year. Eighty per cent (80%) of the overall production is sold in Italy while the rest (20%) is sold in France and Spain. In 2000, Scardovari Consortium obtained two important recognitions that add

[38] www.scardovari.org

value to its products as a sort of brand of origin: "*Cozza di Scardovari*"[39] and "*Vongola del Polesine*"[40]. In addition, Scardovari Consortium obtained the ISO 9001 certification in 2000.

The shellfish produce from Scardovari Consortium has high quality value, in terms of nutritional characteristics, that is strongly appreciated in the EU market, especially in southern Italy, Spain and France. The high quality of the shellfish is the core business of the Scardovari Consortium that allows it to obtain higher prices than competitors.

Furthermore, in 2005 Scardovari Consortium obtained the quality certification "*Prodotto certificato dell'alto Adriatico*" that is a geographic brand of quality of Northern Adriatic sea promoted by Northern Adriatic Regions and EU government.

Moreover, in 2006 the Scardovari Consortium obtained a food supply chain traceability certification UNI 10939:2001 supported by "Adri.fish project" through EU support. Such certification, that includes traceability system implementation, is the object of the case study analysis.

2.4.3.4 Traceability system in Scardovari Consortium

As previously mentioned, the traceability system has been implemented into Scardovari Consortium's plant through the financial support of "Adri.fish project", here simply called Adri.fish. The main goal of Adri.fish was to develop and improve the market and quality of ichthyic products in the Northern Adriatic sea. Adri.fish supported various activities such as designing a regional brand of quality, traceability system, etc.

Thus, Adri.fish supported the implementation of traceability informatics system certified, based on EC regulation n. 178/2002 and standard UNI 10939:2001 in Scardovari Consortium (Socio Economic Observatory of Fishing in the Northern Adriatic Sea, 2005:89). The objective of traceability system implementation is to provide all managers in charge of control with specific and precise information,

[39] The equivalent in English language is "Mussel of Scardovari", that point out on the origin location of the mussels that are supplied from Scardovari.

[40] The equivalent in English language is "Clam of Polesine", that point out on the origin location of the clams that are supplied from Polesine, that is a large lagoon area around Scardovari.

thus avoiding further and unjustified inconvenience when the food safety is a risk. Furthermore, traceability system provides to consumers all information related to the product that they have bought from the origin (e.g. location of harvesting, etc) to the table. Such information is available on the website www.scardovari.org by simply inputting the lot code written on label of the packaging into the website.

For the implementation of traceability system the following operators were involved.

- ✓ Marine Research Centre (CRM) of Cesenatico[41] to carry out the following actions:
  - ➢ design traceability manual (disciplinary) and
  - ➢ assistance to traceability certification and audit Scardovari Consortium;
- ✓ Team Mare[42] and Javadabado[43] to carry out the following actions:
  - ➢ designing, implementation of traceability software and
  - ➢ training employees of Scardovari Consortium at its use;
- ✓ DNV[44] to carry out the following actions: certification and audit of the traceability system complying EC regulation n. 178:2002 and standard UNI 10939:2001.

2.4.3.5 Data collection

The description of the process of data collection is broken down into three sections: locating the project subject to be examined, conducting the semi-structured in-depth interview and in-depth narrative.

Locating project subject

The subject of the case study analysis was found through an agreement between Fishery Department of Emilia Romagna Regional Government, here simply called Fishery Department, and Department of Agricultural Economics and Engineering of University of Bologna. The Fishery Department provided a list of two subjects (Almar Consortium and Scardovari Consortium) that could fit better with goals of the case study research.

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[41] http://www.regione.emilia-romagna.it/CRM/descr_crm.htm
[42] Company designer and producer of machines for shellfish: www.teammare.it
[43] Software house. www.jdd.it
[44] Det Norske Veritas is international third part of certification. www.dnv.it

Then, I attempted to contact these two subjects. Unfortunately, Almar Consortium was involved in some problems and was not able to participate in the case study. Then, I focused the case study research on Scardovari Consortium that expressed the desire to collaborate.

Conducting semi-structured in-depth interview

I contacted by phone Quality Manager (QM) of Scardovari Consortium to set-up a time and location for in-depth semi-structured interview[45]. QM agreed to participate in the project with a face-to-face interview. He chose the location and time. One week before the interview, I emailed QM the questionnaire. The interview was recorded to permit the creation of the transcript and to confirm details perceived by interviewer.

The interview was based on a semi - destructured questionnaire, with a list of traceability costs and benefits extracted from the literature (Tables 2.2 and 2.3).

The list of specific costs and benefits was organized in some categories as presented in the previous sections. Costs were classified into implementation and operation/maintenance while benefits were organized into four categories: regulatory, recall and risk management, supply chain, market and customer response.

[45] A semi-structured interview was chosen, because the objectives of the case study research are also to establish a ranking of importance of costs and benefits perceived, as well as to quantify the differences among *ex-ante* and *ex-post* costs and benefits of traceability system. Thus, the adoption of non-structured interview was not justified. At the same time, using a structured interview is not correct, because it needs a significant number of interviews (Corbetta, 2003) as well as a method strictly which is not possible to collect all the information, that is very important at the first level of investigation.

Table 2.2 – List of costs

CATEGORY	COSTS
System Implementation	Renovation of plant
	Purchase of new equipment and software
	External consultants
	Production, supervisory, managerial/administrative staff time
	Training courses
	Disruption of production
	Laboratory testing
	Certification/audits
System maintenance	Production, supervisory, managerial/administrative staff time
	Upgrading equipments and software
	Laboratory testing
	Monitoring supplies
	Training courses
	External consultants
	Pay more attention to input data
	Inspections/audits

Source: our elaboration from Meuwissen *et al*., (2003); Mora *et al*., (2003) and further sources.

Table 2.3 – List of benefits

CATEGORY	BENEFITS
Regulatory benefits	To meet current and anticipated future regulatory requirements
	To access public funds
Recall and risk management benefits	To reduce product liability
	To reduce the risk of a product problem occurring and product recalls

Table 2.3 – *Continue* - List of benefits

CATEGORY	BENEFITS
Recall and risk management benefits	To reduce customer complaints
	To manage easier the unit not sold or scrap
	To decrease administrative cost
	To better monitor "work flow"
Supply chain benefits	To reduce costs of production or improved yield
	To improve inventory management and coordination of supply chain
	To raise the effectiveness of logistics and distribution operations
	To measure the value added by each business partner in the supply chain
	To accelerate the identification of process and supplier
	To reduce out-of-data product losses
	To provide efficiency and effectiveness in supply chain within and between firms
Market and customer response benefits	To meet current consumer requirements and trust
	To meet current and anticipated future customer requirements
	To obtain higher price for products and improved freshness
	To access new markets and increase share of current markets
	To improve image and promotion

Source: our elaboration.

At the beginning of the interview, there was a brief personal introduction and a short description of the research project. The interviewer attempted to ensure that the bulk of the questions was discussed.

For each cost and benefit, the interviewee had to rate its importance in two different times: *ex-ante* and *ex-post* traceability system implementation. The scale rates in five points from "Very important" to "Very un-important" value.
In addition, comments of each cost and benefit analyzed have been reported. An example of the semi-destructured questionnaire is presented in figure 2.2.

In-depth narrative

To contribute to subsequent research, it is necessary to identify eventual surprises which may emerge from the comparison among expectations and actual outcomes both for costs and benefits. As mentioned above, surprises may be subject to further in-depth investigations.

Figure 2.2 – An extract of the semi-destructured questionnaire

BENEFIT CATEGORY	**Market and customer response benefits**
BENEFIT	Access new markets and increase share of current markets
Level of importance	Very Important .... Very Unimportant
Expected benefit	
Actual benefit	

2.4.4 RESULTS

In this section, I will present the results of the case study analysis introduced above. This section is composed of two parts. In the first part, I will present an overview table and in-depth narrative of costs and benefits examined. In the second section, I will explore the details of surprises which emerged when comparing expectations and actual outcomes by QM point of view.

2.4.4.1 Benefits

The section is divided into two parts: an overview table that summarizes the results (Table 2.4) and the results for each category of benefits and costs.

Regulatory benefits

The regulatory benefits included in the case study research are of two types. First, is "to meet current and anticipated future regulatory requirements" which is strongly important, because it becomes crucial to comply traceability regulations to avoid problems with government and food safety authorities.

Table 2.4 – Resume of importance of benefits

CATEGORY	BENEFITS	LEVEL OF IMPORTANCE EXPECTATIONS	LEVEL OF IMPORTANCE OUTCOMES
Regulatory benefits	To meet current and anticipated future regulatory requirements	4	4
	To have access to public funds	2	2
Market and customer response benefits	To meet current and anticipated future customer requirements	5	5
	To improve image and promotion	4	4
	To meet current consumer requirements and trust	4	3
	To obtain higher price for products and improved freshness	3	2
	To access new markets and increase share of current markets	3	2
Recall and risk management benefits	To reduce product liability	4	4
	To reduce the risk of a product problem occurring and product recalls	4	4
	To manage easier the unit not sold or scrap	4	4
	To better monitor of "work flow"	4	4
	To reduce customer complaints	4	3

Source: our elaboration.

QM ranked this benefit as one of the most important key drivers of the traceability system implementation. In fact, the traceability system implemented allows fulfillment of the EC Regulation 178/2002 and standard UNI 10939:2001.

Table 2.4 – *Continue* - Resume of importance of benefits

CATEGORY	BENEFITS	LEVEL OF IMPORTANCE EXPECTATIONS	LEVEL OF IMPORTANCE OUTCOMES
Supply chain benefits	To reduce out-of-data product losses	4	4
	To raise the effectiveness of logistics and distribution operations	4	3
	To decrease the administrative cost	4	3
	To improve inventory management and coordination of supply chain	4	3
	To accelerate the identification of process and supplier	3	3
	To provide efficiency and effectiveness in supply chain within and between firms	3	3
	To measure the value added by each business partners in the supply chain	3	2
	To reduce costs of production or improved yield	3	2

Source: our elaboration.

Second and less important regulatory benefit is "to have access to public funds". In fact, QM thinks that adopting traceability system certified will be an important prerequisite to having access to other future public funds. For instance, the ISO 9001:2000 certification was a prerequisite necessary for involvement in the Adri.fish.

Market and customer response benefits

The market and customer response benefits included in the semi-structured questionnaire are five. First and most important, is "to meet current and to anticipate future customers requirements". For the Scardovari Consortium's customers, a traceability system certified, is a formal sign of high value of shellfish and thus, it plays a crucial role in the shellfish trading. This is because customers are safer regarding products whose characteristics avoid surprises (e.g.

different quality and hygiene characteristics product). This is especially true for shellfish which are often subjects of hygiene problems (e.g. Salmonella, etc.).

The second market and customer response benefit, is "improve image and promotion" of Scardovari Consortium. It is one of the main key drivers of traceability system to be able to increase trust at all levels: wholesalers, retailers, distributors, consumers, etc. The traceability system has allowed improvement of the relationships between business partners and to consumer level through the internet-traceability (www.scardovari.org).

The third market and customer response benefit, is "to meet current consumer requirements and trust". It means, that traceability system is able to provide more information to the consumer that, nowadays, is very important because consumers are increasing the request of more information about the products purchased. Thus, traceability may become a very important tool to increase consumer trust. To do this, the Scardovari Consortium provides all the information to the final consumer through its website (www.scardovari.org).

The fourth market and customer response benefit, is to "obtain higher prices for products and improvement of its freshness", even if the QM was a little bit sceptical to achieve a higher price. The actual outcomes have shown the traceability system implementation has not increased prices as well as improved the freshness of shellfish.

The fifth market and consumer response benefit is to be able "to access new markets and increase share of current markets" despite not so widely. The actual outcomes almost have confirmed such expectation. In fact, the adoption of the traceability system is not a necessary requirement to be able to increase the market share or have access to new markets. This benefit may be more important if the traceability system is associated with other tools (e.g. brand of quality, etc.). Furthermore, competitors are implementing traceability systems; therefore, the competitive advantage of having traceability system may disappear. In addition to that, the shellfish market is strongly controlled by some big wholesalers, that allows them to impose prices to their suppliers.

Recall and risk management benefits

As reported in table 2.4, all five the recall and risk management benefits had important expectations as explained in the following. First and second benefits provided from the traceability system, may reduce: "product liability, risk of a product problem occurring and product recalls". This is because traceability allows recall of a specific food product, that has shown a problem along the ichthyic chain. Therefore traceability allows one to shift the liability and to protect the firm's reputation, that is particularly important for shellfish products, which are highly perishable and frequently subject to food scandals.

The third benefit is that traceability system is a useful tool able to "improve the easy management of the units not sold and scraps". The management of the units not sold and scraps is always an annoying problem for food processing industries. Traceability system, collecting a lot of data in a faster and accurate manner, can provide a large amount of data product scraps (e.g. location area, time of fishing, name of co-op of harvesting, etc.) and units not sold. This benefit could be very useful, for instance, because it is possible to find out which co-ops supply products with high levels of scraps, and as a consequence, Scardovari Consortium can decide to stop the supplies of shellfish from the areas where such coops harvest shellfish. Furthermore, information about scraps is useful for ASL for further in-depth investigations regarding the problem (e.g. low levels oxygen causes an increasing level of scrap) .

The fourth benefit is that the traceability system also allows a "better monitoring of the work flow" within Scardovari Consortium's plant. As mentioned before, traceability provides a large amount of data in real time, which transformed into graphs, allows one to know in real time the entire productive flow and the business performances. Such a benefit is important especially for the QM and Trade Manager (TM) who can rapidly make decisions in case of emergency (e.g. during a food scandal).

The fifth benefit is that traceability system allows "reduction of customer complaints". In fact, traceability contributes to improved relationships with customers, but it is not enough to guarantee a strong reduction of customer

complaints. There are other factors such as quality products having a stronger impact on the reduction of customer complaints.

Supply chain benefits

As shown in table 2.4, the traceability system determines eight supply chain benefits as described below.

The first benefit is to "reduce out of data product losses", because it saves a large amount of data in the software - database. This is important, because it allows veterinaries[46] to monitor in real time the hygiene parameters of shellfish (e.g. area of fishing, length of depuration, etc.). This is the reason why veterinaries push Scardovari Consortium to improve and the performances of traceability system.

The second benefit is that traceability helps to "raise the effectiveness of logistics and distribution operations". Traceability system has speeded up the logistics and operations determined by a larger and precise availability of data. On the other hand, this requires more attention, work and increasing pressure to the users.

The third benefit, is that the traceability system has not "decreased the administrative costs" as expected, because staff and management need to spend more time on data input and data management, although other administrative costs such as reduction of paper use is significant.

The fourth and fifth benefits, are "to improve the inventory management and coordination of supply chain and accelerating the identification of processes and suppliers". Prior to the traceability system implementation, Scardovari Consortium used to adopt a sort of semi-manual traceability system to manage the large number of suppliers which is quite complicated without a traceability system. Now, the new traceability system support has improved these benefits, because it increased the speed of the system.

The sixth benefit, is to "improve the efficiency and effectiveness in supply chain within and between firms". Traceability has not a significant effect on these benefits, because the relationships between Scardovari Consortium and suppliers

[46] Public veterinaries are people who control hygiene and healthy of ichthyic products and authorize fishing, processing and trade of seafood products activities.

is already efficient and effective since they were part of the Scardovari Consortium, prior to traceability implementation.

The seven benefit, is that the traceability system is not able to "measure the value added by each business partner in the supply chain". This is because the suppliers and processors are highly integrated, and can be considered a unique firm. For this reason, it is not possible to measure added value.

The eight benefit, is to "reduce costs of production and/or improved yield" which is not an important benefit. In fact, the traceability system does not reduce the cost of production. QM did not have big expectations about such a benefit, rather actually experience shows that there is an increasing cost of production due to disruption of production. Workforces need to spend more time to separate lots that increased in number with traceability system.

2.4.4.2 Costs

In this section, I will discuss on important details about traceability costs by QM perspective. From table 2.5 it is observed that the costs of traceability are basically not too important.

First of all, it is important to say that the main part of the traceability costs has been covered by Adri.fish.

Implementation costs

The most important implementation cost is "disruption of production". It is a cost not really understood by QM, because it is quite hard to quantify the time spent for traceability practices by workforces, in terms of Euros. The traceability system allows details in every production lots to separate[47]. For each lot it is necessary to interrupt the work flow. Prior to traceability system implementation, Scardovari Consortium used to have one lot per day, but now it uses a larger number of lots.

As a consequence, disruption of production has becoming a heavy cost. However, in the first stages of using the traceability system the production flow was interrupted many times, but after six months these interruptions decreased. The

[47] A lot is described by different characteristics as for instance data of fishing, supplier, etc.

expectations confirm the actual experience, although cost is "not well understood".

Table 2.5 – Level of importance of costs

CATEGORY	BENEFITS	LEVEL OF IMPORTANCE EXPECTATIONS	LEVEL OF IMPORTANCE OUTCOMES
System implementation	Disruption of production	4	4
	Renovation of plant	2	2
	Purchase of new equipment and software	2	2
	External consultants	2	2
	Training course	2	2
	Laboratory testing	2	2
	Inspection/audits	2	2
System maintenance	Upgrading equipment and software	3	3
	Production, supervisory, managerial/ administrative staff time	2	3
	Pay more attention to input data	2	3
	External consultants	2	2
	Monitoring supplies	2	2
	Training course	2	2
	Laboratory testing	2	2

Source: our elaboration.

Maintenance/operation costs

The most important maintenance costs are of three typologies. First is, "upgrading equipments and software". Equipments and software are in a continual evolution, thus to improve the traceability system performances it is often necessary to upgrade them. In addition, as mentioned before, the veterinaries push the Scardovari Consortium management to upgrade equipment and software to

improve the traceability system performances (e.g. implement more traceability software functions as new applications for statistical data, etc.).

The second cost is "production, supervisory and managerial/administrative staff time" which has been mainly important over the first six months after the traceability implementation. Such cost has been important because management and staff had spent a lot of time training and learning about the using of the traceability system.

The third cost is that the traceability system requests one to "pay more attention to input data", because it requests more effort to data collection which creates pressure and time spent from workforce and staff.

2.4.4.3 Surprises and possible reasons

Now, I will discuss details about the surprises and possible reasons which emerged comparing expectations and actual outcomes (Tables 2.6 and 2.7). At first sight positive surprises do not emerge.

Benefits

From the case study's analysis five surprises emerge. The first and second surprises are that the traceability system does not help to "obtain a higher price for products and improved freshness", and in addition it does not favor "access to new markets and increased share of current markets" as expected.

It is quite difficult to hypothesize the reasons, but some hypothesis could be done:

- ✓ it may be necessary to advertise the traceability system at customer and consumer levels in a better way;
- ✓ actually competitors are implementing traceability system, which may mean that adoption of a traceability system does not provide any competitive edge in terms of price premium;
- ✓ Scardovari Consortium does not have enough market power to impose a higher price to their customers.

Third, is that the traceability system does not "reduce customer complaints", as expected. The main reason may be that the traceability system alone cannot

reduce customer complaints, because customer complaints depend on other factors.

Table 2.6 – Resume of surprises of benefits

CATEGORY	BENEFITS	LEVEL OF IMPORTANCE EXPECTATIONS	LEVEL OF IMPORTANCE OUTCOMES	DIFFERENCE
Market and customer response benefits	Obtain higher price for Products and improved freshness	3	2	- 1
	Access new markets and increase share of current markets	3	2	- 1
Recall and risk management benefits	Reduce customer complaints	4	3	- 1
Supply chain benefits	Decrease administrative cost	4	3	- 1
	Reduce costs of production or improved yield	3	2	- 1

Source: our elaboration.

Fourth, is that the traceability system is not able to "decrease administrative cost" as expected. However, actual outcomes are ambiguous. On one hand, it has significantly decreased use of papers and the time spent writing in the account book while, on the other hand, there has been an increase of time spent on data input and management, as mentioned before.

Fifth, the traceability system has not been able to "reduce costs of production" as expected, mainly due to disruption of production, external consultants and new equipment and software.

Costs

The surprises which emerged by traceability costs are two (Table 2.7).

First, is that "production line, supervisory staff and managerial/administrative time" have shown to be a more important cost of traceability system than expected. Actual outcomes show that employees, who use traceability system,

spend more time than expected. For instance, workforces keep separate lots and staff to data input and management.

Second, is that it is necessary to "pay more attention to input data", a cost more important than expected. Traceability system needs to pay more attention to data input; then it is a cost "not well understood".

Table 2.7 – Resume of surprises of costs

CATEGORY	COSTS	LEVEL OF IMPORTANCE EXPECTATIONS	LEVEL OF IMPORTANCE OUTCOMES	DIFFERENCE
Maintenance/ operation costs	Production, supervisory, managerial/ administrative staff time	2	3	+ 1
	Pay more attention to input data	2	3	+ 1

Source: our elaboration.

2.4.5 RESULTSUMMARY AND RECOMMENDATION

From the Scardovari Consortium case study's analysis emerges some main outcomes. First is that the most important benefit provided to the traceability system is "meeting current and anticipated future customer requirements" that improves image and promotion of the Scardovari Consortium. Second, is that traceability determines high "recalls and risk management benefits" over that allowed to "meet regulatory requirements" which are very important because Scardovari Consortium is often subject to high attention by medias, governments, consumers, etc. Third, the traceability system provides "supply chain benefits". In particular, it "reduces the out of data losses", which are saved on the traceability software. Four, surprises on benefits show that the traceability system does not add value to shellfish such as to "obtain higher prices" and "have access to new markets or increasing market share" as expected. Fifth the traceability system does not reduce any "administrative and production costs" while the most important costs are "upgrading equipments and software", "production, supervisory and managerial/administrative staff time", "pay more attention do data input" and "disruption of production". Sixth, surprises on costs shown as

traceability system determines more time spent by staff and management to data entry and data management over the necessity to "pay attention to data input" than expectations.

Finally, it is possible to provide some useful recommendations for the research, industries and governments. First, for research it would be useful to do in-depth investigations about costs and benefits assessment of traceability system. In particular, it would be important to establish an assessment of the factors which influence costs and benefits of firms, with particular regards to the role played by government support. In addition, it would be important to investigate in-depth the importance of the "costs not well understood", such as, for instance "disruption of production". Finally, it would be important to investigate in-depth the possible ways for better advertising of the traceability system able to add value to the product and increase the market share for firms.

Second, for fishery industries, which are in the process of implementing the traceability system or have already implemented it, it would be important to involve all the employees, such as staff, management and workforces, into traceability practices. This may help for a full utilization of the traceability system at all of its potentialities. In addition, it is necessary to advertise the traceability system at customer and consumer levels in an effective way.

Third, the governments, who intend to support traceability system implementation, have to take into consideration that there are also additional costs such as "disruption of production", that would be important to include in the financial support.

2.5 CONCLUSION

The goal of this Chapter is to provide background information about the impact of the traceability system in the food supply chain. To do this, Chapter two is divided into two parts. In the first part background information based on literature reviews is provided: traceability definitions, its processes, sub-processes and technological applications were explained including the functions of tracking and tracing food. In addition, background information about costs and benefits of

traceability in the food supply chain through government involvement in traceability practices, as reflected in the key process of legislation on traceability practices, is presented. Second, I presented the results of an application of the traceability system into Scardovari Consortium through a case study analysis.

The next Chapter will present an overview of the Italian fishery supply chain.

CHAPTER THREE

THE ITALIAN FISHERY SUPPLY CHAIN

3.0 INTRODUCTION

The aim of Chapter three is to provide background information and to show an overview structure of the Italian fishery supply chain. Such information serves to put the firm's background into a context with the factors and drivers that may affect traceability practices in the fishery supply chain.

Chapter three is divided into four sections. In the first section, I will describe details about the Italian fishing and aquaculture activities and the market of the main species farmed. Second, I will provide information about the Italian fishery processing industry. An overview of the structure with particular emphasis on a description of the tuna, anchovy and deep-frozen ichthyic industry will be provided. Third, I will describe the distribution stage with particular attention to the roles played by wholesaler markets and retailers. Four, I will provide some information about import and export activities. I will conclude Chapter three with some conclusions that will also introduce Chapter four.

3.1 THE PRIMARY PRODUCTION: FISHING AND AQUACULTURE

The primary fishery production is composed of fishing and aquaculture activities. According to Ismea (2007:123-163), the fishing activity supplies 55% quantity and 70.6% value, while aquaculture produces 45% quantity and 29.4% value of the overall ichthyic production.

3.1.1. FISHING IN THE MEDITERRANEAN SEA: AN OVERVIEW

According to Archivio Italiano Licenze[48] (2006) 13,955 Italian vessels work in the Mediterrean Sea. The Italian fleet is one of the most numerous (together with Greece and Spain) in the EU (Ismea, 2007:123-163). The Italian fleet is small with high artisanal level and uses various fishing techniques. The most important fishing techniques are the following:

- ✓ the *small fishing,* that is practiced by over 9,000 vessels. Such a technique is mainly practiced in the south of Italy (Ismea, 2007:123-163). The vessels are small and use passive tools of fishing; for instance, fishing net, fish hook, etc (Ismea, 2007:123-163). The productivity of the small fishing is low, but the negative impact – in terms of damage - of biology ichthyic resources is also very low in comparison to other fishing techniques (e.g. the trawler). The small fishing is of crucial importance to the social/labour perspective: it involves 43% of the overall employees of the fishery and aquaculture activities (Ismea, 2007:123-163);
- ✓ the *trawler* involves 2,845 vessels (Ismea, 2007:123-163). As for small fishing, this technique is mainly practiced in the south of Italy (Ismea, 2007: 123-163). The trawler is used by medium to larger size vessels and it achieves high technical and economic performances: during 2006, the trawler produced 49.5% of overall pay-off of the ichthyic production (Ismea, 2007:123-163);
- ✓ other less important fishing techniques are *hydraulic dredge, fishing boat for circuit, polyvalent*, etc.

Since 2000, the productive capacity of fishing of the Italian fleet has decreased for three main reasons (Ismea, 2007:123-163). The first reason is due to the application of CFP[49] reform. The objective of the CFP reform has been to reduce the impact of fishing activities to preserve the biological resources (Ismea, 2007:123-163). The second reason is that fishermen are reducing the number of days of fishing. This is because they would like to supply less product to the market in order to keep stable prices (Ismea, 2007:123-163). The third reason is

[48] The Archivio Italiano Licenze is an Italian Public Authority that records all the data regards the Italian fleet (e.g. numbers of vessels, etc).
[49] Common Fishery Policy.

that the increasing gas and oil prices have reduced the activity of fishing. This is because gas and oil are some of the foremost costs of the fishing activities (Ismea, 2007:123-163).

As a result, from 2002 to 2006 the Italian fleet has reduced its fleet by 2,000 vessels while the number of employees have decreased from 38,000 to 30,000. Furthermore, the days in a year of fishing decreased from 161 (2002) to 134 (2005) (Ismea, 2007:123-163).

In 2006, an equilibrium between fishing effort and productivity has been achieved: the unit productivity[50]. In the Mediterranean Sea has increased (Ismea, 2007:123-163). The table 3.1 shows some data regarding the captures and proceeds of the fishing activities during 2006.

Table 3.1 – Captures and proceeds of the fishing activities in Italy, 2006

SPECIES	QUANTITY (Tons)	WEIGHT (%)	VALUE (Millions of Euros)	WEIGHT (%)	MEDIUM PRICE (Euros/kg)
Fish	200,624	70.2	842,68	56.4	4.20
Shellfish	56,408	19.7	298,47	20.0	5.29
Crustaceous	28,799	10.1	353,60	23.7	12.28
Overall	**285,831**	**100.0**	**1.494,75**	**100.0**	**5.23**
Main species					
Anchovy	78,051	27.3	138,89	9.3	1.78
Clam	18,760	6.6	49,43	3.3	2.63
Hake	17,856	6.2	133,17	8.9	7.46
Sardinia	13,668	4.8	14,27	1.0	1.04
Red mullet	8,876	3.1	51,80	3.5	5.84
Swordfish	7,626	2.7	85,69	5.7	11.24
Bluefin tuna	4,292	0.5	16,97	1.1	3.95

Source: elaboration Ismea on Mipaaf – Irepa data.

[50] Kg of ichthyic products/day and kg of ichthyic products/fishing vessel.

The fish is the main group of ichthyic products captured from shellfish and crustaceous. In addition, observe that the shellfish and crustaceous achieve higher prices in the market than fish.

The main ichthyic species fishing in the Mediterranean Sea are:

- ✓ anchovy and sardine, which represent about 60% of the overall captures;
- ✓ clam, hake, white prawn, sardine, etc (quantity 10,000 – 20,000 tons);
- ✓ red mullet, swordfish, blue fin tuna, etc (quantity 4,000 tons).

3.1.2 THE AQUACULTURE AND THE MAIN SPECIES FARMED

Italy is the third EU aquaculture producer after France and Spain (Ismea, 2007:138-157). In 2006, the aquaculture production grew over 241,000 tons achieving a turnover of 629 millions of Euros (Ismea, 2007:138-157).

3.1.2.1 Trout

According to Ismea (2007:138-157) trout is the main fish species farmed in Italy (Table 3.2). The farms are mainly located in the north of Italy (e.g. Trentino Alto Adige, Friuli Venezia Giulia, etc). Actually, the farmers are adopting strategies to optimize the techniques of production, decreasing the costs of production and offering products differentiates (e.g. salmon trout, smoked and talked trout).

Trout are exported towards Central EU, for example, to Austria, Germany and Switzerland, basically in live and fresh typologies; whereas, in Italy, over the last years, fresh and cooled trout (e.g. salmon and white trout) have shown high market performances (Ismea, 2007:138-157).

3.1.2.2 Sea bream and sea bass

Italy is traditionally one of the main EU productors of sea bream and sea bass together with Greece, Spain and Turkey (Ismea, 2007:138-157). The Italian production of such species is widely located in the south of Italy, Tuscany and the North Adriatic sea. There are three techniques of production: intensive, semi-intensive and extensive, depending on the level of industrialization adopted.

According to Ismea (2007:138-157), the domestic market of sea bream and sea bass is highly penalized by price - competition of Greece and Turkey, which are able to produce due to low costs of production. As a consequence, the Italian

producers have started to apply policies of market differentiation supplying to the market products with higher levels of quality (e.g. rise of the medium sizes until 400/800 grams) and various levels of processing (e.g. talk out and vacuum – packed) thus able to add value to such products.

Table 3.2 – The main species farmed, 2006

SPECIES	QUANTITY (Tons)	WEIGHT (%)		VALUE (Millions of Euros)	WEIGHT (%)	
Sea-bass	9,300	3.8	12.9	66	10.5	19.4
Sea-bream	9,500	3.9	13.2	64	10.2	18.8
Mullet	3,000	1.2	4.2	12	1.9	3.6
Eel	1,700	0.7	2.4	15	2.4	4.5
Trout	40,200	16.6	55.9	133*	21.1*	38.9*
Catfish	600	0.2	0.8	2	0.4	0.7
Carp	700	0.3	1.0	2	0.3	0.6
Sturgeon	1,300	0.5	1.8	10	1.7	3.1
Other fishes	5,600	2.3	7.8	36	5.7	10.5
Overall fish	**71,900**	**29.7**	**100.0**	**341**	**54.2**	**100.0**
Mussels**	125,000	51.7	73.5	81	12.9	28.2
Clams	45,000	18.6	26.5	207	32.9	71.8
Overall mussels	**170,000**	**70.3**	**100.0**	**288**	**45.8**	**100.0**
Overall aquaculture	**241,000**	**100.0**	**-**	**629**	**100.0**	**-**

***** The value also includes the add value provide from processing activities.

** It also includes mussels produce by natural reefs.

Source: elaboration Ismea on Api/Icram data.

In addition, the market of sea bass and sea bream is extremely influenced by large-scale retail trade (Ismea, 2007:138-157). Big chains require their suppliers

to have high levels of standardization of the products, high productive capacity and high organizational and quality standards (e.g. certifications, etc.).

3.1.2.3 Shellfish and other species

As shown in table 3.2, mussels (*Mytilus galloprovincialis*) and clams (*Tapes philippinarum*) are the main species farmed in Italy. The 359 plants are located in all the Italian coasts with special emphasis on the North Adriatic sea for clams and North Adriatic and Tyrrhenian sea for mussels (Ismea, 2007:138-157). The shellfish are farmed from co-ops or private fishermen who supply the products directly to the market (e.g. wholesalers) or Centres of deportation depending on which types of water the shellfish are grown[51].

Italy is a strong exporter, mainly to France, Spain and Netherlands and also it is a strong importer of shellfish products from Spain and Greece (Ismea, 2007:138-157).

Other important species farmed are eels, sturgeon and freshwater. The production and export of caviar has shown highly positive performances, over last years. On the other hand, eel farming is in difficulty due to the problems with finding seeds, the high competition from other Countries, and the highly obsolescence of its productive structures.

3.2 THE ICHTHYIC INDUSTRY PROCESSING: AN OVERVIEW

As mentioned in the introduction of Chapter three in the second section, I will provide some information about the Italian ichthyic processing industry, here simply called ichthyic processor, with particular emphasis on the tuna, anchovy and deep-frozen industries which are the foremost ichthyic processors in Italy (Ismea, 2005:99-109).

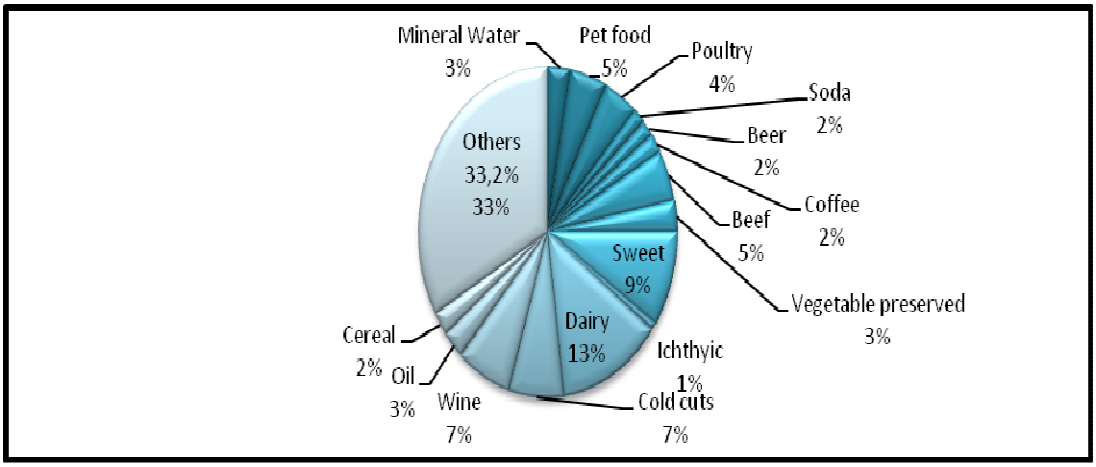
[51] The EC regulations n.853/2004, 2073/2005 and 1881/2006 classify water in three types: A, B and C. The shellfish grew in water A can be sold directly to the market, while for waters B and C the shellfish must be depurated in a Center of depuration before going to the market.

3.2.1 SIZE AND STRUCTURES CHARACTERISTICS OF THE INDUSTRY

Based on information provided from the Italian Census of Industry and Services (2001), the Italian slaughtering, processing and preserving ichthyic industries are 415 (0.6% of the overall food industries) while the overall employees involved are 6,640. Therefore, the ichthyic industry processing plays a minor role within the Italian food processing industry (Figure 3.1).

The ichthyic processors are homogeneous distributors across north and central Italy where one out of three (1/3) of the overall firms involving 48.8% of the overall employees is located.

Figure 3.1 – Revenue of main Italian food processing industries, 2004



Source: Federalimentare.

The larger number of ichthyic processors (59%) are located in the south of Italy which work over the mid (51.2%) of the overall employees (Ismea, 2005:99-109). As a consequence, in north and central Italy, firms are bigger size than south of Italy. The table 3.3 shows the structure of the ichthyic processors in terms of legal status, artisanal role, location, number of locates and types of employees.

It emerges that individual firms are of low importance (25.3%), while the foremost group are stock, limited companies and others (45.8%), not artisanal (65.5%) with unique location (86%), municipal locate and dependent employee (Ismea, 2005:99-109).

Table 3.3 - Structure of the Italian ichthyic processors, 2001

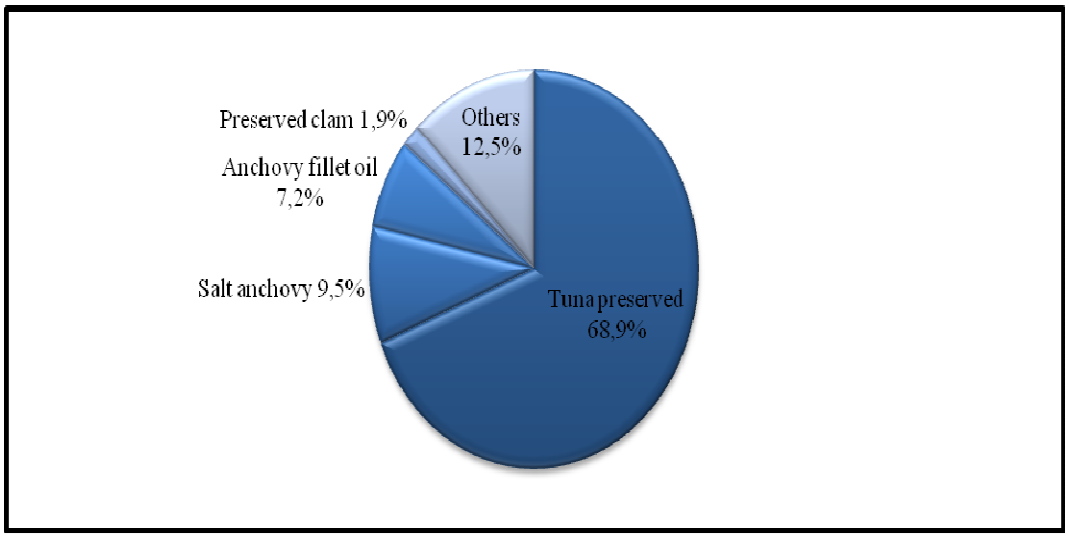
VARIABLE	2001	WEIGHT (%)
LEGAL STATUS		
Individual company	105	25.3
Personal company	96	23.1
Corporation	190	45.8
- stock company	31	7.5
- other	159	38.3
Co-ops	23	5.5
Others	1	0.2
Overall companies	**415**	**100.0**
ROLE ARTISANAL COMPANIES		
Artisanal company	143	34.5
Others	272	65.5
Overall companies	**415**	**100.0**
LOCATION		
Municipal	388	93.5
Provincial	10	2.4
Regional	4	1.0
National	13	3.1
Overall companies	**415**	**100.0**
MULTI LOCATES		
Uni locate	357	86.0
Multi locate	58	14.0
Overall companies	**415**	**100.0**
TYPE OF EMPLOYEES		
Independent	660	9.9
Dependent	5,980	100.0
Overall employees	**6,640**	**100.0**

Source: elaboration Ismea on Istat data.

3.2.2. THE MAIN ICHTHYIC PROCESSORS: TUNA, ANCHOVY AND DEEP-FROZEN

As shown in figure 3.2, the tuna industry is the most important preserved ichthyic industry in Italy, followed by the anchovy industry (Ismea, 2005:126-142).

Figure 3.2 – Percentage composition of ichthyic preserve in volume in Italy, 2003



Source: elaboration Ismea on data Ancit.

As shown in table 3.4, Italy is a strong importer of tuna: in 2006 Italy imported 69,927 tons of tuna (Ismea, 2007:196-176). The main tuna specie, *Thunnus albacores,* is imported in three different forms: frozen, lions and canned.

Table 3.4 - Preserved tuna in Italy: indexes, 2006

VARIABLES	QUANTITY (Tons)	VALUE (Millions of Euro)
Production	85,000	500
Export	14,163	72
Import	69,927	296
Trade balance	**-55,764**	**-225**

Source: elaboration Ismea on different sources.

The frozen tuna is mainly imported from France, Taiwan, Spain and Seychelles while lions is basically imported from Columbia, Ecuador, Costa Rica and Thailand (Ismea, 2005:126-142). The canned tuna is imported from Spain, Costa D'Avorio, Seychelles, France, etc. On the other hand, Italy exports canned tuna to Greece, France, Belgium, Slovenia, Saudi Arabia, etc (Ismea, 2005:126-142).

The market leader in tuna processing industries is Bolton Alimentari through the brand "Rio Mare". Bolton Alimentari is maintaining its market share (38%) constant supplying the market with new products. Other important firms are: Nostromo, controlled by the Multinational Spanish Company Calvò, (market share 10%), Palmera spa (market share 6%), Mare Aperto srl, Iginio Mazzola spa, Nino Castiglione and Giacinto Callipo Conserve Alimentari spa (Ismea, 2007:196-176).

As shown in figure 3.1, the anchovy processors are shared in two types of products: salt anchovy and anchovy fillet oil (Ismea, 2005:126-142). As shown in table 3.5, Italy is a strong importer of salt anchovy, mainly from Croatia, Greece, Argentina, Spain and Morocco (Ismea, 2005:126-142). On the other hand, the salt anchovies are exported to Albania, Tunisia, Australia, Greece, Morocco, etc.

Table 3.5 – Salt anchovy: indexes, 2003

VARIABLES	QUANTITY (Tons)	VALUE (Millions of Euro)
Production	12,500	500
Export	397	72
Import	5,980	296
Trade balance	-5,511	-225

Source: elaboration Ismea on data Ancit.

The last typology of ichthyic processors described, is the deep-frozen industry. It is an industry that plays an important role within the ichthyic processor industry. During 2006, the overall Italian production of deep frozen foods was 890,000 tons for a turnover of 2,4 million Euro (Ismea, 2007:176-183). The domestic

consumption is closely dependent on imports: the trade balance is negative of 104.000 tons (Ismea, 2007:176-183).

The firm leader in the Italian market is Unilever Italia (38% of the market share) with the "Findus" brand. The second foremost company is Nestlè Italiana (11% of the market share) with the "Buitoni" brand. Other important firms are Orogel (5% of the market share) with "Oro del mare" brand, Arena Surgelati with the "Mare Pronto" brand, Panapesca, Appetais Italia, Vis Industrie Alimentari and Pescanova Italia (Ismea, 2007:176-183).

3.4 THE RETAILERS AND WHOLESALER MARKETS: AN OVERVIEW

The ichthyic products are distributed through a large number of distributors: chains, restaurants, local fishery shop, pitchman, etc. Basically, two levels of trade are wholesale and retail. The fishing products are usually sold through wholesalers or wholesaler markets which in turn supply pitchmen, restaurants, processors, small fishery shops, etc. In contrast, the farmed products have a shorter supply chain structure to farms and processors which are usually high vertical integrated and do supply agreements with chains for the distribution.

Now, I will briefly describe the two main typologies of distributors of ichthyic products: wholesaler markets and chains. The wholesale markets play a key role in the Italian fishery supply chain (Table 3.6).

Such structures collect products from fishing activities, and sometimes from farming, by fishermen. According to Ismea (2007:185-202) there are three types of wholesaler markets: production markets, mixed markets and consumption markets. The main type is production markets to which fishermen supply fresh fishing products which in turn are then sold to small retailers (e.g. restaurants, wholesalers, etc.). The second type is mixed markets where the products can be supplied from both fishermen or production markets. The third type is the consumption markets where the products are supplied from mixed or production markets (Ismea, 2007:185-202).

The chains play a key role in the retail trade for ichthyic products (Ismea, 2007:185-202). As stated in table 3.7 "Chain, ipermarket, supermarket, superette e discount" are the main channels where consumers purchase ichthyic products

(68.3%). Over the last years, chains have increased their importance in the ichthyic market (Ismea, 2007:185-202). Such positive performance is mainly due to two factors.

Table 3.6 - The values of the main wholesale markets, 2006

MARKETS	QUANTITY (Tons)	VALUE (.000 Euros)
Goro	1,756	3,510
Cesenatico	2,643	7,732
Ancona	1,571	10,049
Civitanova Marche	1,426	7,738
San Benedetto del Tronto	8,313	15,739
Corigliano Calabro	572	3,086
Livorno	279	1,674
Viareggio	245	1,290
Aci Trezza	4,418	29,786
Trapani	430	1,940
Chioggia	12,224	44,168
Molfetta	1,177	5,123
Messina	2,606	13,462
Catania	5,377	24,798
Turin	5,699	31,803
Venice	10,919	60,319
Milan	8,233	-

Source: Ismea, 2007.

One factor is that chains have started to sell fresh products which is the main group of fishery products sold in Italy. The second is that the challenge of consumer lifestyles; nowadays, consumers ask for higher levels of food quality

and safety over high levels of service (e.g. ready to cook products, etc.) that only chains are able to provide (Ismea, 2007:185-202).

Table 3.7 - Domestic purchases of ichthyic products in Italy for channel of sale, 2006

CHANNEL OF SALES	QUANTITY (Tons)	WEIGHT (%)	VALUE (.000 Euros)	WEIGHT (%)
Chain, ipermarket, supermarket, superette e discount	307,194	67.4	2,969,878	68.3
Local fishery shop	89,141	19.6	848,683	19.5
Pitchman/small local market	30,934	6.8	275,868	6.3
Other channel (shops, cash & carry, door to door, etc)	28,302	6.2	251,707	5.8
Overall	**455,571**	**100.0**	**4,346,140**	**100.0**

Source: Ismea – AC Nielsen.

3.5 THE SUPPLYING BALANCE AND THE EXCHANGES WITH FOREIGN COUNTRIES

As shown in table 3.8 Italy is a strong importer of ichthyic products. The main typologies of ichthyic products exported are fresh fish such as tuna, sardines, anchovy, trout and shellfish such as shrimp and mussels and preserved fish (Ismea, 2007:205-234). The main export markets are Spain, France, Germany, Greece, Croatia, Switzerland.

On the other hand, the main species imported are tuna, cuttlefish, cod, shrimp, etc mainly from Spain, France, Denmark, Netherlands, Greece, Chile, Thailand, Argentina, Ecuador, etc. (Ismea, 2007:205-234).

3.6 CONCLUSIONS

The purpose of this Chapter is to discuss the main drivers that are shaping the Italian ichthyic supply chain and to provide an overview of the ichthyic supply chain.

To sum up, I can extract some outcomes that may justify the introduction of traceability system in the fishery and aquaculture supply chain. First, the fishery

supply chain has a structure highly fragmented and heterogeneous. Second, the Common Fishery Policy has reduced the fishing effort, but has not yet substituted from the aquaculture production.

Table 3.8 – Main economic indexes in the ichthyic sector in Italy, 2006

CATEGORY	UNIT OF MEASUREMENT	2006
Production	**(.000 t)**	**538**
Import	(.000 t)	901
Export	(.000 t)	141
Trade balance	(.000 t)	-,760
Movement[52]	(.000 t)	1,042
Apparent consumption[53]	(.000 t)	1,298
Per capita consumption	**(kg)**	**22.0**
Level of self-supplying	(%)	41.5
Propensity to import	(%)	69.4
Propensity to export	(%)	26.3
Level of covering of import	(%)	15.7
Balance standardize	**(%)**	**- 72.9**

* Fish, shellfish, crustaceous and other water invertebrate and their preparation.

Source: elaboration Ismea on different sources.

Third, Italy being a net importer of ichthyic products, has problems with products that are supplied from extra-EU Countries, thus it is difficult collecting information about products. Fourth, some year's prices of fresh fish, tuna and olive oil are increasing due to the rise of gas and oil prices. Fifth, the domestic consumption of ichthyic products is stable; therefore, there is need to improve the consumption. Sixth, the recent food scares, that hit the food sector, has

[52] Movement is handling of goods: Import + Export.
[53] Apparent consume = Italian production + (Import – Export).

demonstrated the need for food safety which is an argument really important for consumer trust. In fact, the food scares could hit also the fishery sector, especially when the origin of the raw product is uncertain.

CHAPTER FOUR

CONCEPTUAL FRAMEWORK

4.0 INTRODUCTION

Chapter two presented the implications of the relatively new practice of traceability through the food chain. Traceability is increasingly becoming a support tool for business growth and a way of doing business in the food market (Golan *et.al.*, 2004:16-20; Souza – Monteiro *et al.* 2006:1). However, the types of traceability systems vary in terms of breadth, depth and precision, across the food chain, depending on the type of production process, traceability objectives, the firm's characteristics, etc. (Golan, 2003:17-20). To the best of my knowledge there is no empirical study that has investigated the variables impacting on costs and benefits of traceability or performance of traceability practices. This explains the necessity of exploring and analyzing factors affecting the outcomes of costs and benefits of traceability systems within a specific industry of the agrifood chain.

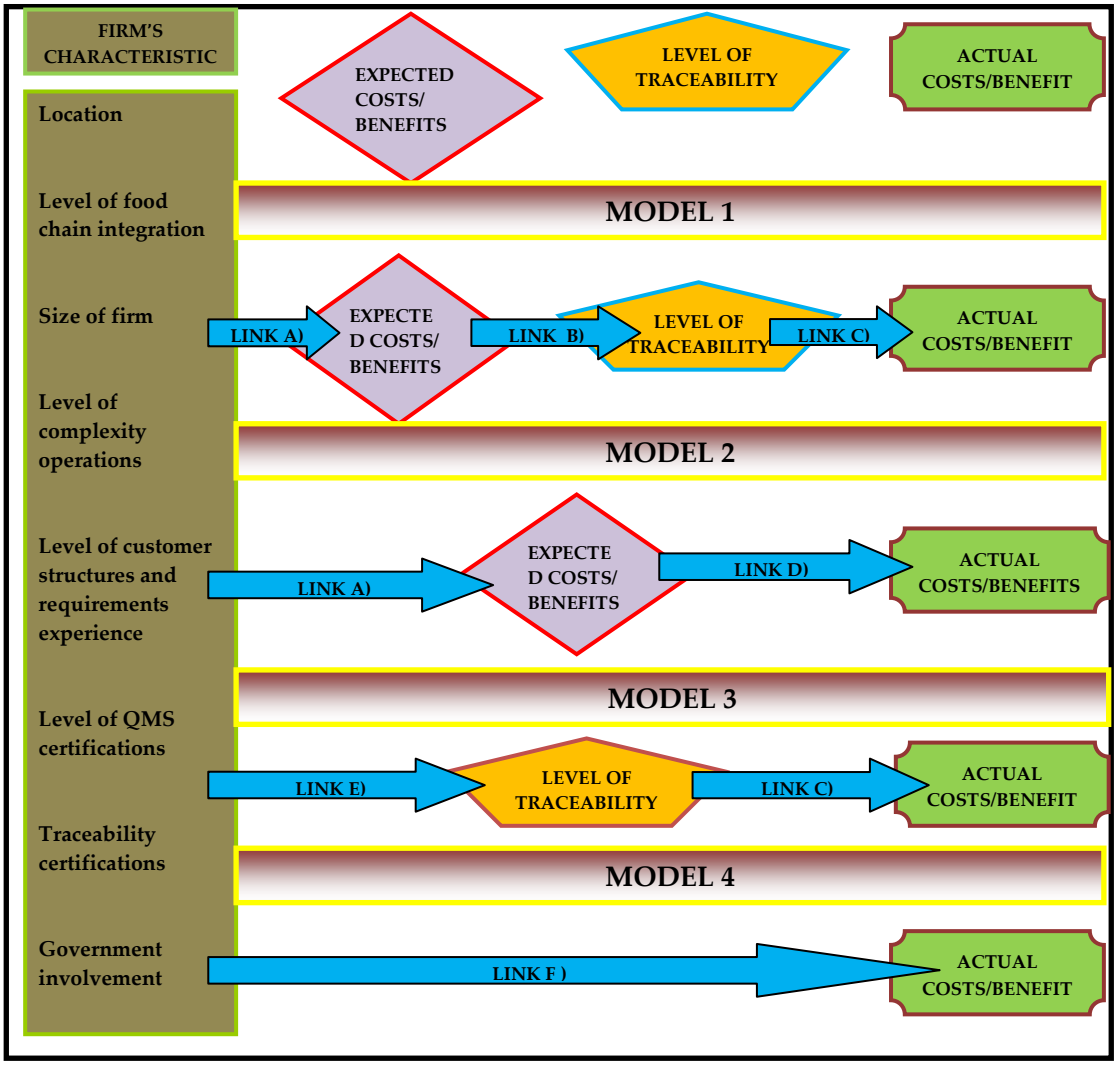
This Chapter is composed of three sections. In the first section, I will present the conceptual framework and the empirical models that will be used to assess and group the survey items into concepts representing variables in hypothesis testing and data analysis. The factors affecting traceability business performance and their hypothesised relationships will be introduced. In the second section, the description of generating processes of indexes used will be provided. The Chapter will conclude with a description of the questionnaire variables and data collection used for this survey.

4.1 CONCEPTUAL FRAMEWORK: AN OVERVIEW

Figure 4.1 presents the conceptual framework that will be used to assess the determinants that are impacting on costs and benefits of traceability practices. This framework is designed to investigate Italian fishery processors that have

implemented some forms of traceability system. The conceptual framework schematizes the factors impacting on traceability business performances as measured through reported actual costs and benefits. As shown in figure 4.1, there are three groups of factors: firm's characteristics, level of traceability and expected costs and benefits.

Figure 4.1 – Traceability net benefits framework



First, the firm's characteristics affect the implementation and operation of traceability. The framework uses individual variables or composed indexes such as location, level of food chain integration, size of firm, level complexity of operations, level complexity of customer structures and requirements experience, level of QMS certifications, traceability certifications and governments support.

Second, the level of traceability is defined by three dimensions: breadth, depth and precision of a traceability system (Golan *et al*., 2004:16-17). As presented in Chapter two, breadth is described as the amount of information collected, depth as the number of supply chain stages up and downstream included in the traceability system, while precision reflects the degree of accuracy with which the tracing system can pinpoint a particular food product's movement or characteristics.

Third, the expected cost and benefits are comprised of variables as overall costs and benefits, as well as specific categories of costs [purchase new equipment and software; certification, audit and external consultants; production line, supervisory staff and managerial/administrative time; training course and materials] and benefits [meeting current and anticipated future regulatory requirements; increasing consumer trust; meeting customers' requirements and increasing their trust; increasing market share, accessing new markets and/or obtaining a price premium; reducing customer complaints, recalls, risk of product liability; improving management within the company and reducing the possibility of errors for data input and data management; improving supply chain management, i.e. inventory, logistics, communication with suppliers and customers].

Finally, actual costs and benefits are measured on the same specific dimensions as expected costs and benefits above.

Figure 4.1 shows six possible links as to how these three factors may interact among each other and impact the resulting actual costs and benefits. These links are combined in four different models. First, a brief description of each model's rationale and structure is presented here, before a more detailed account of the involved variables and generated hypotheses is given in the next section.

Model one represents the complete decision-making model that firms may adopt for traceability system implementation. As stated by Golan *et.al* (2003:19), prior to implementing a traceability system, firms measure the expected costs and benefits based on traceability objectives and the firm's characteristics (link A). Depending on expected costs and benefits, firms will choose the best level of traceability, i.e. the one maximising net benefits (link B). At the end, the level of traceability will determine the actual costs and benefits (link C). Therefore, I hypothesize that measuring the relationships among firm characteristics, expected

costs and benefits, level of traceability and actual costs and benefits captures the full decision making considerations by firms that undergo the process of traceability system implementation.

However, testing the full model might not be possible, because there are difficulties in measuring the level of traceability in a valid manner. In the literature reviews there are only some studies that measure the level of traceability (Bulut *et.al*, 2008). Bulut *et.al*, (2008) measure the depth of traceability (backward and forward), but it is quite hard to combine in one equation the measures of breadth, depth and precision of traceability system. No literature at all informs us about that. Further, it would also be complicated to assess a unique level of traceability for firms, because maybe every firm adopts many levels of traceability depending on types and suppliers of raw materials, types of customers, etc. This is because breadth, depth and precision within firms vary depending on products; for example, the same product that has a certain level of precision at input stage (e.g. lot based on one day of production) may have different levels of precision at output stage (i.e. for chain customers the precision request is multiple lots for each customers for product delivery, while for other customers as processors the precision is two or more days of production).

Based on the reasons reported above, I will introduce model two, a more simple model, which leaves out the level of traceability. Model two proposes that the actual costs and benefits, due to traceability practices, are associated with the expected costs and benefits, without considering the level of traceability, as is captured in link D. The expected costs and benefits, in turn are determined by the firm's characteristics (link A).

However, there might also be difficulties in measuring the expected costs and benefits. Various authors state that while it is not too difficult to measure the potential costs, it may be difficult to measure potential benefits due to traceability practices (i.e. possible price premium). In addition, assessing today the perception of how the expectation of costs and benefits were prior to the traceability system implementation is quite difficult, especially if a lot of time (e.g. 3 years) has passed during which the respondents may not have been involved (e.g. may have worked for other firms).

Since there are difficulties in measuring the expected costs and benefits as stated in model two, I will now introduce model three which leaves out the factor of expected costs and benefits. Therefore, in model three we take into consideration the associations between the firm's characteristics and the level of traceability (link E) and between level of traceability and actual costs and benefits (link C) that may improve the data fit.

Finally, if neither expected cost and benefit nor the level of traceability can be measured in a valid way, model four is proposed as the simplest model for empirical analysis. In this model, it is assumed that the firm's characteristics affect actual costs and benefits as indicators of traceability business performance directly (link F). Measuring the firm's characteristics would be not very difficult as the same actual costs and benefits exist; therefore, maybe this model would fit better with our analysis.

4.2 DISCUSSING COMPETING SPECIFICATION FOR EMPIRICAL TEST

In the first section, I will explain and discuss the four basic conceptual models mentioned in the previous section and presented in figure 4.1. The models will be described and discussed from the most complicated to the least complicated. These form the basis of empirical model specifications that are to be tested for the best fit with the data.

4.2.1 MODEL ONE

As introduced in section 4.1, model one is the most complicated model of the complete decision-making model that firms may adopt for traceability system implementation. To discuss this model it is necessary to describe links A, B and C that compose model one.

Link A proposes that the firm's characteristics may affect the expected costs and benefits associated with potentially appropriate traceability levels. The firm's investments in a traceability system will vary in costs and benefits. That is not an indicator of inadequacy, but of efficiency as a result of careful balancing of costs and benefits (Golan *et.al*, 2004:iii). Thus, firms balance costs and benefits of traceability and tend to efficiently allocate resources to build and maintain the

traceability system only when the benefits outweigh the costs (Golan *et.al*, 2004:4). Thus, I suppose that the firm's characteristics influence expected costs and benefits by traceability system adoption. Thus, it is now described how the firm's characteristics could affect expected costs and benefits perceived.

First, the level of QMS certification may affect the expected costs and benefits, but maybe in an ambiguous way. As mentioned in Chapter two, a high level of QMS certification facilitates the implementation of traceability system because each QMS certification contains elements of traceability. Thus, according to the case study of Scardovari Consortium (Chapter two), firms with well functioning QMS's in place may have expected lower traceability costs than firms with less well functioning quality management systems or even none in place, all else being equal. For benefits, maybe a firm without QMS could benefit very much and more than firms that have a certain level of QMS, simply because they start from zero benefits.

To sum up, with a higher level of QMS the costs and benefits may go down, while with a low level of QMS the costs and benefits may go up. Thus, I hypothesize that net benefits will be ambiguous in each case.

Second, the size of firms could affect the expected costs and benefits of traceability. Various authors report that the variable costs of traceability may increase with the size of firms while the average fixed cost of implementing traceability decreases with the production or processing volume. Then, it is hypothesized an ambiguous and complicated influence of size of firms on expected traceability cost. This thesis could provide more information to clarify such ambiguity.

Third, the complexity of operations within the firm may affect the costs and benefits of traceability. Traceability practices consist of data collection through the food chain. Data collection is easier when the operations are simple (e.g. one kind of raw material and one kind of outcome product). Thus, when the operations are more complicated, the cost of data collection increases in terms of more data collections and management (e.g. need more complicated software, more time spent to manage data, etc.). No literature reviews were found to inform us about the influence of the complexity operation on expected costs and benefits.

However, it is hypothesized that a high level of complexity operations increases traceability costs and therefore causes a lower net benefit.

Fourth, the level of customer structures and experience requirements could affect the expected costs and benefits by traceability practices. Different countries who supply raw material and different kinds of customers may ask for different requisites to their customers to deal with them. This may determine increasing costs of traceability, for instance, determines more time spent by traceability users, more sophisticated traceability software are requested, etc. Therefore, it is reasonable to think that the level of customer structures and requirements experiences could increase the expected traceability costs. Having a high level of customer structures and experience requirements may determine high difficulties and management complications for a processor to deal with them as previously mentioned. As reported in Chapter two, traceability improves the supply chain management (e.g. reduction of transaction costs). Therefore, it is hypothesized that a high level of customer structures and experience requirements will benefit by traceability systems adoption. No literature review was discovered of this regard.

Fifth, the level of food chain integration may affect the expected costs and benefits. As mentioned in Chapter two vertical integration reduces the transaction costs. Traceability system reduces the transaction costs as reported in Chapter two. Thus, it is reasonable to think that a high level of food chain integration may reduce the traceability costs.

Sixth, the geographical location of firms could affect the expected costs and benefits of traceability. Based on the fact, that every geographical area has different levels of infrastructures, different levels of support services, etc. that influence traceability practices, it is reasonable to think that geographical locations have an impact on costs and benefits. No theoretical and empirical literature reviews were found that inform us about the geographical locations of the firms affected by the costs and benefits of traceability. However, it is hypothesized that traceability costs will be less for the North of Italy (generally highly developed) than to the South of Italy (generally less developed).

Seventh, the traceability certification could affect the expected costs and benefits of traceability. Various authors report a list of potential costs and benefits due to traceability certification. Basically, costs are concerned with audits while benefits are concerned with reduced transaction costs, enhanced access to insurance and finance, effectuated due diligence, positive effect on trade, and enhanced license to produce and price premium. Then, it is reasonable to think that having traceability certification, despite costs of certification and audit, will increase the benefits (e.g. reduced transaction costs, enhanced access to insurance and finance, effectuated due diligence, etc.).

Eighth, the level of government involvement could affect the expected costs and benefits of traceability. Some governments, support the traceability systems implementation and maintenance to the food firms, for instance, the Scardovari Consortium's case study. Obviously, this reduces the traceability costs. No literature reviews were found to this regards, but it is quite obvious that the government support reduces the expected cost of traceability. In addition, governments, having interests to protect and increasing the public health as mentioned in Chapter two, may support firms to implement high level of traceability that increase the benefits. Therefore, it would be hypothesized that the net benefits by government involvement will be increased.

Link B supposes that the expected costs and benefits may affect the level of traceability systems adopted by firms. As mentioned before, maybe firms balance costs and benefits of traceability practices and tend to efficiently allocate resources to build and maintain the traceability system.

Although the investments of traceability systems reflect on the level of traceability adopted, the level of traceability will depend on the attributes of interest and each firm's traceability costs and benefits and then firms will balance the optimal level of traceability to adopt those that maximize the net benefits (Golan *et al.*, 2003:19). Thus, different levels of traceability in terms of breadth, depth and precision will determine different expected costs and benefits. For instance, tracking the origin of a cup of coffee could involve different levels of traceability that depend on the balance of costs/benefits. The beans could come from any number of countries: be grown with numerous pesticides or just a few,

grown on huge corporate organic farms or small family-run conventional farms, harvested by children or by machines, stored in hygienic or pest-infested facilities, decaffeinated using a chemical solvent or hot water (Golan *et.al*, 2004:3). The collection of all this data will may be very costly (e.g. collection certifications, make questions to suppliers and food inspection agency, etc), which may not make sense if the benefits do not outweigh the costs.

I will now provide some examples of how expected costs and benefits could affect the level of traceability. In the first example, food retailers could request a high level of precision of the traceability system (e.g. size of batches of fruit canned based on method of harvesting fruit, data harvest, percent content of sugar, etc.) from their suppliers. Then, if these retailers are very important customers for processors (e.g. in terms of sales share, etc) the latter will have an incentive to adopt the required high level of precision, because the benefit of maintaining business with the retailer may easily outweigh the costs of establishing more precision. In the second example, drawn from the Scardovari Consortium case study, government may support the adoption of traceability practices by firms in order to improve public health, i.e. to reduce the cost of public health. Government will fund the traceability cost totally or partially. Thus, the net benefits will improve. Finally, these examples and considerations show that it is reasonable to think that the expected costs and benefits affect the level of traceability adopted by firms.

Link C regards the impact of the level of traceability on actual costs and benefits by traceability practices. The literature review did not produce any research on how the level of traceability affects the actual costs and benefits. By Chapter two, it is reasonable to suppose that the level of traceability affects costs and benefits. Next, I will provide some examples and explanations to support such a hypothesis.

As mentioned in Chapter two, the level of traceability system is measured by three variables: breadth, depth and precision. Concerning the breadth, there is a lot to know about the food that we eat: a recordkeeping system cataloging all food's attributes would be enormous, unnecessary and expensive (Golan *et.al*, 2004:3).

Take for example, a jar of yogurt added to different pieces of fruit. The cows, that produce milk to make yogurt, could be of different breeds and the farmers may cure with different antibiotics; the fruit could come from different countries (e.g. pears from Italy, mangoes from Mexico, bananas from Brazil, etc); the fruits could be harvested by children or machines, etc. Then, collecting this data would cost be very expensive, if the cost of the collection is not balanced by additional benefits. Therefore, it would be expected that a high level of traceability may increase the costs of traceability practices.

According to Golan *et.al*, (2004:3) the precision of the traceability system is determined by the unit of analysis used in the system and the acceptable error rate (e.g. container, truck, day of production, etc). Systems with low acceptable error rates, such as low tolerances for GE kernels in a shipment of conventional corn, are more precise than systems with high acceptable error rates (Golan *et.al*, 2004:3). For instance, if an important customer for a firm (e.g. the customer that has the biggest market share) has a low acceptable error rates, then having a high precision of traceability system will give high benefits. Therefore, it would be expected that a high level of traceability may increase the benefits of traceability practices. In summary, it is hypothesized that a high level of traceability system may increase the actual costs and benefits of traceability. Then, the net benefits will be ambiguous, because both costs and benefits go up.

Of the possible interesting hypothesis that can emerge from model one, one of these could be very interesting. The hypothesis that I am going to test, is linked to how the level of traceability is more closed with expected costs and benefits than actual costs and benefits. No empirical studies or theoretical models were found in the literature review. Then, testing such hypothesis will fill the gap in the literature and clarify if the level of traceability adopted by firms is affected more from the expected costs and benefits or from actual costs and benefits. In short, I will test if the level of traceability adopted by firms is previously determined as consequences of expected costs and benefits tradeoff or is undergone by actual costs and benefits.

4.2.2 MODEL TWO

Now, I will describe in detail model two as introduced in section 4.1. To describe this model it is necessary to describe the links between Link D and Link A which were previously introduced.

While there should be no difference between expected and actual costs and benefits under certainty, discrepancies between the two, may occur under the realistic assumption of uncertainty. These discrepancies may arise from exogenous changes in the environment that cannot be influenced by the firm, such as changes in prices for required services, equipment or materials or changes in customer requirements. Or they may be due to managerial shortcomings in the planning process. As reported in Chapter two, two examples from the Scardovari Consortium case, one for costs and one for benefit, may illustrate the evolution of such discrepancies. In the first example, an important surprise that emerged after traceability system implementation, was the production line, supervisory staff and managerial/administrative time. The management of Scardovari Consortium had not expected that the production line, supervisory staff and managerial/administrative time could have had such a high impact on traceability cost. In the second example, Scardovari Consortium had expected a medium benefit in terms of a price premium paid by customers for the additional assurance of a traceability system. However, the actual experience was that the market had not been paying the price premium in return for the traceability system implementation.

According to Bailey *et al.,* (2002:245) a study conducted of how *ex-ante* predictions of the costs of complying with environmental regulations compare with *ex-post* evaluations of actual compliance costs, shows how there is an increasing evidence that there exists a gap between the *ex-ante* costs' estimates presented by industry in the negotiations of some environmental regulations and the results of *ex-post* evaluations' costs of complying with the requirements of a regulation, which may change during actual implementation and compliance. Furthermore, Bailey *et al.*, (2002:255) stated that *ex-ante* estimates forecasting their accuracy will be limited due to an uncertainty. The *ex-post* estimates of compliance costs should allow one to interpret the overall level of compliance

costs associated with the regulation. In addition, it might be not always be possible to easily identify and interpret the determining factors that influence the fulfilment costs of compliance, such as processes of technological innovation within firm, that are notoriously difficult to predict (Harrington *et.al*, 2000:297-322).

In conclusion, irrespective of the actual cause of a discrepancy, hypotheses associated with model two will aim to identify whether presence and magnitude of discrepancies between expected and actual costs and between expected and actual benefits can be attributed to the firm's characteristics. Based on the reasons discussed above, it would be interesting to test if the discrepancies emerged among expected and actual costs and benefits can be linked with particular firm's characteristics. No literature review was found in this regard. Thus, testing this hypothesis might fill the gap of literature. In addition, testing this hypothesis will provide useful insights and information for the traceability system implementation process to which the firm's characteristics may have to pay more attention to when they plan to implement the traceability system. This could help, for instance, to eliminate higher costs than expected

4.2.3 MODEL THREE

As introduced in section 4.1, in model three I hypothesize the associations between the firm's characteristics and the level of traceability (link E) and between level of traceability and actual costs and benefits (link C), described in model one, that may improve the data fit.

Then following, I will describe link E discussing the possible influences of the firm's characteristics on the level of traceability. First, the level of QMS certification may influence the level of traceability as follows. As reported in model one, QMS certifications may facilitate the adoption of traceability practices. A survey conducted by Bulut *et al.,* (2008:18) in fifty-three (53) meat slaughtering and processing plants in Iowa revealed that the firms, which adopt extra testing of products, are 4.4 times more likely to adopt backward traceability. This is also confirmed by Kramer, Coto and Weidner (2005:161) who state that a plant's traceability system could be part of its recall plans if these plans are tested

through mock scenarios. Souza – Monteiro *et al.,* (2006:19) show that the previous adoption of quality assurance systems, increase the probability to adopt more stringent traceability systems. Therefore, I hypothesize that increasing food safety efforts are positively correlated with more stringent levels of traceability systems.

Second, the size of the firm could affect the level of traceability adopted by firms. Bulut *et al.,* (2007:8) stated that as the size of poultry and meat plants increase, firms adopt more forward traceability practices. A survey conducted by Souza – Monteiro *et al.,* (2006:19) in the Portuguese pear industry, reported that the size of farms and the level of QMS certifications increase the likelihood of adoption of more stringent traceability systems. Thus, it is hypothesized that increasing firm size will lead to the adoption of more stringent traceability practices, i.e. higher levels of traceability.

Third, the complexity of operations within the firms may affect the level of traceability. Having more complex operations, for instance, different raw materials to process generating different final products (e.g. fresh clams, smoked finfish, etc.) should require more depth, breadth and precision of a traceability system and thus more sophisticated data collection and management. However, no literature was found in this regard. Therefore, it is hypothesized that a high level of complex operation will necessitate a high level of traceability.

Fourth, the complexity of customer structures and requirements may affect the level of traceability. Different kinds of customers and countries may ask their suppliers (processors) for various requirements to deal with them (e.g. food safety legislations, breadth of traceability, size of batch, etc.). No literature was discovered in this regard, but it is reasonable to expect that increasingly complex customer structures and requirements call for increasingly high levels of traceability.

With the above considerations, a certain level of traceability may request more efforts and higher cost, for more complex operations than for less complex ones. Therefore, it is reasonable to expect that the level of operations complexity is positively correlated with the level of traceability.

Fifth, the level of food chain integration could affect the level of traceability adopted by firms. Cates *et al.* (2006:957-966) reported in their survey that backward and forward traceability practices had been adopted by five-hundred and ninety-eight (598) meat and two-hundred and nineteen (219) poultry slaughter and processing plants. In such a survey there were two questions about traceability. In the first, they asked about backward traceability: if meat and poultry plants identified and tracked their products backward to specific animals or birds by lots respectively. In the second question, they asked about forward traceability: if the meat and poultry plants were able to identify and track their products, by lot, forward to individual customers. Cates *et al.,* (2006:957-966) reported that poultry plants adopt more backward and forward traceability than their meat counterparts, which could be due to organizational factors as poultry plants are more vertically integrated (Ollinger, Moore and Chandran, 2004:23). Traceability practices require data to be recorded through the food chain stages. To do this, it is necessary to exchange information among stakeholders, which is difficult to obtain in non – integrated chains due to barriers existing between stakeholders, that might increase the transaction costs. As a consequence, less data in terms of breadth and/or depth and/or precision will be available. Thus, it is hypothesized that a higher level of food chain integration may lead to higher levels of traceability.

Sixth, the geographical location of firms could affect the level of traceability. In a less developed area, characterized by low availability of complementary services, to implement a high level of traceability will cost more, because it requests more complicated software and more equipment/hardware. No theoretical and empirical literature was found about the impact of geographical location on the firm's level of traceability, but it is reasonable to hypothesize that the level of traceability will be lower in the less developed South of Italy than in the more highly developed North.

Seventh, the traceability certification may affect the level of traceability. The traceability certification could be seen as a sort of measure of the level of traceability. In fact, it certifies and documents that the traceability system respect traceability standard (e.g. ISO 22005, etc.), that is a customer requirement and

formally signals compliance to mandatory regulations. Thus, it is reasonable to hypothesize that certified firms have higher levels of traceability.

Eighth, the level of government involvement could affect the level of traceability. As reported in Chapter two, governments sometimes fund the traceability systems implementation and maintenance to the food firms. Based on this observation, one would expect higher levels of traceability to coincide with government support, because the additional cost of an enhanced traceability system is covered. Thus, a positive relationship between government support and level of traceability adopted by firms is hypothesized.

To sum up, the hypothesis that might be tested in this model discovers which of the firm's characteristics determine the level of traceability. This test could improve the insights and fill the gap in the literature review. In addition, such a test may provide useful information for firms that are implementing a traceability system, in terms of which of the firm's characteristics determine the level of traceability adopted and then adopt the best solutions (e.g. if it is more the level of QMS certification or level of complex operation and customer structures).

4.2.4 MODEL FOUR

Based on previous research results and logical reasoning, hypotheses will be generated as to how precisely the firm's characteristics are expected to affect costs and benefits associated or experienced with traceability activities. Next, I will describe the possible relationships between the firm's characteristics and actual costs and benefits (link F).

First, the level of QMS certification could affect the cost of traceability. Mora and Menozzi (2005:217) mention that the cost of traceability is lower when firms already have a quality management system in place ,for example, ISO 9001:2000 and HACCP. Then, traceability appears to be complementary to quality assurance systems to differentiate products. QMS require data collection and verification that the necessary actions are taken, and the input stage is a critical point for such systems. HACCP rule Part 417.2 (a) states that firms must conduct hazard analysis "to determine the food safety hazards reasonably likely to occur before, during and after entry into the establishment". Thus, firms may need more

information on incoming supplies for their HACCP plans. According to Resende - Filho *et al.,* (2008:19) traceability just accumulates information about the products and processes as the product moves through its supply chain. This may facilitate the implementation of traceability system and may reduce its cost, that in part is due to data collection and recording (breadth of traceability).

Second, the size of firms could affect the cost of traceability. The variable costs of traceability practices may increase with the size of firms. In fact, it is reasonable that large firms have larger and more complicated operations than small firms; therefore, in order to satisfy a traceability requirement, large firms need to do more arrangements to comply with these standards thus increasing the cost. At the same time, the average fixed costs of implementing traceability decrease with the production or processing volume (Bulut *et al.*, 2008:14). As a consequence, the overall effect of size of firms on cost of traceability is ambiguous. This ambiguity may be reduced through the simultaneous measurement of the level of complexity of operations and customers, that may be strongly related to the size of firms.

Bulut *et al.,* (2008:14) also point out that the large firms may have a disadvantage over small and mid-size firms in implementing traceability. This is because large firms who have a higher number of suppliers may not fill a single batch in the big scale operations and this may complicate the traceability practices and may increase its cost, because they need more sophisticated technologies and managerial efforts.

In terms of the overall traceability cost out of total cost of production (traceability cost/overall cost of production), Mora and Menozzi (2005:219 - 220) in a study conducted on the Italian beef supply chain, found that the percentage varies between 0.5% to 2.5%. Regarding the size of firm, the highest cost for quantity produced is for mid-sized firms. While for the larger firms (> 80 million Euro annual turnover) the low costs for quantity produced is due to economy of scale; for the smaller firms (< 10 million Euro) they may conceal a more limited compliance with the regulation (in terms of structures and IT systems).

Bailey, Robb and Checketts (2005:296-297) report that “farm to fork” traceability may require plant and line redesigns, new types of line equipment and locations

within the plant for disassembling carcasses. Then, the groups of animals from the same origin can be collected into the same lots and processed at the same time under the current batch. This is an advantage for small and mid-size firms compared to large firms in the traceability implementation, because individual farms or feedlots cannot fill the big scale operations. Thus, the cost of tracking increases because it necessitates the mixing of cattle from different origins to form batches in large plants.

Third, possibly correlated with size, the complexity of operations within the firm may affect the costs and benefits of traceability. The diversity of food processing operations means that the way in which traceability records are kept by any business is practically unique and businesses make individual and widely varying decisions with regard to the size of batches that are produced and hence the size of any recall (Food Standard Agency, 2002:3).

As mentioned in Chapter two, traceability practices consist of data collection through the food chain. Data collection is easier where the operations are simple. If a fishery processor processes and packages a unique type of raw material (e.g. clams) into a unique kind of output in terms of size of package, quality of product (e.g. fresh clams in bags of 5 kg) then the data collection is easier; it requires less data input (e.g. data of supplier, name of suppliers, etc.) and data output (e.g. name of customers, etc) and then the level of traceability practices is low. On the other hand, if it has more kinds of raw materials (e.g. clams and mussels) of different categories of quality (e.g. 1, 2, 3) there will be many different outputs and then the data collection will be more complicated. Therefore, this increases the cost of data collection. As a consequence, the complexity of operations is expected to increase the costs of traceability.

Fourth, the complexity of customer structure and requirements could affect actual traceability costs and benefits. Different customers may ask for various requirements to their suppliers. For instance, international chains request more stringent requirements than wholesalers or local markets, in terms of food safety requirements, traceability, certifications, etc. Another example is reported by Souza Monteiro and Caswell (2004:22) for the beef supply chain where exports to Japan and the EU are subject to more stringent and sophisticated traceability

systems compared to other countries. This could increase the costs of traceability, because more and different mechanisms have to be in place (i.e. more sophisticated traceability software). Therefore, it will be reasonable to think that the complexity of customer structure and requirements increases the actual traceability costs. Benefits traceability system may facilitate the management of different customers.

According to Golan *et.al.,* (2004:4) the traceability systems provide the basis for good supply management. A business's traceability system is a key to finding the most efficient ways to produce, assemble, warehouse and distribute products. Although a high level of complexity of customer structures and requirements determines, for instance, more complex management (e.g. more complex inventory and communication), firms could benefit from traceability practices. Therefore, it will be reasonable to think that the complexity of customer structure and requirements increases the actual traceability benefits.

Fifth, the level of food chain integration may affect the outcomes of costs and benefits. According to Hobbs (1996a:16-26) vertical food chain integration reduces the transaction costs (e.g. communication). As mentioned in Chapter two, traceability systems require the data exchange and communications between stakeholders, that is a cost. As a consequence, a hypothesis is that a higher level of food chain integration may reduce the cost of traceability. No publication was discovered in support of this hypothesis. Then, this thesis could provide useful information and fill the research gap about the impact of food chain integration on costs and benefits of traceability.

Sixth, the geographical location of firms might affect the actual costs and benefits due to traceability practices. The activities of firms, in addition to other characteristics (e.g. size of firm, types of food chain, etc.) may be influenced by their geographical location. As mentioned in Chapter two, traceability is an innovation system that requires availability of infrastructures, support of services (e.g. software houses), attitude towards innovations, availability of consultants for traceability implementation, etc. Based on the fact that every geographical area has different levels of infrastructures, support services, attitude towards innovations, that influence traceability practices, it is reasonable to think that

geographical location has an impact on actual costs and benefits. For instance, in more developed areas, services, such as software-houses, might cost less than in less developed areas. No theoretical and empirical literature was found to reveal the impact of geographical location on actual costs and benefits of traceability. In conclusion, it is hypothesized that traceability will cost less for more developed areas, such as northern Italy, than less developed areas, such as the South of Italy.

Seventh, the traceability certifications could affect the actual costs and benefits of traceability, as it signals compliance with customers' requirements and mandatory regulation. The literature review has not produced any research on the impact of certification on the costs and benefits of traceability, mainly due to the novelty of emerging standards for traceability certification. Meuwissen *et al.,* (2003:177), in a study about traceability system and certification in the meat supply chain compare the potential costs and benefits of traceability systems and certifications. They found out that the increasing costs is basically due to audits while benefits are produced by reduced transaction costs, enhanced access to insurance and finance, effectuated due diligence, positive effect on trade, enhanced license to produce and price premium. In addition, the findings by Meuwissen *et al.,* (2003:58-59) suggest that the developments are often driven by technical prospects than by economic considerations. Based on these, it is expected that both costs and benefits increase due to certification. In particular, audit costs should be affected most.

Eighth, the level of government involvement could affect the actual costs and benefits of traceability. Governments, as mentioned in Chapter two, may support the traceability systems to the food firms. Basically, governments support the traceability system implementation (e.g. purchase new equipment, etc.). Thus, the direct effect is to reduce the traceability costs. Therefore, it is hypothesized that there is a negative relationship between government support and actual cost of traceability. Assuming benefits not being affected, government support would increase the net benefit by traceability.

Among the possible hypothesis that can be extracted by model four, the most interesting and reasonable it would be identifying would be the differences in the firm's characteristics which may lead to differences in actual costs and benefits.

No literature was discovered that fills this gap. Then, testing such hypothesis may contribute to filling the gap in the literature reviews. Moreover, it might be interesting to provide useful information and insights for firms that have to implement traceability system in their plants. For instance, these firms could pay attention to which of their characteristics could improve the net benefits or determine big surprises in costs and benefits.

4.3 PROCESSES OF INDEXES GENERATION SINCE VARIABLES

In the second section, I will describe the processes of generation of the indexes, which will be used in the empirical models, since variables content in the questionnaire (Annex one). As stated before, the indexes are organized into three groups: the firm's characteristics, level of traceability and expected/actual costs and benefits.

4.3.1 FIRM'S CHARACTERISTICS

The questionnaire has presented seventeen questions (1 – 13 and 21 - 24) which concern the firm's characteristics that provide variables which I have regrouped in the following indexes.

4.3.1.1 Location

In the first section of Chapter four, I have shown the geographical location of firms as an index that may impact on the level of traceability and expected/actual traceability costs and benefits. In the questionnaire, the geographical location is listed as question one (1) while in the database it is coded as VAR_01.

Such a variable is measured identifying the regional locations of the firms interviewed. The twenty (20) Italian regions are coded from 1 (North) to 20 (South) as following[54]:

1. "Valle d'Aosta" = 1;
2. "Lombardia" = 2;
3. "Trentino Alto Adige" = 3;
4. "Veneto", = 4;

[54] "Region = code".

5. “Friuli Venezia Giulia”, = 5;
6. “Emilia Romagna”, = 6;
7. “Piemonte”, = 7;
8. “Liguria”, = 8;
9. ”Toscana”, = 9;
10. “Umbria”, = 10;
11. “Marche”, = 11;
12. “Lazio”, = 12;
13. “Abruzzo”, = 13;
14. “Molise”, = 14;
15. “Puglia”, = 15;
16. “Campania” = 16;
17. “Calabria”, = 17;
18. “Sicilia”, = 18;
19. “Sardegna” = 19;
20. “Basilicata”, = 20.

This variable could be transformed into the index one (1) aggregating the firms in three groups of locations as following:

- ✓ North of Italy (code: 1 - 8) = 1 point;
- ✓ Centre of Italy (code: 9 - 14) = 2 points;
- ✓ South or Islands of Italy (code: 15 - 20) = 3 points.

Such subdivision is why these three areas are quite homogeneous in terms of general economic development. Index one is provided from the following equation:

INDEX 1 *= Code (1-8) OR (9-14) OR (15-20) = Value (Min 1; Max 3)*

4.3.1.2 Level of food chain integration

The level of food chain integration could be extracted from the positions occupied by firms through the food supply chain. As stated in section 4.2, the level of food chain integration may affect the level of traceability and the expected/actual costs and benefits by traceability practices.

In the questionnaire the information about the level of food chain integration is provided from question three (3) while in the database it is coded as VAR_03. Such a variable is transformed into index two (2) measuring the position/s (or stage/s) occupied from firms through the food supply chain.

The variable three has six options:

1. "Primary producer – Wild fish";
2. "Primary producer – Farmed";
3. "Processor";
4. "Wholesaler Import/Export";
5. "Transport";
6. "Distributor".

For transforming variable three into index two, I assign the following points for the options:

- ✓ options 1 and 2: I assign (=) 1 point if the firm is only a primary producer of wild fish or only a primary producer of farmed fish or a primary producer both for wild and farmed fish. This is because wild and/or farmed production occupy the same position in the food chain that is primary producer;
- ✓ options 3, 4 and 6: I assign (=) 1 point for each option;
- ✓ option 5: I assign if the firm does or does not transport (Yes or No), because it could have different positions throughout the food chain (e.g. between primary producer and processor or between processor and distributor, etc.).

The index two is provided from the following equation:

INDEX 2 $= \sum$ *option 1 and/or 2 + option 3 + option 4 + option 6 = Value: (Min 1 – Max 4)*

4.3.1.3 Size of firm

The size of the firm is another index that could impact on the level of traceability and the expected/actual costs and benefits of traceability system perceived by the firms, as stated in section 4.1. Index three (3) is measured through the combination of two variables: number of employees and the annual revenue. Such a combination gives a more reliable indicator of size through summated scale.

In the questionnaire the number of employees and annual revenue are listed as questions four (4) and eight (8) while in the database as VAR_04 and VAR_08, respectively.

The variable four has three options:

1. “Full time - FT”;
2. “Part time - PT”;
3. “Seasonal - SE”.

For transforming variable four into index (3a), I assign the following points for the options:

1. “Full time - FT” employees:
   - ✓ no full time employees = 0 point;
   - ✓ less than 10 employees = 1 point;
   - ✓ 11 – 25 employees = 2 points;
   - ✓ 26 – 50 employees = 3 points;
   - ✓ more than 50 employees = 4 points.
2. “Part time - PT” employees:
   - ✓ no full time employees = 0 point;
   - ✓ less than 10 employees = 0.5 point;
   - ✓ 11 – 25 employees = 1 points;
   - ✓ 26 – 50 employees = 1.5 points;
   - ✓ more than 50 employees = 2 points.
3. “Seasonal – SE” employees:
   - ✓ no full time employees = 0 point;
   - ✓ less than 10 employees = 0.5 point;
   - ✓ 11 – 25 employees = 1 points;
   - ✓ 26 – 50 employees = 1.5 points;
   - ✓ more than 50 employees = 2 points.

I assigned half points for “Part time” and “Seasonal” in comparison to “Full time” employees, because it is reasonable to suppose that the seasonal employees work an average of six months/year and part time employees work four hours/day that is more/less half weight compared to full time employees.

Index 3a) is provide from the following equation:

INDEX 3a) = ∑ options (1 + 2 + 3) = Value (Min 0.5 – Max 8)

The variable eight has eight options:

1. "Less of € 250,000";
2. "€ 250,001 – 500,000";
3. "€ 500,001 – 1,000,000";
4. "€ 1,000,001 – 2,500,000";
5. "€ 2,500,001 – 5,000,000";
6. "€ 5,000,001 – 10,000,000";
7. "€ 10,000,001 – 25,000,000";
8. "More than € 25,000,000".

For transforming variable eight into index 3b), I assigned the following points for the options:

1. "Less of € 250,000" (=) 1 point;
2. "€ 250,001 – 500,000" (=) 2 points;
3. "€ 500,001 – 1,000,000" (=) 3 points;
4. "€ 1,000,001 – 2,500,000" (=) 4 points;
5. "€ 2,500,001 – 5,000,000" (=) 5 points;
6. "€ 5,000,001 – 10,000,000" (=) 6 points;
7. "€ 10,000,001 – 25,000,000" (=) 7 points;
8. "More than € 25,000,000" (=) 8 points.

The index 3b) is provided from the following equation:

INDEX 3b) = option 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 = Value (Min 1 – Max 8)

To sum up, index three is provided by summing up index 3a and index 3b as following:

INDEX 3 *= INDEX 3a + INDEX 3b = Value (Min 1.5 – Max 16)*

4.3.1.4 Level of complexity operations

In combination with the size of firms, the level of complexity operations represents the given level of complexity that the traceability system has to deal as an index of the difficulties and thus cost of, implementing and operating a

traceability system. As described in section 4.2, it may influence the level of traceability and expected/actual costs and benefits by traceability practices.

The level of complexity operations is provided from index four (4) which is measured from two variables: the numbers of different products produced and the number of different raw materials processed by firms.

In the questionnaire the number of different products produced and the number of different raw materials treated are listed as questions five (5) and six (6) while in the database as VAR_05 and VAR_06.

The variable five has six options:

1. "Fresh";
2. "Frozen";
3. "Deep frozen";
4. "Conserved and semi-conserved";
5. "Dry, salt and smoked";
6. "Others".

The variable five is transforming into index 4a) as following:

INDEX 4a) = ∑ value options 1 + 2+ 3 + 4 + 5 + 6 = Value: (Min 1 - Max 8)

I assigned the following points to calculate the index 4a) for the options:

- ✓ options 1, 2, 3 and 6: I assign (=1) point for each category;
- ✓ options 4 and 5: I assign (=2) points for each category. I assigned higher values for these options, because conserved, semi-conserved, dry, salt and smoked products need more complicated processing operations (e.g. may be conserved products mixed with different types of raw materials that necessitates different operations).

The variable six has five options:

1. "Seafood";
2. "Freshwater";
3. "Shellfish";
4. "Crustaceous";
5. "Others".

Such variable is transforming into index 4b) as following:

INDEX 4b) = ∑ value option 1 + 2 + 3 + 4 + 5 = Value: (Min 1 - Max 4)

I assigned the following points for:

- ✓ options 1 and 2: I assigned (=) 1 point if the firm treats seafood or freshwater or together. This is because the operations necessary to process seafood and freshwater are very similar due to the same morphology characteristics of those fishes;
- ✓ options 3, 4 and 5: I assigned (=) 1 point for each option.

To sum up, indexes 4a) and 4b) are combined into an overall index four (4) as follows:

INDEX 4 *= INDEX 4a) + INDEX 4b) = Value (Min 2 - Max 12)*

4.3.1.5 Level of customer structures and requirements

As mentioned in section 4.2, the level of complexity of customer structures and requirements is an index (index five) that may influence the level of traceability and expected/actual costs and benefits due to traceability practices.

Index five is measured by two variables: the areas of sales of the final products and the types of different customers of the firms. In the questionnaire the areas of sales and the types of different customers are listed as questions ten (10) and twelve (12) while in the database they are listed as VAR_10 and VAR_12.

The variable ten states the geographical area of sales of final products (e.g. EU, Asia, etc.). Various markets might ask for different traceability requirements (e.g. various levels of traceability) due to, for example, different regulations. Such variable has eight options:

1. "Italy";
2. "EU Member State";
3. "Other No-EU Countries";
4. "North America";
5. "South America";
6. "Africa";
7. "Asia";
8. "Others".

The variable ten could be transformed into index 5a) as following:

INDEX 5a) = ∑ options 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 = Value: (Min 1 – Max 8)

I assigned (=) 1 point for each option listed above, because I assume that every area may have the same importance in terms of traceability requirements.

The variable twelve states the types of customers the firms may deal with. Various customers may ask for different traceability requirements, that could influence the traceability performances. Such variable twelve has twelve options:

1. "International/national chain";
2. "Regional/local chain";
3. "Local fishery shop";
4. "Pitchman";
5. "Wholesaler";
6. "Wholesale market";
7. "Food service chain";
8. "Other Food service operators";
9. "Direct to final consumer";
10. "Other processors";
11. "Institutions";
12. "Other".

The variable ten could be transformed into index 5a) as following:

INDEX 5b) = ∑ options 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10 + 11 + 12 = Value: (Min 1 – Max 15)

I assigned the following points for:

- ✓ options 1, 7 and 11: I assign (=) 2 points each, because their requirements may be more stringent than other options;
- ✓ options 2, 3, 4, 5, 6, 8, 9, 10, 12: I assign (=) 1 point each option.

Finally, the overall index five (5), that measures the level of customer structures and requirements is provided from the following equation:

INDEX 5 *= INDEX 5a) + INDEX 5b) = Value: (Min 2 – Max 23)*

4.3.1.6 Level of QMS certifications

The level of QMS certification is index six (6) which may represent a formal level of a traceability system implemented in a firm. As reported in section 4.2, the level of QMS certifications may affect the level of traceability and the expected/actual costs and benefits.

Index six is measured by the number of QMS certifications adopted by firms. Such index is built starting from the variable thirteen (13) as listed in the questionnaire and coded as VAR_13 in the database.

The variable thirteen has nine options:

1. "ISO 9001:2000 – Quality Management System";
2. "ISO 22000:2005 – Food Safety Management System";
3. "HACCP – Hazard Analysis Control Critical Point";
4. "MSC – Marine Stewardship Council";
5. "ISO 14001 – Environmental";
6. "IFS – International food Standards";
7. "BRC – British Retail Consortium";
8. "EUREPGAP – Euro Retailer Produce Working Group";
9. "Others".

The variable thirteen could be transformed into index six (6), summing up the number of QMS certifications adopted, assigning (=) 1 point for each QMS certification adopted, as explained in the following equation:

$$\textbf{\textit{INDEX 6}} = \sum \textit{options } 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 = \textit{Value: (Min 0 – Max 9)}$$

4.3.1.7 Traceability certifications

Traceability certifications adopted by firms represent a way to comply to customer requirements and formalize signals of mandatory regulations. As reported in section 4.2, traceability certifications may affect the level of traceability and expected/actual costs and benefits due to traceability practices.

The traceability certifications are measured by variable twenty-one, as listed in the questionnaire and coded as VAR_21 in the database. Such variable has two options:

1. "Having Traceability Certification";

2. "Not Having Traceability Certifications"

Variable twenty-one could be transformed into index seven (7) assigning (=) 1 point if the firm has adopted traceability certification/s and (=) 0 point if the firm has not adopted it as follows:

***INDEX 7** = option 1 or 2 = Value: (Min 0 - Max 1)*

Option 1 has four sub-options, which indicate the kind of traceability certifications:

- ✓ "Certification UNI 11020:2002 – Internal Traceability";
- ✓ "Certification UNI 10939:2001 – Chain Traceability";
- ✓ "ISO 22005:2007 – Traceability in feed and food chain";
- ✓ "Others".

In this thesis, I consider only if the firms have or not have adopted traceability certifications, because I suppose that all the types of certifications have a similar impact in terms of benefits. There is no further differentiation according to number of certification. For pragmatic reasons only x, y and z of 10 respondents with traceability certification have more than one certificate.

4.3.1.8 Level of government involvement

The level of government involvement represents the level of support that governments may give to firms for the implementation and/or maintenance of a traceability system. As stated in section 4.2, governments could influence the level of traceability and expected/actual costs and benefits due to traceability practices.

The level of government involvement is measured through index eight (8) by two variables. The first variable is listed as twenty-two (22) in the questionnaire and VAR_22 in the database. It indicates if the firms have benefited or not by government support for traceability practices. Such variable has two options:

1. "Having benefit of the government support";
2. "Not having benefit of the government support";

variable twenty-two could be transformed into index 8a) assigning (=) 1 point for option 1) and (=) 0 point for option 2) as following:

INDEX 8a) = option 1 or 2 = Value: (Min 0 – Max 1)

The second variable is listed as twenty-four in the questionnaire and coded as VAR_24 in the database. It measures the level of utility of government support as perceived by firms.

The level of utility is measured by the Likert scale using values from 1 (Not useful at all) to 5 (Very useful) for each area of supporting.

The areas of supporting are:

1. "Equipment/Hardware/Software";
2. "Certification/Audit";
3. "Technical assistance and training";
4. "Legal assistance";
5. "Others"

The value of index eight (8) is provided from the following equation:

INDEX 8 *= (∑ options 1 + 2 + 3 + 4 + 5)/number of areas supported = Value: (Min 0 – Max 5)*

4.3.2 LEVEL OF TRACEABILITY

In the questionnaire there are seven questions (14 – 20) regarding the level of traceability adopted by firms. As presented in Chapter two, the level of traceability is given by three dimensions: breadth, depth and precision. The choice to separate the level of traceability into the three dimensions is also due to the difficulties of providing the best weight of each dimension to build an overall index.

4.3.2.1 Breadth

According to Golan *et al.,* (2004:17) breadth indicates the amount of information collected for traceability practices. As stated in section 4.1, it may influence the expected/actual costs and benefits by traceability practices.

The breadth is measured in the questionnaire by variable fourteen (14) and VAR_14 in the database. The variable fourteen measures the breadth in two different stages: when the products come into the firm – input stage - to be processed (X) and when the products come out of the firm for sales – output stage - (Y). Variable fourteen has, both for input and output stages, the following twelve options:

1. “Supplier details - SD”;
2. “Data and hour of product arrival - DA”;
3. “Date of harvest - DH”;
4. “Location (area) harvesting/farming – LH”;
5. “Water quality classification - WQ”;
6. “Method of production - MP”;
7. “Scientific name of the species - SN”;
8. “Commercial name of the species - CN”;
9. “Quantity - QT”;
10. “Quality grading - QL”;
11. “Other – OT1”;
12. “Other – OT2”.

Index nine (9) measures the level of breadth summing up the numbers of information (data) recorded at the input and output stages of variable fourteen, assigning (=) 1 point for each data recorded as shown in the following equation:

$$\textbf{\textit{INDEX 9}} = \sum SDx + DAx + DHx + LHx + WQx + MPx + SNx + CNx + QTx + QLx + OT1x + OT2x + SDy + DAy + DHy + LHy + WQy + MPy + SNy + CNy + QTy + QLy + OT1y + OT2y = Value: (Min\ 1 – Max\ 24)$$

4.3.2.2 Precision

According to Golan *et al.,* (2004:17) precision reflects the degree of accuracy with which the tracing system can pinpoint a particular food product’s movement or characteristics. As stated in section 4.1, it may influence the expected/actual costs and benefits by traceability practices.

Precision is measured by variable fifteen (15) in the questionnaire and lists as VAR_15 in the database. It measures the precision of the traceability system in two different stages: when the products come into the firm – input stage - to be processed (X) and when the products come out of the firm for sales – output stage - (Y). The level of precision is given by the level of size (and details) with the lots or batches of product that can be identified. The level of precision increases with the decreasing of the lot/unit size identified.

For both stages (X and Y), variable fifteen has the following four sub-options:

1. “Two or more days of production - TD”;

2. “One day of production - OD”;
3. “Input from individual supplier/buyer - II”;
4. “Multiple batches from one supplier/buyer - MB” .

The level of precision is given transforming variable fifteen into index ten (10), summing up the points of stages X and Y. I assigned the following points for each sub-option both valid for options X and Y:

- ✓ “Two or more days of production” (=) 1 points;
- ✓ “One day of production” (=) 2 points;
- ✓ “Input from individual supplier/buyer” (=) 3 points;
- ✓ “Multiple batches from one supplier/buyer” (=) 4 points.

INDEX 10 *= (TDx or ODx or IIx or MBx) +(TDy or ODy or IIy or MBy) = Value: (Min 2 – Max 8)*

4.3.2.3 Depth

According to Golan *et al.,* (2004:17) depth describes how far back or forward the system tracks the relevant information. As stated in section 4.1, it may influence the expected/actual costs and benefits by traceability practices.

The level of depth is measured by two variables. First, is variable seventeen (17) in questionnaire and VAR_17 in the database which measures how far backward the traceability system is. Second, is variable eighteen (18) in questionnaire and VAR_18 in the database which measures how far forward the traceability system is. The variable seventeen is named (=) X while variable eighteen is named (=) Y.

To simplify the reasons and to make questions easier for the respondents, questions seventeen and nineteen refer to if the firms can or cannot regularly extend the traceability one step backward (question seventeen) to their suppliers and one step forward (question eighteen) to their customers. Thus, variable seventeen has two options:

1. “Firm able regularly to track its input beyond the direct suppliers - YES”;
2. “Firm notable regularly to trace its output beyond the direct customers - NO”.

Therefore, I transformed variable seventeen (X) into index 11a) assigning the following points for each option:

- ✓ Option 1 : (=) 0 point;
- ✓ Option 2 : (=) 1 point.

Then, index 11a) is given the following equation:

INDEX 11a) = option 1 or 2 = Value: (Min 0 – Max 1)

Variable eighteen has two options:

3. "Firm able regularly to trace its output beyond the direct customers - YES";
4. "Firm notable regularly to trace its output beyond the direct customers - NO".

Therefore, I transformed variable eighteen (Y) into index 11b) assigning the following points for each option:

- ✓ Option 3 : (=) 0 point;
- ✓ Option 4 : (=) 1 point.

Then, index 11b) is given the following equation:

INDEX 11b) = option 3 or 4 = Value: (Min 0 – Max 1)

To sum up, the level of depth is given summing up the level of backward (X) and forward (Y) traceability. This is provided from index eleven (11) as follows:

INDEX 11 *= INDEX 11a) +INDEX 11b) = Value: (Min 0 – Max 2)*

4.3.3 COSTS AND BENEFITS

The questionnaire presents four questions (25 – 28) regarding the expected and actual costs and benefits as presented in this section.

4.3.3.1 Overall expected, actual costs and benefits

The overall expected, actual costs and benefits are provided by variable twenty-five (25) in the questionnaire and VAR_25 in the database. Such variable is shared in two parts: A and B. Part A refers to the overall implementation and maintenance/operation costs. Part B refers to the overall benefits.

The expected and actual costs are measured by values perceived by the respondents, using Likert scale from one (1) (very low) to nine (9) (very high) of importance of implementation and maintenance/operation costs before (*ex-ante*) and after (*ex-post*) traceability system implementation. Part A presents two options for implementation costs:

1. "Expectation implementation costs";
2. "Actual implementation costs".

Part B presents two options for operation/maintenance costs:

3. "Expectation operation costs";
4. "Actual operation costs".

Therefore, the values of the variables transform into the following indexes:

INDEX 12 *= option 1 = Value: (Min 1 – Max 9)*

INDEX 13 *= option 2 = Value: (Min 1 – Max 9)*

INDEX 15 *= option 3 = Value: (Min 1 – Max 9)*

INDEX 16 *= option 4 = Value: (Min 1 – Max 9)*

In Part B the expected and actual overall benefits refer to the values perceived by respondents, using Likert scale from one (1) (no benefit at all) to nine (9) (extremely/great important benefit) of importance of overall benefits before (*ex-ante*) and after (*ex-post*) traceability system implementation variable twenty-five B) has two options:

5. "Expectation benefits";
6. "Actual benefits".

The values of variable twenty-five B) transform into the following indexes:

INDEX 18 *= option 5 = Value: (Min 1 – Max 9)*

INDEX 19 *= option 6 = Value: (Min 1 – Max 9)*

4.3.3.2 Discrepancies between overall expected, actual costs and benefits

These indexes inform about the discrepancies emerged between expectations and actual overall costs and benefits due to traceability system implementation as required by EC regulation n.178/2002. They represent the indexes of how the actual costs and benefits outcomes, have deviated from the predictions/expectations by traceability practices.

In short, the discrepancies are calculated as actual costs or benefits, gets longer versus expected, costs or benefits (e.g. Actual benefits – Expected benefits).

The levels of costs and benefits discrepancies are provided from the following indexes:

INDEX 14 *= Discrepancy implementation costs = INDEX 13 – INDEX 12 = Value: (Min – 8; Max + 8)*

INDEX 17 *= Discrepancy maintenance/operation costs = INDEX 16 – INDEX 15 = Value: (Min – 8; Max + 8)*

INDEX 20 *= Discrepancy costs = INDEX 19 – INDEX 18 = Value: (Min – 8; Max + 8)*

4.3.3.3 Level of traceability cost

The level of traceability cost informs about the importance of the traceability costs out of total cost of production. It is represented by index twenty-one (21), that is measured in percentage (%) by variable twenty-six (26) in the questionnaire and it listed as VAR_26 in the database.

In short, the value of variable twenty-six is measured by percent cost (%) of incidence of the traceability cost out of total cost of production. For instance, % traceability cost on total cost of production to produce 1 kg of product. The value of such variable is based on the perception of the interviewee, because it might be difficult to measure exactly the traceability cost (e.g. is difficult to measure how more time personnel need for traceability practices, etc).

Thus, variable twenty-six transforms into index twenty-one, reporting the % as following:

INDEX 21 *= % = Value: (Min 0; Max 100)*

4.3.3.4 Specifics costs and benefits

As mentioned in Chapter two, the specific costs and benefits of traceability systems are the particular costs and benefits which are affected from traceability practices.

The variables that inform about the specific costs and benefits are listed as questions twenty-seven (27) and twenty-eight (28) in the questionnaire and VAR_27 and VAR_28 in the database. Each variable presents two levels of values: *ex-ante* (columns A) and *ex-post* (columns B) traceability system implementation. In column A the values of the variables measured from the weight of importance is parceled out for each specific expected cost/benefit from 0 to 100 points. The total sum of specific costs and benefits has to be 100 points.

On the other hand, the values of column B are measured from the weight of importance parceled out for each actual specific cost from 0 to ±100 points. Then, the total sum of actual costs could be more or less 100 points, because the discrepancies between expected and actual cost or benefits are important.
Then, from variables twenty-seven and twenty-eight, I can extract two types of indexes. The first category refers to the importance of each costs and benefits of columns A and B. The second category refers to the discrepancies emerged for each costs and benefits between expectation and actual outcomes, that is provided from the differences of values of column B and column A.

Now, I will list the specific costs and the indexes related to variable twenty-seven:

- ✓ purchase new equipment and software

INDEX 22 (a) *= Expected costs = Value: (Min 0 – Max 100)*

INDEX 22 (b) *= Actual costs = Value: (Min 0 – Max* ±100*)*

INDEX 22 (c) *= Discrepancies costs = INDEX 22 (b) – INDEX 22 (a) =*

- ✓ certification/audit

INDEX 23 (a) *= Expected costs = Value: (Min 0 – Max 100)*

INDEX 23 (b) *= Actual costs = Value: (Min 0 – Max* ±100*)*

INDEX 23 (c) *= Discrepancies costs = INDEX 23 (b) – INDEX 23 (a) =*

- ✓ production line, supervisory staff and managerial/administrative time

INDEX 24 (a) *= Expected costs = Value: (Min 0 – Max 100)*

INDEX 24 (b) *= Actual costs = Value: (Min 0 – Max* ±100*)*

INDEX 24 (c) *= Discrepancies costs = INDEX 24 (b) – INDEX 24 (a) =*

- ✓ training courses

INDEX 25 (a) *= Expected costs = Value: (Min 0 – Max 100)*

INDEX 25 (b) *= Actual costs = Value: (Min 0 – Max* ±100*)*

INDEX 25 (c) *= Discrepancies costs = INDEX 25 (b) – INDEX 25 (a) =*

- ✓ materials

INDEX 26 (a) *= Expected costs = Value: (Min 0 – Max 100)*

INDEX 26 (b) *= Actual costs = Value: (Min 0 – Max* ±100*)*

INDEX 26 (c) *= Discrepancies costs = INDEX 26 (b) – INDEX 26 (a) =*

Now, I will list the specific benefits and the indexes related to variable twenty-eight:

- ✓ meeting current and anticipated future regulatory requirements

INDEX 27 (a) *= Expected benefits = Value: (Min 0 – Max 100)*

INDEX 27 (b) *= Actual benefits = Value: (Min 0 -* ±100*)*

INDEX 27 (c) *= Discrepancies benefits = INDEX 27 (b) – INDEX 27(a) =*

- ✓ increasing consumer trust

INDEX 28 (a) *= Expected benefits = Value: (Min 0 – Max 100)*

INDEX 28 (b) *= Actual benefits = Value: (Min 0 -* ±100*)*

INDEX 28 (c) *= Discrepancies benefits = INDEX 28 (b) – INDEX 28 (a) =*

- ✓ meeting customer's requirements and increasing his trust

INDEX 29 (a) *= Expected benefits = Value: (Min 0 – Max 100)*

INDEX 29 (b) *= Actual benefits = Value: (Min 0 -* ±100*)*

INDEX 29 (c) *= Discrepancies benefits = INDEX 29 (b) – INDEX 29 (a) =*

- ✓ increasing market share or accessing new markets and obtaining a price premium

INDEX 30 (a) *= Expected benefits = Value: (Min 0 – Max 100)*

INDEX 30 (b) *= Actual benefits = Value: (Min 0 -* ±100*)*

INDEX 30 (c) *= Discrepancies benefits = INDEX 30 (b) – INDEX 30 (a) =*

- ✓ reducing customer complaints, recalls, risk of product liability

INDEX 31 (a) *= Expected benefits = Value: (Min 0 – Max 100)*

INDEX 31 (b) *= Actual benefits = Value: (Min 0 -* ±100*)*

INDEX 31 (c) *= Discrepancies benefits = INDEX 31 (b) – INDEX 31 (a) =*

- ✓ improving management within the company and reducing the possibility of errors for data input and data management

INDEX 32 (a) *= Expected benefits = Value: (Min 0 – Max 100)*

INDEX 32 (b) *= Actual benefits = Value: (Min 0 -* ±100*)*

INDEX 32 (c) *= Discrepancies benefits = INDEX 32 (b) – INDEX 32 (a) =*

- ✓ improving supply chain management (inventory, logistics, communication with suppliers and customers)

INDEX 33 (a) *= Expected benefits = Value: (Min 0 – Max 100)*

INDEX 33 (b) *= Actual benefits = Value: (Min 0 -* ±100*)*

INDEX 33 (c) *= Discrepancies benefits = INDEX 33 (b) – INDEX 33 (a) =*

4.4 DATA

In the last section of Chapter four, I will provide information concerning the survey design, the questionnaire description, the limitations of the survey, the characteristics of the sample and finally the response rate result from the conducted survey.

4.4.1 SURVEY DESIGN, QUESTIONNAIRE DESCRIPTION AND SURVEY LIMITATIONS

The survey has been designed starting from the results of the discussions which emerged from the literature reviews and Scardovari Consortiums case study analysis presented in Chapter two. By those outcomes, I pointed out the need to

have a better understanding of the traceability business performances (dependent factors) and its relationships with the firm's characteristics (independent factors) that may influence them. Thus, I have designed a questionnaire, which contains twenty-eight (28) questions in two main sections: the first section included questions about the firm's characteristics [1. Name of the company; 2. Location; 3. Interviewer position; 4. Position of the company in the supply chain; 5. Company employees; 6. Type of products produced; 7. Annual revenue; 8. Raw material origin; 9. Type of supplier; 10. Areas of sales; 11. Methods of sale; 12. Types of customers; 13. QMS adopted; 20. Government support; 21. Areas of Government support; 22. Utility of government support while the second section includes questions regarding traceability costs and benefits performances [14.Traceability system implemented or not; 15. Intention to implement traceability system in the future; 16. Motivations to not implement traceability system; 17. Technical tool of traceability system; 18. Traceability system validation; 19. Access to traceability data; 23. Overall expected/actual costs and benefits; 24. Importance of traceability cost out of overall cost of production; 25. Expected/actual importance of specific implementation and operation costs; 26. Expected/actual importance of specific benefits]. The questionnaire concluded with two questions: 27 (Additional comments) and 28 (Summary sent to firms who have participated in the survey).

After the questionnaire was designed, I pre-tested it in a small number of ichthyic processors industries. The aim of the pre-test was to verify if the questionnaire works well in the interview (e.g. if questions are clear, easy to answer, etc). To do that, I contacted by phone forty (40) ichthyic processors industries from the Yearbook[55] around Bologna to invite them to participate in the pre-test. Eight of these (8/40) decided to participate in the pre-test through personal interviews conducted by Asioli D. in January – February 2008.

In the pre-test there emerged some difficulties and limitations to conducting the survey in the best possible way. Following are some difficulties/limitations which emerged some challenges and rearrangements (e.g. add or delete or rearranged questions) useful for the final version of the questionnaire will be explained:

[55] See section 4.4.2 for more details.

- ✓ it would be reasonable to delete the "Name of the company" interviewed from the questionnaire, putting it on a separate page to preserve the anonymity of the company (question one);
- ✓ it would be reasonable to delete the option "Province" of the firm's location (question two), because it is the detail that may not be very useful for our purposes the "Region" identification would be enough;
- ✓ many firms conduct retailer stage over processor (question four). Thus, it is reasonable to substitute "Retailer" stage instead of "Others";
- ✓ change question six, that regards the types of products processed within the firm, the question is too complicated to answer. Simplify this question by dividing it into two questions that measure together the level of complexity operation depending on type of raw material processed and types of different levels of processing;
- ✓ add a new question regarding the origin of raw materials (fishing and/or aquaculture) because it may be an important firm's characteristic influenced by traceability business performances;
- ✓ I found out some firms that purchase raw materials and sell final products from and to No-EU member State (question ten). Thus, it makes sense to add the option "No EU Member State";
- ✓ I found out some firms which sold their products without any type of brand (question eleven), therefore it makes sense to add the option "Sold to buyer without any direct brand name involvement in contract";
- ✓ there is no difference between "International" and "National chain" (question twelve) thus it makes sense to merge these two options into one: "International and National chain";
- ✓ I found out that some firms adopt other QMS certifications over those already included. In particular, it would make sense to add the following options in the final questionnaire: "ISO 22000:2005 - Food Safety Management System"; "ISO 22005:2007 - Traceability in the feed and food chain"; "BRC – British Retail Consortium"; "EUREPGAP – Euro Retailer Produce Working Group";
- ✓ I found out some difficulties to questions fourteen, fifteen and sixteen, because exist various levels of traceability systems (Golan *et.al* 2005:16-17;

Bulut *et.al*, 2008:12-20). Therefore for the final version of the questionnaire, it would make sense to replace questions fourteen, fifteen and sixteen with questions relative to level of traceability as listed in table 4.1;

- ✓ I discovered difficulties in replying to question seventeen regarding the technical traceability tools used by the firm. This is because firms use mixed tools and it was difficult to know what was the main tool. In addition to that, maybe such a question is not too relevant for our purposes, thus I deleted it;
- ✓ I found out that some firms adopt traceability certifications, thus it would be reasonable to change questions nineteen adding the possible traceability certifications that firms can adopt. As stated before, in various models descriptions traceability certifications may become a firm's characteristic that could affect the traceability performances;
- ✓ I found questions twenty-one and twenty-two heavy and long for the respondent to reply to thus it would be reasonable to merge those into one question to measure the level of utility of the government's support. Furthermore, it makes sense to simplify such questions to reduce the number of options available or merge them into similar groups;
- ✓ I found out that I can make some modifications to question twenty-five in two ways. First, I can use the option "Training courses" instead of "External consultants and training course", because the activities of external course are basically training courses. In addition, I found that "Materials" is an important category of cost, then it makes sense to include it as option instead of "Others". Second, it makes sense deleting the table of maintenance/operation costs, because it generates confusion for the respondent to discern it from the table of implementation costs. Moreover, my impression based on the comments of the respondents, was that such costs were not very important in comparison to implementation costs;
- ✓ I found the reply to question twenty-eight a bit complicated, because there are too many categories that are very similar and therefore it was difficult to share among them. Thus, it makes sense to merge the categories: "Obtain price premium" and "Increasing market share or accessing new markets" into one

and “Reducing the possibility of errors for data input and data management” and “Improving management within the company” into one.

However, the main important challenge is that it is necessary to include the section “Level of traceability” that allows one to understand how much traceability practises are significant and also allows assessment of the traceability business value in the best and logical way (Golan, *et.al.* 2003:19-20).

Second part of this section regards the questionnaire description (Annex one - 1). As presented in table 4.1, the final questionnaire of the survey is composed of thirty questions divided into four sections.

Table 4.1 – The structure of the questionnaire

FACTOR (SUBJECT)	SUB-SUBJECT (Variable)	N° QUESTION
Firm characteristics	Location (Region)	1
	Interviewer’s position within firm	2
	Firm position through the food chain	3
	Employees	4
	Types of products sold	5
	Types of raw materials treated	6
	Methods of production of raw material	7
	Annual revenue	8
	Origin of raw materials	9
	Delivery of final products	10
	Methods of sale	11
	Types of customers	12
	Food safety quality and man. systems	13
	Government involvement	22
	Types of government support	23
	Utility of governments support	24

Table 4.1 – *Continue* - The structure of the questionnaire

FACTOR (SUBJECT)	SUB-SUBJECT (Variable)	N° QUESTION
Level of traceability	Breadth	14
	Depth	15
	Traceability data transparency	16
	Backward traceability	17
	Forward traceability	18
	Traceability tests	19
	Frequency of traceability tests	20
	Traceability certification	21
Traceability costs and benefits	Overall implementation and maintenance costs	25A
	Overall benefits	25B
	Traceability cost share out of total cost of production	26
	Specific cost	27
	Specific benefits	28
General information	Further comments	29
	Interests on research results	30

The sections reflect the considerations made in the preceding sections 4.1, 4.2 and 4.3 of this Chapter. The first questionnaire section captures the firm's characteristics as factors that may influence traceability performance, such as firm size or government support. It includes sixteen questions, numbered 1 through-13 and 22 through 24. The second section aims at identifying the level of traceability, as measured by the depth, breadth and precision of traceability. It includes questions 14 through 21. Then, the third section measures the cost and benefit associated with the firm's current traceability system or practices, ranging from aggregate measures, such as overall costs, to specific measures, such as training for employees. In questions 25 to 28, expected and actual costs and benefits are

measured. In particular, questions 27 and 28 state to respective importance of specific implementation costs and benefits. The importance of specific costs and benefits is measured at two levels: expectation and actual outcomes.

At expectation level, I assume that the total expected implementation costs or benefits can be set equal to 100 units. Then, the respondent has to distribute these 100 units across the categories of specific implementation costs and benefits. (e.g. if all categories had been expected to have about the same magnitude, each would receive 20 units).

At the actual outcomes level, the importance is indicated whether the actual implementation costs or benefits in each category were smaller or bigger than expected and, if so, to what extent (e.g. if costs were as expected, then each category receives the same number of units as under expected. If, however, they deviate from expectations, indicate how much roughly, for example, 30 instead of 25, or 15 instead of 25. So, the sum of the actual cost units may be bigger or smaller than 100).

The final section uses two questions to elicit general information and feedback from the respondents.

The sequence of the questions has been chosen to build up step by step toward the most relevant and difficult to answer questions at the end of the questionnaire. To do that, it has been necessary to undertake and go through the entire process of implementing traceability starting from the fundamental independent factors (firm's characteristics) and then, going through the level of traceability adopted that may affect the traceability performances (costs and benefits) in a coherent manner for a better and more logical understanding. Therefore, this sequence process represents the theoretical path of the traceability process implementing that firms may follow, when they have to implement traceability system (Golan *et.al*, 2004: 3 -10).

This better understanding may be useful to implement the traceability system in a better way that may improve the net benefits for the firms. Furthermore, it is necessary, as stated by Meuwissen *et al.,* (2003:58-60), to improve the scientific knowledge of economic and business aspects due to traceability practices, that is actually lacking.

To reply to the research questions presented in Chapter one, an empirical quantitative survey across the food firms is necessary. This is because the other ways of improving knowledge (e.g. literature review, case studies analyses, etc.) cannot provide and measure the business performances of traceability practices. Only an appropriate survey allows one to measure how much the adoption of traceability practices affect the business performances and how important the influence of factors such as the firm's characteristics or level of traceability adopted on traceability costs and benefits are.

For each techniques, the survey may have some limitations that could affect the value of the final results. Following, I will describe some of the possible limitations in a random order.

First, are the difficulties that the interviewer encounters when arranging interviews. This is because, firms often are reticent to provide information and data, especially as regards topics such as food safety, traceability, revenue, etc (Troilo *et al.,* 2003:170).

Second, is the difficulty that interviewees encounter when replying to the questions. This is because in the mid and large firms the interviewees are mainly quality managers, who are sometimes meet difficulties when replying to all the questions. This is especially true for costs and benefits aspects that they do not know very well or in an in-depth way such as the general manager, staff, etc. Moreover, in the small firms, the interviewees are mainly the bosses of firms, that they may cover different positions within firms (e.g. quality manager, trade manager, etc.) and, therefore do not know the traceability aspects in details.

A third limitation could be, that often there does not exist a unique traceability system adopted by firms (Golan *et.al*, 2004:3). As mentioned before, traceability systems may vary among different raw materials bought, different suppliers, different final products, different customers, etc. Then, it would be difficult to assess an appropriate traceability asset for each firm and, as a consequence difficult to assess appropriate business performance assets.

A fourth limitation, is that it would be impossible to have a complete and in-depth understanding of traceability assessment, because a quantitative survey and the

few times that an interviewer would spend replying to the questionnaire may limit the value of the survey (Troilo *et. al,* 2003:171).

A fifth limitation, referring to questions of costs and benefits, is that the interviewee has to express his opinion in points or votes about the costs and benefits expectations. In fact, sometimes it is difficult to express precious opinions thought in the past. Maybe, the interviewee has forgotten or in the worst case, he was not involved in the traceability implementation.

The survey has been designed in the way presented before, because it has been expected to be the best manner to present the research questions introduced in Chapter one. To have a better understanding of the business value generating from the traceability practices within the Italian ichthyic processing industry it becomes necessary to create a quantitative survey that goes through and explores the factors that may influence that.

4.4.2 SAMPLE FRAME, SAMPLING AND RESPONSE RATE

The entire population, from which I extracted the sample frame, is compiled by cross-checking firms listed from the last Italian Census of Industry and Service of Istat in 2001 and information provided from the Yearbook of Fishery and Fishing (2007/2008, n.18),[56] here simply called Yearbook.

Based on Census data, the overall population of the Italian ichthyic processing industries are composed of 415 firms (Istat, 2001). They represent 0.6% of the overall Italian food industry. The overall employees are 6,640 (1.5% of the overall Italian food industry). Unfortunately, the Census does not provide the names and contacts of firms; therefore, I had to extract such contacts from the Yearbook.

Based on a short internet research and suggestions provided from some fishery operators, I chose as sources, the list of ichthyic processing operators contained in the Yearbook. This is because, the Yearbook is the most complete and unloadable document that contains the fishery operators.

[56] The Yearbook is edit by Edizioni Pubblicità Italia s.r.l. (http://www.pubblicitaitalia.com) that is wide consider by fishery operators the most important professional Italian publishing housein the fishery supply chain. It also publishes the review "Il pesce".

The Yearbook contains the complete list of the Italian fishery supply chain stakeholders (e.g. primary producers, services, retailers, universities, governments, etc.) organized and coded in different groups based on type of activities. As stated in the previous chapters, the aim of the thesis is to point out the processing activities of the ichthyic firms. Thus, I will look for the group that contains the firms that are doing fishery processor activities in some ways. Unfortunately, in the Yearbook the fishery processing firms are regrouped into a larger group that contains also the firms that deal with marketing activities (e.g. local fishery shops, wholesalers, retailers, etc.). Such a group is named "Fish slaughtering, processing and marketing companies" and it is coded [AM]. Such a group contains 2,231 overall firms. Basically, this group contains three types of stakeholders. The first group, includes the firms that only are involved in slaughtering and processing activities. The second group includes the firms that are involved in the slaughtering, processing and marketing activities. The third and last group regards the firms that are involved only in marketing activities (e.g. wholesalers). Therefore our subject includes only the firms that are contained into the first and second groups.

Unfortunately, the Yearbook does not provide any additional information (i.e. the size of firms, etc.) which would help us to find out the firms that deal with processing activities. However, the Yearbook provides all information about contact such as firm denomination, region of locations, telephone, fax, e-mail and website.

Thus, all the 415 ichthyic processing industries, that represent our population, are contained in the first two categories mentioned above of the [AM]. To extract the sample frame, the unique way is calling by phone, a random sample of firms' code [AM] and ask them if they deal with some processing activities or not. If they deal with processing activities, they can be included in our population that I contain in the sample frame.

Thus, I contacted by phone 1,800 firms [AM][57] from May to July 2008 across Italy. Of these firms, 303 were dealing with processing activities[58]. Of this total

[57] [AM] is a group listed in the Yearbook that contents the"Fish slaughtering, processing and marketing companies".

(303), 243 firms have decided not to participate in the survey meaning that 60 interviews have been conducted for a response rate of 19.8% (Table 4.2). The 60 respondents represent 14.5% of the overall number of ichthyic processing plants in Italy (415).

Furthermore, I have to consider that the overall firm population is composed of very small firms (e.g. local fishery shop, etc) that are not interesting for the aim of this thesis. It would be quite difficult for them to participate in this survey, because these firms are very low structured with two or three employees who due to cultural motivations and time available are very reticent to reply to the questionnaire. As a consequence, the sample becomes most significantly representative of the overall population.

Table 4.2 – Number of Survey Respondents

PHASE IN THE PROCESS NUMBER	NUMBER
Contacted	303
Positive response	60 (19.8%)

4.5 CONCLUSION

The purpose of this Chapter is to present and explain the factors impacting on costs and benefits from traceability through a literature review. The conceptual framework that will be used to further explore the factors that are likely to impact on traceability performance has been presented in this Chapter. In particular, four models that link various factors which impact on costs and benefits has been presented. The expected relationships among each variable such as the firm's characteristics, level of traceability and expected and actual costs and benefits have been hypothesized based on the findings from the literature review and case study analysis. The results as emerged by testing hypothesis emerged in this Chapter will be discussed in the next Chapter.

[58] Therefore, such 303 firms are part of the entire population of fishery processing industries that is 415 (Istat, 2001).

In the second section, the description of generating processes of indexes used has been provided. The Chapter concluded with description of the survey design, the questionnaire description, the limitations of the survey, the characteristics of the sample frame and finally the response rate which resulted from the survey conducted.

CHAPTER FIVE

RESULTS

5.0 INTRODUCTION

In Chapter four, the conceptual framework and the variables such as the firms' characteristics, expected costs and benefits and level of traceability, that appear to impact on actual outcomes of costs and benefits of traceability, were introduced.

Chapter five presents and discusses the empirical results of the hypothesis introduced in Chapter one. This Chapter is composed of seven sections. In the first section, I will describe some of the more significant firms' characteristics of the sample. In the second section, the hypotheses and their motivations will be explained. In addition, I will briefly describe the statistical methods used to test the hypothesis. In the third, fourth and fifth, I will present and discuss the results of testing each hypothesis. In addition, for each hypothesis tested, I will provide the descriptive statistics of the indexes used. In the sixth section, I will describe the results of the relative importance of the specific benefits and costs of traceability practices *ex-ante* and *ex-post* traceability implementation.

5.1 DESCRIPTIVE STATISTICS OF THE SAMPLE

In this section, I will briefly describe the most significant characteristics of the firms which compose the sample used in this thesis (Table 5.1). The first characteristic is the size of firms, which is measured in terms of employees and annual revenues as mentioned in Chapter four. Near to 50% (25/56) of the firms interviewed have an annual revenue over 10 million Euros.

Second, near to half of the firms (28/60) of the sample are vertically integrated[59]. The vertical integration plays a crucial role in traceability implementation: as

[59] In this context, the vertical integration, means that a firm occupied more than one stage through the food chain (e.g. primary production and processing).

stated in chapters two and four, traceability implementation is the favorite when firms are vertically integrated (Cates *et al.*, 2006:957-966; Hobbs, 1996a:16-26).
Third, in terms of geographical location, more than half the sample firms (34/60) are located in the North of Italy. This means that firms are located in the area more economically developed in Italy, where the traceability implementation (e.g. services/facilities of traceability software) is facilitated as mentioned in Chapter four.

Table 5.1 – Describing sample: some firms' characteristics

VARIABLE	COUNT / VALID
Revenue > EURO 10 million	25 / 56
Vertically integrated	28 / 60
Region = Northern Italy	34 / 60
HACCP certified	53 / 60
ISO 9000:2001 certified	25 / 60
Traceability certified	7 / 60
Government support received	9 / 60

Fourth, as reported in chapters two and four, the QMS certifications have an impact on traceability (Mora and Menozzi, 2005:217; Souza – Monteiro *et al.,* 2006:19). The results show that almost all the firms interviewed (53/60) adopt HACCP systems and almost half of the firms (25/60) adopt ISO 9000:2000 certification. In addition, the traceability systems of seven firms have been certified according to UNI 10939:2001, UNI 11020:2002 and ISO 22005:2007. Given that traceability certification has only become available in 2001, a share of more than 10% traceability certified firms in the sample is rather high.
The fifth firms' characteristics, which is of particular importance for the objectives of the thesis, is the government support: 15% of the firms (9/60) have received some form of government support for traceability system implementation.

5.2 OVERVIEW OF HYPOTHESES AND METHODS

In this section, I give a brief overview of the hypotheses, and the related motivations and relevance, that will provide useful insights and information for research, industry and government.

5.2.1 MOTIVATIONS FOR HYPOTHESES

The hypotheses tested in this thesis, as largely explained and discussed in chapters one and four, are as follows. Hypothesis one would like to determine if the three dimensions of the level of traceability - breadth, depth and precision - are more strongly linked with the expected or actual costs and benefits.

Hypothesis two would like to determine if the firms' characteristics can be linked with the implementation and operation costs, benefits and their discrepancies among expectations and actual outcomes. In particular, I will analyze the influence of government support on actual costs and benefits. Hypothesis three sets out to discover which of the firms' characteristics can be linked with changes in the level of traceability.

The justification for these hypotheses is that testing them could provide useful insights and information for academic researches, industry and government.

As stated in the previous chapters, the academic literature review shows a gap in business and economic consideration due to traceability practices in the food supply chain (Meuwissen *et.al.*, 2003). The literature review does not show any research that links the level of traceability with costs and benefits. Golan *et.al.,* (2004) states that firms choose the best level of traceability based on the expected costs and benefits. Therefore, testing hypothesis one could provide information about whether if the level of traceability adopted has any causal relation with expected or actual costs and benefits and can then improve the gap in literature review. Furthermore, literature review shows some research that links the firms' characteristics with expected and actual costs and benefits into traceability practices. For instance, Bulut *et al.*, (2008:14) report the size of the firms influence the traceability costs. However, there is not any research that links the costs and benefits with firms' characteristics. In addition, Golan *et al.,* (2004) state that firms choose the best level of traceability that fits the objectives and

costs and benefits in the best way. As a result, perhaps firms' characteristics can be linked with the level of traceability. In addition, literature review shows some research that links some firms' characteristics with the level of traceability (Bulut *et.al*, 2008; Souza-Monteiro *et.al*, 2006; Cates *et.al*, 2006).

Thus, the academic literature could benefit from this thesis by providing empirical information about which of the firms' characteristics determine the level of traceability.

Food industries in the process of traceability implementation, could benefit by this thesis in various ways. First, there may exist a dimension of the level of traceability which is more convenient to invest in to increase the level of traceability than other dimensions. Second, there might exist a firms' characteristic that increases the expected and actual costs and benefits than others. Then, firms that are planning to implement a traceability system can take into account that perhaps some of their characteristics could determine higher costs or lower benefits than other firms. For instance, if the level of complexity operations strongly influence the costs (positive correlation) perhaps firms which have a high level of complexity operations can discourage implementation of traceability systems. Third, this thesis could provide useful insights to food industry about which of the firms' characteristics can increase the level of traceability more than others. For instance, adopting the traceability certification may increase that level of traceability with a higher net benefits than other firms' characteristics.

Government could benefit by this thesis with its useful insights and skills about traceability in the food supply chain for a better understanding of practical implications of it in the food industry. Such knowledge could be useful to improve legislation and support of traceability practices. For instance, government could learn how much their support is effective in increasing the level of traceability and in which areas, government should improve its support. In addition, as stated in Chapter two, one of the objectives of the government is to increase food safety which could be improved by increasing the level of traceability. Therefore, government could discover which dimension (breadth, depth or precision) of level of traceability is most effective to improve the level of traceability. This knowledge could help the governments to support the firms in the best way.

5.2.2 METHODS OF ANALYSIS

In addition to the measures of central tendency and dispersion for describing the key sample characteristics, data analysis for hypothesis testing will rely on correlation analysis. According to Koop (2001:29) and Berenson *et al.,* (1989:549), the most important statistical tools to assess associations between variables are correlation and regression analysis. Correlation analysis relates two variables while multiple regression analysis relates three or more variables (Koop, 2001:29). The correlation analysis measures the level of association between quantitative variables (Berenson *et al.*, 1989:549).

Correlation analysis can be conducted with various software packages, e.g. Excel, SPSS, that provide a measure named as correlation coefficient (r_{xy}) that is an indication of how much two variables (X and Y) are correlated. The value of the correlation coefficient varies from – 1 to + 1. A value of r_{xy} = - 1 means that variable X and Y are perfectly negatively correlated while a value of r_{xy} = + 1 means that variable X and Y are perfectly positively correlated. A value of r_{xy} = 0 means that variable X and Y are uncorrelated.

5.3 HYPOTHESIS ONE: THE RELATIONSHIPS BETWEEN LEVEL OF TRACEABILITY AND EXPECTED AND ACTUAL COSTS AND BENEFITS

In this section, I will explore and discuss in detail, the empirical results of whether the level of traceability is more strongly linked with expected costs and benefits or actual costs and benefits. The section is divided into two sub-sections. First, I will provide an overview about the descriptive statistics of the level of traceability, costs and benefits. Second, I will discuss and interpret the results as emerged by application of correlation analysis on hypothesis one.

5.3.1 OVERVIEW OF LEVEL TRACEABILITY AND COSTS AND BENEFITS: DESCRIPTIVE STATISTICS

Before presenting the results of hypothesis testing, key descriptive statistics are presented to give an overview of the data structure with respect to measures of central tendency and dispersion for the level of traceability indices and the expected cost and benefit variables (Table 5.2).

Table 5.2 – Descriptive statistics for level of traceability, costs and benefits

INDEX	SCALE		MEAN	STANDARD DEVIATION	MIN	MAX
Breadth	0	24	12.72	**4.32**	2	24
Precision	2	8	6.28	**1.80**	2	8
Depth	0	2	0.95	0.94	0	2
Expected impl. cost	1	9	5.83	1.967	1	9
Actual impl. cost	1	9	5.43	2.604	1	10
Discrepancy impl. cost	- 8	8	-0.38	2.346	-8	4
Expected oper. cost	1	9	5.07	2.157	1	9
Actual oper. cost	1	9	5.23	2.464	1	9
Discrepancy oper. cost	- 8	8	0.20	1.721	-3	5
Expected benefits	1	9	6.66	1.979	1	9
Actual benefits	1	9	6.32	2.072	1	9
Discrepancy benefits	- 8	8	-0.35	1.798	-7	5
% traceability cost*	0	100	1.60	1.177	0.5	5.0

* Two observations have been deleted, because were outlines (12.5% and 30%).

There is considerable variation between firms with regard to the level of traceability implemented, as can be seen by the large measures of standard variation relative to the arithmetic means.

On average, expected implementation cost and overall benefits were both overestimated prior to implementation, while maintenance and operation costs were underestimated. However, the discrepancies were rather small, and in only a few cases spanned two or more points on the nine point scale.

5.3.2 RESULTS

In this section, I interpret the results by correlation analysis among the three dimensions of the level of traceability - breadth, precision and depth - and the

expected and actual costs and benefits (Tables 5.3 and 5.4). From the analysis the following outcomes emerge.

First, as shown in table 5.3, the value of the correlation coefficients among breadth, precision and depth are very low and not significant at any conventional level of error probability (Table 5.3). This means that breadth, depth and precisions are strong uncorrelated among them. This justifies and confirms, that the decision to split the level of traceability in the three dimensions as stated by Golan *et. al.,* (2004), was correct.

Table 5.3 - Correlation coefficients between breadth, precision and depth of traceability

	BREADTH		**PRECISION**	
	Correlation coefficient	**Sig. (2-tailed)**	**Correlation coefficient**	**Sig. (2-tailed)**
PRECISION	0.081	0.541		
DEPTH	0.075	0.573	0.019	0.888

Second, I discuss how breadth, precision and depth are linked with the expectations, actual outcomes and discrepancies of implementation and operation costs as shown in table 5.4.

The values of the correlation coefficients (r) show that breadth is medium correlated with actual implementation costs (r = 0.329) and more with discrepancy of implementation costs (r = 0.425). Thus, as breadth increases so does discrepancy of implementation cost increase. That means that cost of breadth is underestimated when firms estimate implementation cost. Therefore, there is an increase in the uncertainty of implementation cost, as breadth increases, and the traceability system consequently becomes more complex.

In addition, breadth is moderately correlated with actual operating cost (r = 0.361) and less correlated with discrepancy between actual and expected operation costs (r = 0.245). This means that breadth is linked more strongly with the actual costs than with expected costs.

Table 5.4 – Correlation coefficients between level of traceability and traceability business performances

	BREADTH		PRECISION		DEPTH	
	Correlation coeff.	Sig. (2-tailed)	Correlation coeff.	Sig. (2-tailed)	Correlation coeff.	Sig. (2-tailed)
Expected impl. costs	-0.118	0.371	-0.028	0.832	0.068	0.606
Actual impl. costs	**0.329****	0.012	0.067	0.620	0.071	0.601
Discrepancy impl. costs	**0.425*****	0.001	0.043	0.749	-0.067	0.621
Expected oper. costs	0.137	0.301	-0.057	0.670	*0.251*	0.057
Actual oper. costs	**0.361*****	0.006	-0.002	0.988	0.120	0.379
Discrepancy oper. costs	*0.245**	0.069	0.018	0.898	-0.149	0.275
Expected benefits	0.068	0.608	**0.272****	0.037	0.136	0.310
Actual benefits	0.213	0.112	**0.375*****	0.004	0.108	0.430
Discrepancy benefits	0.185	0.168	0.108	0.422	-0.024	0.858
Percentage (%) cost	**0.309****	0.032	-0.056	0.705	0.181	0.220

*,**,*** significant at 1%, 5%, 10% error probability level.

Precision does not have any particular links with costs: all the value of correlation coefficients show small and insignificant values ($r < 0.1$; $\alpha \leq 0.1$). Depth is insignificant when uncorrelated with all categories of costs and small when correlated with expected operation costs ($r = 0.251$).

Third, I interpret how breadth, precision and depth influence the expected, actual and discrepancies of benefits. The firms interviewed had expected that a higher level of precision ($r = 0.272$) is associated with higher expected benefits more than breadth ($r = 0.068$) and depth ($r = 0.136$). The actual outcomes show that precision is medium correlated ($r = 0.375$) while depth ($r = 0.108$) and breadth ($r = 0.213$) are hardly at all correlated with actual costs.

Four, I interpret how breadth, precision and depth influence the percentage costs. Only breadth ($r = 0.309$) is medium correlated with percentage costs, while correlation coefficients both for precision ($r = - 0.056$) and depth ($r = 0.181$) are very low. This shows that increasing the breadth increases the percentage cost of traceability.

Five, each dimension of the level of traceability has a different association with costs and benefits: a depth leads in correlation with expected operation costs, while the linkages with other costs, benefits and percentage costs are weak. Precision is most strongly linked with expected and actual benefits. Breadth is more linked with actual implementation and discrepancies of operation costs, benefits and percentage costs.

In conclusion, I reply to the first research question as follows: first, the level of traceability is complex in its correlations with expected and actual costs, benefits and percentage costs. Second, breadth is medium linked with actual outcomes than expectations for costs, benefits and percentage costs. Third, the precision is almost uncorrelated with expected and actual costs, but it is significantly linked with expected and actual benefits. Four, depth is most weakly linked with the business performance measures of traceability. With the exception of the barely significant correlation coefficient for expected operating costs, none of the coefficients are significant.

These outcomes could be subject to some more in-depth investigations. First, it may be meaningful to investigate in-depth which of the specific costs lead the actual and discrepancy on implementation costs and also for percentage cost that are linked with breadth. Such knowledge may help the firms that are in the process of adopting a traceability system. Second, it may be meaningful to conduct an in-depth investigation to discover which of the specific benefits (which are actually more important than expectations) are linked with precision. Such knowledge may help to understand in detail which of the specific benefits lead to the positive discrepancies in precision. Furthermore, this may be useful information for firms that are in the process of traceability implementation. For instance, they may be more interested in increasing some specific benefits than others.

5.4 HYPOTHESIS TWO: THE RELATIONSHIPS BETWEEN FIRMS' CHARACTERISTICS AND EXPECTED AND ACTUAL COSTS AND BENEFITS

In this section, I will explore and discuss the empirical results of how the firms' characteristics are linked with expected and actual costs and benefits. The section

is divided into two sub-sections: the first provides an overview of the descriptive statistics of firms' characteristics while the second provides the results between firms' characteristics, with particular emphasis on government support, expected and actual costs and benefits.

5.4.1 OVERVIEW OF FIRMS' CHARACTERISTICS: DESCRIPTIVE STATISTICS

Before presenting the results of hypothesis testing, key descriptive statistics are presented to give an overview of the data structure with respect to measures of central tendency and dispersion for the firms' characteristics indices (Table 5.5).

Table 5.5 – Descriptive statistics for firms' characteristics

INDEX	SCALE		MEAN	STANDARD DEVIATION	MIN	MAX
Level of food chain integration	1	4	1.60	0.74	1	4
Size of firms	1.5	16	8.52	2.92	2	14
Level of complexity of operation	2	12	5.63	2.12	2	11
Level of customer requirements	2	23	7.98	2.95	3	15
Level of QMS certification	0	9	2.07	1.23	0	5

The descriptive statistics shown that the sample frame has the following characteristics. The mean and standard deviation show that firms are widely distributed in terms of size and level of complexity operation. On the other hand, firms have generally a low level of food chain integration, basically 1 or 2 stages, and low level of QMS certification, which the mean is around 2 certifications and the maximum is 5 out of 9. Finally, the level of customer structure is widely distributed (S.D. 2.95), but the mean (7.98) and the maximum value (15) show that the level of customer structure is well distributed, but at a low level.

5.4.2 RESULTS

In this section, I will discuss the results in two sub-sections. First, I will interpret the linkages of firms' characteristics - level of food chain integration, size of firm, level of complexity operations, level of customer structures and level of QMS certification – and expected and actual costs and benefits. Second, I will interpret in-depth the relationships among government support and expected and actual costs and benefits and discrepancies between actual and expected performance indicators.

5.4.2.1 The firms' characteristics and costs and benefits

First, I will interpret the results as emerged from correlation analysis among the firms' characteristics – level of food chain integration, size of firm, level of complexity operation, level of customer structures and requirements and level of QMS certification - and the expected and actual costs and benefits as shown in tables 5.6 a) and b).

First, none of the firms' characteristics are significantly linked with implementation and operating costs: the correlations coefficient present very low values [min (r) = -0.178; max (r) = 0.178]. This means, that most likely, firms' characteristics do not affect implementation and operation costs in a system across the characteristic ranges presented here.

Second, I discuss how the firms' characteristics affect the expected and actual benefits as follows. The size of firm is medium correlated with expected (r = - 0.249) and actual (r = - 0.246) benefits. This means that if the size of firms raise the benefits due to traceability the system will decrease. The level of QMS certification is medium correlated with the expected benefits (r = 0.261). This means, that with a high level of QMS certification firms were expected to have high overall benefits. In addition, none of the other firms' characteristics – level of food chain integration, level of complexity operation and level of customers' structures and requirements – is linked with benefits.

Third, the percentage cost of traceability is weakly correlated with firms' characteristics: the values go from a minimum of (r = - 0.108) to a maximum of (r

= 0.152). Therefore, the firms' characteristics do not influence the percentage of traceability costs.

Table 5.6 a) – Correlation coefficients among firms' characteristics, costs and benefits

	LEVEL OF FOOD CHAIN INTEGRATION		SIZE OF FIRM		LEVEL OF COMPLEXITY OPERATION	
	Correlation coeff.	**Sig. (2-tailed)**	**Correlation coeff.**	**Sig. (2-tailed)**	**Correlation coeff.**	**Sig. (2-tailed)**
Expected impl. costs	-0.105	*0.426*	-0.100	*0.448*	0.124	*0.345*
Actual impl. costs	0.054	*0.687*	-0.018	*0.895*	0.069	*0.608*
Discrepancy impl. costs	0.134	*0.320*	0.021	*0.879*	0.016	*0.904*
Expected oper. costs	-0.005	*0.972*	-0.035	*0.790*	-0.129	*0.329*
Actual oper. costs	0.048	*0.726*	-0.045	*0.741*	0.065	*0.634*
Discrepancy oper. costs	0.058	*0.671*	-0.017	*0.903*	0.178	*0.189*
Expected benefits	-0.115	*0.386*	**-0.249***	*0.057*	-0.067	*0.616*
Actual benefits	-0.127	*0.346*	**-0.246***	*0.065*	-0.021	*0.877*
Discrepancy benefits	0.023	*0.867*	-0.008	*0.951*	0.045	*0.738*
Percentage (%) cost	-0.036	*0.810*	-0.026	*0.860*	0.068	0.647

*Correlation is significant at the 10% level (2-tailed).

Table 5.6 b) – Correlation coefficients among firms' characteristics, costs and benefits

	LEVEL OF CUSTOMER STRUCTURES AND REQUIREMENTS		LEVEL OF QMS CERTIFICATION	
	Correlation coeff.	Sig. (2-tailed)	Correlation coeff.	Sig. (2-tailed)
Expected impl. costs	-0.178	*0.173*	0.165	*0.207*
Actual impl. costs	-0.162	*0.228*	0.124	*0.358*
Discrepancy impl. costs	-0.030	*0.827*	0.008	*0.955*
Expected oper. costs	-0.177	*0.180*	0.011	*0.933*
Actual oper. costs	-0.176	*0.193*	0.090	*0.510*
Discrepancy oper. costs	0.056	*0.682*	0.062	*0.648*
Expected benefits	-0.161	*0.223*	**0.261***	*0.046*
Actual benefits	0.001	*0.994*	0.147	*0.275*
Discrepancy benefits	0.187	*0.164*	-0.129	*0.338*
Percentage (%) cost	-0.108	*0.446*	0.152	*0.303*

* Correlation is significant at the 5% level (2-tailed).

5.4.2.2 The effect of government support on level of traceability and expected, actual costs and benefits

Now, I will discuss the results which emerge from the impact of government support on level of traceability, expected and actual costs and benefits. Only the 15% of the ichthyic processors interviewed (9/60) had received some form of government support for the implementation of traceability system.

To interpret the results, I divided the sample into two groups:

- ✓ group A: firms which have not received the government support (51/60);
- ✓ group B: firms which have received the government support (9/60).

The first analysis regards the firms which have received government support (B): I measured the levels of utility[60] of government support (table 5.7).

From the analysis emerge two main outcomes. First, governments mainly support the firms in the areas of equipment/software, certification/audit and technical assistance of traceability implementation. Second, with the exception of the legal

[60] The level of utility is measured by Likert Scale. The values going from 1 (Very low utility) to 5 (Very high utility).

assistance, all the others areas were generally rated positive with respect to utility from the firm's perspectives: almost all values were equal to three or higher out of five point Likert scale.

Table 5.7 – The utility of government involvement

FIRM	UTILITY*					
	EQUIPMENT/ SOFTWARE	CERTIFICATION/ AUDIT	TECHNICAL ASSISTANCE	LEGAL ASSISTANCE	OTHER	MEAN UTILITY
1	4	4	4	/	/	**4**
2	3	5	2	/	/	**3.3**
3	5	/	/	/	/	**5**
4	5	3	3	1	5	**3.4**
5	/	/	/	/	3	**3**
6	3	2	2	1	/	**2**
7	/	5	5	/	/	**5**
8	4	3	3	1	/	**2.8**
9	/	5	/	/	/	**5**
Mean	**4.00**	**3.86**	**3.17**	**1.00**	**4.00**	**3.17**

*The range of utility goes from 1 (very low utility) to 5 (very high utility).

The second analysis regards the descriptive statistics of costs and benefits shared for groups A and B (Tab. 5.8) from which emerge some outcomes.

First, the expected and actual costs and benefits are higher for firms which had received government support than for firms that had not. Moreover, the values of standard deviation for both implementation and operation costs are higher for firms A than firms B. This means, that the values of the costs are more spread for firms A than firms B.

Second, the percentage traceability costs are lower for firms A (mean = 1.46) than firms B (mean = 1.75).

Third, the firms A show a negative discrepancy in implementation costs (mean = -0.4) that means that expected implementation costs were higher than actual ones. On the other hand, firms B display positive discrepancy in operation costs that

means that actual operation costs were higher than expected. Fourth, both groups of firms (A and B) present a negative discrepancy in benefits, which was larger for firms B than firms A. This means that firms A and B were expected larger benefits than actual ones, and firms B more than A.

Table 5.8 – Descriptive statistics of costs and benefits for firms which have not received government support (A) and which have received government support (B).

INDEX	A) No government support		B) Government support	
	MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION
Expected impl. cost	5.77	2.01	6.11	1.69
Actual impl. cost	5.30	2.71	6.11	1.69
Discrepancy impl. cost	**-0.47**	2.46	**0.00**	1.41
Expected oper. cost	4.92	2.19	5.89	1.69
Actual oper. cost	5.02	2.54	6.33	1.50
Discrepancy oper. cost	**0.10**	1.61	**0.44**	2.24
Expected benefits	6.59	1.95	7.2	2.11
Actual benefits	6.31	2.11	6.56	1.88
Discrepancy benefits	**-0.28**	1.62	**-0.67**	2.55
% traceability cost*	1.46	1.06	1.75	1.44

* Two observations have been deleted, because were outlines (12,5% and 30%).

Plus, in summary: Firms B were overly optimistic, underestimated costs and overestimated benefits more extensively than did firms A. The biggest difference in discrepancy between groups A and B is implementation cost. Although government support reduced uncertainty about implementation cost, because large

parts of it were covered by the support, expected cost is clearly higher than for group A, whose members had, in addition, smaller costs than expected.
The third analysis regards the descriptive statistics of the level of traceability for groups A) and B) (Table 5.9).

Table 5.9 – Descriptive statistics of level of traceability for firms which have not received government support (A) and which have received government support (B).

INDEX	A) NO government support		B) Government Support	
	MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION
Breadth	12.510	4.1201	15.333	4.7434
Precision	6.137	1.8657	7.111	1.0541
Depth	0.840	0.9337	1.333	0.8660

In line with the reported differences in implementation and operating costs, breadth, precision and depth of traceability are significantly higher for firms which had received government support than for firms that had not.

To sum up, I can extract the following outcomes to reply to the second research question. First, none of the firms' characteristics – except for government support – influence the operation, maintenance and percentage costs.
Second, only the size of firms and the level of QMS certification are moderately correlated with benefits. In particular, the size of firms is moderately negatively correlated with expected and actual benefits while the level of QMS certification is moderately positively correlated with expected benefits. Third, basically government support for the traceability system implementation in the areas of equipment/software, certification/audit and technical assistance with utility satisfy the firms. Fourth, the government support is linked with higher costs of traceability, but also higher benefits than firms which do not receive any support. Fifth, regarding the discrepancy between expected and actual implementation costs, the government support does not have any effect while the firms without the

government support show an important reduction from the expectations to the actual outcomes. Sixth, the firms that have received government support have higher actual operating costs, than expected. Seven, the firms that have received the support had expected higher benefits than other firms, but the actual outcome does not show any particular differences. Eighth, the percentage cost of traceability is higher for firms that have received government support than other firms.

5.5 HYPOTHESIS THREE: THE RELATIONSHIPS BETWEEN FIRMS' CHARACTERISTICS AND THE LEVEL OF TRACEABILITY

In this section, I will explore the empirical results to determine if some firms' characteristics determine the level of traceability.

5.5.1 RESULTS

In this section, I will provide the results in two sub-sections. First, I will interpret the linkages of firms' characteristics and the level of traceability. Second, I will interpret in-depth the aggregate government support and the level of traceability of the firms which have received support.

5.5.1.1 Firm characteristics and the level of traceability

In this section, I will interpret the results which emerged from correlation analysis between the firms' characteristics – level of food chain integration, size of firm, level of complexity operation, level of customer structures and requirements and level of QMS certification - and breadth, precision and depth (Table 5.10).

The main results which emerged as indicated in table 5.10 is that there are not any significant linkages among breadth, precision, depth and the firms' characteristics. This means, that the level of traceability is not determined by any firms' characteristics.

Table 5.10 – Correlation coefficients among firms' characteristics and level of traceability

INDEX	BREADTH		PRECISION		DEPTH	
	Correlation coeff.	Sig. (2-tailed)	Correlation coeff.	Sig. (2-tailed)	Correlation coeff.	Sig. (2-tailed)
Level of food chain integration	-0.051	*0.698*	0.010	*0.938*	0.194	*0.141*
Size of firms	0.196	*0.134*	0.096	*0.465*	0.080	*0.548*
Level of complexity operation	0.018	*0.890*	-0.072	*0.584*	0.027	*0.840*
Level of customer structures and requirements	0.043	*0.746*	0.039	*0.766*	0.032	*0.811*
Level of QMS certification	0.010	*0.937*	0.098	*0.454*	-0.115	*0.384*

5.5.1.2 Government support and level of traceability in detail

Now, I will present the results which emerged by the impact of government support on the level of traceability and aggregate government support (Table 5.11).

The analysis reveals that firms which have received government support present high values of the level of traceability. In fact, 5 out of 9 firms have a maximum level both for precision and depth. In addition, the aggregate government support is not high. Only one (1) firm presents a medium-high level (17/25) while the rest of the firms present a value lower than 12 out of 25 points, while 3 firms show value under 5 out of 25.

To sum up, I can extract the following outcomes to reply to the third research question. First, none of the firms' characteristics – except for government support – has linkages with breadth, depth and precision. Second, government support increases depth and precision of traceability, thus it plays a crucial role in

increasing the level of traceability. Third, firms perceived that government support does not present high levels of aggregate utility.

Table 5.11 – The level of traceability and the aggregate government support

FIRM	BREADTH (min 2 – max 24)	PRECISION (min 2 – max 8)	DEPTH (min 0 – max 2)	AGGREGATE GOVERNMENT SUPPORT (min 1 – max 25)
1	14	8	0	12
2	15	6	2	10
3	16	6	2	5
4	24	8	1	17
5	16	8	0	3
6	19	6	2	8
7	11	8	2	5
8	7	8	2	10
9	16	6	1	11

5.6 SPECIFIC BENEFITS AND COSTS: SELECT DESCRIPTIVE RESULTS

In this section, I will provide some selected descriptive results that emerged from an in-depth investigation of specific costs and benefits of traceability implementation, again comparing expected and actual outcomes, as explained in details in Chapter four (section 4.4). In tables 5.12 and 5.13, I can see that the measures of dispersion (min, max, but in particular S.D. vs. Mean) show a variation of the importance of each specific costs and benefits which is immense. This is because the costs and benefits of traceability are unique to each firm's specific situation or strategy.

5.6.1 SPECIFIC BENEFITS

As shown in table 5.12, I can extract some main outcomes. First, comparing the average value of each specific benefits (mean) the three most important specific benefits are: "Meeting current and anticipated future regulatory requirements",

“Meeting customer's requirements and increasing his trust” and “Increasing consumer trust”. Thus, I can say that the adoption of traceability system is basically due to the request from “external“ stakeholders such as government, authority (e.g. Food safety Agency, etc) and customers than “internal” factors (e.g. improving the firm management) .

Second, when comparing expectations with actual outcomes, the specific benefits which have shown positive surprise are: “Improving management within the company and reducing the possibility of errors for data input and data management”, “Reducing customer complaints, recalls, risk and product liability”, “Meeting customer's requirements and increasing his trust” and “Meeting current and anticipated future regulatory requirements”.

Table 5.12 – The specific benefits: descriptive statistics *ex-ante* and *ex-post* traceability implementation

SPECIFIC BENEFITS	Min	Max	Mean	S.D.
Meeting current and anticipated future regulatory requirements – *Expected*	0	70	21.772	15.9609
Meeting current and anticipated future regulatory requirements – *Actual*	4	70	23.036	16.0703
Increasing consumer trust – *Expected*	0	40	15.667	8.8041
Increasing consumer trust – *Actual*	0	40	14.964	9.7196
Meeting customer's requirements and increasing his trust – *Expected*	0	50	16.175	10.7456
Meeting customer's requirements and increasing his trust – *Actual*	0	50	17.286	9.8474
Increasing market share or accessing new markets and obtain a price premium – *Expected*	0	40	11.123	8.8359
Increasing market share or accessing new markets and obtain a price premium – *Actual*	0	25	8.429	7.7009

Table 5.12 – *Continue* - The specific benefits: descriptive statistics *ex-ante* and *ex-post* traceability implementation

SPECIFIC BENEFITS	Min	Max	Mean	S.D.
Reducing customer complaints, recalls, risk and product liability – *Expected*	0	30	10.684	7.4069
Reducing customer complaints, recalls, risk and product liability – *Actual*	0	30	12.464	8.6213
Improving management within the company and reducing the possibility of errors for data input and data management – *Expected*	0	50	12.912	9.2240
Improving management within the company and reducing the possibility of errors for data input and data management – *Actual*	0	40	14.518	9.5060
Improving supply chain management (inventory, logistics, communication with suppliers and customers) – *Expected*	0	50	11.667	11.1745
Improving supply chain management (inventory, logistics, communication with suppliers and customers) - *Actual*	0	40	11.517	10.6530

Third, when comparing expectations with actual outcomes the specific benefits which have shown negative surprise are: "Increasing consumer trust" and "Increasing market share or accessing new markets and obtain a price premium". Thus, the traceability system does not provide any added value in terms of price premium or increasing the market share.

5.6.2 SPECIFIC COSTS

As stated in Chapter four, I collected data only about specific implementation costs. As shown in table 5.13, when comparing expectations with actual outcomes of specific costs, I can extract some main outcomes.

First, when comparing the average value of each specific costs (mean) the three most important specific costs are: "Purchase new equipment and software", "Production line, supervisory staff and managerial administrative time" and "Certification and audit and external consultants". In particular, the most significant traceability cost is "Purchase new equipment and software".

Table 5.13 – The specific costs: descriptive statistics *ex-ante* and *ex-post* traceability implementation

SPECIFIC COSTS	Min	Max	Mean	S.D.
Purchase new equipment and software – *Expected*	0	90	32.638	21.6898
Purchase new equipment and software – *Actual*	0	70	30.737	20.2145
Certification and audit and external consultants – *Expected*	0	50	18.172	12.8324
Certification and audit and external consultants – *Actual*	0	60	20.140	14.1477
Production line, supervisory staff and managerial administrative time – *Expected*	0	50	21.966	11.7398
Production line, supervisory staff and managerial administrative time – *Actual*	0	70	24.263	13.944
Training course – *Expected*	0	50	13.000	9.5274
Training course – *Actual*	0	30	11.667	8.9310
Material – *Expected*	0	50	12.500	9.8145
Material – *Actual*	0	50	12.754	11.2318

Second, when comparing expectations with actual outcomes the specific costs which have increased their importance (negative surprises) determined from traceability system implementation are: “Production line, supervisory staff and managerial administrative time” and “Certification and audit and external consultants”.

Third, when comparing expectations with actual outcomes the specific costs which have decreased the importance (positive surprise) due to traceability system implementations are: “Purchase new equipment and software” and “Training course”.

5.7 CONCLUSIONS

The purpose of this Chapter was to describe and discuss the results as emerged by testing the three research hypothesis of the thesis. The motivations which lead to each hypothesis and method of analysis have been described. The descriptive statistics of the sample, firms’ characteristics, level of traceability over the results of the three hypotheses and some descriptive statistics of specific benefits and costs have been discussed.

Table 5.14 resumes some of the main important characteristics of the firms interviewed such as their characteristics and level of traceability.

Table 5.15 lists the main results of which relationships were found to be statistically significant, as well as the corresponding hypothesized relationships based on a review of the literature. Looking at table 5.15, the five most significant findings are explained as follows.

First, the level of precision is closely linked with overall benefits while it is not linked with the cost of traceability. The positive linkage with overall benefits is in line with expectations mentioned in Chapter four: as level of precision increase the overall benefits increase. On the other hand, the level of precision is not linked with traceability cost. This is a surprise, because as stated in Chapter four, increasing the level of precision should be increased cost (e.g. cost of data collection). The reasons for such deviation could be many: for instance, perhaps the system of lot/batch is very simple (e.g. one lot/batch per day at input stage of raw material and two lots/batches of end products delivery at output stage). Thus,

perhaps the level of customer structures and requirements is very low. Another reason may be that firms have low level of complexity operations (e.g. a few types of raw material and a few types of final products) which does not require a complicated traceability system.

Table 5.14 – Descriptive statistics of the sample, firms' characteristics and level of traceability: some results

OUTCOMES
✓ Nearly 50% of the firms have an annual revenue over 10 Million Euros
✓ Nearly half (28/60) of the firms interviewed operate at more than one stage of the supply chain
✓ Generally firms show low level of food chain integration (1 or 2 stages)
✓ Nearly 90% of the firms (53 out of 60) have been HACCP certified
✓ 42% of firms adopt ISO 9000:2000 certification
✓ 7/60 firms adopt traceability certification
✓ On average firms show low level of QMS certification (2 certifications on average)
✓ Firms are wide distributed in terms of size, level of customer structure and level of complexity operation
✓ 57% of the firms are located in the North of Italy
✓ 15% of firms have received government support
✓ Firms show a considerable variation in terms of level of traceability
✓ On average, firms overestimated prior to implementation the expected implementation costs and overall benefits

Thus, it is possible to increase the level of precision without increasing the cost significantly (e.g. traceability software high level complicated which is costly).
Second, government support appears to increase the level of traceability and overall benefits as hypothesized in Chapter four, but it also raises costs (e.g. actual and percentage cost).

Table 5.15 –Significant results from models I, II, III and IV

MODEL	HYPOTHESIS	RELATIONSHIPS	HYPOTHESIEZED RELATIONSHIPS	ESTIMATED RELATIONSHIPS
I,II	2	Size of firm – Expected benefits	No literature	(-)*
I,II	2	Level of QMS certification – Expected benefits	(+)	(+)**
IV	2	Size of firm – Actual benefits	No literature	(-)**
III	3	Government support - Depth	(+)	(+)
III	3	Government support - Precision	(+)	(+)
I, III	1	Breadth – Actual implementation costs	(+)	(+)**
I, III	1	Breadth – Actual operation costs	(+)	(+)***
I	1	Precision – Expected benefits	(+)	(+)**
I, III	1	Precision – Actual benefits	(+)	(+)***

*, **, *** Correlation is significant at the 10%, 5% and 1% level respectively (2-tailed).

The raising of traceability cost is not in line with expectations. As stated in Chapter four, the cost of traceability should decrease with government support because government covers, at least, a part of traceability cost (e.g. certification/audit costs). It is difficult to find a reason for this finding, but perhaps when firms design the plan and budget of traceability system implementation, they estimate a larger project considering that government support, but at the end

government does not cover all the cost estimate. For this reason, the cost of traceability will be higher.

Third, none of the firms' characteristics - except government support – influence traceability costs and level of traceability. This is a surprise, because as mentioned in Chapter four, the other firms' characteristics should affect cost and level of traceability. For instance, regarding the costs traceability just accumulates information about the products and processes as the product moves through its supply chain (Resende - Filho *et al.,* 2008:19). This may facilitate the implementation of traceability system and may reduce its cost, that in part is due to data collection and recording. Thus an higher level of QMS certification should be to reduce the cost. Perhaps as shown in table 5.14 the level of QMS certification is low; therefore, it does not significantly affect traceability costs.

Fourth, the size of firms and the level of QMS certification influence benefits. In particular, the size of firms is negatively correlated with expected and actual benefits. There is no literature which states that. On the other hand, the level of QMS certification is positively correlated with expected benefits. This finding is in line with literature review and hypothesis provided in Chapter four.

Fifth, in terms of specific benefits, it appears that the adoption of a traceability system is basically due to the request from "external" stakeholders such as government, authority (e.g. Food safety Agency, etc) and customers than "internal" factors (e.g. improving the firm management). In particular, the traceability system in itself only provides little perceived benefit in terms of a price premium or increased market share. This finding is in line with expectations as stated in literature review and case study analysis presented in Chapter two.

Chapter six, will resume the summarized results and in addition, the limitation of the thesis over implications and recommendations for academic, industry and policy makers will be discussed.

CHAPTER SIX

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

6.0 INTRODUCTION

This thesis assesses the business value of traceability practices in the Italian ichthyic processing industry through the analysis of the linkages between firms' characteristics, costs, benefits and levels of traceability. The empirical models were developed to explore and measure the factors that impact the performances of actual costs and benefits. This required group variables to be placed into the categories "firms' characteristics", "level of traceability", "expected costs", "expected benefits", "actual costs" and "actual benefits" of traceability.

This concluding Chapter presents a review of the main results and how they relate to the objectives stated at the beginning of the study. A discussion of how representative the sample is of the Italian ichthyic processing industry will be provided. The limitations of this research are also discussed. Recommendations are then made to processing plants dealing with traceability implementation and operation, policy makers working on traceability programs supporting traceability development and for researchers studying traceability. Finally, suggestions are provided for further research related to traceability practices, performance or business value.

6.1 RESULTS SUMMARY

As stated in Chapter one, the overall goal of this thesis is to establish an assessment of the factors, such as firms' characteristics, level of traceability and expected costs and benefits, which impact on actual costs and benefits as resulting from implementing traceability practices in the Italian ichthyic processing industry.

Chapter five presents the results which emerged from empirical analysis of testing the three hypotheses, presented in Chapter one which are based on data from the Italian ichthyic processing industries survey undertaken by the Department of Agricultural Economics and Engineering at the University of Bologna during 2008. In particular, Chapter five contains the results of the relationships between level of traceability, expected and actual costs and benefits; the relationships between firms' characteristics, expected and actual costs and benefits, with particular emphasis on the role of government support; and finally, the relationships between firms' characteristics and the level of traceability. The three hypotheses developed in Chapter four were composed of four models, which link different factors – firms' characteristics, level of traceability, expected costs and benefits and actual costs and benefits. In my perspective the most important findings of the analysis are following explained.

First, the level of precision is closely linked with overall benefits while is not linked with cost of traceability.

Second, government support appears to increase the level of traceability and overall benefits as hypothesized in Chapter four, but it also raises costs (e.g. actual and percentage cost).

Third, none of the firms' characteristics - except government support – influence traceability costs and level of traceability.

Fourth, the size of firms and the level of QMS certification influence benefits. In particular, the size of firms is negatively correlated with expected and actual benefits while the level of QMS certification is strongly positive linked with benefits.

Fifth, in terms of specific benefits, it appears that the adoption of a traceability system is basically due to the request from "external" stakeholders such as government, authority (e.g. Food safety Agency, etc) and customers than "internal" factors (e.g. improving the firm management). In particular, the traceability system in itself only provides little perceived benefit in terms of a price premium or increased market share.

6.2 REPRESENTATION OF THE SAMPLE

In order to investigate if the sample is representative of the overall Italian ichthyic processing industries, unfortunately there are not strong official statistics that could help to verify if the sample is representative or not.

As mentioned in the previous chapters, the choice of firms to be interviewed was random. However, as regards to the size of the sample, my opinion is that the typical revenue of the sample (> 10 Millions of Euros) is, on average, higher than typical revenue of the entire population of industry. This is basically due to two motivations. First, is why almost all the firms which have declined to participate to the survey were very small firms: they told me that they are small with only two or three employees – typical of small fishery and processing. Second, in terms of geographical location, 34/60 (56.7%) firms interviewed are located in the North of Italy. According to Ismea (2001), the statistics information shows that the main part of ichthyic processing industry is located in the Centre, Islands and South of Italy (76.4%). As a result, in the North of Italy there are 98 ichthyic processing operations. Therefore, the sample is representative of the 34.7% of the firms located in the North of Italy. Firms located in the North of Italy are larger in terms of size than firms located in the Centre and South of Italy (Parisi, *et. al*, 2007). Bigger size firms are in general more sophisticated and advanced in terms of technological skills, management, knowledge, etc.

Finally, in my opinion on average the sample is representative of large, high structured and more sophisticated ichthyic processing industry located in the North of Italy.

6.3 LIMITATIONS

This thesis presents some major limitations. The first relates to the fact that research on motivations for and impacts of traceability practices are still in their infancy and there is no empirical analysis which can serve as a benchmark for this study. However, researchers, industry managers and policy makers would benefit from further research.

The second limitation is that it is impossible to measure with an unique index, which includes breadth, depth and precision, the level of traceability. This is

because is quite difficult to combine in one equation such dimensions of the level of traceability. No literature at all informs us about that. Furthermore it is also complicated to assess an unique level of traceability for firms, because perhaps each firm adopts various levels of traceability depending on types of raw materials, types of customers, etc.

The third limitation is that it might be difficult to measure the expected and actual costs and benefits. Assessing today the perception of the expectation of costs and benefits, prior to the traceability system implementation is quite difficult, especially if a lot of time (e.g. three years) has passed. In addition, there are cases when the respondent had not been involved in the implementation of the traceability system. Moreover, some information confidential. However, because there is no previous research on the value of traceability practices, there is opportunity to develop a common practice to assess business value of traceability. The fact that this proxy is estimated with a five point Likert scale is another limitation due to the subjective perception of benefits and costs that may differ between managers. In addition, costs and benefits values are based on perceptions of the interviewer and not full reality. Various authors stated that while it is not too difficult to measure the potential costs, it may be difficult to measure potential benefits due to traceability practices (i.e. possible price premium). However, past research results have demonstrated that there is a correlation between managers' perceptions of firms' performances and traditional objective measures (Venkatraman, 1987 in Tallon, 2004; Jarvenpaa, 1991). This indicates that using perceived values instead of real values is a limitation, but not a restriction to such research.

The fourth limitation is that this study focused on the ichthyic processing industry and the results cannot necessarily be generalized for the entire food processing industry. This is largely because the ichthyic processing industry has a different supply chain structure in comparison to other food supply chains. For instance, a significant part of the ichthyic processing industry does not deliver the end products to the chains, but they deliver to other customers (e.g. small markets or shops) which may not require traceability system. On the other hand, for other food supply chains maybe the role played of the chains is more important to the

traceability practices. Therefore, the results and recommendations presented in this research apply only to the food processing industry which presents similarities to the ichthyic processing industry.

The fifth limitation is budget limits restrict the extent of the size of the sample. A larger number of firms interviewed could give more validity and provide more valuable data.

6.4 IMPLICATIONS FOR RESEARCH, MANAGEMENT AND REGULATION

In this section, considering specific objectives mentioned in Chapter one, I will provide some useful implications for academic research, industry and government.

6.4.1 IMPLICATIONS FOR ECONOMIC RESEARCH

The development of traceability has led to a need for better understanding of the factors that impact its business value as perceived by industry managers. According to Meuwissen *et.al.,* (2003), most studies on traceability have focused on the technical characteristics of tracing showing a lack of economic and business considerations. The findings of this research represent a contribution to the economics and business of traceability research literature. The continuing development of traceability, whether it is motivated by regulation, food safety practices, market development and/or supply chain practices, will continue to require analysis of its performance or business value. The food industry is moving toward both increased food safety practices and more technologically complex supply chain management practices that require better support from more efficient systems. These factors increase the need for more efficient traceability, which in turn requires ongoing research and development. Furthermore, traceability is often seen as an imposition that requires investment, but it does not contribute to profits or competitiveness (Verdenius, 2006).

The results of this study shed some light on the costs and benefits associated that affect the performance or perceived costs and benefits of traceability. In particular, one finding shows that firms which have received government support have increased discrepancy between expected and actual benefits. An implication

could be that if governments offer a support to each firm discrepancy may increase.

Furthermore, it would be difficult to establish unique or heterogeneity traceability levels and benefits for each individual firm. The consequences is that there is no simple measurement in one grand index of traceability levels and outcomes.

6.4.2 IMPLICATIONS FOR ICHTHYIC INDUSTRY MANAGEMENT

The findings of this thesis has important implications for ichthyic processing industry that have implemented or will implement traceability as explain in the following:

First, as mentioned before, firms which have received government support increase the level of traceability more than firms which have not received support. Thus, it is recommended that firms which would like to increase the level of traceability apply for government subsidies.

Second, larger firms will obtain lower benefits by traceability implementation. This result is important because firms which would like to implement a traceability system have to take into consideration when they will decide the strategic plan that the traceability benefits will decrease by increasing the size of the firm.

Third, precision is the dimension of the level of traceability which determines higher benefits without impacting costs. Therefore, it is recommended for firms which intend to implement a traceability system, to invest in precision of traceability than breadth and/or depth.

Fourth, it appears that the adoption of a traceability system is basically due to the request from "external" stakeholders such as government and customers than "internal" factors (e.g. improving the firm management) while the traceability system does not provide any added value such as price premium or the market share increase.

6.4.3 IMPLICATIONS FOR REGULATION AND POLICY MAKERS

This research also has implications for policy makers due to the fact that traceability is a relatively new practice and its regulations and supporting

programs are still emerging. The policy implications of this research are described as follows.

First, as mentioned before, government support increases the level of traceability. This outcome is very important and effective because the government, would like to increase food safety and provide more information at the consumer level about food and also increase the level of traceability. This finding recommends to governments that they subsidize the firms into traceability implementation to increase the level of traceability.

Second, the findings show that firms which have received support have higher costs of traceability than firms which have not received support. This is also confirmed by a higher percentage cost. This suggests that policy makers should assess carefully the impact of their supports on the business performances of firms. As a consequence, it will be necessary to conduct in-depth investigations to understand the reasons for such increasing of costs.

Third, the findings suggest that government support raises the benefits of traceability perceived by firms, but as mentioned above also increase costs. Thus, the net benefits perceived by firms is uncertain. At this regard, further investigations will be needed to establish a more clear assessment of the role played by government support into business performance of the firms.

Finally, I can suggest to policy makers that government involvement shows a clear effect on increasing the level of traceability and then increases the food safety and public health. On the other hand, further investigations are needed to establish more clearly and in-depth, the effect of government support on perceived business performances of firms, and in particular why the costs of traceability perceived have increased.

Public programs that would improve food safety traceability through the improvement of the level of traceability will benefit supporting traceability programs. Traceability can reduce the probability of a problem, as well as the severity of the consequences. Governments have an interest in supporting high performing traceability systems which can improve competitiveness of food safety. Both the economic and public health benefits to society provide incentives

for governments to be involved in improving traceability performance in the food industry.

6.5 RECOMMENDATIONS FOR FURTHER RESEARCH

Previous research on traceability has focused mainly on the technical characteristics of tracing and not economic considerations (Meuwissen *et al*., 2003). This study contributes to the literature by assessing the costs and benefits perceived of traceability. The following is recommended for further research.

First, it would be interesting to identify in-depth which specific costs and benefits are affected by the implementation of a traceability system. Each specific cost and benefit should be analyzed further and in-depth to determine their respective importance on costs and benefits. In particular, it may be meaningful to investigate in-depth which of the specific costs leads to the actual and discrepancy on implementation costs and percentage cost. Furthermore, it may be interesting to conduct an in-depth investigation to discover which of the specific benefits are determined by increasing precision. Furthermore, this may be useful information for firms that are in the process of traceability implementation. For instance, they may be more interested in increasing some specific benefits than others.

Second, as stated earlier, it would be necessary to conduct an in-depth investigation for a more clear costs and benefits assessment for firms which have received government support, and in particular to understand why the costs increase.

Third, other interesting research would be to understand in-depth the reasons which lead to the not very high benefits perceived by firms of government support and how government support determine higher traceability costs.

In addition, some interesting research questions regarding the impact that government funding for traceability implementation has determined among a firm in the market.

Finally, this study could be replicated in other food processing industries. This would allow comparable results about traceability performance across food processing industries to be generated. The differences in traceability performance between supply management and free market industries could then be further

assessed. Extension of this research to other food processing sectors would allow a better understanding of the performance of traceability which characterize the food processing industry as a whole.

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ANNEX ONE- QUESTIONNAIR

QUESTIONNAIRE

University of Bologna

Faculty of Agricultural

Department of Agricultural Economics and Engineering

Traceability System in the Italian Fishery Supply Chain

The Department of Agricultural Economics and Engineering at the University of Bologna is currently undertaking a study of traceability systems in the Italian ichthyic supply chain. The aim of this study is to assess the value of the traceability system practices adopted by ichthyic slaughtering, processing, shellfish harvesting centers, filtering plants and marketing companies across Italy as well as investigating the role of the government in traceability implementation and *ex-ante* and *ex-post* cost/benefits analysis.

As a part of this study a postal, e-mail, fax, phone and personal survey is being undertaken of all the above mentioned companies in Italy. The success of the study depends on the willingness of respondents such as you to participate and we sincerely hope you can find time to answer the questions in the survey. Below are a few basic instructions which will help you to complete the questionnaire:

- please answer all the questions as best you can. An approximate answer is better than no answer at all
- there are no right or wrong answers. Firms operate under different conditions and may respond in their own particular ways to similar circumstances. The aim of this survey is to understand better these differences
- most questions only require single word answers or a check in a box
- please feel free to write on the questionnaire to provide additional information or clarification
- please, feel free to choose your more comfortable way for you to return the questionnaire

  You could choose one of the followings options:

  → E-mail: daniele.asioli2@unibo.it

  → Fax: +39 05 12 09 61 05 attention: Daniele Asioli

  → Mail/postal: Attention to Daniele Asioli

  Department of Agricultural Economics and Engineering

Faculty of Agricultural
University of Bologna
40127 Bologna
Via Fanin, 50
3° Floor East

This research is being undertaken in accordance with ethical procedures of the University of Bologna. All the responses to the survey will remain confidential to the study team at the University of Bologna. To ensure anonymity your company's name and address will not be disclosed.

We would like to thank you for your valuable contribution to this study.

CONTACT INFORMATION

- Data (gg/mm/aa):_____
- Name of the company:_____
- Address:_____
- Interviewer:
  - → Name and surname:_____
  - → E-mail address:_____
  - → Phone number:_____
  - → Fax number:_____

UNIVERSITY CONTACTS

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GENERAL COMPANY INFORMATION

1. Location (*Please indicate the Region*):_____
2. Interviewer's position:_____
3. At which level (s) of the supply chain does your company operate? (*Please check all that apply*).

Primary producer – wild fish	□	Wholesaler – Import/export	□
Primary producer – farmed fish	□	Transport	□
Processor	□	Retailer	□

4. How many people did your company employ in 2007, including yourself? (*Please, check as appropriate for full, part time and seasonal employees)*.

N° EMPLOYEES	FULL TIME	PART TIME	SEASONAL
Less than 10			
11 – 25			
26 – 50			
More than 50			

5. At which level (s) of the processing/conservation of ichthyic products does your company produce? (*Please check all that apply*)

Fresh	□
Frozen	□
Deep frozen	□
Preserved and semi-preserved	□
Dry, salt and smoked	□
Other (*Please specify*):_____	□

6. Which types of ichthyic products does your company produce? (*Please check all that apply*)

Seafood	□
Freshwater	□

Shellfish	□
Crustaceous	□
Other (*Please specify*):_____	□

7. Which types of sources and ichthyic product do you process in your company?

Wild	□
Farmed	□
Both	□

8. What was the total revenue of the plant in the last fiscal year (2007) ? (*Please check one*)

Less than € 250,000	□	€ 250,001 - € 500,000	□
€ 500,001 - € 1,000,000	□	€ 1,000,001 - € 2,500,000	□
€ 2,500 001 – 5,000,000	□	€ 5,000,001 - € 10,000,000	□
€ 10,000 001 - € 25,000,000	□	More than € 25,000,000	□

YOUR SUPPLIERS AND CUSTOMERS

9. Where are your sources of raw material located? (*Please check all that apply*).

Italy	□	South America	□
EU Member State	□	Africa	□
Other European Countries (No EU Members)	□	Asia	□
North America	□	Others (*Please Specify*):_____	□

10. Where are your products sold? (*Please check all that apply*).

Italy	□	South America	□
EU Member State	□	Africa	□
Other European Countries (No EU	□	Asia	□

Members)

North America □ Others (*Please Specify*):_____ □

11. In which of the following ways are your products sold? (*Please check all that apply).*

Sold under the company's brand name to the final consumer □

Sold under licensing agreement for another brand name □

Sold to buyer without any direct brand name involvement in contract □

12. Which are your customers? (*Please check all that apply).*

Retail chains (*Please specify the kinds of chains here below*)	
International/national chains (e.g. Carrefour, Coop)	□
Regional or local chains	□
Local fishery shops	□
Pitchmen	□
Wholesalers	□
Wholesale markets	□
Food service chains (e.g. McDonald)	□
Other Food service operators	□
Direct to the final consumer	□
Other processors	□
Institutions (e.g. Hospital, Universities, etc.)	□
Other (*Specify*):_____	□

FOOD QUALITY AND SAFETY SYSTEMS

13. Which of the following Quality Management Systems do you have implemented? (*Please check all that apply*).

ISO 9001:2000 - Quality Management System □

ISO 22000:2005 - Food Safety Management System □

ISO 22005:2007 - Traceability in the feed and food chain □

HACCP - Hazard Analysis Critical Control Points □

MSC - Marine Stewardship Council □

ISO 14001 – Environmental □

IFS - International Food Standard □

BRC – British Retail Consortium □

EUREPGAP – Euro Retailer Produce Working Group □

Others (*Specify*):_____ □

TRACEABILITY SYSTEM – GENERAL INFORMATION

The survey now turns to questions about traceability systems. According to ISO 8402, traceability is defined as the ability to trace the history, application or location of an entity by means of recorded information from input selling to the final consumer.

14. What information is recorded for an individual input batch/lot? And which of these are regularly linked with an output unit? (*Please check all that apply*)

	Recorded	Linked with output
Supplier details (e.g. address, etc.)	□	□
Data and hour of product arrival	□	□
Date of harvest	□	□
Location (area) of harvest/farming	□	□
Water quality classification (e.g. type A, B or C)	□	□
Method of production (Farmed or harvested)	□	□
Scientific name of the species	□	□
Common name of the species	□	□
Quantity	□	□
Quality grading	□	□
Other (Please specify):_____	□	□
Other (Please specify):_____	□	□

15. What are the smallest units that your company can trace at the input and output levels?

Input		**Output**	
Two or more days of production	□	Two or more days of production	□
One day production	□	One day production	□
Input from individual supplier	□	Output for individual buyer	□
Multiple batches from one supplier	□	Multiple batches for one buyer	□

Individual batches received □ Individual batches delivered □

16. Besides your own company, who else has access to your traceability data, regularly or in times of crisis?

	REGULARLY	CRISIS
Suppliers	□	□
Customers	□	□
Consumers or Consumer Groups	□	□
Food inspection agencies	□	□
Other government agencies	□	□
Other (*Please specify*):_____	□	□
Other (*Please specify*):_____	□	□

17. The legal requirement is to be able to trace a product to the direct supplier of an input. Are you able to trace your inputs beyond the direct suppliers of inputs?

Yes ☐ No ☐

18. A further legal requirement is to be able to trace a product to the direct buyer of an output. Are you able to trace your outputs beyond the direct buyers of outputs?

Yes ☐ No ☐

19. Do you undertake periodic tests or simulations to assess the effectiveness of your traceability system?

Yes ☐ No ☐ (Proceed to question 21)

20. If yes, how frequently do you undertake such tests within one year? ____times/year

21. Is your data documentation certified by one or more of the following kinds of traceability certifications?

Yes □ If yes, which certification/s do you have?

Certification UNI 11020 (Internal traceability) □

Certification UNI 10939 (Chain traceability) □

ISO 22005:2007 (Traceability in the feed and food chain) □

Other (*Please specify*):_____ □

No □

22. Has a government (EU, National, Regional, Provincial or Municipality) or a government agency been or is involved in supporting the implementation of the traceability system?

Yes ☐ *(Proceed to question 23)* No ☐ (*Proceed to question 26)*

23. Has your company received financial support from any of these government levels? (*Please, check all that apply*).

National □ Provincial □ EU □

Regional □ Municipality □

24. For those areas for which you have received financial or other support from government or a government agency, please rate how useful you found this support. Please check the category that best matches your assessment on a scale from 1 (not useful at all) to 5 (very useful).

	Not useful at all (1)				Very useful (5)
Equipment/Hardware	□	□	□	□	□
Technical Assistance	□	□	□	□	□
Legal Assistance	□	□	□	□	□
Other (Please specify):_____	□	□	□	□	□

TRACEABILITY SYSTEM – OVERALL COSTS AND BENEFITS

The following questions deal with the costs and benefits of traceability systems, differentiating between expectations and actual outcomes. As a start, we would like to ask

you to assess the overall benefits and costs of implementing and operating/maintaining the traceability system in your company.

25. A) Please indicate, on a scale from 1 (very low costs) to 9 (extremely high costs) the expected costs (before implementation) and the actual costs of implementing and operating/maintaining the traceability system.

TYPE OF COST	EXPECTED	ACTUAL
Implementation		
Operating/Maintenance		

B) Please indicate, on a scale from 1 (no benefit at all) to 9 (extremely great/important benefit) the expected (before implementation) and the actual benefits of the traceability system.

	EXPECTED	ACTUAL
Overall benefits		

26. If at all possible, please indicate the percentage (%) share of the overall traceability cost (implementation and operating/maintenance) in the total unit cost of production. Providing a range, e.g. 1.0%-1.5%, or 4%-5% is sufficient.

TRACEABILITY SYSTEM – SPECIFIC COSTS

Now, we would like to turn to the specific costs of implementing a traceability system.

27. a) Please let's assume that the total expected cost can be set equal to 100 units. How were these 100 units distributed across the categories of specific implementation costs below? For example, if all categories had been expected to have about the same magnitude, each would receive 20 units.

b) Now, please indicate whether the actual costs in each category were smaller or bigger than expected and, if so, to what extent. For example, if costs were as expected, then each category receives the same number of units as under a)

EXPECTED. If, however, they deviate from expectations, indicate how much roughly, for example, 30 instead of 25, or 15 instead of 25. So, the sum of the actual cost units may be bigger or smaller than 100.

IMPLEMENTATION COST	a) EXPECTED (Total adds up to 100)	b) ACTUAL (Total may be more or less than 100)
Purchase new equipment and software		
Certification audit		
Production line, supervisory staff and managerial/administrative time		
Training course		
Material		

TRACEABILITY SYSTEM – SPECIFIC BENEFITS

We would now like to turn to the specific benefits from having implemented and operating a traceability system.

28. a) Please let's assume that the total expected benefits can be set equal to 100 units. How were these 100 units distributed across the various benefit categories below (plus possibly any that you think is important but is not represented by any of the ones listed)?

    b) Now please indicate whether the actual benefits in each category were smaller or bigger than expected and, if so, to what extent. For example, if benefits were as expected, then each category receives the same number of units as under a) EXPECTED. If, however, they deviate from expectations, indicate how much roughly.

BENEFIT CATEGORIES	a) EXPECTED (Total adds up to 100)	b) ACTUAL (Total may be more or less than 100)
Meeting current and anticipating future regulatory requirements		
Increasing consumer trust		
Meeting customers' requirements and increasing their trust		
Increasing market share or accessing new markets and obtaining a price premium		
Reducing customer complaints, recalls and risk of product liability		
Improving management within the company and reducing the possibility of errors for data input and data management		
Improving supply chain management (inventory, logistics, communication with suppliers and customers)		

CLOSING QUESTIONS

29. Are there any further comments you would like to make?

_____

_____

_____

_____

_____

30. Would you like us to send you a summary of the survey results?

Yes □

No □

Many thanks for your valuable contribution to this study. Please now return the questionnaire by:

- **E-mail: daniele.asioli2@unibo.it OR**
- **Fax: 051/2096105 (Attention Daniele Asioli) OR**
- **Postal mail, at the following address:**

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ANNEX TWO- DESCRIPTIVE RESULTS

GENERAL COMPANY INFORMATION

Table 1 – Interviewer position within firm

INTERVIEWER POSITION	FREQUENCY (%)
Quality Manager	27 (45%)
Logistic Manager	1 (1.7%)
Trade Manager	1 (1.7%)
Technical manager	3 (5%)
Employee – General	5 (8.3%)
Secretary	2 (3.3%)
Administrative Manager	3 (5%)
Production Manager	1 (1.7%)
President	7 (11.7%)
Sole director	5 (8.3%)
General Director	2 (3.3%)
Veterinary	2 (3.3%)
Biologist	1 (1.7%)
Overall	**60 (100%)**

Table 2 – Firms' locations in Italy

AREA	FREQUENCY (%)
North	34 (56.7%)
Centre	12 (20%)
South and Islands	14 (23.3%)
Overall	**60 (100.0%)**

Table 3 – Level of food chain integration

NUMBER OF STAGES OCCUPIED BY FIRMS	FREQUENCY (%)
1	32 (53.3%)
2	21 (35%)
3	6 (10%)
4	1 (1.7%)
Overall	**60 (100%)**

Table 4 – Firm position through the food chain

POSITION	FREQUENCY (%)
Primary producers - Wild fish	6 (10%)
Primary producers - Farmed fish	8 (13.3%)
Processor	44 (73.3%)
Wholesale - Import/export	23 (38.3%)
Transport	5 (8.3%)
Retailer	18 (30%)

Table 5 – Employees

TYPES OF EMPLOYEE	LESS THAN 10	11-25	26-50	MORE THAN 50	AGGRAGATE
Full time	10 (16.7%)	23 (38.3%)	17 (28.3%)	10 (16.7%)	60 (100%)
Part time	31 (51.7%)	2 (3.3%)	0 (0%)	0 (0%)	33 (55%)
Seasonal	9 (15%)	5 (8.3%)	2 (3.3%)	1 (1.7%)	17 (28.3%)

Table 6 – Types of product produced by firms

TYPES OF PRODUCT	FREQUENCY
Fresh	32 (53.3%)
Frozen	37 (61.7%)
Deep frozen	24 (40%)
Preserved and semi-preserved	25 (41.7%)
Dry, salt and smoked	23 (38.3%)
Others	5 (8.3%)

Table 7 – Types of raw materials treated by firms

TYPES OF RAW MATERIAL	FREQUENCY (%)
Seafood	54 (90%)
Freshwater	29 (48.3%)
Shellfish	46 (76.7%)
Crustaceous	40 (66.7%)
Others	1 (1.7%)

Table 8 – Revenues

REVENUES	FREQUENCY (%)
Less than € 250,000	0 (0%)
€ 250,001 - € 500,000	0 (0%)
€ 500,001 - € 1,000,000	1 (1.7%)
€ 1,000,001 - € 2,500,000	9 (15%)
€ 2,500,001 - € 5,000,000	13 (21.7%)
€ 5,000,001 - € 10,000,000	8 (13.3%)
€ 10,000,001 - € 25,000,000	12 (20%)
More than € 25,000,000	13 (21.7%)
Missing	4 (6.7%)
Overall	**60 (100%)**

SUPPLIERS AND CUSTOMERS

Table 9– Sources of raw materials: areas of supply

AREA	FREQUENCY (%)
Italy	51 (85%)
EU Member State	47 (78.3%)
Other EU Countries (not EU Member)	20 (38.7%)
North America	22 (36.7%)
South America	32 (53.3%)
Africa	27 (45%)
Asia	33 (55%)
Others	2 (3.3%)

Table 10 – Areas of sale of final products

AREA	FREQUENCY (%)
Italy	60 (100%)
EU Member State	33 (55%)
Other EU Countries (not EU Member)	9 (15%)
North America	6 (10%)
South America	2 (3.3%)
Africa	0 (0%)
Asia	7 (11.7%)
Others	1(1.7%)

Table 11 – Methods of sale of final products

METHODS OF SALE	FREQUENCY (%)
Company's brand name to final consumer	52 (86.7%)
Licensing agreement with other brand name	29 (48.3%)
Buyer without brand name	21 (35%)

Table 12 – Customers

CUSTOMER	FREQUENCY (%)
International/National chain	46 (76.7%)
Regional/local chain	34 (56.7%)
Local fishery shop	36 (60%)
Pitchman	26 (43.3%)
Wholesaler	50 (83.3%)
Wholesale market	20 (33.3%)
Food service chain	21 (35%)
Direct to final consumer	24 (40%)
Other processors	13 (21.7%)
Institutions (e.g. Hospital, Universities, etc)	9 (15%)
Other	6 (10%)

FOOD QUALITY AND SAFETY SYSTEMS

Table 13 – Food quality and safety management systems

FOOD QUALITY AND SAFETY MANAGEMENT SYSTEMS	FREQUENCY (%)
ISO 9001:2000 - Quality Management System	25 (41.7%)
ISO 22000:2005 - Food Safety Management System	5 (88.3%)
HACCP - Hazard Analysis Control Critical Point	53 (88.3%)
MSC - Marine Stewardship Council	1 (1.7%)
ISO 14001 - Environmental	6 (10%)
IFS - International Food Standard	15 (25%)
BRC - British Retail Consortium	13 (21.7%)
GLOBALGAP (ex-EUREPGAP) - Retailer Producer Working Group	0 (0%)
Others	6 (10%)

TRACEABILITY SYSTEM – LEVEL OF TRACEABILITY

Table 14 – Breadth

TYPES OF INFORMATION RECORDED	FREQUENCY (%) at input stage	FREQUENCY (%) at output stage
Supplier details	57 (95%)	24 (40%)
Data and hour of product arrival	51 (85%)	21 (35%)
Data of harvest	29 (48.3%)	14 (23.3%)
Location (area) of harvest/farming	54 (90%)	44 (73.3%)
Water quality classification	19 (31.7%)	12 (20%)
Method of production (Farmed or harvested)	47 (78.3%)	39 (65%)
Scientific name of the species	51 (85%)	43 (71.7%)
Common name of the species	56 (93.3%)	49 (81.7%)
Quantity	55 (91.7%)	36 (60%)
Quality grading	27 (45%)	12 (20%)
Other	15 (25%)	13 (21.7%)
Other	3 (5%)	5 (8.3%)

Table 15 – Precision

TYPES OF INFORMATION RECORDED	FREQUENCY (%) at input stage	FREQUENCY (%) at output stage
Two or more days of production	4 (6.7%)	5 (8.3%)
One day of production	7 (11.7%)	13 (21.7%)
One (1) lot for one (1) supplier	25 (41.7%)	10 (16.7%)
Multiple lots from one (1) supplier	24 (40.0%)	32 (53.3%)

Table 16 – Transparency traceability data

STAKEHOLDER	FREQUENCY (%) – Regular access	FREQUENCY (%) – Access in case of crises
Supplier	12 (20%)	22 (36.7%)
Customer	29 (48.3%)	33 (55%)
Consumer or Consumer Group	9 (15%)	19 (31.7%)
Food Inspection Agency	44 (73.3%)	41 (68.3%)
Other Food Inspection Agency	17 (28.3%)	22 (36.7%)
Other	6 (10%)	7 (11.7%)

Table 17 – Depth

TYPE OF DEPTH	FREQUENCY (%)
Able to trace back more than one stage	27 (45%)
Able to trace forward more than one stage	29 (48.3%)
Missing	1 (1.7%)

Table 18 – Traceability system simulation

TYPES OF FIRM	FREQUENCY (%)
Do not simulate	12 (20%)
Simulate	47 (78.3%)
Missing	1 (1.7%)
Overall	**60 (100%)**

Table 19 – Number of traceability system simulation

NUMBER OF SIMULATION/YEAR	FREQUENCY (%)
0	12 (20%)
1.0	9 (15%)
1.5	1 (1.7%)
2.0	10 (16.7%)
2.5	2 (3.3%)
3.0	3 (5%)
3.5	1 (1.7%)
4.0	3 (5%)
4.5	1 (1.7%)
5.0	1 (1.7%)
6.0	3 (5%)
6.5	1 (1.7%)
7.0	1 (1.7%)
10.0	1 (1.7%)
12.0	4 (6.7%)
24.0	1 (1.7%)
40.0	1 (1.7%)
50.0	1 (1.7%)
52.0	1 (1.7%)
Missing	3 (5%)
Overall	**60 (100%)**

TRACEABILITY SYSTEM – GOVERNMENT SUPPORT

Table 20 – Government support

FIRM	FREQUENCY (%)
Received support	9 (15%)
Do not received support	50 (83.3%)
Missing	1 (1.7%)
Overall	**60 (100%)**

Table 21 – Types of government support

TYPES OF GOVERNMENT	FREQUENCY (%)
National	1 (1.7%)
Provincial	2 (3.3%)
EU	4 (6.7%)
Regional	5 (8.3%)
Municipality	1 (1.7%)
Missing (Firms do not received support)	51 (85%)
Overall	**60 (100%)**

Table 22 – Level of utility of government support – Equipment and software

SCALE*	FREQUENCY**
1	0 (0%)
2	0 (0%)
3	2 (22.2%)
4	2 (22.2%)
5	2 (22.2%)
Missing	3 (33.3%)
Overall	**9 (100%)**

*From 1 (very low utility) to 5 (very high utility).
**% based on 9 firms which received support.

Table 23 – Level of utility of government support – Certification and audit

SCALE*	FREQUENCY**
1	0 (0%)
2	1 (11.1%)
3	2 (22.2%)
4	1 (11.1%)
5	3 (33.3%)
Missing	2 (22.2%)
Overall	**9 (100%)**

*From 1 (very low utility) to 5 (very high utility).
**% based on 9 firms which received support.

Table 24 – Level of utility of government support – Technical assistance

SCALE*	FREQUENCY**
1	0 (0%)
2	2 (22.2%)
3	2 (22.2%)
4	1 (11.1%)
5	1 (11.1%)
Missing	3 (33.3%)
Overall	**9 (100%)**

*From 1 (very low utility) to 5 (very high utility).
**% based on 9 firms which received support.

Table 25 – Level of utility of government support – Legal assistance

SCALE*	FREQUENCY**
1	3 (33.3%)
2	0 (0%)
3	0 (0%)
4	0 (0%)
5	0 (0%)
Missing	6 (66.6%)
Overall	**9 (100%)**

*From 1 (very low utility) to 5 (very high utility).
**% based on 9 firms which received support.

Table 26 – Level of utility of government support – Other

SCALE*	FREQUENCY**
1	0 (0%)
2	0 (0%)
3	1 (11.1%)
4	0 (0%)
5	1 (11.1%)
Missing	7 (77.7%)
Overall	**9 (100%)**

*From 1 (very low utility) to 5 (very high utility).
**% based on 9 firms which received support.

OVERALL COSTS AND BENEFITS

Table 27 - Overall expected implementation costs

SCALE	FREQUENCY (%)
1	1 (1.7%)
2	3 (5%)
3	3 (5%)
4	8 (13.3%)
5	11 (18.3%)
6	8 (66.6%)
7	14 (23.3%)
8	7 (11.7%)
9	5 (8.3%)
Missing	0 (0%)
Overall	**60 (100%)**

Table 28 - Overall actual implementation costs

SCALE	FREQUENCY (%)
1	5 (8.3%)
2	7 (11.7%)
3	1 (1.7%)
4	7 (11.7%)
5	9 (15%)
6	4 (6.7%)
7	9 (15%)
8	8 (13.3%)
9	7 (11.7%)
Missing	3 (5%)
Overall	**60 (100%)**

Table 29 - Overall expected operation costs

SCALE	FREQUENCY (%)
1	3 (5%)
2	6 (10%)
3	7 (11.7%)
4	6 (10%)
5	11 (18.3%)
6	7 (11.7%)
7	13 (21.7%)
8	3 (5%)
9	3 (5%)
Missing	1 (1.7%)
Overall	**60 (100%)**

Table 30 - Overall actual operation costs

SCALE	FREQUENCY (%)
1	5 (8.3%)
2	6 (10%)
3	5 (8.3%)
4	3 (5%)
5	9 (15%)
6	9 (15%)
7	7 (11.7%)
8	7 (11.7%)
9	5 (8.3%)
Missing	4 (6.7%)
Overall	**60 (100%)**

Table 31 – Discrepancy implementation cost

SCALE	FREQUENCY (%)
-8	1(1.7%)
-7	1(1.7%)
-6	1(1.7%)
-5	0 (0%)
-4	0 (0%)
-3	5 (8.3%)
-2	8 (13.3%)
-1	4 (6.7%)
0	19 (31.7%)
1	5 (8.3%)
2	10 (16.7%)
3	2 (3.3%)
4	1 (5%)
5	0 (0%)
6	0 (0%)
7	0 (0%)
8	0 (0%)
Missing	3 (5%)
Overall	**60 (100%)**

Table 32 – Discrepancy operation cost

SCALE	FREQUENCY (%)
-8	0 (0%)
-7	0 (0%)
-6	0 (0%)
-5	0 (0%)
-4	0 (0%)
-3	2 (3.3%)
-2	6 (10%)
-1	10 (16.7%)
0	21 (35%)
1	5 (8.3%)
2	6 (10%)
3	3 (5%)
4	2 (3.3%)
5	1 (1.7%)
6	0 (0%)
7	0 (0%)
8	0 (0%)
Missing	4 (6.7%)
Overall	**60 (100%)**

Table 33 - Overall expected benefits

SCALE	FREQUENCY (%)
1	1 (1.7%)
2	2 (3.3%)
3	4 (6.7%)
4	1 (1.7%)
5	4 (6.7%)
6	9 (15%)
7	15 (25%)
8	14 (23.3%)
9	9 (15%)
Missing	1 (1.7%)
Overall	**60 (100%)**

Table 34 - Overall actual benefits

SCALE	FREQUENCY (%)
1	1 (1.7%)
2	3 (5%)
3	1 (1.7%)
4	6 (10%)
5	8 (13.3%)
6	9 (15%)
7	8 (13.3%)
8	13 (21.7%)
9	8 (13.3%)
Missing	43 (5%)
Overall	**60 (100%)**

Table 35 – Discrepancy benefits

SCALE	FREQUENCY (%)
-8	0 (0%)
-7	1 (1.7%)
-6	0 (0%)
-5	0 (0%)
-4	1(1.7%)
-3	5 (8.3%)
-2	3 (5%)
-1	10 (16.7%)
0	25 (41.7%)
1	6 (10%)
2	4 (6.7%)
3	1 (1.7%)
4	0 (0%)
5	1 (1.7%)
6	0 (0%)
7	0 (0%)
8	0 (0%)
Missing	3 (5%)
Overall	**60 (100%)**

Table 36 - Percentage traceability cost

PERCENTAGE	FREQUENCY (%)
0.5	9 (15%)
0.8	4 (6.7%)
1.0	8 (13.3%)
1.3	4 (6.7%)
1.5	1(1.7%)
2.0	9 (12%)
2.5	4 (6.7%)
2.8	1 (1.7%)
3.0	1 (1.7%)
3.3	1 (1.7%)
3.5	1 (1.7%)
4.0	1 (1.7%)
4.5	3 (5%)
5.0	1 (1.7%)
Missing	12 (20%)
Overall	**60 (100%)**

Table 37 - Overall actual costs

VALUE	FREQUENCY (%)
0	2 (3.3%)
40	1 (1.7%)
70	1 (1.7%)
85	1 (1.7%)
90	3 (5%)
100	34 (56.7%)
105	2 (3.3%)
108	2 (3.3%)
109	1 (1.7%)
110	6 (10%)
115	1 (1.7%)
120	2 (3.3%)
130	2 (3.3%)
Total	58 (96.7%)
Missing	2 (3.3%)
Overall	**60 (100%)**

SPECIFIC COSTS

Table 38 - Purchase new equipment and software – Expectations

VALUE	FREQUENCY (%)
0	5 (8.3%)
5	1 (1.7%)
10	3 (5%)
15	3 (5%)
17	1 (1.7%)
20	10 (6.7%)
22	1 (1.7%)
24	1 (1.7%)
25	2 (3.3%)
30	8 (13%)
40	6 (10%)
45	3 (5%)
50	4 (6.7%)
55	1 (1.7%)
60	4 (6.7%)
70	2 (3.3%)
80	2 (3.3%)
90	1 (1.7%)
Missing	2 (3.3%)
Overall	**60 (100%)**

Table 39 - Purchase new equipment and software – Actual outcomes

VALUE	FREQUENCY (%)
0	5 (8.3%)
10	8 (13.3%)
15	2 (3.3%)
20	10 (16.7%)
22	1 (1.7%)
25	3 (5%)
30	5 (8.3%)
35	2 (3.3%)
40	3 (5%)
45	3 (5%)
50	6 (10%)
60	3 (5%)
65	3 (5%)
70	2 (3.3%)
Total	57 (95%)
Missing	3 (5%)
Overall	**60 (100%)**

Table 40 - Certification, audit and external consultants – Expectations

VALUE	FREQUENCY (%)
0	7 (11.7%)
5	6 (10%)
10	8 (13.3%)
11	1 (1.7%)
15	3 (5%)
19	1 (1.7%)
20	15 (25%)
22	1 (1.7%)
25	4 (6.7%)
30	5 (8.3%)
32	1 (1.7%)
35	1 (1.7%)
40	2 (3.3%)
50	3 (5%)
Total	58 (96.7%)
Missing	2 (3.3%)
Overall	**60 (100%)**

Table 41 - Certification, audit and external consultants – Actual outcomes

VALUE	FREQUENCY (%)
0	8 (13.3%)
5	4 (6.7%)
10	6 (10%)
11	1 (1.7%)
15	2 (3.3%)
20	16 (26.7%)
22	1 (1.7%)
25	1 (1.7%)
30	9 (15%)
35	2 (3.3%)
40	4 (6.7%)
50	2 (3.3%)
60	1 (1.7%)
Total	57 (95%)
Missing	3 (5%)
Overall	**60 (100%)**

Table 42- Production line, supervisory staff and managerial administrative time – Expectations

VALUE	FREQUENCY (%)
0	2 (3.3%)
5	4 (6.7%)
10	5 (8.3%)
11	1 (1.7%)
12	1 (1.7%)
15	2 (3.3%)
17	1 (1.7%)
19	1 (1.7%)
20	21 (35%)
25	5 (8.3%)
30	5 (8.3%)
35	1 (1.7%)
40	6 (10%)
45	1 (1.7%)
50	2 (3.3%)
Total	58 (96.7%)
Missing	2 (3.3%)
Overall	**60 (100%)**

Table 43 - Production line, supervisory staff and managerial administrative time – Actual outcomes

VALUE	FREQUENCY (%)
0	1 (1.7%)
5	3 (5%)
7	1 (1.7%)
10	5 (8.3%)
11	1 (1.7%)
15	3 (5%)
20	21 (35%)
25	3 (5%)
30	8 (13.3%)
40	5 (8.3%)
45	2 (3.3%)
50	2 (3.3%)
60	1 (1.7%)
70	1 (1.7%)
Total	57 (95%)
Missing	3 (5%)
Overall	**60 (100%)**

Table 44 - Training course – Expectations

VALUE	FREQUENCY (%)
0	6 (10%)
2	2 (3.3%)
5	7 (11.7%)
10	19 (31.7%)
15	5 (8.3%)
17	1 (1.7%)
19	1 (1.7%)
20	10 (16.7%)
22	2 (3.3%)
25	1 (1.7%)
30	2 (3.3%)
35	1 (1.7%)
50	1 (1.7%)
Total	58 (96.7%)
Missing	2 (3.3%)
Overall	**60 (100%)**

Table 45 - Training course – Actual outcomes

VALUE	FREQUENCY (%)
0	9 (15%)
2	2 (3.3%)
5	8 (13.3%)
7	1 (1.7%)
10	16 (26.7%)
15	4 (6.7%)
20	10 (16.7%)
22	2 (3.3%)
30	5 (8.3%)
Total	57 (95%)
Missing	3 (5%)
Overall	**60 (100%)**

Table 46 - Materials – Expectations

VALUE	FREQUENCY (%)
0	5 (8.3%)
3	1 (1.7%)
5	13 (21.7%)
8	1 (1.7%)
10	18 (30%)
11	1 (1.7%)
15	1 (1.7%)
17	1 (1.7%)
19	1 (1.7%)
20	8 (13.3%)
22	1 (1.7%)
25	2 (3.3%)
30	3 (5%)
35	1 (1.7%)
50	1 (1.7%)
Total	58(96.7%)
Missing	2 (3.3%)
Overall	**60 (100%)**

Table 47 - Materials – Actual outcomes

VALUE	FREQUENCY (%)
0	6 (10%)
3	2 (3.3%)
5	11 (18.3%)
8	1 (1.7%)
10	18 (30%)
11	1 (1.7%)
15	2 (3.3%)
20	8 (13.3%)
2	1 (1.7%)
25	1 (1.7%)
30	3 (5%)
40	1 (1.7%)
50	2 (3.3%)
Total	57 (95%)
Missing	3 (5%)
Overall	**60 (100%)**

SPECIFIC BENEFITS

Table 48 - Meeting current and anticipated future regulatory requirements – Expectations

VALUE	FREQUENCY (%)
0	2 (3.3%)
4	1 (1.7%)
5	3 (5%)
10	12 (20%)
13	2 (3.3%)
15	4 (6.7%)
16	1 (1.7%)
20	13 (21.7%)
25	4 (6.7%)
30	7 (11.7%)
40	3 (5%)
50	2 (3.3%)
70	3 (5%)
Total	57 (95%)
Missing	3 (5%)
Overall	**60 (100%)**

Table 49 - Meeting current and anticipated future regulatory requirements – Actual outcomes

VALUE	FREQUENCY (%)
4	1 (1.7%)
5	3 (5%)
7	3 (1.7%)
10	12 (20%)
15	7 (11.7%)
16	1 (1.7%)
18	1 (1.7%)
20	9 (15%)
25	3 (5%)
30	8 (13.3%)
35	1 (1.7%)
40	3 (5%)
45	1 (1.7%)
50	2 (3.3%)
70	3 (5%)
Total	56 (93.3%)
Missing	4 (6.7%)
Overall	**60 (100%)**

Table 50 - Increasing consumer trust – Expectations

VALUE	FREQUENCY (%)
0	6 (10%)
2	1 (1.7%)
5	3 (5%)
10	10 (16.7%)
13	1 (1.7%)
15	4 (6.7%)
16	1 (1.7%)
17	1 (1.7%)
20	22 (36.7%)
22	1 (1.7%)
23	1 (1.7%)
25	1 (1.7%)
30	4 (6.7%)
40	1 (1.7%)
Total	57 (95%)
Missing	3 (5%)
Overall	**60 (100%)**

Table 51 - Increasing consumer trust - Actual outcomes

VALUE	FREQUENCY (%)
0	9 (15%)
2	1 (1.7%)
5	2 (3.3%)
10	9 (15%)
13	1 (1.7%)
15	7 (11.7%)
16	1 (1.7%)
17	1 (1.7%)
20	15 (25%)
22	1 (1.7%)
25	5 (8.3%)
28	1 (1.7%)
30	1 (1.7%)
40	2 (3.3%)
Total	56 (93.3%)
Missing	4 (6.7%)
Overall	**60 (100%)**

Table 52 - Meeting customer's requirements and increasing his trust – Expectations

VALUE	FREQUENCY (%)
0	4 (6.7%)
2	1 (1.7%)
5	4 (6.7%)
8	1 (1.7%)
10	13 (21.7%)
13	2 (3.3%)
15	7 (11.7%)
16	1 (1.7%)
17	1 (1.7%)
20	13 (21.7%)
23	1 (1.7%)
25	1 (1.7%)
30	5 (8.3%)
40	1 (1.7%)
50	2 (3.3%)
Total	57 (95%)
Missing	3 (5%)
Overall	**60 (100%)**

Table 53 - Meeting customer's requirements and increasing his trust - Actual outcomes

VALUE	FREQUENCY (%)
0	2 (3.3%)
2	1 (1.7%)
5	3 (5%)
8	2 (3.3%)
9	1 (1.7%)
10	10 (16.7%)
13	1 (1.7%)
15	8 (13.3%)
20	18 (30%)
25	1 (1.7%)
28	1 (1.7%)
30	5 (8.3%)
40	2 (3.3%)
50	1 (1.7%)
Total	56 (93.3%)
Missing	4 (6.7%)
Overall	**60 (100%)**

Table 54 - Increasing market share or accessing new markets and obtaining a price premium – Expectations

VALUE	FREQUENCY (%)
0	9 (15%)
1	1 (1.7%)
2	1 (1.7%)
5	9 (15%)
10	17 (28.3%)
15	5 (8.3%)
16	1 (1.7%)
17	1 (1.7%)
18	1 (1.7%)
20	8 (13.3%)
30	3 (5%)
40	1 (1.7%)
Total	57 (95%)
Missing	3 (5%)
Overall	**60 (100%)**

Table 55 - Increasing market share or accessing new markets and obtaining a price premium – Actual outcomes

VALUE	FREQUENCY (%)
0	16 (26.7%)
1	1 (1.7%)
2	1 (1.7%)
5	9 (15%)
10	15 (25%)
15	3 (5%)
16	1 (1.7%)
20	7 (11.7%)
23	1 (1.7%)
25	2 (3.3%)
Total	56 (93.3%)
Missing	4 (6.7%)
Overall	**60 (100%)**

Table 56 - Reducing customer complaints, recalls, risk and product liability – Expectations

VALUE	FREQUENCY (%)
0	8 (13.3%)
2	2 (3.3%)
5	11 (18.3%)
10	12 (20%)
11	2 (3.4%)
13	1 (1.7%)
15	9 (15%)
16	1 (1.7%)
25	10 (16.7%)
30	1 (1.7%)
Total	57 (95%)
Missing	3 (5%)
Overall	**60 (100%)**

Table 57 - Reducing customer complaints, recalls, risk and product liability - Actual outcomes

VALUE	FREQUENCY (%)
0	6 (10%)
2	1 (1.7%)
5	10 (16.7%)
10	15 (25%)
13	1 (1.7%)
15	7 (7.11%)
16	1 (1.7%)
20	7 (11.7%)
22	1 (1.7%)
25	2 (3.3%)
30	5 (8.3%)
Total	56 (93.3%)
Missing	4 (6.7%)
Overall	**60 (100%)**

Table 58 - Improving management within the company and reducing the possibility of errors for data input and data management – Expectations

VALUE	FREQUENCY (%)
0	4 (6.7%)
3	1 (1.7%)
4	1 (1.7%)
5	8 (13.3%)
8	1 (1.7%)
10	19 (31.7%)
11	1 (1.7%)
13	1 (1.7%)
15	5 (8.3%)
17	1 (1.7%)
20	9 (15%)
25	2 (3.3%)
30	2 (3.3%)
35	1 (1.7%)
50	1 (1.7%)
Total	57 (95%)
Missing	3 (5%)
Overall	**60 (100%)**

Table 59 - Improving management within the company and reducing the possibility of errors for data input and data management – Actual outcomes

VALUE	FREQUENCY (%)
0	4 (6.7%)
2	1 (1.7%)
4	3 (1.7%)
5	1 (1.7%)
8	3 (5%)
9	1 (1.7%)
10	18 (30%)
13	1 (1.7%)
15	6 (10%)
17	1 (1.7%)
20	12 (20%)
25	1 (1.7%)
30	3 (5%)
40	3 (5%)
Total	56 (93.3%)
Missing	4 (6.7%)
Total	**60 (100%)**

Table 60 - Improving supply chain management (inventory, logistics, communication with suppliers and customers) – Expectations

VALUE	FREQUENCY (%)
0	14 (23.3%)
2	2 (3.3%)
5	8 (13.3%)
10	8 (13.3%)
11	1 (1.7%)
13	1 (1.7%)
15	4 (6.7%)
16	1 (1.7%)
17	1 (1.7%)
20	12 (20%)
22	1 (1.7%)
32	1 (1.7%)
40	2 (3.3%)
50	1 (1.7%)
Total	57 (95%)
Missing	3 (5%)
Overall	**60 (100%)**

Table 61 - Improving supply chain management (inventory, logistics, communication with suppliers and customers) - Actual outcomes

VALUE	FREQUENCY (%)
0	16 (26.7%)
2	1 (1.7%)
5	3 (5%)
9	1 (1.7%)
10	12 (20%)
11	1 (1.7%)
13	1 (1.7%)
15	2 (3.3%)
16	1 (1.7%)
20	13 (21.7%)
22	1 (1.7%)
30	1 (1.7%)
40	3 (5%)
Total	56 (93.3%)
Missing	4 (6.7%)
Overall	**60 (100%)**

Table 62 - Overall actual benefits

VALUE	FREQUENCY (%)
0	1 (1.7%)
50	2 (3.3%)
65	1 (1.7%)
75	1 (1.7%)
76	1 (1.7%)
80	1 (1.7%)
85	1 (1.7%)
90	3 (5%)
97	1 (1.7%)
100	26 (43.3%)
105	2 (3.3%)
106	1 (1.7%)
110	3 (5%)
114	1 (1.7%)
115	3 (5%)
120	3 (5%)
125	1 (1.7%)
133	1 (1.7%)
135	1 (1.7%)
140	3 (%%)
Total	57 (95%)
Missing	3 (5%)
Overall	**60 (100%)**