Effect of using smart goods on traceability information and carried out activities in supply chains of fresh food - a cross case analysis

Ringsberg, Henrik; Mirzabeiki, Vahid; Lumsden, Kent

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EFFECTS OF USING SMART GOODS ON TRACEABILITY INFORMATION AND CARRIED OUT ACTIVITIES IN SUPPLY CHAINS OF FRESH FOOD – A CROSS CASE ANALYSIS

Vahid Mirzabeiki*
Henrik Ringsberg**
Kent Lumsden***

*) Department of Transport and Logistics, Chalmers University of Technology, SE-412 96, Gothenburg, Sweden, E-mail: vahid.mirzabeiki@chalmers.se, Tel: +46 31 772 1354, Fax: +46 31 772 1337

**) Department of Design Sciences, Packaging Logistics, Lund University, SE-221 00, Lund, Sweden, E-mail: henrik.ringsberg@plog.lth.se, Tel: +46 46 222 4042; Fax: +46 46 222 8060

***) Department of Transport and Logistics, Chalmers University of Technology, SE-412 96, Gothenburg, Sweden, E-mail: kenth.lumsden@chalmers.se, Tel: +46 31 772 1345; Fax: +46 31 772 1337

ABSTRACT

Purpose of this paper
The purpose of this paper is to investigate the effects of using the smart goods on traceability information and consequently on the carried out activities for different actors of the fresh food supply chains. Identification of the valuable traceability information types in fresh food supply chains is conducted as the first step to reach the purpose.

Design/methodology/approach
Literature is reviewed to identify a theoretical frame for the smart goods and traceability in the fresh food supply chains. Three Nordic supply chains of fresh food are studied for answering the research questions.

Findings
The valuable types of traceability information from perspective of different actors of the fresh food supply chains are identified as an outcome of the paper. Advantages and disadvantages of using the traditional and smart-goods-based traceability systems are found. The traceability information and activities in the fresh food supply chains that are affected by using the smart goods and kinds of such effects are generated out of this research.

Research implications
This paper is contributing to the literature on the traceability especially in the food supply chains. The smart goods concept developed by literature is empirically analyzed and evaluated in this paper.
Practical implications

The results of this paper are useful for operations managers of the fresh food supply chains to understand the effects of using the smart goods to manage their supply chain information and activities.

What is original/value of paper

This paper evaluates the effects of using the smart goods from perspective of different actors including authorities in fresh food supply chains. Supply chains with both centralized and decentralized information systems are studied in this paper.

Keywords: Supply Chain (SC), Fresh food, Smart goods, Traceability, Information, Activities.
1. INTRODUCTION

Smart goods equipped with smart tags with capability of communication to the supply chain infrastructure is introduced and investigated from different perspectives in recent literature (e.g. Meyer et. al., 2009; Wong et. al., 2002; Lumsden and Stefansson, 2007; Holmqvist and Stefansson 2006; Stefansson and Lumsden, 2009). Different studies have analyzed application of the smart goods by using combinations of different technologies and systems for storing more types of information on the goods. Such goods are used to enable local decision making and to increase different performance criteria in supply chains by their capability of communication to the transportation infrastructure (Meyer et. al., 2009; Wong et. al., 2002).

According to the literature one of the most significant applications of the smart goods is to increase traceability in the supply chains. A number of studies have determined the advantages and disadvantages of using the smart goods for achieving traceability of the items through different industrial supply chains generally and a group of published studies have investigated the willingness of different actors of industrial supply chains to apply the smart goods in the future (Johansson and Pålsson, 2009).

An interesting area for investigation of the traceability in supply chain is the fresh foods industries. Consumer and government economic losses, resource losses, undermining of eco-campaigns and health problems are some of the consequences of lack of appropriate traceability in fresh food supply chains. Liberalization of trade is another significant reason for increasing concerns on traceability of all products including fresh food (Jacquet and Pauly, 2008). Reviewing the related literature indicates that still there is lack of research on the effects of using the smart goods on the activities carried out to transport the goods from upstream to downstream of the supply chains of the fresh food considering the special features of these supply chains.

According to the discussion above, the purpose of this paper is to investigate the effects of using the smart goods on traceability information and consequently on the carried out activities for actors of the fresh food supply chains. This purpose is reached through studying different elements of the information systems used for transferring the traceability information between partners of the supply chains of fresh food. The research questions below are formulated to be answered in order to achieve the purpose of the paper:

RQ1: What types of information related to the goods are valuable for achieving traceability in supply chains of fresh food?

RQ2: What type of activities do different actors of the fresh food supply chains carry out by using the traceability information?

RQ3: What are the advantages and disadvantages of traditional and smart-goods-based traceability systems for the supply chains of fresh food?

A simplified model of fresh food supply chain used for analysis in this paper is introduced on the figure 1.1. This model shows the actors in the fresh food supply chains that are studied in this research.
Figure 1.1 - Actors of the fresh food supply chain used for analysis in this paper

The concept of smart goods is introduced by different names in books and papers but all of such terms carry almost the same meaning. Some of the terms used are intelligent goods, intelligent freight or smart freight. The term used in this paper for describing this concept is smart goods.

Traceability information is the information that is needed to be available with the goods during the transportation to achieve high level of traceability.

Except from the traceability perspective mentioned above, the paper has an operational perspective on application of the smart goods for transportation and material handling of fresh food in a supply chain. The results indicate some of the effects of using the smart goods on costs of operations in the fresh food supply chains.

2. METHODOLOGY

A research design is the logic that links the collected data to the initial question of a study (Yin, 2003). In this chapter after providing the motivations behind selecting the cases, the process of conducting the empirical data collection is described.

Literature in form of books, journal papers, conference papers, and organizations’ websites are reviewed to identify a theoretical frame for the smart goods and traceability in the fresh food supply chains.

One Swedish supply chain of fresh fishes, one Danish supply chain of fresh fishes and one Norwegian supply chain of fresh meat are selected to be studied in this paper. The Swedish supply chain is using the traditional tags and delivering notes as carrier of information about the items. The Norwegian and Danish supply chains have been using the smart goods quipped with RFID tags on the packages to carry the information regarding the goods in their supply chains. This research is going to identify the important traceability information in the Swedish supply chain by conducting a deep empirical study. Then the Danish and Norwegian traceability systems are investigated and compared to the Swedish supply chain to identify the effects of using the smart goods on the traceability information and on the activities that are carried out by using such information in the fresh food supply chains.

Selection of the cases is based on these criteria that first the Nordic countries are large fresh fish producers and investigating two large supply chains from Nordic countries helps to better generalization of the results of the paper. All of these three supply chains use almost the same types of information for achieving traceability of goods that makes the comparisons between them possible. Another reason behind selection of these three supply chains for this research is that all of these supply chain have to follow the same European regulations and respect existing standards within the fresh food industry.
After selecting the cases, the data collection protocol was prepared and followed according to the Yin (2003). The protocol includes an overview of the project’s objectives, case study issues, field procedures, case study questions and a guideline for the case study’s report. According to Yin (2003) the six sources of evidence in conducting case studies are: documentation, archival records, interviews, direct observations, participant observations, and physical artifacts. Documentations and archival records of the actors of these three supply chains are used as sources of data. Direct observations from different operations of the supply chains are conducted by the authors. Interviews with representatives from actors of the supply chains are conducted as other significant source of empirical data for this research. 14 interviews are carried out by using semi-structured questions together with interview forms to be filled by the interviewees. All the interviews are recorded and saved together with filled interview forms in the prepared case study database. For increasing validity of the collected data, after finishing the interviews the results are again sent to the interviewees to be confirmed. In addition to the interviews, documentations from different actors were reviewed and when possible direct observations were conducted to make triangulation of data according to Yin, 2003. Cross-case conclusions are drawn after comparing the analyzed data from all three supply chains according to Eisenhardt (1989) and Yin (2003).

3. SMART GOODS

There are different definitions proposed for the intelligent or smart goods that have some similarities and difference (McFarlane et. al. 2003, Kärkkäinen et. al. 2003, Meyer et. al., 2009, Lumsden and Stefansson, 2007). According to McFarlane et. al. (2003), an intelligent or smart good has the following properties:

- Possesses a unique identification;
- Is capable of communicating effectively with its environment;
- Can retain or store data about itself;
- Deploys a language to display its features, production requirements.
- Is capable of participating in or making decisions relevant to its own destiny.

According to Holmqvist and Stefansson (2006), Smart Goods is characterized by a higher level of sophistication than traditional goods identification. This means that instead of using former technologies such as barcodes to identify an item, it is now possible to identify the freight, either individual items or the load unit, with new smart technologies like RFID tag as a carrier of data. Combination of the auto identification tags with sensors that measure and record different physical attributes of the goods are used for creating advanced generations of the smart goods (Lumsden and Mirzabeiki, 2008). Several technologies that are combined for making the smart goods, including RFID, GSM/GRPS and web technology are introduced and explained in the literature (Kärkkäinen et al., 2003; Ghibi and Logrippo, 2000).

According to the literature application of smart goods provides new opportunities for increasing efficiency of transportation operations. According to Lumsden and Stefansson (2007), the concept of smart goods is defined on different levels of packaging such as the container level, pallets level, and item level depending on transportation activities to be carried out in supply chain. There are different classifications based on levels of smartness of the smart goods depending on the level of sophistication of technologies applied in them.
Two levels of smartness are defined by literature for the smart goods. In the level 1 the smartness of the goods is information-oriented based and allows the product to communicate with its environment regarding its status. In the level 2 the smartness of the goods is decision-oriented. In this level the smart goods can influence on their functions in addition to communicating its status with environment and other smart goods (Wong et. al., 2002; McFarlane et al., 2003; Johansson 2009). Examples of the information systems functioning by using the smart goods concept are described in below:

*Auto identification (ID) systems for goods management:* A basic purpose of introducing the smart goods concept in the supply chain is to maintain the identity of the products. Optical and RFID labels are used for goods identification to fulfill customers’ orders, for checking goods in and out of the warehouse, and for keeping an up-to-date inventory. As a result one of the advantages of the smart goods is to increase the security of the supply chains. By maintaining the identity of the product or shipment it is possible to pinpoint where thefts occur and to verify the authenticity of the item and reduce the risk of forgery (Meyer et. al., 2009).

*Tracking systems for moving goods through a supply chain:* The software and hardware components together make the information systems that are used for controlling the location of the products through the supply chain. Such information systems update the location of the shipments when they pass the checkpoints or they are used for querying or updating product information in general (Meyer et. al., 2009).

*Systems for controlling the physical features of the goods:* different types of sensors together with an RFID tag and a memory to save the information gives this capability to the goods to store data regarding physical condition of itself during shipment or storage. Temperature, humidity, impact and light are some of the attributes that are stored on memory of the smart tags. This information could be transmitted to the central operation centre as well (Lumsden and Mirzabeiki, 2008).

### 4. TRACEABILITY IN FRESH FOOD SUPPLY CHAINS

There are several definitions for traceability in supply chains of the fresh food. According to the International Standardization Organization (ISO), traceability is defined as “the ability to trace the history, application or location of that which is under consideration” or “when considering a product, traceability can be related to the origin of materials and parts, the processing history, and the distribution and location of the product after delivery”. The EU Regulation 178/2002 describes the food traceability as “the ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution” (Abad et al, 2009).

According to Abad et al, 2009 the smart goods provide real-time traceability information of the product to the different actors of the food supply chain, allow tracing if the expected physical condition were maintained for the fresh food on its way from the producer to the consumer, and allow getting a better safety and quality control along the food supply chain. Therefore, the smart goods developed can help to improve the competitiveness of the food companies, to improve their logistic management, and also to reinforce the confidence of the consumers in the food supply chain (Abad et al, 2009; Jacquet and Pauly, 2008).
Regulatory aspects of food traceability are a very important issue to be considered in management of the fresh food supply chains (Regattieri et al. 2007). In the recent years more fish stocks collapsed around the world, and the issue of traceability, particularly for illegal, unreported, and unregulated fisheries, was identified as a factor for controlling the overfishing (Jacquet and Pauly, 2008). Different standard data models are created to enable traceability of products, product authentication, diversion detection and other similar applications across multiple actors of supply chains. Electronic Product Code Information Service (EPCIS) is one of such standard data models that by using it each trading partner or actor keep their data and only share information that they wish with the other actors of the supply chain (EPC Global, 2010).

5. ANALYSIS MODEL

The analysis model used in this paper is illustrated on the figure 5.1. According to a number of published studies the smart goods affect different types of traceability information in a supply chain of the fresh food. Such effects could be on accuracy, timeliness or exchange of traceability information or other information quality dimensions. One important reason for these effects is reduction of the amount of manual data entry and copying into the information systems of different actors compared to the traditional goods tracing systems. Consequently the activities carried out by using traceability information are affected by application of the smart goods as a hypothesis. In the next chapters of the paper this relationship would be identified and validated through analyzing the collected empirical data from three selected supply chains of the fresh food. Identification of the valuable traceability information is conducted before studying the affected activities by using the smart goods.

![Figure 5.1 Analysis model to identify the effects of using smart goods on traceability information and consequently on the activities carried out by using such information in the fresh food supply chains.](image)

6. EMPIRICAL FINDINGS

In the first part of the empirical studies information systems used in order to transfer the information in the fresh food supply chains are investigated. The second part includes identification and evaluation of traceability information and identification of the affected information and activities by using the smart goods in fresh food supply chains.
6.1. The Swedish supply chain

The information system used to transfer the information between actors of the Swedish supply chain is decentralized. It means that each actor in the supply chain has their own information system which is not electronically integrated with each other. The labeling stickers, delivery notes, and at some points, EAN-bar codes are used to capture and transfer the information between actors in the supply chain. Storage of transferred information is based on manual handwriting. The only direct electronically transfer and storage of information, without any human interference in the supply chain is the transfer of vessel position information to authorities to control the position of fishing.

Figure 6.1 shows the information flow, and tools or technologies used for information transfer between different actors in the supply chain for fresh fish in Sweden.

![Figure 6.1 Information exchange in Swedish fresh fish supply chain.](image)

On the figure 6.1 the information at different stages is shown by numbers between 1 and 9. The tools used for information transfer and types of transmitted information related to each number are introduced below:

1. Tag-stickers: a) Vessel external marketing, landing quantity (kg), name of receiver, name of fishing area, fishing zone (according to ICES- International Council for Exploration of the Sea), specie denotation (Swedish), date of fishing activity, size class. b) Vessel denotation, landing quantity (kg), name of receiver, specie denotation (English), date of fishing activity. c) Vessel external marketing, specie denotation (Swedish), size class.

2. Delivery note: Vessel external marketing, landing quantity (kg), name receiver, name of fishing area, fishing zone (ICES), specie denotation (Swedish), date of fishing activity, size class, batch/lot number.

3. Tag-sticker: Production date, net-weight, name of receiver, name of seller, name of fishing area, fishing zone (ICES), specie denotation (English), species denotation (Swedish), temperature.

4. Barcodes: Vessel external marketing, seller name, specie denotation (English), specie denotation (Swedish), size class, date landing.
5. Delivery note: Vessel external marketing, captain name, date/time landing, net-weight, internal batch, internal lot number, name of seller, name buyer, selling date, name of fishing area, fishing zone (ICES).

6. Barcodes, tag-stickers: Fishing tackle/method, date/time landing, production date, best before date, net-weight, batch number, name seller, selling date, name of fishing area, fishing zone (ICES), specie denotation (English), specie denotation (Swedish), processing degree/class, size class, date fishing activity.

7. Delivery note: Fishing tackle/method, net-weight, batch number, name seller, name buyer, selling date, buy-off date, specie denotation (English), specie denotation (Swedish), processing degree/class, size class, date fishing activity.

8. Tag-stickers: Vessel name, vessel external marketing, production date, packing date, best before date, net weight, name seller, name of fishing area, fishing zone (ICES), specie denotation (English), specie denotation (Swedish), prize information.

9. Tag-stickers: Production date, net-weight, name receiver, name seller, name of fishing area, fishing zone (ICES), specie denotation (English), specie denotation (Swedish), temperature.

10. Fax, email: Log fishing activity: Position ICES zone, third country fishing zone, net weight (kg), processing degree/class, quantities (kg), quantities (units), Captain name, name receiver.

11. Fax, email: Landing declaration: Vessel name, vessel external marketing, captain name, date/time departure, date/time arrival, date/time landing, landing place, departure place, arrival place, fishing tackle, date for transshipment, name of receiving vessel (transshipment), external marketing of receiving vessel (transshipment), Nationality of receiving vessel (transshipment), date fishing activity, number of fishing operations, position statistical rectangle, position ICES zone, third country fishing zone, net weight (kg).

12. Fax, email: Deductive bill: Name receiver, deductive bill nr, buy-off date, date landing, captain name, third country name, vessel external marketing, specie denotation (English), specie code, processing degree, size class, freshness class, net weight, price.

6.2. The Danish supply chain

The information system used in Danish supply chain for tracing and tracking of the fresh fishes is developed based on cooperation between a software development company and the major supplier of Danish fish crates. The system is created for asset management of fish crates and contains approximately 40 000 RFID tagged fish crates and an ISO-certified (ISO 2001:2000) IT-solution implemented in four different harbors. The system has a holistic view on the fish supply chain through cooperation between different actors such as producers, distributors, buyers, restaurants, retailers, auctions, wholesalers, collectors, washing companies, and customers. For collection of information from the actors, the system include installed RFID portals/scanners at key sites in the supply chain, i.e. at crate wash area, crate dispatch area, on fishing vessels, at collector terminals, auctions, harbors and at exporters. These portals and scanners have the ability to read the RFID-tagged fish crates from a distance between 0.5 - 12 meters. Each fish crate in the system is tagged with two RFID-tags molded into the plastic material of the crate which has a GRAI number (Global Returnable Asset Identifier, identification key used by GS1 for identification of returnable assets) for
unique identification. Figure 6.2 shows the information system used for traceability of the crates through the Danish fish supply chain by using smart goods.

![Diagram of the information system for traceability](image)

**Figure 6.2 System descriptions for traceability of fish within Danish supply chain. The information flow is illustrated by the arrows.**

Asset management information stored within the system includes the GRAI number of each crate and the actual location of the crate (last place of registration through the supply chain). This traceability information is stored in the system’s central database structured according to the GS1 Tracefish standard. This standard includes parameters such as fishing vessel’s name, vessel’s denotation, specie, size and weight of fishes, time of fishing, name of fishing area, name of current owner, parties and timestamp for each handover of the crate between the actors.

### 6.3. The Norwegian supply chain

Activities conducted in the Norwegian supply chain include slaughtering, cutting, processing and distribution of meat by using RFID tagged crates and pallets from one of the largest returnable asset providers in Norway. The aim of implementation of this system was to reduce paper handling, less manual information acquisition and to create more secure readings, efficient asset management and traceability.

By each handover of crates in the supply chain, process information, i.e. information about when, what and why the crate is moved, are transferred to the next actor. This information is then combined with information that each actor are willing to share with each other within the meat supply chain. The system is built up from the principle that no central database for achievement of traceability is needed since all needed information already is stored in information systems of every actor in the supply chain. Each actor decides which information that is going to be shared and sent further to other actors in the supply chain. Therefore in this system actors are able to make the information unreadable for other actors if necessary. For exchange of traceability information between the actors the EPCIS (Electronic Product Code Information Service) standard is used. Therefore the information on the crate tags is structured according to this standard.

Each crate in this system has a GRAI number. It is only the GRAI-number of each crate that is transferred, making connections to information at different actors, GTIN-numbers (Global Trade Item Number, identification key used by GS1 to identify trade items) and product
information stored at EPC. The figure 6.3 show the basic principle of the Norwegian traceability information system studied.

Figure 6.3 The Norwegian traceability system working based on EPCIS-standard. The information flow is illustrated by the arrows.

6.4. Overview of the studied cases

Table 6.1 summarizes characteristics of the three studied supply chains according to the type of goods, number of actors and the systems used to transfer the information between different actors.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Swedish supply chain</th>
<th>Danish supply chain</th>
<th>Norwegian supply chain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of system used for traceability</td>
<td>None</td>
<td>Asset management system</td>
<td>Traceability system</td>
</tr>
<tr>
<td>Type of goods</td>
<td>Non-smart</td>
<td>Smart-level 1</td>
<td>Smart-level 1</td>
</tr>
<tr>
<td>No. of actors that goods is transported in between</td>
<td>6</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Information storage</td>
<td>Decentralized, i.e. at each actor</td>
<td>Central i.e. database at IT-company</td>
<td>Decentralized, i.e. at each actor</td>
</tr>
<tr>
<td>Technology used</td>
<td>Paper, stickers, barcodes (at some points)</td>
<td>UHF-RFID passive tags</td>
<td>UHF-RFID passive tags</td>
</tr>
<tr>
<td>Reading range (m)</td>
<td>Direct, 0-2 (bar-codes).</td>
<td>0.5 – 12</td>
<td>5-15</td>
</tr>
<tr>
<td>Standards information transfer</td>
<td>None</td>
<td>EPC Gen 2</td>
<td>EPCIS, EPC Gen 2</td>
</tr>
<tr>
<td>Connection to the information systems</td>
<td>None</td>
<td>Secure web-access (XML), ERP solutions</td>
<td>Secure web-access (XML), ERP solutions</td>
</tr>
</tbody>
</table>

7. EVALUATION AND ANALYSIS

Table 7.1 shows advantages and disadvantages related to application of the current traditional system for traceability of items in the supply chain for fishes in Sweden according to the empirical studies.
Table 7.1 Advantages and disadvantages related to application of the traditional traceability system in Swedish fish supply chain.

<table>
<thead>
<tr>
<th>Swedish fish supply chain traceability</th>
<th>Aspect</th>
<th>Description</th>
<th>Affected actor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disadvantages</td>
<td>Labeling</td>
<td>Sticker left-over problems</td>
<td>Fisherman; Receiver</td>
</tr>
<tr>
<td></td>
<td>Cost</td>
<td>High buying cost High operation cost</td>
<td>Fisherman; Receiver; Wholesaler; Retailer</td>
</tr>
<tr>
<td></td>
<td>Tagging</td>
<td>Glue problems caused by low Temperature Glue problems caused by water</td>
<td>Fisherman, Receiver</td>
</tr>
<tr>
<td></td>
<td>Printing</td>
<td>Stickers get stuck in printers</td>
<td>Wholesaler, Retailer</td>
</tr>
</tbody>
</table>

Advantages

| Simplicity of use Easy to use for personnel | Receiver, Distributor, Wholesaler, Retailer |
| Understandability Easy to understand/ deliver information | Fisherman, Receiver, Distributor, Wholesaler, Retailer |
| Security Easy (hand ability) to use for personnel for showing all information | Distributor, Retailer |

According to the analysis model introduced in the chapter 5, application of the smart goods affects traceability information and consequently has impacts on the activities carried out by using such information in the fresh food supply chains. Therefore first the traceability information in the fresh food supply chain is identified and then the consequences of application of smart goods on such information are recognized. The consequences of application of the smart goods on the carried out activities in the fresh food supply chains is identified as the next step. According to the empirical data from the three studied supply chains, information in the fresh fish supply chain can be divided into three categories including: production-related information, transportation-related information and item-related information. Each of these developed information categories contains different information types. The three main information categories and information types related to each category from perspective of the actors of the Swedish fresh fish supply chain are shown on the table 7.2. The last column of the table shows the information types that are the most important traceability parameters in the fresh food supply chains according to the empirical studies.

Table 7.2 Information categories, information types related to each category and valuable traceability parameters in the fresh food supply chain.

<table>
<thead>
<tr>
<th>Information categories</th>
<th>Information types related to each category</th>
<th>Valuable traceability parameters from the industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production information</td>
<td>Vessel name, vessel external marketing, Captain name, Fishing tackle/ method, Date/ time (departure), Date/ time (arrival), Date/ time (landing), Date for transshipment Name of receiving vessel (transshipment), Nationality of receiving vessel (transshipment), Id number (logbook), Productions date, Packing date, Best before date, Landing quantity (kg), Landing quantity (units), Transhipment quantity (kg), Transhipment quantity (units)</td>
<td>Vessel name Vessel external marketing Best before date Name receiver</td>
</tr>
<tr>
<td>Transportation information</td>
<td>Net weight (kg), Batch number, Lot number, Name receiver, Name seller, Name buyer, Buy off date, Selling date</td>
<td>Name seller Name buyer</td>
</tr>
<tr>
<td>Item information</td>
<td>Specie denotation (English), Specie denotation (English), Specie denotation (Swedish), Specie code, Processing degree/class, Size-class, Freshness class, Date (fishing activity), Id number, deductive bill, Selling price information, Temperature</td>
<td>Specie denotation (Swedish) Size-class Selling date</td>
</tr>
</tbody>
</table>
Table 7.3 shows the activities carried out by using the traceability information for different partners in the Swedish fresh fish supply chain. Comparison of the Swedish supply chain with the Danish and Norwegian supply chains shows the effects of the smart goods on the supply chain information and activities.

Table 7.3 Activities carried out by using different traceability information by different actors in the fresh food supply chain.

<table>
<thead>
<tr>
<th>Information Category</th>
<th>Producer</th>
<th>1st hand receiver</th>
<th>Distributor</th>
<th>2nd hand receiver</th>
<th>Customer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production information</td>
<td>Producing (fishing), landing, managing Reporting (to authorities)</td>
<td>Managing Reporting (to authorities)</td>
<td>Managing Reporting (to authorities)</td>
<td>Managing</td>
<td>Selection of specific producer Creation of added values</td>
</tr>
<tr>
<td>Transport</td>
<td>Labeling, selling</td>
<td>Labeling, selling storing</td>
<td>Labeling, selling storing Product recall</td>
<td>Labeling, selling storing Product recall</td>
<td></td>
</tr>
<tr>
<td>Item information</td>
<td>Identifying, cost reduction Prove quality</td>
<td>Identifying Buying</td>
<td>Identifying Buying Prove quality</td>
<td>Identifying Buying Prove quality Creation of safer food Creation of added values</td>
<td>Demand safer food Buying Ability demand quality</td>
</tr>
</tbody>
</table>

Table 7.4 shows the effects of using the smart goods on traceability information and consequently on the activities that are carried out by using such information for different actors in the three studied supply chains of fresh food. On the table the positive or beneficial identified effects are indicated by “+” and the negative or harmful effects are indicated by “-”. This table is describing the effects caused by application of the smart goods in the food supply chains that is correlated to the analysis model introduced in chapter 5.

As shown on the table 7.4, the affected activities after using the smart goods are divided into three categories. These categories are logistics-related, control-related, and buying-selling-related activities. The logistics-related group represent the activities that are a part of the logistics operations in the fresh food supply chains. The control-related activities are activities conducted to have better control over the assets in order to reduce the number of missed items or activities conducted to have better quality of products when arriving to the customers. The buying-selling effects shown on the table 7.4 are related to different types of costs involved in traceability operations of the fresh food. As shown on the table 7.4 the negative effects of application of the smart goods indicated by actors of the studied fresh food supply chains are caused by high costs of implementaiton of the information systems that work by using the smart goods. Some of such costs include buying the smart tags, readers or crates quipped with the smart tags. As shown on the table 7.4 the smart goods has positive effects on many of the logistics-related or control-related activities for different actors of the studied fresh food supply chains. As the table shows, the actors of the studied supply chains are put into three segments of producer, distributor and customer. This segmentation makes comparisons of the studied supply chains based on their actors possible.
Table 7.4. Effects of using smart goods on traceability information, costs of operations and activities carried out in fresh food supply chain.

<table>
<thead>
<tr>
<th>Affected buying-selling activities</th>
<th>Affected control activities</th>
<th>Affected logistics activities</th>
<th>Affected information types</th>
<th>Supply chain actors</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ Better price from sales</td>
<td>+ Quicker/ easier report into authorities</td>
<td>+ Easier tagging</td>
<td>Production, transportation, item</td>
<td>Producer</td>
</tr>
<tr>
<td>+ Cost reduction (tagging/labeling)</td>
<td>+ Better abilities to prove product quality</td>
<td>+ Quicker tagging</td>
<td></td>
<td>Distributor</td>
</tr>
<tr>
<td>+ Cost reduction (tagging/labeling)</td>
<td>+ Increased no. customers</td>
<td>+ Quicker landing</td>
<td></td>
<td>Customer</td>
</tr>
<tr>
<td>- Buying costs from producers</td>
<td>- Costs smart goods technique</td>
<td>+ Identification of crates</td>
<td></td>
<td>Danish</td>
</tr>
<tr>
<td>- System transaction costs</td>
<td>+ Control of crates</td>
<td>+ Easier tagging</td>
<td></td>
<td>Norwegian</td>
</tr>
<tr>
<td>+ Cost reduction (tagging/labeling)</td>
<td>+ Cost reduction crate management</td>
<td>+ Quicker tagging</td>
<td></td>
<td>Norwegian</td>
</tr>
<tr>
<td>+ Cost reduction (tagging/labeling)</td>
<td>+ Cost reduction crates</td>
<td>+ Quicker storage</td>
<td></td>
<td>Norwegian</td>
</tr>
<tr>
<td>+ Cost reduction (tagging/labeling)</td>
<td>+ Costs smart goods technique</td>
<td>+ Identification of crates</td>
<td></td>
<td>Norwegian</td>
</tr>
<tr>
<td>+ System costs traceability</td>
<td>+ Control of crates</td>
<td>+ Easier tagging</td>
<td></td>
<td>Norwegian</td>
</tr>
<tr>
<td>+ Product quality</td>
<td>+ Control of crates</td>
<td>+ Quicker tagging</td>
<td></td>
<td>Norwegian</td>
</tr>
<tr>
<td>- Buying costs in stores</td>
<td>+ Product quality</td>
<td>+ Quicker landing</td>
<td></td>
<td>Norwegian</td>
</tr>
<tr>
<td>+ Cost reduction (tagging/labeling)</td>
<td>+ Cost reduction crate management</td>
<td>+ Identification of crates</td>
<td></td>
<td>Norwegian</td>
</tr>
<tr>
<td>+ Cost reduction (tagging/labeling)</td>
<td>+ Cost reduction crates</td>
<td>+ Less paper work and manual data acquisition</td>
<td></td>
<td>Norwegian</td>
</tr>
<tr>
<td>+ Costs smart goods technique</td>
<td>+ System costs traceability</td>
<td>+ Less paper work and manual data acquisition</td>
<td></td>
<td>Norwegian</td>
</tr>
<tr>
<td>+ Traceability</td>
<td>+ System costs traceability</td>
<td>+ Less paper work and manual data acquisition</td>
<td></td>
<td>Norwegian</td>
</tr>
<tr>
<td>+ Demand product quality</td>
<td>+ Control of crates</td>
<td>+ Less paper work and manual data acquisition</td>
<td></td>
<td>Norwegian</td>
</tr>
</tbody>
</table>

Comparison between the three different supply chains.
8. CONCLUSIONS AND FURTHER RESEARCH

The most valuable information for traceability of the goods through different actors in a supply chain for fresh food is mainly related to three categories. The first category is production information that has an important impact on willingness of the customer to pay for the product. The second category is transportation information that is important from the shipping and material handling perspective. Information related to the quality attributes of the goods such as their weight or their specie is the third significant type of information for the customers and an important pricing factor.

Application of the smart goods with capability of auto-identification has a positive effects on different activities carried out in the supply chains for fresh foods. Such activities include different logistics operations, activities related to control the quality of the transported fresh food and management of the assets and resources used for transportation such as the crates. Buying and selling activities are affected by using the smart goods in the fresh foods supply chains. The most important negative effects of application of the smart goods is related to its costs of implementation for some of the actors in the supply chains.

Studying application of the smart goods with higher levels of smartness, for example by using sensors that can record different information regarding the physical characteristics of the goods, is an interesting subject for further research on this area.

In recent years there has been a significant interest for actors of the supply chains to decrease the environmental side effects of their operations. Studying the applications of the smart goods for this purpose is an interesting subject for research in the future.

According to the empirical studies, currently no international standard is used for labeling of the items through the supply chains in specially fish industries. Developing such standards to be followed by different actors of the fresh food supply chains is suggested by the authors as a solution to improve efficiency of the supply chain operations.

This paper is contributing to the literature written on the smart goods and traceability in food supply chain by studying three supply chains in form of a cross case analysis.

Different actors of the supply chains of fresh food can use this study for having a better vision of how to implement smart goods for traceability of products. The advantages and disadvantages related to application of the smart goods generated in this paper are used as a decision support for implementation of the smart goods.

REFERENCES


